Human skeletal remains from Kimberley: an assessment of health in a 19th century mining community

by

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Declaration

I declare that the dissertation that I am hereby submitting to the University of Pretoria for the MSc degree in Anatomy degree is my own work and that I have never before submitted it to any other tertiary institution for any degree.

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_____ day of ________________2007

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Abstract

In April 2003 the Sol Plaatjie Municipality disturbed several unmarked graves while digging a storm-water trench next to what is today known as the Gladstone Cemetery in Kimberley, South Africa. They are believed to date to between 1897 and 1900. All remains were excavated and housed at the McGregor museum in Kimberley where they were investigated. The purpose of this study was to analyze and interpret the health status and diseases present within this sample, and to determine whether bone lesions caused by ossified haematomas and treponemal infection can be diagnosed through histological investigations.

Standard anthropometric techniques were used to determine the age and sex of the individuals. All bones were assessed for signs of trauma and pathology present on the bones, and histological bone samples were prepared according to a method described by Maat (2002).

A total of 107 individuals were investigated, comprising of 86 males and 15 females. The remains were mostly those of young persons, with the majority being younger than 30 years of age. A wealth of pathology was observed with skeletal lesions indicating advanced treponemal disease, scurvy, non-spesfic osteomyelitis, several amputations, cranial fractures and osteoarthritis. A high incidence of dental caries, antemortem tooth loss and periodontal disease were also noted.

The remains studied were those of migrant workers, of low socio-economic status, mainly consuming a diet consisting of refined carbohydrates lacking vitamin C. A high prevalence of degenerative changes and cranial fractures suggested participation in regular strenuous physical activities and a high incidence of interpersonal violence. The high incidence of infectious diseases was ascribed to the poor living conditions as well as limited medical care. Surgical procedures were conducted regularly as could be extrapolated from the high incidence of amputations. It was also concluded that a distinction could be made between bone reactions resulting from of haemorrhage and lesions caused by an infectious condition, on histological level. Three stages of ossified haematoma development and remodeling were described. It is hoped that this study gave some recognition to those so unceremoniously dumped in these pauper graves.

Abstrak

Tydens die grawe van 'n stormwatersloot in Kimberley, Suid-Afrika, het die Sol Plaatjie munisipaliteit verskeie ongemerkte grafte langs die Galdstone begrafplaas versteur. Die grafte dateer tussen 1897 en 1900. Alle skelet materiaal is opgegrawe en gestoor by die McGregor museum in Kimberley vir ondersoek.

Die doel van hierdie studie is om die gesondheidsstatus en siektes teenwoordig in hierdie populasie te beskryf en om vas te stel of dit moontlik is om op histologiese vlak te onderskei tussen beenletsels wat veroorsaak is deur sifilis of geossifiseerde subperiosteale hematome.

Standaard antropometriese tegnieke is gebruik om die ouderdom en geslag van die individue te bepaal. Alle skelette was ondersoek vir enige tekens van trauma of patologie. Histologiese been monsters was voorberei volgens die voorskrifte van Maat (2002).

'n Totaal van 107 individue, waarvan 86 manlik en 15 vroulik was, was teenvoordig. Die skelette was oor die algemeen die van persone jonger as 30 jaar oud. Verskeie patologiese letsel is opgemerk, onder andere letsels moontlik veroorsaak deur sifilis, skeurbuik, osteomiëlitis, amputasies, skedelfrakture en osteoartritis. Tandkaries, antemortem tandverlies en periodontitis is ook opgemerk.

Die skelette was die van trekarbeiders. Hul was van 'n lae sosio-ekonomiese klas en was op 'n dieet wat hoofsaak uit verfynde koolhidrate betaan het. Degeneratiewe verandering in gewrigte en skedelfrakture was algemeen sigbaar en is toegeskryf aan gereelde deelname aan swaar fisiese aktiwiteite en geweld. Die teenwoordigheid van letsels veroorsaak deur gevorderde infektiewe toestande, soos sifilis, is toegeskryf aan die beperkte mediese sorg verkrygbaar gedurende die 19de eeu asook die slegte lewensomstandighede waarin hierdie persone gewoon het. Die hoë voorkomssyfer van amputaties het daarop gedui dat chirurgiese prosedures gereeld uitgevoer is. Daar is ook vasgestel dat daar wel op histologiese vlak onderskeid gemaak kan word tussen geossifiseerde hematome en infektiewe been reaksies, en drie vlakke van been hermodellering is geïdentifiseer.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Palaeopathology is defined as the study of disease in antiquity, in both humans and non-humans (Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003). It gives insight into the evolution of disease and how humans adapt to change (Mann & Murphy, 1990; Roberts & Manchester, 1995). Skeletal and mummified remains as well as ancient documents and illustrations are investigated as sources of information (Mann & Murphy, 1990; Roberts & Manchester, 1995; Anderson 1997; Ortner, 2003). The study of palaeopathology is generally a reconstructive discipline and it has two fundamental goals: firstly the measurement and reconstruction of health and health differences in ancient populations, and secondly the interpretation of these differences (Wood et al., 1992).

The early publications of palaeopathology dealt mainly with describing abnormalities encountered by early scientists against the background of normal anatomy. Little attention was given to the biological or pathological significance of lesions being described (Ortner, 2003). The first biological discussion on the origin and history of a certain pathological condition, was the question of the origin of syphilis, which started at the end of the 19th century. With the turn of the century came more questions and publications dealing with the incidence of diseases within populations and its significance (Mann & Murphy, 1990; Ortner, 2003).

As is the case in any scientific discipline, certain limitations can be identified in the study of palaeopathology. Firstly, historical documents are often imprecise in their description of symptoms and characteristics of diseases in past populations. It should also be considered that the skeletal manifestation of disease can be influenced by various factors such as evolutional, cultural, biological and environmental factors (Ortner, 2003). Therefore, diseases in antiquity might have been very different from what is observed today. Throughout the development of palaeopathology as a discipline, several problems occurred in both theory and methodology (Ortner, 2003).

It is thus evident that the context of the remains investigated in any palaeopathological study is extremely important. This includes the period in which the individuals lived, as well as the geographical context (Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003). Even more important is a clear description of the pathological lesions and diagnosis of the conditions encountered in archaeological remains (Ortner, 2003).

Palaeopathological studies were initially done by physicians, who had little knowledge of archaeology, and more recently by biological anthropologists, most of whom have limited experience with pathology (Ortner, 2003). This caused crucial shortcomings in the palaeopathological literature: some valuable pathological evidence was attributed to the wrong time period by individuals with little knowledge of archaeological dating, and on the other end of the spectrum, insufficient knowledge of pathology and medical terminology led to incorrect diagnosis of some conditions.

The specific diagnosis of pathological conditions is often problematic, due to the similarity in skeletal manifestation of different diseases (Ortner, 2003). Bone can only react in three ways when affected by a pathological condition: resorbtion of bone can occur, new bone can be deposited or a combination of both resorbtion and deposition can be seen (Mann & Murphy, 1990). It has thus been suggested that specific diagnosis of disease should be avoided and that broader, more inclusive categories of diseases should be used (Miller et al., 1996; Ortner, 2003). It has been shown by Miller et al. (1996) that diseases could be more accurately diagnosed when they were merely assigned to a category, such as infectious or proliferative, than when specific diagnosis was made. It was accordingly suggested that consistency in data collection will increase comparability between palaeopathological study populations (Miller et al., 1996).

Another inherited methodological problem in the study of palaeopathology in archaeological remains is that of incomplete skeletons (Mann & Murphy, 1990; Roberts & Manchester, 1995). It is well known that certain pathological diseases manifest only in specific skeletal elements, such as rheumatoid arthritis mainly affecting the hands and feet and the presence of possible tuberculosis being primarily identified by the presence of Pott's disease of the vertebrae (Mann & Murphy, 1990). It is therefore obvious that the identification of pathological conditions is dependent upon the completeness of the skeletal remains (Mann & Murphy, 1990; Roberts & Manchester, 1995). Unfortunately, archaeological remains are rarely complete. It is therefore clear that poor skeletal preservation will cause an underestimation in the incidence of pathological conditions in the once living population (Mann & Murphy, 1990; Roberts & Manchester, 1995).

Apart from these methodological shortcomings, certain problems regarding the theoretical arguments have also been identified (Wood et al., 1992). It is generally accepted that a direct association exists between the incidence of certain pathological lesions and the pathogen load and incidence of the specific disease in archaeological populations (Ortner, 2003). It is accordingly suggested that an increase in the frequency of a specific type of skeletal lesion can be interpreted as being indicative of an elevation in the risk of being affected by the condition that produces the lesion (Wood et al., 1992).

According to Wood et al. (1992), however, the relationship between the frequency of lesions and the incidence of the causative disease within archaeological populations are not that simple. The first theoretical problem identified by them is that of selective mortality. According to Wood et al. (1992) the assessment of the distribution of specific pathological conditions are biased by the fact that the only individuals investigated in a skeletal series are those that actually died (Mann & Murphy, 1990; Wood et al., 1992; Roberts & Manchester, 1995). Individuals who survived the disease are thus not investigated, and consequently, no matter how large the sample being investigated, it will never be truly representative of the living population (Wood et al., 1992). Due to this inherited selectiveness of a skeletal sample, the observed frequency of pathological conditions is normally an overestimate of the true incidence of the conditions in the larger population.

A second theoretical problem deals with the presence of skeletal lesions and its association with general health (Wood et al., 1992). It is well known that only traumatic events, such as a fracture or gunshot wound, as well as chronic diseases lead to the formation of lesions on the skeleton (Mann & Murphy, 1990; Roberts & Manchester, 1995; Steyn & Henneberg, 1995b; Ortner, 2003). In order for skeletal lesions to heal, or diseases to be chronic, the individual has to survive the traumatic event or the initial onslaught by the pathogen (Wood et al., 1992; Steyn & Henneberg, 1995b). For example, a person who acquires venereal syphilis and passes away shortly after acquiring the condition, be it due to the syphilis or another disease, will show no skeletal evidence of the disease in question. On the other hand, should an individual suffer from venereal syphilis, but survive the condition for several years, skeletal evidence of the condition may manifest. It has been shown that only approximately 5% of those infected present with bone changes.

It is accordingly suggested that individuals presenting with healed traumatic lesions and evidence of chronic disease were most likely generally in good health and at a lower risk of death (Wood et al., 1992; Ortner, 2003). It is thus suggested that an immune system of intermediate strength needed to be present in individuals presenting with skeletal lesions, especially those indicative of infection (Ortner, 2003). The immune system was thus strong enough to prevent the individual from dying as a result of the disease, but not strong enough to eradicate the pathogen (Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003).

For those individuals showing no evidence of pathological skeletal lesions, three possible scenarios exist: Firstly, the individual may have died from a disease that does not cause skeletal changes (Mann & Murphy, 1990; Roberts & Manchester, 1995). A second possibility is that death occurred before its associated skeletal lesions could manifest, or thirdly, the immune system of the individual was strong enough to eliminate the disease before skeletal lesions could develop (Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003). Determining which of these scenarios is applicable to a seemingly, "healthy" skeleton is normally impossible (Mann & Murphy, 1990; Roberts & Manchester, 1995; Ortner, 2003).

Nevertheless, the study of palaeopathology is still important in the study of human diseases through time. It should be kept in mind, though, that it is extremely difficult to infer the general health characteristics of a once living population from an archaeological sample (Wood et al., 1992; Steckel et al., 2002). According to Goodman (1993) and others, many of these theoretical issues can be overcome by not investigating pathology as a single entity, but rather to integrate pathological evidence with the demographic composition of the sample population, archaeological findings and historical records (Steckel et al., 2002). By comparing the incidence of pathological lesions within the archaeological samples being studied to well-documented medical collections, some conclusions about health might be possible (Wood et al., 1992).

Diagnostic error should always be considered and therefore the clear description of pathological lesions and their distribution is of great importance (Ortner, 2003). Care should also be taken not to draw unjustifiable conclusions from skeletal manifestations of disease in the study population (Steckel et al., 2002; Ortner, 2003). It is thus evident that accurate differential diagnosis of pathological lesions is fundamental to the study of palaeopathology.

1.2 PURPOSE OF THE STUDY

In April 2003 the Sol Plaatjie Municipality disturbed several unmarked graves while digging a storm-water trench next to what is today known as the Gladstone Cemetery in Kimberley, South Africa. The graves are believed to date from 1897 to 1900. All the remains were excavated and housed at the McGregor museum in Kimberley, where they were investigated by the researcher.

The purpose of this study was firstly to analyze and interpret the health status and diseases present in the skeletons of a 19th century mining community from Kimberley, based on palaeopathological observations.

In order to interpret the incidence of pathological conditions within this sample, a general description of the skeletal remains will be done with regards to age, sex and stature of each individual. Attention will be given to signs of pathology observed on the bones, with special reference to those suggesting infectious disease, scurvy, trauma and enthesopathies indicating possible regular participation in strenuous physical activities. Dental health of the sample will also be described and all dental pathology as well as indications or normal variation recorded.

The incidence of all pathological conditions observed in the Gladstone population will be compared to other skeletal studies from South Africa as well as other countries. Diseases observed in this study will also be interpreted in relation to archival documents describing the health of mine labourers in 19th century Kimberley, as well as hospital records reporting the incidence of certain pathological conditions during this period. Although numerous historical documents are available describing Kimberley in the 19th century, very little is known about the lowest class of mine labourers during this time period. Therefore, this study will give valuable insight into a relatively unknown group of people.

It has been shown that skeletal lesions caused by spesific pathological conditions can be accurately diagnosed on the bases of their histological characteristics (Schultz, 2003; Von Hunnius et al., 2006). A high incidence of pathological conditions, especially diseases such as treponematosis and scurvy causing lesions on the anterior tibiae, were present in this sample. Since lesions on the anterior tibiae are often ambiguous on a macroscopic level, a decision was made to employ microscopic investigation in order to: firstly, test the methods available in cases where a reliable diagnosis could be made on a macroscopic level and secondly, to improve the accuracy of diagnosis of these lesions based on their histological characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1 KIMBERLEY IN THE LATE 19TH CENTURY

2.1.1 The discovery of diamonds in Kimberley

By the time diamonds on Colesberg Kopje were discovered, it was already well established that it was located in diamondiferous surroundings. Several diggings were by that time, taking place at Du Toits Pan, Bultfontein and the Vaal River. Many stories are told about the discovery of Colesberg Kopje, today known as the "Big Hole" in Kimberley, but only two of these seem plausible. The first is that it was discovered by Sarah, Albert Ortlepp's wife. She claimed that in 1871, she and her family went on a Sunday afternoon walk to the hilltop. When they came to the top of the hill, they sat down under a tree, and most likely out of habit, Sarah starting "sifting the surface gravel through her fingers" (Roberts, 1976: 46). She found a diamond, and her family kept it safe and strangely secret. The second story states that a person by the name of Fleet Rawstorne had a Cape Coloured servant, Damon, who had a habit of drinking too much and misbehaving. Consequently Damon was sent away from the Red Cap digging party digging somewhere near Colesberg Kopje, with only a few cooking utensils and food, and instructed to go do some digging on the hill (Roberts, 1976). He returned a few nights later with two or three diamonds, which he claimed he discovered on Colesberg Kopje. That same night, all men in the camp rushed to the hilltop and started marking claims in the dark.

The discovery of Colesberg Kopje had a huge effect on people at the surrounding diggings. Many people came rushing to mark their claims, and by the beginning of August 1871, approximately 800 claims had been cut out of Colesberg Kopje and between 2 000 to 3 000 men were working there (Roberts, 1976). Little did they know that Colesberg Kopje was soon to become Kimberley, the first large inland settlement in

South Africa to be developed away from a natural water source. It was the first town to be totally dependant on the mineral wealth of South Africa, the first place to experience a strike, as well as the first town in South Africa to have its streets lit by electricity (Roberts, 1976).

2.1.2 Health care facilities at the diggings

South Africa's diamond industry took off when O'Reilly discovered a diamond on the banks of the Orange River near Hope Town in 1867. From all over the world, people came to South Africa in the search of quick fortune. The first diggings were on the banks of the Vaal River, near where Barkly West is situated today, and by 1870 there was a tent town with approximately 7000 people. Diamonds were also discovered on the surrounding farms, such as Du Toits Pan and Bultfontein and later Colesberg Kopje (Kretsmar, 1973).

Thousands of people were digging in extremely dry surroundings, without any natural water and no proper waste disposal, resulting in contamination of the few wells they had dug. It is therefore not surprising that epidemics, especially one they identified as "camp fever", spread through the camps. Camp fever is described as "a combination of malaria, typhus, typhoid, dysentery, tuberculosis, syphilis, gonorrhoea, measles, chickenpox, smallpox, pneumonia and other common garden infections" (Kretsmar, 1973: 156). It seems that without proper knowledge of medical conditions, any illness was termed "camp fever". There were no qualified medical personnel and families relied on motherly care for their health, while Black labourers received attention from witch doctors and medicine men (Kretsmar, 1973).

The first doctor, Dr. B.W. Hall, came to the diamond fields in 1868 and settled on the Vaal River diggings, where he worked for seven years (Kretsmar, 1973). The second to arrive were Drs. Otto and Dyer, and in 1871, Dr. J.W. Matthews also came to Kimberley (Booth, 1929; Kretsmar, 1973). The first hospital was established in 1868, at the Vaal River diggings in Pniel. It was a stone building functioning until 1870, when it burned down. By then, most diggers had left for the dry diggings and there was no more need for the hospital (Kretsmar, 1973). A Roman Catholic priest, Father Hidien, established the first hospital at the dry diggings on Bultfontein in 1871 (Booth, 1929; Kretsmar, 1973). He erected a tent without any beds for patients and cared for the sick himself. Conditions were extremely unfit for attending to the sick and by the end of 1872, a new hospital with 26 beds and three qualified medical doctors were established, where patients could receive free medical care (Kretsmar, 1973). This hospital was situated where Kimberley Hospital today stands, and was known as the Diggers Central Hospital (Kretsmar, 1973; Roberts, 1976).

In 1974, another hospital was opened next to the Diggers Central Hospital. It was called the Provincial or Carnarvon Hospital and had 14 beds (Booth, 1929). These two hospitals later amalgamated to form the Kimberley Hospital (Booth, 1929; Roberts, 1976). Although both hospitals had trained doctors, there were no other medical personnel to help care for the patients (Kretsmar, 1973). Help eventually came in 1879, in the form of ladies and nurses of the sisterhood of St. Michael and All Angels. These nurses were headed by Sister Henrietta Stockdale (Booth, 1929; Kretsmar, 1973; Swanepoel, 2003). During this time, Kimberley Hospital was established as the largest regular hospital in the Cape and the best training school for nurses in the country (Kretsmar, 1973).

In 1883, the hospital experienced financial difficulties and the Cape Provincial Government introduced "Hospital Tax" (Booth, 1929). All natives had to pay one shilling per person per month. The hospital gradually recovered and grew and had wards for paupers, Blacks and paying patients (Swanepoel, 2003). It also included a nurses' home, maternity ward, tuberculosis ward as well as a "Native" surgical ward. By 1888, an average of 255 patients were being treated there monthly (Kretsmar, 1973).

2.1.3 Death and diseases in Kimberley Hospital

Many of the skeletons examined in this study presented with lesions indicating hospital procedures such as amputations. Therefore, hospital statistics and procedures will be discussed briefly, with special attention to hospital practices between 1897 and 1900.

By 1880, Kimberley was, after Cape Town, the second largest centre in the Cape Colony (Burrows, 1958; Swanepoel, 2003). Mortality rates were very high due to the poor sanitary conditions. In 1888 alone, a total of 1 638 African and Coloured individuals died in Kimberley Hospital (Mayor's Minutes, 1888). The main causes of death, as described by the mayor's minutes, were pneumonia, fever, convulsions and bronchitis (Mayor's Minutes, 1888).

In 1890, a total of 321 operations were performed under anaesthetics, of which 124 were performed on Black patients. Twenty-one of the patients who received operations died (Cape of Good Hope Votes and Proceedings of Parliament, 1890; Swanepoel, 2003). During the 1890's, less Black individuals were admitted to Kimberley Hospital due to the opening of a hospital by the De Beers Company for its labourers (Swanepoel, 2003).

In 1892, 1 513 Black persons were admitted, of which 344 died (273 males and 71 females). The most likely causes were pneumonia (94 deaths), pulmonary tuberculosis formerly referred to as phthisis (57 deaths), camp fever (26 deaths), typhoid fever (14 deaths) and fractured skulls (8 deaths) (Cape of Good Hope Votes and Proceedings of Parliament, 1893; Swanepoel, 2003).

In 1897, 2 653 patients were admitted to Kimberley Hospital, of which 1 855 were Black, with an average of 116.13 patients per day. Of the treated patients, 380 died. A total of 98 of these individuals died within the first 24 hours of admission (Cape of Good Hope Votes and Proceedings of Parliament, 1898). A list of the main diseases treated as well as the resulting deaths throughout 1987 can be seen in Table 2.1. The most frequently treated disease was "zymotic diseases", and it resulted in 186 deaths (21.5% of admissions with the condition) (Cape of Good Hope Votes and Proceedings of Parliament, 1898). Zymotic disease is a name used to describe contagious diseases. According to the Oxford Medical Dictionary (2002), these diseases were previously thought to develop inside the human body following an infection, in a process similar to the growth of yeast. A total of 354 patients were admitted for dietetic diseases, which probably included scurvy, and 11 (3.1%) died (Cape of Good Hope Votes and Proceedings of Parliament, 1898). Constitutional diseases, which most likely referred to inherited disorders, diseases of the respiratory system and diseases of bones and joints were also observed, to name but a few (Cape of Good Hope Votes and Proceedings of Parliament, 1898). Injury and violence (as it was termed in historical documents), brought 322 patients to the hospital, of which 16 died. In addition, 191 minor assaults were also treated (Cape of Good Hope Votes and Proceedings of Parliament, 1898).

Although it is unclear exactly how the different diseases were catagorized it was stated that spesific diseases such as Tuberculosis (referred to as phthisis), claimed 94 lives and pneumonia caused the death of 63 Black individuals (half of those admitted with the disease) (Cape of Good Hope Votes and Proceedings of Parliament, 1898).

A total of 311 patients with scurvy were admitted to hospital. According to the report, this could have been prevented if "employers [were] properly feeding their men" (Cape of Good Hope Votes and Proceedings of Parliament, 1898: D2). It was also stated that due to the neglect of the employers, it became the hospital's responsibility to cure the malnourished natives employed in the mines (Cape of Good Hope Votes and Proceedings of Parliament, 1898). "Native" workers in Kimberley were mainly given a diet consisting of maize meal and occasional coarse meat. To make things worse, the hot and dry climate in Kimberley made naturally occurring fresh fruit and vegetables hard to come by and cultivation difficult (Roberts, 1976). The diets of these individuals were thus normally high in carbohydrates, low in animal proteins and low in fresh fruit and vegetables (Grusin & Samuel, 1957; Seftel et al. 1966).

During 1898, 2 613 patients were admitted to Kimberley Hospital, of which 1 875 were Black. This was 20 more than in 1897. Four-hundred-and-nine of the individuals admitted to hospital died (Cape of Good Hope Votes and Proceedings of Parliament, 1899). Several improvements were done at the hospital during this year. It included a new "Native medical ward", and a bathroom and kitchen was added to the existing ward for Black women and children. The veranda of the "Native surgical ward" was also paved with asphalt (Cape of Good Hope Votes and Proceedings of Parliament, 1899).

The high death rate recorded for 1898 was ascribed to Black individuals suffering from pneumonia being brought to the hospital only after their disease had progressed into an extremely serious condition. The main classes of diseases treated during the year can be seen in Table 2.2. Zymotic diseases were again treated most frequently and resulted in 196 deaths (21.9% of admissions), 10 more than the previous year. A total of 185 more patients than in 1897 (n = 539) were admitted to hospital with dietetic diseases (Cape of Good Hope Votes and Proceedings of Parliament, 1899). An increase in the number of patients with respiratory diseases was also noted, with 47 more being admitted and a total of 104 patients dying (35.9% of admissions).

More Black labourers were admitted with pneumonia than in 1897 and 80 passed away (17 more than the previous year). As many as 16.5 Black individuals per a 1000 died due to pneumonia in 1898. According to a report by the Officer of Health, pneumonia was responsible for more than 25% of deaths recorded in Kimberley, many patients never making it to Kimberley Hospital. The majority of these deaths occurred in the mine compounds, where it was responsible for two thirds of all deaths (Stoney, 1900a). Tuberculosis was diagnosed in 185 patients, in contrast to only 158 in 1897, with 117 deaths (63% of all individuals diagnosed), which is extremely high. According to the Officer of Health, "the natives appear to be especially susceptible to the disease" (Stoney, 1900a: 7). Due to the high incidence of patients treated for tuberculosis, it was requested that a special ward be built for the treatment of these individuals. This would increase the amount of beds available for these patients, and would also be in the favour of individuals admitted to hospital with other diseases, since they were all at that stage in the same ward infecting one another (Cape of Good Hope Votes and Proceedings of Parliament, 1899).

Due to the high incidence of infectious disease in the population and the spreading thereof, it was made compulsory, from the first of January 1898, to report all cases of infectious diseases to the local authority. A total of 192 reports were received, including eight cases of probable small-pox, which turned out to be either syphilis or chicken-pox, two cases of puerperal infection, three cases of leprosy, 30 of scarlet fever, 27 cases of diphtheria and typhoid, which was by far the most prevalent with 116 cases being reported. Typhoid was found to be most prevalent during the summer and autumn seasons, with almost no reports of the disease during the winter months (Stoney, 1900a).

In 1899, a total of 2 587 patients was admitted to Kimberley Hospital, of whom 1 638 were Black (Cape of Good Hope Votes and Proceedings of Parliament, 1900). This was 237 less than the previous year. The decrease in the number of Black patients treated in the hospital was due to an increasing need for beds for Europeans that were wounded during the siege in the last three months of 1899 (Stoney, 1900b). Consequently, a larger number of Black individuals were treated by the compound hospitals (Cape of Good Hope Votes and Proceedings of Parliament, 1900; Booth, 1929). The siege of Kimberley formed part of the second Anglo-Boer war between the Boers and the ruling British authorities in South Africa. The Boers besieged Kimberley between October 1899 and January 1900, and demanded its unconditional surrender. Reluctance by the British authorities to comply with this demand resulted in the death of 48 per thousand white, and 138 per thousand black individuals, mainly as a result of malnutrition and disease, but also due to war injuries (Roberts, 1976).

The various classes of diseases treated during 1899 can be seen in Table 2.3. Infectious diseases were again at the top of the list, reaching a record high of 979 cases admitted and 169 deaths (17.3% of admissions). It can also be seen that a total of 330 patients were treated for injuries and violence. This high incidence can probably be ascribed to the injured soldiers treated in Kimberley Hospital during the siege (Cape of Good Hope Votes and Proceedings of Parliament, 1900). Although no exact numbers were given for the diseases, it was reported by the Senior House Surgeon that "both phthisis [tuberculosis] and syphilis are playing havoc among the coloured races" (Cape of Good Hope Votes and Proceedings of Parliament, 1900: 42). Furthermore, a decrease was seen in the number of individuals affected by pneumonia (n = 92), as well as scurvy (n = 292), with the majority of these cases admitted to hospital in the last few months of the year when fresh fruit and food in general was relatively hard to come by due to the siege (Cape of Good Hope Votes and Proceedings of Parliament, 1900). A total of 52 deaths resulting from scurvy were registered (Stoney, 1900b).

In general, the main cause of death in 1899 can again be attributed to pneumonia, diarrhoea, tuberculosis, dysentery, scurvy, accidents and warfare. Many of the individuals affected by these conditions never made it to hospital (Stoney, 1900b). As was seen in 1898, the majority of deaths resulting from pneumonia came from the compounds, with up to 14.7 individuals per a 1 000 dying of the condition. This is extremely high, taking into consideration that pneumonia only affected 1.04 individuals per 1 000 in the White population. Tuberculosis still proved to be a problem among the Black individuals, especially in the compounds, with up to 7 individuals per 1 000 being infected with the disease. A total of 310 infectious diseases were reported to the authorities, 118 more than the previous year (Stoney, 1900b). Eighty-six of these cases were among the Black population in Kimberley. Scarlet fever was reported in five Black individuals and 77 Whites. Fifty-one cases of diphtheria were reported, of which 34 were in European and 17 in Black individuals, as well as 172 cases of enteric fever (112 White and 69 Black persons), 37 cases of measles (12 Europeans and 25 Black children) and 11 cases of whooping cough (Stoney, 1900b). Despite the siege, which commenced in October 1899, there seems to be little change in the incidence of deaths due to violence when compared to the previous year. When considering that a large number of patients were being treated at the compound hospitals during this period, it is plausible that the number of individuals treated at the Kimberley hospital only represents a small portion of the injured.

In 1900, the strain of the siege on the Kimberley Hospital was still present in the first few months of the year. An extremely large number of White military patients were being treated. Black individuals were mainly treated in the compound hospitals in order to increase the number of beds available in Kimberley Hospital for military individuals (Cape of Good Hope Votes and Proceedings of Parliament, 1901; Booth, 1929).

In 1901, the condition at Kimberley Hospital had eventually been restored to normal after the siege and statistics of patients being treated were comparable to those seen in 1898 and 1899 (Cape of Good Hope Votes and Proceedings of Parliament, 1902). Of interest was the treatment of 164 cases of syphilis among Black individuals (Cape of Good Hope Votes and Proceedings of Parliament, 1902).

2.1.4 Demographic background

A census was held in 1898 and it was established that there lived approximately 14 500 Europeans and 26 500 Black persons (of which 8 800 were in mine compounds, the convict station and goal) lived in Kimberley (Stoney, 1900a). This census did not include Black labourers in the Wesselton village, Wesselton, Kamfersdam and Otto's Kopje compounds.

A total of 1 240 births were registered for this year, with 664 of these infants being Black, and it was also stated that "more than half (369) [of these births] were not ... legitimate" (Stoney, 1900a: 4). According to the annual report of the Medical Officer of Health in 1898, the low birth rate of Black infants can be ascribed to the high number of Black males "living under restrictions in compounds" (Stoney, 1900a: 4).

A total of 1 787 deaths were registered for 1898, of which almost two thirds were Black males. The extremely high death rate of "Native" individuals within Kimberley was of great concern. Mortality rates were the highest in the first two years of life, and between the ages of 15 and 45 years (Stoney, 1900a).

The infant mortality rate was also extremely high. More than half of the Black infants (628/1000) died before the age of two years. In comparison, only 251 infants per 1 000 died within the first two years of life in the White community. Most infant deaths were the result of diarrhoea. This was mainly ascribed to poor sanitary conditions, improper feeding and neglect (Stoney, 1900a).

A census in 1899 indicated that there were approximately 16 300 Europeans and 28 200 Black individuals in Kimberley. A total of 580 Black infants were born, 84 less than in 1898. The birth rate was calculated to be 24.7 births per 1 000 individuals, which was very low (Stoney, 1900b). As in the previous report, the low birth rate was again attributed to Black male labourers under strict supervision in the mine compounds, convict stations and goals.

A total of 1 899 deaths were registered in 1899, 112 more than in 1898. The majority of individuals passed away during the hot summer months, with only a few individuals dying in the cool winter season. Thirty percent of deaths were recorded in the last two months of the year, when Kimberley was under siege, the main causes being infantile diarrhoea and scurvy. Four fifths of all Black deaths registered were male. The death rate for Black individuals was calculated to be 53.1 deaths per 1 000 individuals, which is extremely high. Revised calculations, excluding deaths in the months of the siege, were estimated to be 44.9 deaths per 1 000 individuals. This is still extremely high considering that the White death toll for the same period was estimated at approximately 17 deaths per 1 000 individuals (Stoney, 1900b). An extremely high infant mortality rate was again reported, with more than half of the Black infants passing away within the first two years of life.

2.1.5 Environmental and housing conditions

According to a report by the Medical Officer of Health in 1898, accommodation facilities for Black individuals were extremely unsatisfactory. "The huts [were] clustered together ... vacant spaces between the huts [were] used as rubbish heaps ... [and] the huts themselves [were] frequently very dirty and overcrowded, the average number of persons to each hut being over six" (Stoney, 1900a: 9). He also reported the complete absence of sanitary arrangements, with drinking water from wells constantly being contaminated by surface water and dust.

In 1899 it was proposed that all native locations be demolished and the inhabitants moved to a single, central location. According to the Officer of Health, these locations would have "properly constructed dwellings... and adequate sanitary accommodation" (Stoney, 1990b: 13). He suggested that "under strict supervision, accumulations of filth, overcrowding of dwellings and other unsanitary conditions, which characterize [the] present locations, will be prevented" (Stoney, 1900b: 13).

2.1.6 Compounds

When mining activities commenced in Kimberley, all Black labourers were given accommodation and food by their employers and were free to walk around town at will. However, in 1885 a decision was made that all Black labourers should be confined to closed camps (compounds) for the duration of their contracts at the mine. Several reasons were put forward for this confinement: They would be isolated from unlawful diamond buyers, and this in turn would reduce the amount of diamonds stolen from the mine. They would also not have access to canteens in Kimberley and will accordingly be fit for work each day (Roberts, 1976). Food would furthermore be provided to all persons in the compounds, which was sure to benefit their health.

The first compound was opened in April 1885 with a gala occasion, and inspection by the public was invited. The compounds consisted of a "large yard some 150 yards square enclosed partly by buildings and the remainder by sheets of iron 10 feet high, a magnificent kitchen and pantry, large baths, guard room, dispensary and sick ward, stores and mess rooms" (Roberts, 1976: 231).

By 1891, 10 compounds housing 5 231 Black labourers could be found in the Kimberley district (Leary, 1891). The compounds were still described to be beneficial to the labourers supplying food, education, medical treatments and spiritual guidance to all

(Barnes, 1895; Leary, 1891). No liquor was allowed in the compound, which according to Leary (1891), was the main reason for robbery and assaults among Black individuals outside the compounds (Barnes, 1895).

Although the compounds were developed in order to limit the need for searching of individuals working in the mine and to provide the Black labourers with proper housing and adequate nutrition, conditions in the compounds were poor (Jovhelson, 2001). After reporting the extremely high death rate of individuals affected by pneumonia in 1899, the Officer of Health made the following statement: "there will be little decrease in the disease until compounds are extended and remodelled, with a considerable increase in the air-space and lighting of the sheds, and with floors made of some impermeable material. So long as the compound sheds continue to be overcrowded, with many dark corners and permeable floors..., so long will these diseases continue to be prevalent" (Stoney, 1900b:6).

2.1.7 Gladstone cemetery

The Gladstone cemetery was officially opened on the 24th of March 1883. It is clearly stated in archival documents that half of this ground was devoted to native burials. Nearly 5000 "Native" individuals were buried at Gladstone cemetery between the June 24, 1887 and the November 28, 1892. Unfortunately, no registers were available for the period between 1892 and 1900. Some documents only indicated that a total of 611 burials also took place between February and June 1900. All paupers who died in hospitals were buried wrapped in blankets, without coffins (Swanepoel, 2003).

In 1897, the cemetery was enlarged with an extra strip of land given by De Beers on the east side of the cemetery. It is exactly here where the trenching by the Sol Plaatjie municipality in 2003 started that uncovered the graves being investigated in this study. The cemetery was closed in mid-1900, and opened again in April 1902 for European internments only.

2.2 PALAEOPATHOLOGY: MACROSCOPIC INDICATIONS OF DISEASE

2.2.1 Introduction

General knowledge of normal osteology and its variations are essential for the investigations of pathological conditions and the diagnosis thereof (Mann & Murphy, 1990). According to Ortner (2003), chronic pathological conditions can manifest on bones in five different ways: Abnormal bone formation, abnormal bone destructions, abnormal bone density, abnormal bone size and finally abnormal bone shape. The expression of pathological conditions on bone can manifest as one or a combination of the above (Ortner, 2003). Abnormal bone formation, density, size and shape can always be associated with antemortem pathological conditions, whereas abnormal bone destruction can be due to either antemortem diseases, perimortem or postmortem damage (Mann & Murphy, 1990; Ortner, 2003). Distinguishing between antemortem disease and pseudopathology can often be problematic. Pseudopathology is caused by environmental factors such as soil composition, temperature, water, insects or excavation techniques (Ortner, 2003).

Pathological lesions can be diagnosed through visual assessment of the skeleton, radiographs, microscopic examination of the lesions as well as through chemical and histological analyses of the bone (Mann & Murphy, 1990; Ortner, 2003). Due to an often present limit in time and financial resources, visual assessment of lesions present on bone are normally the method of choice (Ortner, 2003).

Determining the exact cause of skeletal lesions is often problematic, due to the similarity of skeletal manifestation of different pathological conditions. In such cases, the features and distribution of such lesions should be described in detail and specific diagnosis should be avoided (Ortner, 2003).

2.2.2 Infectious diseases

2.2.2.1 Introduction

Infectious disease has been an important factor in natural selection in human evolution and has influenced the development and fall of many civilizations (Steinbock, 1976; Roberts & Manchester, 1995; Steckel et al., 2002;Ortner, 2003; Tayles & Buckley, 2004). It is unfortunate that only a few of these diseases leave identifiable skeletal lesions, since this is most often the only means available to study diseases in past populations (Steinbock, 1976; Tayles & Buckley, 2004). The presence and virulence of pathogens is dependant on human culture, human biological adaptation, as well as population size and density. It thus explains why the development of agriculture, migration of populations as well as the expansion of trade between various population groups have such an important influence on the spread as well as maintenance of infectious pathogens (Tayles & Buckley, 2004). Various infectious diseases have been studied in past populations, among them treponemal disease, osteomyelitis and tuberculosis. These will be described in more detail in the following paragraphs.

2.2.2.2 Treponemal disease

The history, origin and spreading pattern of treponematosis is one of the most disputed issues in the medical sciences (Meyer et al. 2002; Ortner 2003; Roberts & Manchester, 1995; Steinbock, 1976). Important questions are being debated, such as: where did the disease originate, how did it spread through the world and are the four different clinical manifestations of treponematosis caused by the same organism? (Reichs, 1989; Roberts & Manchester, 1995; Ortner, 2003). Also, do the variants of treponemal infection exhibit different skeletal manifestations?

Four theories regarding the spread of venereal syphilis exist, namely the Columbian, Pre-Columbian, Unitarian and Alternative Theory (Steinbock, 1976; Meyer et al. 2002; Rothschild & Rothschild, 1995). The Columbian theory states that Christopher Columbus carried syphilis to Europe in 1493 when he returned from the New

World (Steinbock, 1976; Reichs, 1989; Rothschild & Rothschild 1995; Meyer et al., 2002; Bouwman & Brown, 2005; Erdal, 2006). The lack of resistance against the new disease led to the immediate wide-spread infection of almost all European populations (Meyer et al., 2002).

According to the Pre-Columbian theory, syphilis was present in Europe even before Columbus and his crew returned from their voyage (Steinbock, 1976; Reichs, 1989; Meyer et al., 2002; Erdal 2006). It is said that the symptoms associated with syphilis were not distinguishable from other infectious diseases such as leprosy and therefore it was not identified as syphilis (Steinbock, 1976; Rothschild & Rothschild, 1995; Meyer et al., 2002). It is known that "leprosy" asylums were often built in the 12th and 13th centuries, to prevent the spread of the supposedly extremely contagious disease. However, it is known that leprosy is hardly contagious and has an extremely long incubation period, whereas the incubation period of syphilis is only a few days and this disease can spread through mere body contact (Steinbock, 1976).

The Unitarian or independent New and Old World Theory states that the four treponemal syndromes are not separate diseases and they are caused by the same organism (Steinbock, 1976; Rothschild & Rothschild, 1995; Meyer et al., 2002; Erdal, 2006). They are merely the result of different strains of the *Treponema pallidum* organism, each favouring different environmental and sociological conditions (Steinbock, 1976; Rothschild & Rothschild, 1995). It is thus suggested that venereal syphilis developed independently in each country or region from whichever strain of treponematosis was present in the surrounding areas (Rothschild & Rothschild, 1995; Meyer et al., 2002). For example, endemic syphilis might be present in a population living in hot, dry climates. In such conditions, people wear little clothes and skin-to-skin contact between individuals occurs often. Conditions are thus favourable for the spread of the disease. A rise in the level of hygiene and civilization within this population will decrease the chances of spread for the organism causing bejel, and it will consequently mutate into another form, such as the organism causing venereal syphilis, in order to survive.

According to the Alternative Theory, syphilis originated from tropical Africa. Contact with Africa occurred earlier than 1492, and it is suggested that it thus spread to Europeans and the rest of the world (Meyer et al., 2002).

Treponemal disease can be seen all across the world, and can manifest as one of four different clinical syndromes, namely yaws, bejel, syphilis and pinta (Hackett, 1978; Larsen, 1997; Meyer et al., 2002; Ortner, 2003). These conditions are caused by *Treponema pallidum pertenue, Treponema pallidum endemicum, Treponema pallidum pallidum* and *Treponema careteum* respectively (Roberts & Manchester, 1995; Larsen, 1997). All of these syndromes cause skeletal lesions, except for pinta (Mann & Murphy, 1990; Roberts & Manchester, 1995; Rothschild & Rothschild 1995; Larsen, 1997). The majority of scientists currently agree that each of these variants are caused by a different pathogen, and that these manifestations are limited to specific geographical areas, except for syphilis, which can be found worldwide (Steinbock, 1976; Antal et al., 2002; Meyer et al., 2002; Ortner, 2003).

Regions of the skeleton with little overlying soft tissue, such as the anterior tibiae and skull, are most often affected by the treponemes (Larsen, 1997; Ortner, 2003). It is proposed that the distribution of lesions caused by the various syndromes is so similar that it is impossible to distinguish between the variants based on skeletal evidence (Meyer et al., 2002; Ortner, 2003). Although differences in the skeletal manifestation of the syndromes do exist, the degree of overlap between the various syndromes is too big to support differentiation based on skeletal evidence (Hackett, 1978; Larsen, 1997; Meyer et al., 2002; Ortner, 2003). Osteological evidence to distinguish between the different strains of treponematosis was proposed by Hackett (1976) and Rothschild (1993). Although this criteria will be discussed in a separate section for each syndrome, it should be kept in mind that scientists such as Heathcote et al. (1998), have a critical view of these descriptions (Meyer et al., 2002).

The treponemes enter the body through the skin or mucous membranes and then spread through the body via the circulatory system (Larsen, 1997; Ortner, 2003). Yaws occurs primarily in the tropics and bone lesions are often observed, with between 5 -15% of affected individuals showing skeletal involvement (Antal et al., 2002; Meyer et al., 2002; Ortner, 2003). The disease spreads through direct contact with the secretions of cutaneous lesions (Meyer et al., 2002). Yaws is often acquired during childhood, mainly between the ages of two and ten years, and the disease is therefore most active in children and adolescents (Meyer et al., 2002; Ortner, 2003). Osteological manifestations can be seen in the tertiary phase of the disease, which is normally about five to ten years after the individual came into contact with the pathogen (Meyer et al., 2002).

The tibiae are affected most often and lesions on the pelvis are rarely reported. It is described to be present in only 2% of cases (Roberts & Manchester, 1995; Meyer et al., 2002; Ortner, 2003). New bone formation on the anterior tibia results in it bowing anteriorly, resembling a sabre-blade (Meyer et al., 2002). Dactylitis of the phalanges, gummatous periostitis of the long bones, caries sicca of the skull as well as destruction of the nasal cavity and palate (gangosa), are typical skeletal lesions associated with yaws (Mann & Murphy 1990; Larsen, 1997; Antal et al., 2002; Meyer et al., 2002; Ortner, 2003). These lesions might be seen uni- or bilaterally. When yaws cause sabre-shin formation in children or adolescents, the condition may be referred to as "boomerang-leg" (Meyer et al., 2002).

Should the individual survive the disease, bony lesions can be remodelled, leaving no evidence of the infection on the adult skeleton (Ortner, 2003). Yaws cannot be distinguished from venereal syphilis by a difference in the osseous pattern of bone involvement, but it is suggested that quantitative differences do exist. Caries sicca is not often seen in yaws and should it be present, the lesions of cranial destruction are of a lesser extent when compared to venereal syphilis (Meyer et al., 2002).

Bejel, also known as endemic syphilis or treponarid, is mostly associated with dry regions such as the Middle East and Africa (Steinbock, 1976; Mann & Murphy, 1990; Roberts & Manchester, 1995; Antal et al., 2002; Meyer et al., 2002; Ortner, 2003). This condition is associated with populations exposed to overcrowding, unsanitary conditions and children wearing little clothes (Antal et al., 2002; Meyer et al., 2002). Children between the ages of two and ten years are mainly affected and the disease spreads through direct body contact with an infected person (Steinbock, 1976; Mann & Murphy, 1990; Meyer et al., 2002). Skeletal lesions of the tibia (saber-shin) and ulna are most often associated with this syndrome, with cranial lesions such as caries sicca, destruction of the nasal cavity and palate being relatively rare (Reichs, 1989; Roberts & Manchester, 1995; Larsen, 1997; Ortner, 2003).

Venereal syphilis, also known as acquired syphilis, is transmitted through sexual contact (Meyer et al., 2002). The condition can also be transmitted across the placenta to the foetus from the infected mother, and is then referred to as congenital syphilis (Steinbock, 1976; Mann & Murphy, 1990; Roberts & Manchester, 1995; Larsen, 1997; Ortner, 2003; Erdal, 2006). Venereal syphilis is found world-wide and shows no preference for specific climatic conditions as is seen in yaws or bejel (Meyer et al., 2002). Taking the mode of transmission into account, it is not surprising that acquired syphilis mostly only manifests after sexual maturity has been reached. This syndrome can be divided into three distinct phases, namely primary, secondary and tertiary (Ortner, 2003).

The primary stage of infection commences a few weeks after the host came into contact with the pathogen and is characterized by the formation of a chancre (painless ulcer at the site where the infection entered the body) and the migration of the infectious organisms to regional lymph nodes (Ortner, 2003). During the secondary stage of the syndrome, the pathogen disseminates through the body via the circulatory system.

It is only in the tertiary stage that organs and bones are affected by the infection (Mann & Murphy, 1990; Ortner, 2003). Syphilitic bone lesions normally develop between two and ten years after infection with the pathogen. Various bones are often affected by the disease, and since it is disseminated systemically, lesions are normally bilateral (Ortner, 2003). The tibia, nasal cavity and cranial vault are most often affected by lesions (Reichs, 1989; Mann & Murphy, 1990; Ortner, 2003). All syphilitic lesions in bone can be characterized by an advanced osteosclerotic response to the infection (Ortner, 2003).

Caries sicca, which is a scarring pattern seen on the frontal, parietal and occasionally occipital bones of the skull, is a very characteristic lesion associated with tertiary syphilis (Steinbock, 1976; Roberts & Manchester, 1995; Larsen, 1997; Meyer et al., 2002; Ortner, 2003). Three types of lesions together form caries sicca, namely cavitations and nodes (also called gummatous lesions) and stellate scarring (Mann & Murphy, 1990; Roberts & Manchester, 1995; Steinbock, 1976).

Gummatous lesions are firstly recognized by patches of hypervascularity, which develops on the outer table of the skull vault and on long bones (especially the tibia), eventually causing focal destruction (Maat et al., 1997; Ortner, 2003). The lytic lesions are often surrounded by a thick and elevated sclerotic margin (Reichs, 1989; Mann & Murphy, 1990; Ortner, 2003). Should these lytic lesions heal, they leave a depressed stellate scar on the bone (Steinbock, 1976; Mann & Murphy, 1990; Larsen, 1997; Ortner, 2003). The nasal bones, nasal septum and hard palate are often also affected by the infection (Ortner, 2003). These bones are normally destroyed and consequently the nasal cavity of skeletal remains from affected individuals will seem enlarged (Roberts & Manchester, 1995; Larsen, 1997; Ortner, 2003).

Syphilis is a blood-borne disease and primarily involves the walls of the arterioles. Since the metaphyses of long bones are extremely vascular, these regions are often affected by the condition. The long bones most often affected are the tibia, fibula, clavicle, radius and ulna (Steinbock, 1976). Periostitis and subsequent subperiosteal bone growth is initiated and this eventually leads to the thickening of the affected bone (Steinbock, 1976; Reichs, 1989). The anterior tibia is the site most often affected during tertiary syphilis (Roberts & Manchester, 1995; Ortner, 2003). Hypertrophy of the anterior crest of the tibia is often seen, resulting in very characteristic "saber-shin" tibiae (Larsen, 1997; Meyer et al., 2002).

Bone regeneration caused by syphilis can also cause the medullary cavities of the long bones to narrow due to cortical thickening (Steinbock, 1976; Reichs, 1989; Meyer et al., 2002). This is primarily seen in the tibia and femur (Steinbock, 1976). Other bone changes may be observed such as the bones appearing slightly striated, coarsely striated or even pitted due to gummata formation on the longbones (Reichs, 1989; Maat et al., 1997).

Several cases of treponemal infection have been reported from all over Africa (Meyer et al., 2002). The earliest report is that of a *Homo erectus* (KNM-ER 1808), possibly suffering from yaws dating from the Pleistocene (Rothschild, 1995; Meyer et al., 2002). Very little evidence of treponemal infection is however available from Sub-Saharan Africa (Steyn & Henneberg, 1995a). The first case of treponemal infection in South Africa was recorded by Steyn and Henneberg (1995), who discovered a case of treponemal infection (possibly yaws) from the late Iron Age site in Mapungubwe (Steyn, 1994; Steyn & Henneberg, 1995a; Meyer et al., 2002).

2.2.2.3 Osteomyelitis

The presence of pyogenic bacteria in bone leads to the development of osteomyelitis. These bacteria can be introduced into the bone by direct infection due to trauma, such as a compound fracture, or surgical procedures (Ortner, 2003). It can also reach the bone due to systemic distribution of bacteria from a soft tissue infection somewhere else in the body, such as was seen with osteomyelitis developing after smallpox infection (Cockshott & MacGregor, 1958; Ortner, 2003). Lastly, direct infection of the bone can occur due to infection of soft tissue in its close vicinity (Ortner, 2003). In most cases of osteomyelitis, *Staphylococcus aureus* is the causative bacteria, and infection caused by *Streptococcus* is also often seen (Shandling, 1960; Mader & Calhoun, 1989; Ortner, 2003).

Osteomyelitis due to trauma or secondary to tissue infection in the vicinity of the bone can occur in any age group on any bone, depending on the location of the injury or the soft tissue infection. Hematogenous osteomyelitis, on the other hand, has a specific pattern as well as incidence in different age groups (Ortner, 2003). Haematogenous osteomyelitis is most often seen in children and adolescents, peaking between the ages of six to ten years, and mostly affects the long bones of the lower extremities, whereas in adults, the axial skeleton is mostly involved in the infection (Shandling, 1960; Ortner, 2003). Acute osteomyelitis in children often develops into the chronic form. Osteomyelitis in adults normally develops due to an injury or secondary to another infectious disease such as smallpox and typhoid fever, and the lesions are normally localized. In most cases, bacteria responsible for the development of osteomyelitis enter the body though an open skin wound or a lesion in a mucous membrane. It travels through the haematogenous system and eventually starts multiplying in a suitable area, normally a bone high in haemopoietic bone tissue. Puss eventually develops inside the bone and this infection then spreads to the periosteum and a subperiosteal abscess forms (Anderson, 1985). The subperiosteal abscesses deprive the bone of its blood supply and consequently lead to necrosis of certain areas of the bone. These lesions are known as sequestra. Continuous new formation around the necrotic lesions will eventually form a shell of bone around these lesions known as the involucrum (Lovell, 1997). One or more cloacae are often present in the involucrum for the draining of the subperiosteal puss to the outside of the skin (Mader & Calhoun, 1989; Lovell, 1997). Sometimes the diaphysis does not undergo a process of necrosis and no sequestra, involucrum or claocae form. Such bones may have an inflated appearance, with the outer surface of the bone seeming irregular (Anderson, 1985).

2.2.2.4 Tuberculosis and Brucellosis

For the purpose of this study, literature of tuberculosis and brucellosis will be reviewed together, since lesions produced by these infections are similar, often complicating diagnosis.

Tuberculosis, also known as struma, phthisis and consumption, develops after infection by bacteria of the genus *Mycobacterium* (Roberts & Manchester, 1995; Santos & Roberts, 2001; Ortner, 2003; Santos & Roberts, 2006). Four strains of this bacteria exist, but humans can only be infected by the bovine and human strains (Roberts & Manchester, 1995. Ortner, 2003).

Infection by *Mycobacterium bovine* results after consumption of milk or meat from an infected domesticated animal (Steinbock, 1976; Ortner, 2003). The bovine strain of tuberculosis can thus not be passed from one human to the next. *Mycobacterium tuberculosis,* on the other hand, is the human strain of the bacteria and is passed from one individual to the next through the inhalation of airborne bacteria (Ortner, 2003).

It has been shown that tuberculosis infection normally commences at a young age, with the majority of individuals being infected during childhood and early adolescence (Steinbock, 1976; Ortner, 2003). Tuberculosis infection is often chronic and can last for years, and therefore adult skeletal remains presenting with tuberculosis lesions are most probably of individuals who have had the disease since childhood (Steinbock, 1976).

Skeletal tuberculosis is normally the result of secondary infection from pulmonary or lymphatic tuberculosis (Steinbock, 1976). Skeletal manifestation of tuberculosis is very low, with only 5-7% of individuals infected with tuberculosis presenting with defects

(Steinbock, 1976; Santos & Roberts, 2001). Areas in the skeleton where haemopoietic bone marrow can be found, are more often affected by the disease (Larsen, 1997; Ortner, 2003). This explains why the spine as well as metaphyses and epiphyses of the long bones, such as the hip and knee joints, are most often affected by the condition (Steinbock, 1976; Roberts & Manchester, 1995; Ortner, 2003; Santos & Roberts, 2006). Lesions affecting the vertebrae are the most diagnostic and are seen in 25 - 50% of all cases of skeletal tuberculosis (Steinbock, 1976; Roberts & Manchester, 1995; Santos & Roberts, 2001; Ortner, 2003; Santos & Roberts, 2006). The bodies of the lower thoracic and upper lumbar vertebrae are often affected by tuberculosis, with most lesions being observed on the first lumbar vertebra (Steinbock, 1976; Roberts & Manchester, 1995; Ortner, 2003). It has also been shown that at least two vertebrae are affected in 80% of individuals with spinal involvement in tuberculosis (Steinbock, 1976; Ortner, 2003). The central and anterior portion of the vertebral bodies is most often the sites of tubercular lytic lesions (Steinbock, 1976). Abscesses develop in the body of the vertebrae, causing collapse and consequent kyphosis, as well as eventual ankylosis of the affected portion of the spine (Steinbock, 1976, Roberts & Manchester, 1995; Larsen, 1997; Ortner, 2003). Bony regeneration is normally minimal, and marginal osteophytes do not develop as is seen in brucellosis (Steinbock, 1976). These spinal features of tuberculosis are known as Pott's disease (Roberts & Manchester, 1995; Santos & Roberts, 2006). A common complication of vertebral tuberculosis is the formation of a psoas abscess (Ortner, 2003). This paravertebral abscess can form bilaterally or unilaterally, and can cause flaring bony outgrowths from the affected vertebrae, which may eventually descend along the psoas muscle downwards into the pelvis (Ortner, 2003).

Tuberculosis of the hip is seen second most frequently (Santos & Roberts, 2001; Ortner, 2003). The disease can easily access the hip joint via the circulatory system, or by direct extension from abscesses of spinal and pelvic tuberculosis. Here it causes abscess formation and cavitations. Several other bones such as the tibia, fibula, radius, ulna, humerus, scapula and skull, to name but a few, can also be affected by tuberculosis (Ortner, 2003).

Pulmonary tuberculosis can also cause inflammatory responses on the visceral surface of the ribs, resulting in periosteal bone reactions (Roberts & Manchester, 1995; Larsen, 1997; Santos & Roberts, 2001; Ortner, 2003; Santos & Roberts, 2006). The middle ribs are more frequently affected than the upper or lower ones, and the infection can easily spread to adjacent ribs (Ortner, 2003). Lesions are often located on the vertebral end of the ribs (Santos & Roberts, 2006). It has been noted by Santos and Roberts (2006) that up to 85.7% of individuals suffering from pulmonary tuberculosis present with rib lesions.

Brucellosis is caused by bacteria from the genus *Brucella*, and results after the consumption of meat or byproducts of animals infected with the disease, as is also seen in the bovine strain of tuberculosis (Ortner, 2003). Although none of the historical documents available refer to this condition, it is suggested that this condition might have been present in South Africa during the late 19th century (McDermott & Arimi, 2002). Brucellosis infection causes "Maltese fever" in humans. The disease is characterized by an extremely high fever and splenomegaly in the acute phase. Should the disease become chronic, visceral, bone and nerve involvement can be seen (Capasso, 1999). Adult males are most often affected by the disease and skeletal lesions caused by this condition are often observed in the spine, knee, interphalangeal joints and the sacroiliac joint (Capasso, 1999; Ortner, 2003). Children can also be infected, but the distribution of the pathological lesions are slightly different with the hip and knee being affected most and lesions of the spine being rare (Ortner, 2003).

As was also seen in tuberculosis, the lower thoracic and lumbar vertebrae are most often affected by the condition and the lesions are normally present on more than one vertebra (Capasso, 1999; Ortner, 2003). Spinal involvement in brucellosis, also known as anterior epophysitis, develops due to infection of the intervertebral discs. It then starts affecting the antero-superior portion of the vertebral body directly below the affected intervertebral disc. It is therefore important to note that only the antero-superior portion of vertebral bodies will be affected by osteolysis due to the infection (Capasso, 1999). Brucellosis can also be distinguished from tuberculosis by the fact that collapse of the vertebral body with consequent ankylosis is rarely seen (Ortner, 2003). Osteophyte formation follows the development of these lesions and third degree osteophytes with the characteristic "birds beak" shape are often seen on the margins of the affected vertebrae (Capasso, 1999; Ortner, 2003). Destruction of the intervertebral discs and end plates of the vertebral bodies may follow, and this can result in eventual ankylosis of the affected vertebrae (Ortner, 2003).

The most effective way to distinguish between tuberculosis and brucellosis is through molecular investigations. It has been shown that ancient bacterial DNA extracted from bone can be used to identify *Mycobacterium tuberculosis* infection (Spigelman & Lemma, 1993; Salo et al., 1994; Haas et al., 2000;Spigelman et al., 2002).

2.2.3 Metabolic and nutritional disorders

2.2.3.1 Introduction

Metabolic disorders develop due to malnutrition, or physiological anomalies resulting in the malabsorption of certain nutritional elements (Ortner, 2003). These nutritional deficiencies cause a disturbance in the normal bone metabolism, resulting in decreased osteoid production, inadequate osteoid mineralization and increased levels of bone resorption (Steinbock, 1976). The three diseases most often encountered can be identified as: Scurvy, or vitamin C deficiency, iron deficiency anaemia and vitamin D deficiency (rickets) (Stuart-Macadam, 1989; Ortner et al., 1999). Since these conditions also result from general malnutrition, it is not surprising that more than one condition can be present in a single patient or overlapping evidence might be observed in skeletal remains (Ortner et al., 1999).

The recognition of these metabolic disturbances is extremely important, since it gives additional information on socio-economic conditions of past societies (Ortner et al., 1999; Ortner et al., 2001; Brickley & Ives, 2006). Special attention should therefore be given to defining the incidence of each of these conditions in archaeological populations (Ortner et al., 1999). It would be ideal if clear differentiation could be made between the various nutritional deficiencies, but unfortunately this is not always possible (Ortner et al., 1999; Ortner et al. 2001).

Only one nutritional disorder, namely scurvy, is important in the study population. Thus, only this condition will be reviewed.

2.2.3.2 Scurvy

Scurvy results from the extended limited intake of vitamin C, also known as ascorbic acid (Stuart-Macadam, 1989; Ortner & Ericksen, 1997; Ortner, 2003; Brickley & Ives, 2006). Ascorbic acid is responsible for the hydroxylation of lysine and proline in the body (Steinbock, 1976; Pangan & Robinson, 2001; Fain, 2005; Brickley & Ives, 2006). It is thus an essential element during the formation of polypeptide precursors for the formation of collagen fibrils, and therefore a deficiency in vitamin C causes collagen abnormalities (Steinbock, 1976; Stuart-Macadam, 1989; Ortner & Ericksen, 1997; Pangan & Robinson, 2001; Ortner, 2003; Fain, 2005; Brickley & Ives, 2006). Accordingly, clinical abnormalities include abnormal dentine production, damage to the walls of blood vessels and a tendency to haemorrhage, oedema, purpura, tooth loss, bone changes and keratin abnormalities (Pangan & Robinson, 2001; De Luna et al., 2003; Ortner, 2003; Fain, 2005).

Vitamin C cannot be produced in the body; therefore the regular intake of this vitamin is essential (Stuart-Macadam, 1989; Fain, 2005; Brickley & Ives, 2006). At least 10mg of vitamin C should be consumed every day in order to prevent a deficiency (Reuler et al., 1985; Pangan & Robinson, 2001; Fain, 2005). The best natural sources of vitamin C are citrus fruits and uncooked green vegetables. Large amounts of potatoes can also provide sufficient levels of ascorbic acid (Steinbock, 1976; Roberts & Manchester, 1995; De Luna et al., 2003; Fain, 2005; Brickley & Ives, 2006). Some meat such as liver and kidney are also good sources (De Luna et al., 2003). Scurvy has been recognized as a serious disease in history, resulting in many mortalities due to limited resources of fresh vegetables and fruit during poverty, war, famine or long journeys (Steinbock, 1976; Reuler, Broudy & Cooney, 1985; Pangan & Robinson, 2001; Maat, 2002; De Luna et al., 2003; Ortner, 2003; Fain, 2005). Hippocrates described sufferers of the disease as having "a foul breath, boggy gums and a propensity for nose bleed; they may have leg ulcers" (Fain, 2005). The Skeletal manifestation of scurvy is different in infantile remains than in adult skeletons; therefore each will be discussed separately (Ortner, 2003).

Infantile scurvy

Infantile scurvy, also known as Möller-Barlow disease, is rarely seen in neonates, since vitamin C can pass from the mother to the foetus. In cases where the mother suffers from scurvy, the disease might also manifest in the neonate (Ortner, 2003). Infantile scurvy normally starts to develop at around 4 months to 1 year of age, should the infant be subjected to the insufficient intake of ascorbic acid (Steinbock, 1976; Stuart-Macadam, 1989; Ortner, 2003; Brickley & Ives, 2006).

Subperiosteal haemorrhage due to minor trauma, or normal levels of strain on the bone, is an important indication of possible scurvy (Steinbock, 1976; Stuart-Macadam, 1989; Ortner & Ericksen, 1997; Brickley & Ives, 2006). These lesions are prone to develop on the metaphyses of the femur and tibia (Steinbock, 1976; Ortner, 2003). The periosteum is normally stripped from the bone during this process, resulting in an increase in osteogenic activity from the periosteum and the formation of ectopic bone and ossification of haematomas if vitamin C is supplemented and healing can take place (Ortner et al., 1999; Maat, 2002; Ortner, 2003; Brickley & Ives, 2006). These lesions are valuable archaeological evidence of scurvy (Steinbock, 1976; Brickley & Ives, 2006). Although most literature describes these lesions to be found on the long bones, the skull and cranial vault can also be affected (Ortner & Ericksen, 1997).

Transverse fractures through metaphyses, near the junction of the metaphysis and epiphysis, are often seen (Steinbock, 1976; Stuart-Macadam, 1989). It has also been noted that the formation of porous bone in the roof of the orbits can be associated with scurvy (Steinbock, 1976; Ortner, 2003; Brickley & Ives, 2006). This condition resembles criba orbitalia and can easily be ascribed to the accompanying anaemia (Roberts & Manchester, 1995). It should be kept in mind though that the diagnosis of anaemia in skeletal material is greatly dependant on evidence of marrow hyperplasia (Ortner et al., 1999; Ortner et al. 2001). Should this condition not be present, scurvy is a much more likely explanation for porous bone formation in the orbital roof (Ortner et al., 1999). It should also be kept in mind that scurvy causes alternations in the metabolic pathways of iron and folate, and thus can contribute to the development of accompanying anaemia

(Reuler et al., 1985; Pangan & Robinson, 2001). Therefore, both these conditions can easily be present in the same individual (Reuler et al., 1985).

According to a study by Brickley (2006), abnormal porosity of bone, sometimes accompanied by subperiosteal bone growth, is one of the most diagnostic features of scurvy in children (Ortner et al., 1999).

Adult scurvy

Musculoskeletal involvement is observed in 80% of individuals suffering from scurvy (Fain, 2005). Bleedings within the joints of the hips, knees and ankles are often seen. Cortical infractions leading to subperiosteal haematoma formation mostly affect the weight-bearing bones (Reuler et al., 1985; Maat, 2002; Fain, 2005). Ossified haematomas are also often seen in individuals recovering from scurvy (Melikian & Waldron, 2003). In contrast to what is seen in infantile scurvy, pathological features are more prone to develop on the diaphyses rather than the metaphyses (Steinbock, 1976).

A study conducted by Maat (1982), provides valuable insight into the development of skeletal lesions in adult scurvy. He examined 50 Dutch whalers excavated from a cemetery on the Arctic island of Zeeusche Uytkyck (Maat, 1982; Maat, 2004). Historical records indicated that scurvy had been a major problem among the men who participated in the whaling expeditions; accordingly lesions suggestive of scurvy were found in 39 of the 50 individuals (Maat, 1982). These lesions included signs of haematosis, subperiosteal haematomas, periodontal bleeding as well as resorption of alveolar bone (Maat, 1982; Maat, 2004). It was found that subperiosteal haematomas often affected the tibiae and fibulae and that these lesions were normally bilateral (Maat, 1982).

The occurrence of scurvy in adults is also associated with the loss of teeth due to constant bleeding of the gingiva and the development of severe periodontal disease (Roberts & Manchester, 1995; Stuart-Macadam, 1989; Reuler et al, 1985;De Luna et al., 2003; Ortner, 2003). It should be noted that this condition will not be detectable in edentulous individuals (Reuler et al., 1985).

Reuler (1985) noted that up to 75% of individuals suffering from scurvy are anaemic. Food containing vitamin C often contains iron as well and therefore a scorbutic diet is often iron deficient (Reuler et al., 1985). Another possible explanation for the anaemic condition in scurvy sufferers is the loss of blood due to defective collagen in the walls of blood vessels, resulting in haemarthroses and subperiosteal haematomas. It has also been noted that intraocular haemorrhage occurs in patients suffering from scurvy (Reuler et al., 1985).

Scurvy has also been associated with osteoporosis (Grusin & Samuel, 1957; Seftel et al., 1966; Stuart-Macadam, 1989). A study conducted by Seftel (1965) on Johannesburg Blacks showed that up to 71% of individuals suffering from osteoporosis were scorbutic. The association between these two conditions most likely results from the role of vitamin C in collagen formation and ultimately bone formation (Reuler et al., 1985). It was also shown that the incidence of scurvy was seasonally related, with a higher incidence being seen in the late winter and spring and only a few individuals presenting with the condition during the summer months (Seftel et al., 1966). This can most likely be explained by taking the seasonal availability of fresh fruit and vegetables into account.

The regular consumption of alcohol has also been associated with the development of scurvy in adults (Seftel et al., 1966; Pangan & Robinson, 2001; Santos & Roberts, 2001; De Luna et al., 2003). Individuals participating in chronic alcohol abuse have a deficient diet in general, causing conditions such as scurvy to develop due to the malnourishment. The production of homemade traditional beer is a frequently observed practice in African Negroid communities. The beer is brewed using a variety of carbohydrates, normally sorghum, and then stored in iron containers such as petrol drums of paraffin tins (Seftel et al., 1966). Consequently, the iron content of the beer is extremely high and can easily cause siderosis when consumed regularly. It has been shown that scurvy occurs in individuals suffering from siderosis (Grusin & Samuel, 1957; Seftel et al., 1966). It is suggested that large amounts of ferric iron in the liver causes accelerated oxidative catabolism of vitamin C, consequently leading to the individual becoming scorbutic (Seftel et al., 1966).

2.2.4 Trauma

2.2.4.1 Introduction

Trauma is the result of violent or accidental encounters with animals, humans, cultural hazards found in and around the home and working place or therapeutic procedures that cause injury to living tissue (Merbs, 1989; Lovell, 1997; Neri & Lancellotti, 2004). Indications of trauma within an archaeological sample are often high. However, traumatic events occurring around the time of death (perimortem trauma) are often extremely difficult to identify and is normally diagnosed as postmortem damage. Thus, the incidence of trauma is often underestimated (Ortner, 2003).

The assessment of the incidence of trauma in an archaeological population is often difficult to interpret, since the investigation of dry bone poses several limitations. Firstly, determining trauma frequency rates is often hindered by poor preservation and fragmentation of skeletal remains. Perimortem trauma often mimics postdepositional damage and consequently passes undetected. This is also the case in well remodelled fractures. Due to the large variability in the rate of trauma healing, determining the age at which a certain traumatic event occurred is extremely difficult if not impossible. Lastly, it is difficult to determine whether medical attention was available to archaeological populations, since splinted bones are rarely found (Grauer & Roberts, 1996).

Various different opinions are expressed in the literature regarding the attribution of a specific event to traumatic lesions observed on human skeletal remains in the archaeological record. Some researchers support the historical reconstruction of injuries wherever possible. On the other hand, some academics express caution when attempting to interpret archaeological evidence of trauma, since similar macroscopic patterns of traumatic lesions may be due to entirely different traumatic events (Wakely, 1996).

Notwithstanding the limitations, the assessment of trauma within a population can still yield considerable information. Trauma can manifest as crushing injuries, scalping scars, trephination, mutilations, damage caused by sharp objects or bullets and fractures (Ortner, 2003).

The prevalence and the location of trauma are influenced by intrinsic factors such as age and sex, as well as extrinsic factors such as culture (Glencross & Stuart-Macadam, 2000; Lovell, 1997; Ortner, 2003). Different environmental conditions and cultural practices expose individuals to specific traumatic hazards. Therefore, the study of the prevalence of trauma within a population can aid in reconstructing the occupational and environmental stresses they were exposed to, as well as possible cultural behaviour (Steinbock, 1976; Jurmain & Bellifemine, 1997; Kilgore et al., 1997; Lovell, 1997; Ortner, 2003). By assessing whether the fracture is healed, unhealed or infected, an indication can be given of the availability of medical care and accommodation of injured individuals within the community (Steinbock, 1976; Kilgore et al., 1997; Neri & Lancellotti, 2004).

A number of studies focusing on the incidence of trauma in a population have been done in South Africa, namely on the modern Venda, Maroelabult, K2 and Mapungubwe, as well as the Koffiefontein population (Steyn, 1994; Steyn et al., 2002 L'Abbé et al., 2003; L'Abbé, 2004). The incidence of trauma within these populations was, in general, extremely low.

2.2.4.2 Fractures

Fractures can be identified as the partial or complete break in a bone, normally resulting from abnormal stress applied to the bone (Steinbock, 1976; Rothschild & Martin, 1992; Lovell, 1997; Ortner, 2003). Various forces such as tension, compression, torsion, flexion, shearing as well as re-occurring stress can cause a bone to fracture (Rothschild & Martin, 1992; Lovell, 1997; Ortner, 2003).

Tension fractures are normally associated with tendinous attachments to the bone. Excessive strain on the muscle and its associated tendon can cause a fracture of the tubercle or process the tendon is attached to. These fractures are also often associated with the dislocation of joints. Compression fractures result due to a sudden impaction of the bone. These factures are often seen in the vertebral column, joint surfaces and as depression fractures in the skull (Ortner, 2003).

Torsion fractures occur when one end of a limb is fixed and the other end rotates (Ortner, 2003). This type of stress results in the fracture line spiralling around the bone, also known as a spiral fracture (Mann & Murphy, 1990; Lovell, 1997). In long bones, this type of fracture can easily be confused with a compression fracture. Bending fractures are most commonly seen. These fractures result from the bone bending due to a fall or as a response to a blow, as seen with a parry fracture (defence fracture). The stress on a specific part of the bone can result in either a single transverse break in the bone, or a transverse as well as oblique fracture resulting in a wedge of bone (butterfly fragment) breaking loose (Ortner, 2003). Bending fractures can also often result in the incomplete transverse fracture of a bone in association with longitudinal splitting, known as a 'greenstick' fracture (Steinbock, 1976; Mann & Murphy, 1990; Ortner, 2003). These fractures normally result from indirect trauma and are mostly seen in children, since their bones are still pliable and thus less likely to break (Lovell, 1997).

Shearing fractures occur when opposite forces are applied to a bone in different planes and it often results in a complete fracture as well as displacement (Ortner, 2003). An example of a shearing fracture is the Colles' fracture of the radius.

Fractured bones can also result from repetitive forces exerted on the bone, eventually causing a stress or fatigue fracture (Lovell, 1997). This type of fracture usually occurs in the metatarsals, calcaneous and tibia (Lovell, 1997; Wilson & Katz, 1969). Stress fractures are identified by a nondisplaced crack (hairline fracture; infraction) in the bone, which is only radiographically detectable after bony callus has formed over the injury (Lovell, 1997).

Fractures are also classified according to the severity of the fracture, with a simple fracture indicating a single break in the bone and a comminuted fracture referring to multiple broken fragments (Steinbock, 1976; Mann & Murphy, 1990; Lovell, 1997; Ortner, 2003).

In addition to the abovementioned categories, fractures can also classified as "closed" or "open". Closed fractures occur in situations where the fractured bone does not come into contact with the outer surface of the skin. On the other hand, an open, or compound fracture occurs when the bone protrudes through the skin (Lovell, 1997). This is of great importance, since compound fractures are at great risk of infection, normally caused by *Staphylococcus aureus* (Grauer & Roberts, 1996; Lovell, 1997). If this is not treated successfully, periostitis and/or osteomyelitis may develop (Lovell, 1997). (More information regarding the abovementioned conditions can be seen in the section on infectious diseases and non-specific indications of pathology).

It is often problematic to decide when a fracture occurred. Three time windows are distinguished: antemortem, which is a fracture that occurred before death; perimortem, which occur around the time of death, and postmortem fractures, which occur after death and are often the result of environmental factors or occur due to poor excavation techniques (Mann & Murphy S.P, 1990).

The reason for the difficulties associated with distinguishing between ante-, peri- or post-mortem fractures is firstly that no soft tissue is left for interpretation on archaeological remains. Secondly, bone retains its elasticity for several weeks to months after death, depending on the deterioration of the collagen components in the bone. Thus, it is obvious that in the absence of soft tissue evidence, the peri-mortem fracture is obscured. Since bone retains it elasticity for weeks after death, it is extremely difficult, if not impossible, to distinguish between fractures that occurred just before death or a few days or weeks after (Mann & Murphy, 1990).

Antemortem fractures that occurred well before the time of death can easily be identified by signs of healing (Mann & Murphy, 1990; Lovell, 1997). Within the first week after the fracture, the medullary and periosteal blood supply increases (Rhinelander et al., 1968). During the second week, the fracture line becomes filled with granulation tissue, eventually forming highly vascular fibrous callus (Ortner, 2003; Rothschild & Martin, 1992). Primary callus formation start forming within the fibrous callus as early as the second to third week after the fracture occurred (Lovell, 1997; Ortner D.J., 2003; Rothschild & Martin, 1992). Union of the fracture will commence around the fourth week and bony replacement of fibrocartilage will be completed around the sixth week after the fracture. In time, remodelling of the fracture will occur and by the 16th week, the fracture line should be totally obliterated (Rothschild & Martin, 1992).

Taking all of the above-mentioned into account, it is evident that a fracture can easily be diagnosed as antemortem, had it occurred two or more weeks prior to death (Mann & Murphy, 1990; Rothschild & Martin, 1992; Lovell, 1997).

Further evidence of ante- and peri-mortem fractures includes characteristics such as fracture lines that are generally sharp and smooth and are associated with radiating lines (hairline fractures) at the site of trauma (Lovell, 1997; Mann & Murphy, 1990). Due to the high elasticity of bone, incomplete fractures of fresh bone can show bending of the bone, also known as the "greenstick" response (Mann & Murphy, 1990). In archaeological material, the fractured ends are normally as discoloured and weathered as the adjacent bone (Mann & Murphy, 1990; Lovell, 1997).

Postmortem fractures can be identified by blunt, irregular fracture lines (Mann & Murphy, 1990). Bone is often brittle, and due to the loss of elasticity, trauma to the bone results in a shattered appearance, as opposed to the "greenstick" response of fresh bone (Mann & Murphy, 1990; Lovell, 1997). The fractured ends will often not have the same degree of discolouration and weathering as the surrounding bone (Mann & Murphy, 1990; Lovell, 1997).

2.2.4.3 Myositis ossificans (acuta)

As is also seen in bone, trauma to muscle can lead to the formation of a haematoma. The haematoma normally dissolves in time, but occasionally, muscle tissue responds by the formation of bone within the muscle, in association with the haematoma (Ortner, 2003). The ossification in muscle in response to trauma is known as myositis ossificans traumatica (Ortner, 2003; Steinbock, 1976).

Myositis ossificans is most commonly seen after trauma of the extensor and adductor muscles of the thigh, the deltoid as well as pectoralis muscle, and is more likely to develop in response to trauma in young individuals than in the older age groups (Ortner, 2003). Body outgrowths due to myositis ossificans can easily be confused with osteosarcomas and primary bone tumours. Therefore, the location of the ossification should be clearly specified in order to aid in the differential diagnosis (Steinbock, 1976; Ortner, 2003). Myositis ossificans normally occurs at the implantation or origin of a muscle or its associated tendon. It should be kept in mind that the ossification of muscle due to trauma can also produce ectopic bone that is not in contact with the bone (Ortner, 2003).

The earliest case of possible myositis ossificans was observed in a femur of *Homo erectus* from the middle Pleistocene. A prominent medial exostosis was visible on the proximal half of the femoral shaft. This bony outgrowth most likely developed due to trauma and subsequent ossification of the origin of the vastus medialus muscle tendon (Steinbock, 1976).

2.2.4.4 Amputations

The finding of archaeological skeletons with healed amputations are not often seen (Mays, 1996). Limbs are often lost in battle, amputated for medical reasons or severed as crime punishment or as a sign of grief (Merbs, 1989; Mays, 1996). By investigating the morphology of the amputated stump, assessing the pattern of mutilation and considering historical evidence, distinctions can be made between the various causes for amputation (Mays, 1996).

Within two weeks after an amputation, callus starts to develop in order to close the medullary cavity of the amputated bone (Merbs, 1989; Mays, 1996; Ortner, 2003). After several months, the medullary opening will be closed and the bone will be remodelled to assume a very characteristic peg shape (Merbs, 1989; Mann & Murphy, 1990; Mays, 1996).

The development of osteophytes on the stump of archaeological amputations is often seen (Barber, 1929; Barber, 1930; Mays, 1996). These osteophytes arise from the damaged periosteum at or near the site of amputation. Advanced stages of osteophyte formation often cause ankylosis in cases where a pair of bones, such as the radius and ulna, or tibia and fibula, was amputated. In modern surgical amputations, the periosteum is removed from the amputated ends to prevent the formation of osteophytes (Mays, 1996).

The amputation of a limb has several influences on the remaining structures. Firstly, it causes a dramatic decrease in the bony substance remaining part of the amputated limb. For example, the amputation of a hand will cause a decrease in the bone quality of the radius and ulna, as well as the humerus, which was associated with it. The decrease in bone substance is attributed to the reduction in mechanical stress and strain caused by the severing of muscles associated with the amputation. Secondly, the robusticity of muscle attachments are influenced. A decrease in the robusticity of muscle attachments of the amputated limb is seen in contrast to an increase in the robusticity of muscle attachments of the opposite limb (Mays, 1996). Since the frequency and degree of strain exerted on muscles influences the robusticity of muscle attachments, these changes can be explained as being due to a dramatic decrease in muscular activity on the amputated limb, with consequent compensation on the opposite side (Mays, 1996; Scott, 1957).

2.2.4.5 Spondylolysis

Spondylolysis is defined as a fracture of the vertebral arch, mostly resulting in bilateral separation of the pars interarticularis of, usually, the fourth or fifth, and occasionally, the third lumbar vertebra (Wiltse, 1975; Merbs, 1989; Mann & Murphy, 1990; Lovell, 1997; Earl, 2002; Merbs, 2002;). Epidemiological studies have revealed that this condition is related to age, sex, race, the level of physical activity and hereditary factors (Wiltse, 1975; Comstock, Carraggee & O'Sullivan, 1994; Earl, 2002). Although it was first described as being congenital, it is widely accepted that this lesion is most likely associated with trauma (Merbs, 1989; Earl, 2002). Since the occurrence of spondylolysis has a distinctly familial pattern, it is suggested that the susceptibility to attain this fracture is hereditary (Merbs, 1989; Earl, 2002).

Spondylolysis is only present in humans, suggesting that erect posture and bipedal locomotion greatly influence its occurrence (Merbs, 1989; Earl, 2002; Merbs, 2002). According to Merbs (1996), spondylolysis is the cost of bipedal locomotion. Bipedal locomotion certainly predisposes the human race to spondylolysis, but the cause for the fracture of the pars interarticularis can most likely be associated with habitual activity (Arriaza, 1997).

The incidence of spondylolysis differs greatly among various populations. According to Wiltse (1975), 2% of African-American individuals present with this condition in the USA, and it is seen in 6% of the White population. Spondylolysis can also be seen in up to 60% of native Alaskans and 15-54% of Inuit (Wiltse, 1975; Arriaza, 1997; Lovell, 1997). It is accordingly suggested that the difference in the incidence of spondylolysis among various populations can be related to differences in the levels and types of physical activity they regularly participate in, rather than the difference in genetic affiliation (Arriaza, 1997). It has been shown that activities that require repetitive hyperextension or hyperflexion of the lumbar spine increase the risk of spondylolysis (Johnson, 1993; Hickey et al., 1997; Lovell, 1997; Earl, 2002). It is thus not surprising that participation in sports such as gymnastics, diving, wrestling, rowing and weight-lifting (which is of special importance to this study) leads to a particularly high incidence of spondylolysis (Johnson, 1993; Hickey et al., 1997;Earl, 2002).

Spondylolysis can be categorized into four groups according to the aetiology of the lesion, namely dysplastic, isthmic, traumatic and pathological (Wiltse, 1975; Earl, 2002;). Dysplastic spondylolysis is the result of abnormal development of the neural arch such as seen during spina bifida (Wiltse, 1975; Arriaza, 1997). The abnormal vertebral arch is less able to withstand normal forces and is accordingly predisposed to fracture at the pars interarticularis (Wiltse, 1975). Isthmic spondylolysis is the most common and normally occurs at the level of L5 and S1 (Wiltse, 1975; Merbs, 1996;Arriaza, 1997; Earl, 2002). This type is mostly seen in adolescents and young adults and is the result of a fatigue or stress fracture due to continuous stress exerted on the lumbar spine (Earl, 2002).

The traumatic and pathological fracture of the pars interarticular is extremely rare (Wiltse, 1975). Traumatic spondylolysis usually occurs alongside other fractures, and it heals well with immobilization (Wiltse, 1975; Earl, 2002;). Pathological fracture of the pars refers to incidences in which tumours weakens the bone and thus predisposes the individual to spondylolysis (Earl, 2002).

Spondylolisthesis, a condition described as the anterior shift or 'slippage' of the vertebral body, is often associated with spondylolysis (Wiltse, 1975; Merbs, 1989; Lovell, 1997; Earl, 2002; Merbs, 2002). It occurs due to a loss of stability caused by the separation of the vertebral body from the neural arch (Arriaza, 1997). Another condition associated with spondylolysis is pedicular fracture. Pediculolysis is often observed in cases of contralateral spondylolysis (Sirvanci et al., 2002). Changes in the distribution of force due to unilateral spondylolysis causes an increase in the strain exerted on the contralateral pedical and eventually causes it to fracture (Sirvanci et al., 2002).

2.2.4.6 Dislocations, subluxation and avulsion

Dislocation can be defined as the disruption of the normal relationship between the bony elements of a joint, resulting in complete loss of normal contact between the various components (Lovell, 1997; Ortner, 2003). This condition mostly develops due to trauma, although some genetic abnormalities may make an individual more susceptible to dislocation (Ortner, 2003). Subluxation is also defined as the disruption of the normal relationship between the bony elements of the joint, but it is a less severe condition than dislocation referring to only partial loss of the contact between joint components (Lovell, 1997; Ortner, 2003). Although the chronic dislocation or subluxation of a joint may be congenital or spontaneous, they are most commonly associated with traumatic events and often occur in conjunction with a fracture (Lovell, 1997).

In order for either dislocation or subluxation to be observed in an archaeological skeleton, the condition have to be unreduced and longstanding to result in bone remodelling and consequent disruption of the normal anatomical structure of the joint (Lovell, 1997; Ortner, 2003). Dislocations most often affect young and middle-aged adults, since forces associated with dislocations cause epiphyseal separation and pathological fractures in subadults and older adults respectively (Lovell, 1997). The shoulder and the hip joint are especially prone to chronic or permanent dislocation, as well as other joints, such as those in the spine (Lovell, 1997; Maat & Mastwijk, 2000; Ortner, 2003).

The anatomical relationship between the humerus, scapula and clavicle in the shoulder joint allows for easy movement in virtually all axes. Although this is favourable when concerning the manipulation of the arms, the instability of the joint to allow the movement makes it prone do dislocation (Lovell, 1997; Ortner, 2003). This makes it the most commonly dislocated joint in the body. Due to the anatomy of the glenohumeral joint, spontaneous reduction of the dislocation will not occur. In situations where the dislocation is not reduced, a new articulation surface will develop, where the humerus is in contact with the scapula, and this will provide clear archaeological evidence of a permanent dislocation (Ortner, 2003).

The prevalence of hip dislocations is far less when compared to that of the shoulder joint (Lovell, 1997; Ortner, 2003). Since the hip is a classic deep ball-and-socket joint, it is much more stable than that of the shoulder. Dislocation of the hip is often seen in relation with genetic disorders such as congenital hip dysplasia (Lovell, 1997; Ortner D.J. 2003). This disorder creates a tendency for the hip joint to dislocate when exposed to only slight trauma or during walking (Ortner, 2003).

An avulsion injury of the spine results from abrupt hyperextension-hyperflexion of the spine, such as can be associated with a whiplash injury, causing a dislocation injury of the spine. Bone lesions caused by an avulsion injury is dependant upon the age at which the injury occurred, and distinction can be made between injuries that occurred in an immature spine or those that were sustained in adulthood (Maat & Mastwijk, 2000).

Avulsion injuries sustained in juvenile individuals where the vertebral epiphyses are still unfused, causes avulsion of the superior annular epiphysis resulting in a "bow-shaped" antero-superior border. This lesion is usually accompanied by an impression fracture, resulting in a depression in the antero-superior section of the vertebral body. Avulsion of the inferior annular epiphyses will cause anterior displacement of the epiphyses, resulting in a "teardrop" osteophyte forming at the antero-inferior corner (Maat & Mastwijk, 2000). Injuries sustained during youth or early adulthood will result in a haematoma forming between the vertebral endplate and the intervertebral disc. This will result in a "partial or complete uniform porotic endplate" (Maat & Mastwijk, 2000: 148).

Avulsion injuries sustained after complete fusion of the vertebral epiphyses will result in a "step-off" of the antero-superior corner of the vertebral body. An elevation of the antero-superior portion of the vertebral body, resulting from a compression fracture of the anterior-inferior corner of the vertebral body, might also be seen (Maat & Mastwijk, 2000). These avulsion injuries caused by hyperextension and hyperflexion of the spine can also result in a discontinuity in the anterior-inferior margin of the vertebral body.

2.2.5 Congenital abnormalities

2.2.5.1 Introduction

Congenital abnormalities constitute a group of developmental diseases that originates during foetal development and starts to manifest just before or shortly after birth. These abnormalities range from minor anomalies that are asymptomatic to severe conditions that are life threatening. Not all congenital abnormalities are skeletal; anomalies of the vascular, digestive and nervous system are also often seen. Since only skeletal evidence is mostly available in the study of past populations, the incidence of congenital anomalies in history is underestimated (Roberts & Manchester, 1995).

Congenital anomalies are multifactoral in aetiology and are normally influenced by environmental factors such as viral infections and drug administration that affected the mother during pregnancy. These anomalies can also be genetically based or develop due hereditary factors (Roberts & Manchester, 1995).

2.2.5.2 Spina bifida

Spina bifida can be described as the incomplete development of the elements of the neural arch, resulting in a cleft or open neural canal (Mann & Murphy, 1990; Auferheide & Rodriguez-Martin, 1998; Ortner, 2003). Three types of spina bifida can be identified, i.e. spina bifida occulta, cystica and aperta.

In living individuals, this can result in the protrusion of the spinal cord through the openings in the neural arch and is known as spina bifida cystica. This condition can often lead to paraplegia and other serious complications. Spina bifida occulta is the less severe failure of vertebral arch development and has very little to no clinical significance (Ortner, 2003). Since the more serious types of spina bifida (cystica and aperta) are not compatible with life, spina bifida occulta is most often seen in archaeological remains (Roberts & Manchester, 1995).

Spina bifida is the most serious and most frequently seen congenital anomaly of the spine (Post, 1966). It is reported to occur in one out of every 775 births in the US and it has been shown that spina bifida occulta can be detected in 2.7% of early British skeletal remains (Neel, 1958; Roberts & Manchester, 1995).

Complete or partial congenital absence of the posterior arch of the atlas is a well-known but uncommon occurrence (Plaut. 1937; Motateanu et al., 1991). During the second month of foetal life, the three ossification centres of the atlas appear, one for each posterior lateral arch as well as one for the anterior arch (Plaut, 1937; Dalinka et al., 1972; Logan & Stuard, 1973; Motateanu et al., 1991). The posterior arches fuse together around the age of three to five years, and the posterior section then fuses to the anterior part at the age of nine years (Plaut, 1937; Dalinka et al., 1972; Logan & Stuard, 1973; Schulze & Burman, 1987 Motateanu et al., 1991). This process of development and ossification explains the various forms of congenital skeletal anomalies observed in the atlas, caused by either the absence of the ossification centres, or the faulty ossification and fusion between the various parts of the vertebra (Motateanu et al., 1991).

The majority of gaps in the posterior atlas appear near the midline, and the width of these openings can range between a fissure-like opening to gaps of about 10 mm or more (Plaut, 1937; Dalinka et al., 1972). Histological investigations have shown that these gaps are crossed by dense tracks of connective tissue originating from the periosteum (Dalinka et al., 1972; Schulze & Burman, 1987). It can therefore be suggested that the absence of the arch is not due to a disturbance in the ossification of the atlas, but rather an abnormality in the development of the cartilaginous preformation of the arch (Schulze & Burman, 1987). Nonfusion of the anterior arch is seen less frequently (Plaut, 1937; Logan & Stuard, 1973).

Congenital skeletal anomalies of the atlas are relatively rare (Post, 1966). In a study by Shulze and Burman (1987), it was found that clefts in the posterior arch of the atlas are only found in 64 (4%) of 1 613 investigated cadavers. Presence of this congenital condition has been suggested to have autosomal dominant inheritance (Motateanu et al. 1991).

Abnormalities of the atlas are normally asymptomatic, unless they are combined with other congenital defects such as Klippel-Feil or Turner Syndrome (Schulze & Burman, 1987). It should be kept in mind that the congenital absence of the posterior arch of the atlas will most likely be associated with atlantoaxial instability, which may produce some neurological symptoms (Schulze & Burman, 1987).

Shore (1930) investigated 82 South African Negroid skeletons, which he obtained from dissection room cadavers, and found spina bifida in 23 (28%) individuals (Shore, 1930; Post, 1966). In five cases the cervical region was affected; nine cases where the thoracic region was affected; three cases where the lumbar vertebrae were affected and six cases where the sacrum was involved (Shore, 1930; Post, 1966). Steward (1932) examined 217 Eskimo skeletons and found spina bifida in 16 (7.3%) individuals; this included one cervical, six thoracic and nine cases of lumbar spina bifida (Post, 1966; Stewart, 2006).

2.2.5.3 Supernumerary vertebrae

An individual presenting with more or less than 7 vertebrae in the cervical, 12 in the thoracic or 5 in the lumbar region is described to have a congenital numerical variation in vertebral number (Nozawa et al., 2002). This condition mostly develops in the lower thoracic and lumbar region and appears to be of no clinical significance (De Beer Kaufman, 1974). According to a recent study, this condition is present in the thoracic region of 3.2% of individuals and the lumbar region of 6.2% of persons (Nozawa et al. 2002).

According to a study conducted on the South African Negroid population, a variation in the number of presacral vertebrae is a common occurrence (De Beer Kaufman, 1974). According to De Beer Kaufman (1974), sacralization of L5, leaving only four available lumbar vertebrae, occurs in 2.8% of South African Negroids and 7.1% of persons from the San community. A sixth lumbar vertebrae is also common with 8.2% of South African Negroids and 14.3% of San individuals. It has accordingly been suggested that variation in the number of presacral vertebrae is a 'morpho-genetic' characteristic in Khoisan populations (De Beer Kaufman, 1974; Morris, 1984).

2.2.5.4 Craniostenosis

Craniostenosis or craniosynostosis is a condition caused by the premature fusion of cranial sutures (Gordon, 1959; Bennett, 1967; Mann & Murphy, 1990; Ortner, 2003). The skull grows secondary to the brain; thus, should the brain fail to grow, so will the skull. It is accordingly suggested that the pressure exerted on the skull during brain growth stimulates the growth of the skull. Growth at the coronal suture is responsible for an increase in the length of the forehead, lambdoid suture growth increases length of the skull, and growth at the sagittal suture causes an increase in skull breadth. Should one of these three sutures fuse prematurely, other open sutures will compensate in order to accommodate the growing brain (Gordon, 1959). Accordingly, craniosynostosis causes changes in the shape of the skull, depending on the age at which the fusion occurred, as well as the sutures involved (Gordon, 1959; Ortner, 2003). Premature fusion of the sagittal suture will result in an elongated skull (hyperdolicocephaly or scaphocephaly) with a prominent forehead, whereas fusion of the coronal suture will result in a short, high skull (oxycephaly) with a prominent frontal region and high forehead (Bennett, 1967; Mann & Murphy, 1990; Ortner, 2003). Premature fusion of one or more cranial sutures after growth of the brain had ceased, or when it only proceeds slowly, will only cause minimal deformation (Gordon, 1959).

In a study conducted by Gordon (1959) on craniostenosis among the African Negroid populations, he found that the conditions were more frequently seen in males. In an examination of 600 African skulls, it was found that only 6 (1%) presented with premature fusion of cranial sutures. The majority of these cases included fusion of the sagittal suture. It was also concluded that a strong hereditary pattern can be observed for this condition (Gordon, 1959).

2.2.6 Degenerative diseases and miscellaneous pathological conditions of joints

2.2.6.1 Introduction

All animals, plants and humans are subjected to gradual deterioration with advancing age. Degenerative processes can be recognized in all bodily systems, but only the degeneration patterns of joint and bone are recognizable in skeletal remains from past populations (Roberts & Manchester, 1995).

Written records of prehistoric populations are rarely available and therefore the activities and occupations of the population being studied are mostly unknown. The reconstruction of history related to a population, activities they regularly participated in and their occupation mainly relies on artefacts found in association with the remains. This method relies heavily on assumptions based on ethnographic and historical parallels and is rather speculative (Stirland & Waldron, 1997).

As is experienced during the interpretation of artefacts found in association with human remains for the reconstruction of occupation and activities, the interpretation of palaeopathological conditions for this purpose presents its own restrictions. Scientists often attribute general skeletal changes, such as enthesophyte formation and asymmetric development of paired bones, to habitual physical activity within a population. This is sometimes done without considering the size of the sample population, its age distribution and normal variation patterns within the human skeleton (Stirland & Waldron, 1997).

It is well known that habitual occupational or recreational activities may induce changes in the musculoskeletal system (Bird, 1990). However, it is crucial to take into account the age ranges of the sample population when evaluating skeletal changes that might be associated to activity (Stirland & Waldron, 1997). This will prevent evidence of normal age-related degeneration being misinterpreted as occupational-related stress (Stirland & Waldron, 1997).

2.2.6.2 Schmorl's nodes

Due to expansion of the nucleus pulposus of the intervertebral discs into the vertebral endplates, pressure is exerted on the adjacent vertebral endplates and eventually, resorption of bone in the affected locations follows (Mann & Murphy, 1990; Roberts & Manchester, 1995 Lovell, 1997). These resorption lesions are known as Schmorl's nodes and they are early indications of degenerative disc disease (Roberts & Manchester, 1995; Lovell, 1997).

Schmorl's nodes are normally seen in the lower thoracic and lumbar spine (Roberts & Manchester, 1995). They are a common finding amongst the elderly and develop due to degenerative disc disease (Mann & Murphy, 1990). During the usual degeneration of skeletal elements and its associated structures with age, herniation of the discs develops gradually, due to a loss of resiliency in the intervertebral disc (Larsen 1997; Lovell, 1997). The presence of these nodes in adolescents and young adults are uncommon (Mann & Murphy, 1990; Lai & Lovell, 1992). Trauma to the spine has been described as the main cause of Schmorl's node development in young persons, and is associated with heavy lifting, a fall from a height and regular participation in strenuous physical activities (Mann & Murphy, 1990; Lai & Lovell, 1992; Roberts & Manchester, 1995).

Schmorl's nodes can be identified by a circular to linear depression with a sclerotic floor in the centra of vertebral body endplates (Mann & Murphy, 1990).

2.2.6.3 Diffuse idiopathic skeletal hyperostosis (DISH)

Although diffuse idiopathic skeletal hyperostosis (DISH) is not a joint disease, but rather a condition affecting connective tissue, this condition is often accompanied by osteoarthritis or erosive athropathies, making differential diagnosis difficult (Ortner, 2003). The ossification of tissue around joints also often renders the affected joint immobile and therefore this condition will be briefly discussed in this section.

Diffuse idiopathic skeletal hyperostosis (DISH), also known as ankylosing hyperostosis and Forestier's disease, is easily confused with variants of spinal arthritis (Roberts & Manchester, 1995; Ortner 2003). Individuals affected by this condition have a tendency to the ossification of connective tissue, such as ligaments, especially the anterior longitudinal ligament along the spine (Ortner, 2003). All sorts of ligament ossifications, such as those resulting in calcaneul spurs and iliac whiskering, to name but a few, have also been associated with this condition (Roberts & Manchester, 1995; Ortner, 2003).

Clinically, spinal involvement in DISH can be characterized by ossification of the anterior longitudinal ligament, causing ankylosis of at least four anterior vertebral bodies in a row. The diarthrodial or costovertebral joints are not affected by this condition and the intervertebral vertebral surfaces also retain their integrity (Roberts & Manchester, 1995). The sacroiliac joint is usually unaffected, but the joint capsule may be affected. Although a bony bridge might form between the sacrum and iliac, intra-articular ankylosis, as is the case in ankylosing spondylitis, is not seen (Roberts & Manchester, 1995; Jankauskas, 2003). Osteophytes, which seem to "flow like candle wax", are generally present on the right side of the thoracic region since the left anterior longitudinal ligament is kept moving by aorta pulsations, thereby preventing ossification (Roberts & Manchester, 1995).

Other skeletal lesions associated with DISH includes the formation of enthesopathies at tendon and ligament insertions such as on the patella and calcanei (Ariaze, 1993; Ariaze et al., 1993; Roberts & Manchester, 1995). Ossification of costal and laryngeal cartilages is also often observed (Roberts & Manchester, 1995).

DISH is said to be more common in males than in females, and the prevalence of the condition increases with age (Roberts & Manchester, 1995; Ortner, 2003). The exact cause of this condition is unknown, but it seems to be associated with diabetes and obesity (Ariaze, 1993; Ariaze et al., 1993; Maat et al., 1995; Roberts & Manchester, 1995; Jankauskas, 2003). The earliest case of DISH was described in a Neanderthal skeleton from Iraq. These remains date to between 40 000 and 73 000 years BC (Roberts & Manchester, 1995).

2.2.6.4 Arthritis

Arthritis is a universal term used to describe joint diseases (Steinbock, 1976). Various clinical classifications exists for different types of arthritic changes, but only nine of these can be classified on dried bone (Steinbock, 1976; Ortner, 2003):

a. Osteoarthritis (degenerative joint disease);
b. Vertebral osteophytosis (degenerative disc disease);
c. Rheumatoid arthritis;
d. Ankylosing spondylitis;
e. Septic arthritis;
f. Psoriatic arthritis; and
g. Gout.

Two processes can be identified during skeletal involvement in joint diseases: new bone formation or bone destruction. Distinguishing between various joint diseases can be extremely difficult. It is therefore important to clearly describe the morphology of the lesions as well as its distribution across the skeleton, since this will aid in the diagnosis of the disease (Roberts & Manchester, 1995).

2.2.6.4a Osteoarthritis

Osteoarthritis, also known as degenerative joint disease, arthrosis, arthritis deformans and hypertrophic arthritis, is the most common form of arthritic changes seen in archaeological as well as modern populations (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995). Osteoarthritis can be described as the deterioration and corrosion of articular cartilage in synovial joints, as well as the formation of new bone on the joint surface (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995; Weiss, 2006).

The development of this condition can be closely associated with the normal biological changes occurring in bone as an individual grows older, as well as genetic susceptibility, obesity, increased level of physical activity, hormonal influences and environmental factors, such as climate (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995; Larsen, 1997; Crubezy et al., 2002; Weiss, 2006). It is accordingly most often seen in persons older than 40 years of age (Steinbock, 1976). The regular overexertion of a joint can also initiate the development of degenerative changes in the articular cartilage and its associated bone elements (Larsen, 1997; Steinbock, 1976). Osteoarthritic lesions are often seen bilaterally, in the weight-bearing joints such as the hips and knees, but other joints, such as the temperomandibular and shoulder joints, can also be affected as a complication of strain during physical activity (Steinbock, 1976; Roberts & Manchester, 1995).

Osteoarthritis can be recognized by evidence of erosion of the joint cartilaginous surface as well as osteophyte formations visible on the edges of synovial joints only (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995; Larsen, 1997; Debono et al., 2004). As the condition advances, cartilage covering the articular surfaces will eventually erode away and the bone will be exposed. With exposure to continuous friction, eburnation of the associated bones in the joint will develop (Steinbock, 1976; Waldron & Rogers, 1991; Rothschild & Martin, 1992; Roberts & Manchester, 1995; Larsen, 1997; Debono et al., 2004). Ankylosis due to osteoarthritis is extremely rare (Steinbock, 1976).

The presence of osteoarthritis provides valuable information regarding the relationship between bony structures and their function, as well as the level of physical activity regularly participated in (Rothschild & Martin, 1992). This will be discussed in more detail in the section on degenerative changes and occupation.

2.2.6.4b <u>Vertebral osteophytosis</u>

Vertebral osteophytosis or degenerative disc disease is a condition recognized by bony outgrowths that become visible on the margins of the vertebral bodies and develops due to the degeneration of fibro-cartilagenous joints (Steinbock, 1976; Van der Merwe et al., 2006). They can occur on the superior or inferior border of the vertebral body. In relation to these borders, they may develop on either the anterior or posterior aspect (Nathan, 1962; Van der Merwe et al., 2006). Intervertebral disc degeneration can be caused by a combination of factors, such as primary pathology, strenuous labour that exerts pressure on the spine, or aging (Van der Merwe et al., 2006).

In a normal spine, vertebral osteophytes do not develop before the vertebral epiphyseal rings have fused; a process that occurs around 20 years of age (Krogman & İşcan, 1986; Nathan, 1962). At this time, bony spurs may begin to appear and increase in severity and frequency, as the individual gets older and intervertebral disc degeneration starts (Van der Merwe et al., 2006).

The main reason for the development of osteophytosis is pressure exerted on the spinal column over time, leading to collapse of the intervertebral disc and general weakening of the vertebral column due to the process of aging (Shore, 1934; Maat et al., 1995; Van der Merwe et al. 2006). As a person becomes older, osteophytes develop in an attempt to capture the bulging sides of the vertebral disc in response to continual pressure and weakening of the intervertebral structure (Nathan, 1962; Lipson & Muir, 1980; Van den Berg, 1999).

Some investigators link the pattern of anterior osteophyte development in the vertebrae to the secondary curvatures of the spine, which are a result of human bipedality (Shore, 1934; Nathan, 1962; Chapman, 1972; Roberts & Manchester, 1995; O'Neill et al., 1999; Van der Merwe et al., 2006). These curvatures, when compared to the line of gravity, are defined as the tip of the odontoid process being the top of the cervical curve and C4 being the point the furthest away from the line in the cervical region (Shore, 1934). It passes through T2, which is the end of the cervical and the top of the thoracic curves. The point of maximum curvature in the thoracic region is on T7 and T8, with the line then passing through T12. The lumbar curve is described as being from T12 to L5. Wherever the curves are furthest away from the line of gravity, the pressure will be the greatest on the discs of the spine, and on points where the spine crosses the line, the pressure will be the least (Shore, 1934; Gloobe & Nathan, 1971). Consequently, it is hypothesized that wherever the curve is furthest away from the line, the occurrence of osteophytes will be the highest, and wherever the curve crosses the line of gravity, osteophytes will be the least (Shore, 1934; Van der Merwe et al., 2006). This pattern of vertebral osteophyte development was clearly illustrated in a study conducted by Van der

Merwe et al. (2006) on the distribution of vertebral osteophytes across the spine of South African Negroid individuals.

In advanced stages of vertebral osteophytosis, osteophytes assume the very characteristic shape of a "bird's beak", curving to the closest intervertebral space (Nathan, 1962). During this development, osteophytes of adjacent vertebrae often come into close contact with each other and seldomly fuse, causing ankylosis of the spine (Steinbock, 1976; Roberts & Manchester, 1995; Larsen, 1997).

Since the development of vertebral osteophytosis is a mostly mechanically induced condition, especially in young individuals, the incidence of these lesions differs greatly among individuals exposed to different levels of physical activity (Roberts & Manchester, 1995; Van der Merwe et al., 2006). Therefore, it is a valuable indicator of physical stress within a population (Van der Merwe et al., 2006). The presence of vertebral osteophytosis in older individuals, on the other hand, can mostly be related to the usual degenerative processes associated with aging.

2.2.6.4c Rheumatoid arthritis

Rheumatoid arthritis is a autoimmune disorder that involves the synovial membranes in the joints (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995). The disease is mostly seen in females over the age of 30 years and seems to develop due to hereditary, endocrine and metabolic factors (Steinbock, 1976 Rothschild & Martin, 1992; Roberts & Manchester, 1995).

According to Steinbock (1976), rheumatoid arthritis is initiated by the inflammation of the synovial membrane. Due to fibrin deposition and hyperplastic overgrowth, a layer of granulation tissue, also known as pannus, forms and covers the articular surfaces. This granulation layer causes complete destruction and distortion of the joint. Once the inflammation subsides, organization of the granulation tissue starts with an increase in the amount of fibrous tissue, causing fibrous ankylosis. Bony ankylosis might then develop through the ossification of the fibrous tissue (Steinbock, 1976).

Since rheumatoid arthritis is a systemic disorder, it affects almost all joints symmetrically (Rothschild & Martin, 1992). Hands, wrists, elbows, shoulders, temperomandibular joints, knees, feet as well as the cervical vertebrae, are often affected

(Roberts & Manchester, 1995; Steinbock, 1976). The sacro-iliac joint, as well as thoracic and lumbar vertebrae, are normally not affected (Rothschild & Martin, 1992). As opposed to osteoarthritis, rheumatoid arthritis generally affects younger individuals and it involves many joints in a symmetrical manner. The disease is also accompanied by marked osteoporosis (Steinbock, 1976). Bony ankylosis is uncommon, unless the person received steroid therapy. Eburnation of the affected joint rarely occurs (Steinbock, 1976; Rothschild & Martin, 1992).

2.2.6.4d <u>Ankylosing spondylitis (Marie-Strümpell disease; Morbus Von Bechterew)</u>

Ankylosing spondylitis is a chronic autoimmune disease affecting the synovial joints as well as the ligaments of the vertebral column (Steinbock, 1976; Rothschild & Martin, 1992). It normally starts with erosion of the sacro-iliac joint, sometimes progressing to fusion of the joint, from where it spreads to the lumbar, thoracic and eventually cervical vertebrae (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995). In a few cases, the pubic symphysis, hips, knees and shoulders may also become involved (Steinbock, 1976; Roberts & Manchester, 1995).

Ankylosing spondylitis mainly affects male individuals between 16 and 40 years of age, and it is hereditary (Steinbock, 1976; Rothschild & Martin, 1992;Roberts & Manchester, 1995). The condition is rarely seen in African populations (Roberts & Manchester, 1995). The disease is normally initiated by an inflammation of the sacro-iliac joint as well as the costovertebral joints, followed by bilateral bony ankylosis that spreads over the whole vertebral column (Steinbock, 1976; Roberts & Manchester, 1995). Should the disease develop further, inflammation and eventual ossification of the annulus fibrosis occurs, with ossification of longitudinal ligaments in severe cases (Steinbock, 1976; Rothschild & Martin, 1992; Roberts & Manchester, 1995). Ossification may progress to a point where ossified ligaments form a solid smooth sheet of bone across the spine, giving it a very characteristic bamboo appearance; hence referred to as bamboo spine (Steinbock, 1976; Rothschild & Martin, 1992).

2.2.6.4e Septic arthritis

Infectious arthritis of a synovial joint develops due to an original infectious disease, such as osteomyelitis, tuberculosis or syphilis (Steinbock, 1976). Pyogenic infectious arthritis is normally caused by osteomyelitis and may affect knees and hips of infected individuals under the age of 16 years (Steinbock, 1976; Roberts & Manchester, 1995). The condition can be recognized by sinus tracts in the epiphyses and diaphyses for the draining of puss in addition to arthritic changes (Steinbock, 1976). Ankylosis of the affected joint is often seen (Steinbock, 1976).

Tuberculous arthritis is caused by systemic tuberculosis (Steinbock, 1976; Roberts & Manchester, 1995). The macroscopic characteristic of infectious arthritis caused by tuberculosis is very similar to pyogenic infectious arthritis. It also affects the hips and knees and is often seen in individuals younger than 16 years of age. It might be distinguished from pyogenic infectious arthritis by the regular involvement of the vertebral column (Steinbock, 1976).

2.2.6.4f Psoriatic arthritis

Psoriatic arthritis is a condition associated with chronic psoriasis, which is an autoimmune skin disease. The onset of this condition is normally between the ages of 20 and 50 years, and males and females are equally affected (Roberts & Manchester, 1995; Ortner, 2003). Psoriatic arthritis has been reported in approximately 5% of individuals suffering from psoriasis. The exact cause of this condition is unknown (Roberts & Manchester, 1995). It has been suggested that some individuals are genetically predisposed for this abnormal immune response, which is commonly triggered by a streptococcal organism (Ortner, 2003).

Joint lesions, very similar to ankylosing spondylitis and rheumatoid arthritis, develop due to this condition. Characteristic lesions include arthritic changes to the sacroiliac joint and ankylosis of the vertebral column (Roberts & Manchester, 1995). In cases where the cervical spine is involved, the intervertebral joints may be damaged resulting in subluxation and eventual ankylosis in an abnormal position (Ortner, 2003).

Lesions also tend to affect joints symmetrically. Complete or partial resorption of the distal phalanges may also be observed, resulting in the shortening of the fingers and toes. Destruction of the distal interphalangeal joints often result in the pointing of the intermediate phalanx and flaring of the proximal end of the distal phalanx. No osteoporotic changes are associated with this condition, as seen in rheumatoid arthritis (Ortner, 2003).

2.2.6.4g Gout

Primary gout is a hereditary metabolic disorder, resulting in the abnormally high production of uric acid. This causes the deposition of uric acid crystals in the cartilages and epiphyses of bones, causing inflammation of the affected joint. The condition is normally seen in the joints of the lower extremities and hands of males (Steinbock, 1976; Roberts & Manchester, 1995). Macroscopic paleopathological observations of gout may be similar to osteoarthritis, but are usually distinct due to the characteristic tophic lesions.

2.2.6.5 Occupational changes (Enthesopathies and cortical pitting)

The first publication on diseases associated with certain occupations was written by Bernardiino Ramazzini in 1700. (Kennedy, 1989; Roberts & Manchester, 1995). These diseases mostly did not involve skeletal changes, but it set the stage for other studies to come (Roberts & Manchester, 1995). In AD 1892, 'Wolf's law of transformation' was formulated. According to this law, "bone will adapt to functional pressure or force by increasing or decreasing in its mass to resist the stress" (Kennedy, 1989; Roberts & Manchester, 1995; Stock & Pfeiffer, 2001). This is the fundamental concept on which the study of skeletal changes and its association with occupation is based. According to this law, should a person participate in habitual activities, certain parts of the skeleton will respond by becoming larger, or it will degenerate at a faster rate then when subjected to normal aging stress (Kennedy, 1989; Roberts & Manchester, 1995; Stock & Pfeiffer, 2001). Accordingly, osteophytes, enthesophytes and various other spurs develop in order to enlarge the bony framework and thus dissipate the pressure. In this manner, prolonged strain and increased pressure exerted on the skeleton will cause changes, which can be interpreted as markers of occupational (or habitual) strain (Kennedy, 1989).

A multitude of studies have since been done on the skeletal changes and stress by authors such as Dutour (1986), Kennedy (1989) and Stirland (1991). Some focused on specific activities and its skeletal signature, such as auditory exostoses in individuals who regularly submerge in cold water and the presence of an os acromiale (non-fusion of the acromial process) in persons who regularly participate in archery (Kennedy, 1986; Stirland, 1991; Lai & Lovell, 1992; Roberts & Manchester, 1995).

Other studies investigated the incidence and pattern of osteoarthritis to describe difference in lifestyles and subsistence, such as the change from hunter-gathering to agriculture (Kennedy, 1989; Lai & Lovell, 1992; Roberts & Manchester, 1995). This might seem like a stretch of evidence, since several activities are participated in each day, and any of these could affect the body. However, according to Merbs (1983), activities necessary for survival will be repeated over and over again, and it is these activities that will initiate development of osteoarthritis or enthesophytes in strained joints. It is thus suggested that sexual divisions of strenuous labour can be investigated by interpreting differences in the distribution of certain stress markers between males and females in a population (Larsen, 1997; al-Oumaoui I et al., 2004). Likewise, by comparing osteological indicators of stress between populations, comparisons can be made regarding the levels of strenuous activities they participated in daily (Kennedy, 1989; al-Oumaoui I et al., 2004).

The presence of skeletal markers on bone depends greatly on the physical activity the individual participated in, but it should be kept in mind that the development of markers is influenced by age, sex and hormonal levels, as well as genetic differences (al-Oumaoui et al., 2004; Wilczak, 1998). Therefore, care should be taken not to compare populations showing large differences in skeletal size and sexual dimorphism, since this will make the comparison unreliable. The mean age of comparative samples should also be examined. Since indicators of stress increase with increasing age, similar age distributions should be present in comparable populations (al-Oumaoui et al., 2004; Kennedy, 1989).

Osteoarthritis is strongly associated with age, as mentioned earlier, and therefore the presence of this condition in younger individuals can most likely be linked to occupational stress (Roberts & Manchester, 1995; Weiss, 2006). Other indicators of stress includes enthesophyte formations, cortical defects as well as changes in the size and robusticity of bones (Roberts & Manchester, 1995). Cortical defects can be described as a crater-like defect at the site of muscle attachment on bone due to deep tendon insertion. An example of this condition is distal femoral cortical "pitting". This lesion is characterized by a crate-like defect above the medial condyle, due to excessive strain at the site of attachment of the medial head of the gastrocnemius muscle. These lesions are usually bilateral (Mann & Murphy, 1990).

Enthesophytes (also sometimes wrongly referred to as osteophytes) can be recognized as new bone formation, or spur development, at the location of muscle and tendinuous insertions (Mann & Murphy, 1990; Roberts & Manchester, 1995). These lesions develop due to an increase in the muscle size as well as continuous strain exerted on the associated muscle or tendon due to increased physical activity (Mann & Murphy, 1990; Roberts & Manchester, 1995). These spurs, which are often asymmetrical, are frequently seen on the linea aspera, greater and lesser trochanter of the femur, iliac crest, ischial tuberosity, ischial crest, ischial spine, obturator foramen, the attachment of the achilles tendon in the calcaneus, supinator crest of the ulna, radial tuberosity, and popliteal line of the tibia (Mann & Murphy, 1990).

2.2.7 Non-specific indicators of pathology

2.2.7.1 Introduction

Although some pathological conditions such as syphilis, tuberculosis and dental caries leave very specific and relatively easily identifiable lesions on bone, other diseases causing general periostitis, osteomyelitis and cribra orbitalia, do not. Individuals exposed to nutritional deficiencies and an environment with a high pathogen load (viruses, bacteria and parasites) during their development often present these non-specific markers of pathology (Stuart-Macadam, 1992; Roberts & Manchester, 1995; Buckley, 2000; Buzon, 2006). Although these lesions are not representative of a specific pathological condition, they are valuable indicators of the general level of hardship within a skeletal population (Roberts & Manchester, 1995; Steyn & İşcan, 2000; Buzon, 2006). These non-specific markers of pathology give an indication of the living conditions and socio-economic status of past populations (Steyn & İşcan, 2000).

Stress in this context can be defined as a physical disruption caused by unhealthy environmental conditions resulting in pathological adaptation (Buzon, 2006). Stressors include pathological, dietary, occupational, environmental or cultural aspects that prove to be threatening to the health of the individual (Buckley, 2000). The development of skeletal lesions during these periods of stress is dependant upon the timing, duration and magnitude of the onslaught (Wood et al., 1992; Buzon, 2006). These unhealthy conditions, particularly during childhood, result in non-specific markers of pathology (Buzon, 2006).

Non-specific indicators of pathology can be divided into two categories: bone indicators and dental indicators. Bone indicators of pathology include non-specific periostitis, cribra orbitalia, porotic hyperostosis and Harris lines (Roberts & Manchester, 1995; Buzon, 2006). Dental indicators of stress are enamel hypoplasia (reviewed in dental section).

For the purpose of this study, periostitis and cribra orbitalia will be reviewed.

2.2.7.2 Periostitis

Periostitis is usually the result of pathological changes of the underlying bone, due to trauma, malnutrition, infection and venous insufficiency, as in varicose veins (Mann & Murphy, 1990; Larsen, 1997; Walker, Cook & Lambert, 1997; Ortner, 2003). The periosteum is a fibrous layer of connective tissue, which covers all bones in the skeleton. Even after growth had ceased, the inner layer of the periosteum retains osteogenic capabilities (Larsen, 1997; Ortner, 2003). Therefore, the periosteum has the ability to produce bone, should it be disturbed or subjected to pathological conditions (Ortner, 2003).

Infection can reach the periosteum from infectious lesions on the adjacent or surrounding soft tissue, via systemic dissemination of the infective pathogens from lesions located somewhere else in the body or from the bone marrow (Ortner, 2003). Infection of the periosteum (periostitis) usually results in the formation of woven bone. It has an irregular appearance and is hypervascular (Mann & Murphy, 1990; Larsen, 1997;

Ortner, 2003). Focal periosteal bone deposition may eventually form a plaque-like sheet over the cortex of the affected bone (Mann & Murphy, 1990; Larsen, 1997; Lovell, 1997).

Periosteal reaction can be divided into specific and non-specific periosteal lesions (Ortner, 2003). Specific periostitis are lesions of subperiosteal bone growth, which can be linked to a specific disease, such as treponemal infection, rheumatoid arthritis, leprosy or scurvy, to name but a few (Mann & Murphy, 1990; Ortner, 2003). Non-specific lesions on the other hand cannot be linked to a specific pathological condition. These non-specific periosteal lesions are some of the most common abnormalities seen in archaeological remains (Ortner, 2003). It has been suggested by Larsen (1997) that the incidence of these lesions increases as stressful living conditions increase.

Periostitis most often develops in areas such as the anterior tibia where the blood flow is slow, allowing for the depositions of microorganisms. The periosteum is also close to the skin surface and is thus more at risk to trauma (Ortner, 2003). Longstanding subperiosteal lesions can be completely incorporated into the cortex and the woven bone can be replaced by remodelled lamellar bone (Larsen 1997; Ortner, 2003). Healed periostitis can be recognized by a smooth bone surface that appears to be somewhat blown up (Larsen, 1997).

Although the presence of periosteal bone lesions is a non-specific indicator of disease, the investigation of these lesions are important in the assessment of health in a community (Larsen, 1997).

2.2.7.3 Cribra orbitalia

Cribra orbitalia, also known as usura orbitae or hyperostosis spongiosa orbitae, was first described by Welcker in 1888, who noticed the lesions in 3.7% of German crania (Steinbock, 1976). These lesions are normally bilateral and can be recognized as small holes in the superior roofs of the orbits (Steinbock, 1976; Mann & Murphy, 1990; Buckley, 2000; Wapler et al., 2004).

It is generally known that cribra orbitalia is more prevalent in children and that adults less frequently present with these lesions (Steinbock, 1976). Fairgrieve (2000) observed the same distribution pattern in a study on two population samples from the Dakhleh Oasis, where 100% of individuals younger than 18 years and 75% of adults presented with the condition.

The cause of this condition is still very much under debate (Steinbock, 1976; Stuart-Macadam, 1989; Mann & Murphy, 1990; Stuart-Macadam, 1992). Iron-deficiency, scurvy, malnutrition, chronic gastrointestinal bleeding, ancylostomiasis as well as infectious diseases have all been associated with the development of cribra orbitalia (Mann & Murphy, 1990).

Earlier views suggested that inflammation of the lacrimal gland might be responsible for the development of the condition (Steinbock, 1976; Wapler et al., 2004). Infection of the lacrimal gland is often seen in individuals suffering from leprosy (Steinbock, 1976) It was accordingly suggested that this infection was responsible for the high incidence of cribra orbitalia (69.7%) in individuals excavated from a leprosarium cemetery in Denmark (Moller-Chritensen & Sandison, 1963; Steinbock, 1976). Other infectious diseases such as mumps and trachoma have also been suggested to cause cribra orbitalia (Moller-Chritensen & Sandison, 1963; Steinbock, 1976). It should be kept in mind that orbital lesions, identical to the condition in humans, is also often seen in other primates such as gorillas and chimpanzees. These animals do not suffer from leprosy or mumps and therefore it cannot be accepted that these infectious diseases are exclusively responsible for the condition in question (Steinbock, 1976).

Nutritional deficiencies have been described as a possible cause for cribra orbitalia. Since the growing skeleton is much more susceptible to nutritional disturbances, it explains why children more often presents with the condition (Steinbock, 1976). It is also suggested that infectious diseases such as leprosy can cause nutritional disturbances and this will explain the close relationship between the infection and cribra orbitalia found in skeletons (Steinbock, 1976; Fairgrieve & Molto, 2000). Angel (1964) noted that poor living conditions could be linked to an increase in the incidence of cribra orbitalia. It was suggested that the lesions could be due to thalassemia or a childhood vitamin deficiency or both (Angel, 1964; Steinbock, 1976). The same was observed by Nathan and Haas (1966), with a higher incidence of the condition in population groups known to have lived under conditions of restricted nutritional resources (Nathan & Haas, 1966; Steinbock, 1976).

Lack of certain nutritional elements are most likely responsible for the development of cribra orbitalia. The first of these is vitamin C. As described earlier in the discussion on scurvy, vitamin C deficiency can cause cribra orbitalia due to haemorrhage between the periosteum and the anterior orbital roof (Steinbock, 1976).

It is currently suggested that cribra orbitalia is the result of anaemia due to iron deficiency, although other conditions such as malaria and parasites causing haemolytic anaemia also plays an important part in the formation of these lesions (Steinbock, 1976; Stuart-Macadam, 1989; Stuart-Macadam, 1992; Fairgrieve & Molto, 2000; Jacobi & Danforth, 2002; Peckmann, 2003; Wapler et al., 2004). According to the Oxford Medical Dictionary (2004: 28), anaemia is a condition recognized by 'a reduction in the quantity of the oxygen-carrying haemoglobin in the blood' (Kent et al., 1994). An iron deficiency and consequent anaemia can develop due to inadequate sources of iron being consumed, blood loss, haemorrhage, chronic diarrhoea and parasitic infections (Stuart-Macadam, 1989; Larsen, 1997). There are accordingly two models to explain the occurrence of iron deficiency anaemia: the dietary model and the parasite model.

According to the dietary model, iron deficiency anaemia can be linked to inadequate iron being consumed or the regular consumption of products that inhibits iron absorption in the body (Lallo et al., 1977; Mensforth et al., 1978; Peckmann, 2003). Apart from the fact that traditional diets consisting mainly of maize and vegetables are low in iron, Tannins (polyphenols) found in vegetables inhibits the uptake of iron and phytic acid in maize make any iron available in the food unusable (Garn, 1992; Peckmann, 2003).

The parasite model was introduced by Stuart-Macadam (1992). According to this model, iron deficiency anaemia is more likely to develop due to chronic infection or parasitism than due to an inadequate diet. It is said that the body, as part of an immune response, creates an anaemic condition when an individual is exposed to an environment with a high pathogen load (Buckley, 2000; Peckmann, 2003). Many microorganisms do not have their own iron supply and are reliant on the iron they receive from their host for their survival and replication (Kent et al., 1994). Humans have thus developed mechanisms in order to withhold iron from pathogens. The first mechanism is by iron binding proteins such as transferrin and lactoferrin (Peckmann, 2003). The second is by lowering the concentration of plasma iron (Kent et al., 1994). By withholding the iron from the blood, thus inducing an anaemic condition, microorganisms in need of the iron for replication are starved (Kent et al., 1994; Buckley, 2000). Iron deficiency anaemia thus becomes a successful physiological adaptation in environments with a high pathogen load (Kent et al., 1994; Buckley, 2000).

Another important parasite to keep in mind is the hookworm (Cook, 1980; Peckmann, 2003). According to Cook (1980), a single hookworm can remove 0.05 - 0.2 ml of blood per day, resulting in anaemia, should many worms be involved.

Although the exact cause of this condition is uncertain, it is generally accepted that these lesions are an indication of the stress a population is exposed to, be it malnutrition or endemic diseases (Steinbock, 1976; Larsen, 1997; Wapler et al., 2004).

2.3 PALAEOHISTOPATHOLOGY

2.3.1 Introduction

The examination of the histological structure of archaeological bone does not only help investigators estimate age at death of individuals, inform them whether the bone is human or not, or give information regarding the preservation of the bone, but can also aid in the accurate diagnosis of pathology (Martin & Armelagos, 1979; Garland, 1993; Herrmann, 1993; Schultz, 2001; Maat, 2004). Reliable diagnosis of pathological bone lesions is the basis of reconstruction of diseases in past populations (Schultz, 2001; Schultz, 2003). Macroscopic investigations, conventional X-rays and CT scans are techniques available to study pathological lesions present in bone, but false diagnosis are still common due to the absence of soft tissue evidence and similarities in the bone lesion formation of different diseases (Ortner & Putschar, 1981; Mann & Murphy, 1990; Schultz, 2001). Therefore, it is important that different techniques, microscopic methods in particular, should be developed and refined in order to increase the accuracy with which the diagnosis of pathological lesions can be done (Schultz, 2003; Schultz, 2001).

Light microscopic investigation of dry human bone was first done at the end of the 19th century. In 1889, Schaffer published the first paper describing the microscopic structure of fossil bone (Stout, 1978; Schultz, 2001;Schultz, 2003). Microscopic investigation of palaeopathological lesions has been done since 1920, with valuable research published by Moodie (1923) and Weber (1927), to name but a few (Stout & Teitelbaum, 1976; Schultz, 2001; Schultz, 2003). Recent studies included research on the histomorphological characteristics of bony lesions caused by treponemal disease, leprosy, haematogenous osteomyelitis, periostitis, tumours and haemorrhagic reactions such as scurvy (Schultz, 2001; Schultz, 2003b; Maat, 2004; Von Hunnius et al., 2006). Unfortunately, many of the recent publications are in German, making it difficult to understand the details of the results.

2.3.2 General histology of bone

A sheath of dense fibrous connective tissue containing osteoprogenitor cells, called the periosteum, covers all bones (Coetzee et al., 2003; Junqueira & Carneiro, 2005; Ross & Pawlina, 2006). In actively growing bones, the periosteum consists of a fibrous dense connective tissue outer layer and an inner layer consisting of osteoprogenitor cells (Junqueira & Carneiro, 2005). In the absence of active bone formation, the periosteum mainly consists of the fibrous dense connective tissue. The inner layer is ill-defined.

It should be kept in mind, though, that the few periosteal cells that are present in the inner layer are capable of dividing through mitosis and becoming osteoblasts when subjected to an appropriate stimulus (Junqueira & Carneiro, 2005; Ross & Pawlina, 2006). Bone cavities are lined by a single layer of cells called the endosteum (Coetzee et al., 2003; Junqueira & Carneiro, 2005). These cells can differentiate into osteoblasts if necessary (Ross & Pawlina, 2006).

Two types of bone can be observed: woven bone and lamellar bone (Junqueira & Carneiro, 2005). Woven bone, also known as primary bone tissue or immature bone, is newly formed bone, like callus, and is gradually replaced by secondary bone. The former is characterized by irregular arrangements of collagen fibres. Secondary or lamellar bone, on the other hand, is characterized by the organization of mineralized collagen in lamellae (Junqueira & Carneiro, 2005). Two types of lamellar bone can be distinguished, compact bone and cancellous bone (Young & Heath, 2000).

Cancellous bone is composed of thin trabeculae made up of irregular lamellae of bone normally not containing any Haversian systems, as is characteristic of compact bone (Young & Heath, 2000). Lamellar compact bone, on the other hand, is composed of fields of parallel lamellae (e.g. subperioseal) or cylindrical units referred to as osteons or Haversian systems (Figure 2.1). An osteon consists of several concentric lamellae of bone surrounding a central Haversian canal (Coetzee et al., 2003; Ross & Pawlina, 2006). This canal contains the vascular as well as nerve supply of each osteon. The long axis of an osteon is usually parallel to the long axis of the bone (Coetzee et al., 2003; Junqueira & Carneiro, 2005; Ross & Pawlina, 2006). Circumferential lamellae enclose the Haversian systems and form layers of bone matrix following the entire inner and outer circumference of the bone (Figure 2.1) (Coetzee et al., 2003). The layer of external lamellae is thicker than the internal lamellae. The number of internal and external lamellae decreases with age and is gradually replaced by Haversian systems (Schultz, 2001). Volkmann's canals run perpendicular to the long axis of lamellar bone and Haversian systems and allow vascular as well as nervous tissue to enter the bone. It also serves as connections between Haversian canals (Coetzee et al., 2003; Junqueira & Carneiro, 2005; Ross & Pawlina, 2006). It is important to note that the Volkmann's canals are not surrounded by concentric lamellae (Junqueira & Carneiro, 2005; Ross & Pawlina, 2006).

Lamellae in lamellar bone are separated from each other distinctly, due to the arrangement of lacunae with osteocytes and the orientation of the collagen fibres within each layer (Schultz, 2001). Lacunae can be found on the borders between lamellae and they contain osteocytes. Canaliculi radiate from these lacunae, connecting the lacunae to each other as well as to the Haversian canal (Coetzee et al., 2003).

Mineralized collagen fibres have a typical orientation within each layer of lamellar bone (Schultz, 2001). When the collagen fibres look bright in polarized light, they are in a transverse orientation in relation to the light beam (Schultz, 2001; Schultz, 2003). The light beam meets the collagen fibre vertically, and the layers are referred to as anisotropic layers (Schultz, 2001; Junqueira & Carneiro, 2005). When the collagen appears dark, the light beam meets the fibres at an oblique angle (isotropic layers) (Junqueira & Carneiro, 2005; Schultz, 2001; Schultz, 2003).

These alternating bright and dark layers thus develop due to the changing orientation of collagen fibres in each lamella. Within each lamella, fibres are arranged parallel to each other following a helical course. The pitch of the helix is different for each lamella. Collagen fibres are accordingly arranged that at a specific point, the fibres in adjacent lamellae are at right angles to each other (Junqueira & Carneiro, 2005)

Three types of cells can be distinguished in bone: osteoblasts, osteocytes and osteoclasts. Osteoblasts are responsible for bone deposition (growth). These cells synthesize osteoid (a collagenous extracellular matrix) and initiate its mineralization. Osteocytes are inactive osteoblasts trapped within formed bone and osteoblasts are phagocytic cells with the ability to resorb bone. Thus, two types of cells are important to recognize, i.e. osteoblasts and osteoclasts. The relationship between these two groups of cells is responsible for the remodelling of bone (Young & Heath, 2000).

2.3.3 Diagnosis of pathological conditions through microscopic investigations

Many pathological conditions such as dental caries, fractures, myositis ossificans, genetically caused malformations, treponematosis, non-specific osteomyelitis and bone tumours, to name but a few, can be positively recognized and diagnosed macroscopically from bone lesions (Ortner & Putschar, 1981; Mann & Murphy, 1990; Henneberg, 1991; Rothschild & Martin, 1992; Roberts & Manchester, 1995; Jurmain & Bellifemine, 1997; Hillson, 1998; Schultz, 2001; Schultz, 2003). Nevertheless, the diagnosis of many of the lesions are still ambiguous, be it due to the often fragmentary condition of archaeological remains, or the similarities in lesion formation between various diseases (Ortner & Putschar, 1981; Mann & Murphy, 1990; Roberts & Manchester, 1995; Schultz, 2003). It has accordingly been suggested by Schultz (2001) that many diseases cause specific changes on the microscopic level of bone, which might aid in the accurate diagnosis of disease (Schultz, 2003; Von Hunnius et al. 2006).

It is important to note that only mineralized structures and collagen can be studied during microscopic investigation of archaeological bone, and that no soft tissue and cells are present (Stout, 1978; Schultz, 2001). The only organic component of bone present in archaeological material is collagen (Stout, 1978). The nature of the mineralized architecture of bone, in particular of newly formed bone, is thus of great importance (Stout, 1978; Schultz, 2001).

For the purpose of this study, only microscopic features of proliferative periosteal reactions on the long bones will be reviewed, in particular lesions caused by scurvy and treponemal infection.

Numerous diseases can be responsible for bone formation on the surface of long bones, such as haematogenous osteomyelitis, treponemal disease, leprosy, scurvy and trauma, to name a few (Steinbock, 1976; Ortner & Putschar, 1981; Mann & Murphy, 1990; Roberts & Manchester, 1995; Rothschild & Rothschild, 1995; Schultz, 2001). Two behaviours of bone can be recognized during microscopic investigation of bone, namely proliferate (osteoblastic) or osteolytic (osteoclastic) patterns (Martin & Armelagos, 1979; Schultz, 2003). The first is responsible for the deposition of new bone and the latter causes the resorption of bone (Coetzee et al., 2003; Junqueira & Carneiro, 2005; Ross & Pawlina, 2006).

According to Schultz (2001), three groups of bone changes due to newly formed bone (proliferate behaviour) on the surface of long bones, can be described microscopically: hemorrhagic, inflammatory, and tumorous. Haemorrhagic changes, such as an ossified haematoma that develops, for instance, due to scurvy, is characterized by newly build spongy bone onto the external surface of the original bone (Schultz, 2001; Schultz, 2003). It has been shown that subperiosteal haematomas might develop and calcify on the long bones of individuals suffering from scurvy. Histological investigation of diaphyseal bone in vitamin C deficient guinea pigs indicated that the calcified haematomas consisted of narrow bony trabeculae radiating from the original bone surface to the periosteum. As was also noted by Schultz (2001), these radiating trabeculae often join together with bony bridges (Murray & Kodicek, 1949). The external circumferential lamellae of the original bone are still intact and the compact bone substance seems unaffected (Schultz, 2001). It was also shown by Murray and Kodicek (1949) that once the vitamin C deficient diet is corrected, the structure of the radiating trabeculae starts to change. Spaces separating the trabeculae start to narrow and the trabecular bone gets remodelled into compact bone, while still retaining its former radiating architectural characteristics. Therefore, the radiating structure of the previously formed trabeculae may still be visible (Murray & Kodicek, 1949).

Infectious diseases, such as non-specific osteomyelitis and treponematosis, can also cause bone apposition on the external surface of long bones, but in those cases, the border between the original bony cortex and the newly formed bone, the periosteal surface, becomes broken up and disappears (Maat, 2006). Chronic osteomyelitis can often be identified by recurring periostitis on the original bone surface, resulting in layers of short bulky trabeculae forming on top of each other. Accordingly, several layers of newly formed bone (resembling periostitic changes microscopically) can often be distinguished. This picture can sometimes also be seen in non-specific osteomyelitis and in specific infections such as treponemal and lepromatous periostitis (Schultz, 2003).

According to Schultz (2003), lesions caused by treponemal disease are characterized by "polsters" and "grenzstreifen" when examined under polarized light (Schultz, 2001; Schultz, 2003; Von Hunnius et al., 2006). "Polsters", also translated to "padding", can be identified as lamellae at the periosteal level resembling pillow-like, newly build bone delimited by periosteal blood vessels (Schultz, 2001; Schultz, 2003; Von Hunnius et al., 2006). These structures seem regular and homogeneous (Schultz, 2003). Polsters may also be observed in bony lesions caused by lepromatous periostitis, but they are often underdeveloped and flat (Schultz, 2001; Von Hunnius et al., 2006).

"Grenzstreifen", also translated as "border stripes", are also said to be characteristic of treponemal infection (Schultz, 2001; Schultz, 2003; Von Hunnius et al., 2006). This structure can be identified as a fine line or narrow band-like structure, which represents the original periosteal surface of the bone (Schultz, 2001; Von Hunnius et al., 2006). On the external aspect of the grenzstreifen, newly formed bone will be visible as a solid mass (Schultz, 2001). Another important characteristic of infectious changes in bone, in particular treponemal disease, is said to be the osteoclastic changes to the endosteal bone and bony trabeculae. This results in resorption holes, corroded structures and vestiges of extensive remodelling processes being visible throughout the original cortical bone structure (Schultz, 2001; Schultz, 2003; Von Hunnius et al., 2006).

2.4 DENTAL HEALTH

Due to the extremely hard and robust structure of teeth, they are normally recovered during archaeological excavations and are accordingly available for investigation (Hillson, 1979; Roberts & Manchester, 1995).

The investigation of teeth can yield important information, such as an indication of the age at the time of death, clues regarding oral health and diet, stress levels during childhood as well as non-dietary, habitual or occupational behaviours the person participated in (Hillson, 1998; Lukacs, 1995; Roberts & Manchester, 1995; Ortner, 2003).

The oral cavity is mainly responsible for food processing (Hillson, 1979; Lukacs, 1989a). The composition and the consistency of different foods consumed determine the types of microorganisms present in the mouth as well as the degree of dental attrition (Lukacs, 1989a). Therefore, the study of dental pathology can yield information regarding the dietary characteristics of earlier population groups (Hillson, 1979; Lukacs, 1989a; Walker & Hewlett, 1990).

Several anomalies and dental diseases can be investigated, such as the incidence of carious lesions, antemortem tooth loss, dental wear, enamel hypoplasia and supernumerary teeth, to name but a few (Hillson, 1979; Hillson, 1998; Roberts & Manchester, 1995; Ortner, 2003). All of these conditions add to our understanding of past populations.

2.4.1 Dental caries

Dental caries can be defined as an infectious disease during which progressive demineralization of the tooth structure is initiated by microbial activity on the tooth surface (Lukacs, 1989a; Henneberg, 1991; Larsen, 1997; Hillson, 1998; Ortner, 2003). The bacteria usually associated with the formation of carious lesions are *Streptococcus mutans* as well as *lactobacillus, actinomyces*, *Staphylococcus,* and *Veillonella* (Henneberg, 1991; Roberts & Manchester, 1995; Hillson, 1998; Ortner, 2003).

The cause of carious lesions is multifactorial (Sealy et al., 1992; Roberts & Manchester, 1995). Factors such as the types of food consumed, the fluoride content of drinking water, oral hygiene, the anatomical features of teeth, genetic susceptibility and the quality of tooth enamel influences the development and distribution of carious lesions (Henneberg, 1991; Sealy et al., 1992; Ortner, 2003). Therefore, the etiological factors responsible for the development of carious lesions can be divided into two groups, namely essential factors and modifying factors (Henneberg, 1991; Larsen, 1997).

Essential factors are those that have to be present in order for carious lesions to develop. The first of these is that the host (in this instance the various types of teeth) should be susceptible: bacteria, viruses, fungi and other microbes can be found everywhere in the mouth, including the lips, palate, tongue, cheeks and gums. Fortunately, these microbes can only adhere to the above-mentioned surfaces for a limited period due to constant shedding of the mucosa covering these structures. Teeth, on the other hand, have a hard, non-shedding surface with fissures and crevices. Salivary flow and contact with the cheeks and tongue is limited, if not impossible in these crevices and fissures, resulting in a perfectly undisturbed environment for microbes (Hillson, 1998). Thus, it is clear that the more complicated the anatomical structure of the tooth, the more susceptible it will be to caries formation, making molar and premolars more prone to carious lesions than anterior teeth (Hillson, 1998; Holm, 1990).

A second essential factor is the presence of plaque. Plaque contains organisms, such as *Streprococcus mutans, S. salivarius, S. oralis* and *Veilonella* to name but a few, which produce acids and consequently cause a decline in the pH on the tooth surface it adheres to (Hillson, 1979; Holm, 1990; Hillson, 1998). During this acidic condition, minerals in the enamel are dissolved, leading to cavitations (Hillson, 1979; Richardson, 1982).

The last essential factor is food. The cariogenicity of food is determined by the amount of simple sugars present (Davies, 1963; Hillson, 1979; Richardson, 1982; Holm, 1990; Walker & Hewlett, 1990; Henneberg, 1991). Starches, when consumed alone, have a low cariogenicity, but when it is combined with sugar, it becomes a major cariogenic factor (Turner, 1979; Holm, 1990;Hillson, 1998). The higher the sugar content of food, and the simpler the composition of the carbohydrate being consumed, the more cariogenic the food (Hillson, 1979; Turner, 1979; Holm, 1990; Sealy et al., 1992; Walker & Hewlett, 1990; Hillson, 1998). It has been shown that the regular consumption of food with a high protein and fat content causes plaque to produce an alkaline environment, thus lowering the changes of caries development (Hillson, 1979; Walker & Hewlett. 1990).

The texture of food is also important. Food with a rough and hard texture is less cariogenic than those which are sticky and soft (Davies 1963; Richardson, 1982; Henneberg, 1991). Studies have shown that there is a strong relationship between attrition caused by the consumption of rough foods, and the prevalence of carious lesions (Maat & Van der Velde, 1987; Larsen, 1997; Hillson, 1998). Carious lesions are often visible between the grooves and fissures of unworn molar crowns. Increased dental wear, be it due to dietary composition or cultural practices, reduces the depth of the grooves on the crowns and often removes these fissures from molar teeth altogether. This leads to a decline in the incidence of carious lesions (Larsen, 1997; Hillson, 1998). The association between dental wear and dental caries should however not be over-generalized (Hillson, 1998). The consumption of food with a rough texture but a high carbohydrate content can cause a positive correlation between attrition and the incidence of carious lesions (Larsen, 1997). It has also been shown that frequent eating increases the incidence of carious lesions (Davies, 1963; Richardson, 1982; Henneberg, 1991; Hillson, 1998).

Modifying factors are not necessary for the formation of caries, but they have an influence on the distribution of the dental lesions, the speed at which the lesion progresses and the remineralization of the defect (Henneberg, 1991; Larsen, 1997). The first modifying factor is saliva (Henneberg, 1991). The composition of saliva and its rate of flow can aid in the mechanical cleansing of teeth, reduce enamel solubility, buffer and neutralize acids caused by plaque and function as an antibacterial medium (Richardson, 1982; Henneberg, 1991). Therefore, salivary flow causes a decline in the number of carious lesions.

The fluoride content of drinking water can also have an influence on the frequency of dental caries within a population (Davies, 1963; Holm, 1990; Henneberg, 1991; Larsen, 1997; Hillson, 1998;Van Loveren & Duggal, 2002). The regular intake of fluoride inhibits the formation of dental caries by decreasing the solubility of dental tissue (Holm, 1990; Roberts & Manchester, 1995; Hillson, 1998; Van Loveren & Duggal, 2002). The optimal fluoride concentration in drinking water should be between 0.07mg/l and 1.2mg/l

(Silverstone et al., 1981). Too much fluoride, on the other hand, can cause fluorosis, which affects the integrity of the teeth (Roberts & Manchester, 1995).

It is also known that some systemic diseases, such as hypothyroidism, make an individual less susceptible to dental caries, whereas an increase was noted in persons suffering from diabetes and congenital syphilis. Sex and age also have an influence on the incidence of carious lesions. It is known that females and older individuals are normally more affected (Henneberg, 1991).

Oranje *et al.* (1935) suggest that oral hygiene also has an influence on the incidence of dental caries. Most native South Africans clean their teeth with their fingers and some with water after each meal (Oranje et al., 1935). Other methods include using ash, sand and some plant species (Oranje et al., 1935; Walker & Hewlett, 1990). It was concluded that the number of carious teeth per mouth is significantly lower in individuals practicing some form of oral hygiene (Oranje et al., 1935; Walker & Hewlett, 1990; Van Loveren & Duggal, 2002).

The last modifying factor is socio-economic status. This is a complex factor, as the incidence of carious lesions can either increase due to poor oral hygiene and limited dental services in people of low socio-economic status, or increase in those of high socio-economic status due to a change in diet to more refined foods and sugars (Holm, 1990; Henneberg, 1991). Therefore, the incidence of carious lesions cannot be viewed as a universal indicator of socio-economic status.

Carious lesions can be classified according to the tissue it attacks. Four different types of dental caries can be identified: enamel-, cemental-, dentine-, and pulp-caries (Henneberg 1991; Hillson, 1998). Enamel caries, also known as first-degree caries, can be recognized by the presence of microscopic white or brown opaque spot on the enamel surface of the tooth. These spots are defined as initial caries and the lesions are clearly visible under ultraviolet illumination of archaeological teeth (Shrestha, 1980; Henneberg, 1991; Hillson, 1998). As the enamel caries progresses, the white spots on the smooth enamel surface grows. The smooth surface eventually starts to break down, becomes rough en then develops into a cavity (clinical caries) (Henneberg, 1991; Hillson, 1998). Cemental caries forms through carious lesions in the thin cement coating of the roots, which got exposed by periodontal disease. These lesions form broad, shallow craters around the circumference of the root (Hillson, 1998). Dentine caries, also described as second-degree caries, occur when enamel or cement lesions spread into the dentine (Henneberg, 1991; Hillson, 1998). And finally, third-degree caries or pulp caries is recognized when the enamel and dentine have been affected by the caries, leading to opening of the pulp chamber (Henneberg, 1991).

Carious lesions can also be classified according to their anatomical location on the teeth. These include the occlusal pits and fissures (occlusal caries), the smooth surface of the crown cusps (buccal, lingual or interproximal caries) or on the root surface at the cemeto-enamel junction (neck caries) (Henneberg, 1991; Hillson, 1998). As mentioned previously, the pits and fissures of molars and premolars are a common site for carious lesion development. Microbes in plaque are safe from saliva and other cleaning mechanisms and can multiply undisturbed. Smooth surfaces of the tooth includes the sides of the crown. The smooth buccal and lingual surfaces of the teeth rarely develops carious lesions, since it can regularly be cleaned by salivary flow, the tongue and the cheeks. Therefore, plaque that causes carious lesions normally accumulates along the buccal or lingual gingival margins and between the approximal surfaces of teeth. Lastly, root surface caries, or neck caries, are closely associated with root exposure through periodontitis (Hillson, 1998).

Taking all of the above-mentioned information into account, it is a clear that the distribution of carious lesions follows a characteristic pattern. Of all the types of teeth, molars are the most affected, followed by premolars and then the anterior teeth. Taking the various tooth surfaces into account, carious lesions are more prone to develop in occlusal fissures and pits of molar teeth, followed by the interproximal surfaces with buccal and lingual aspects being least affected (Hillson, 1998).

Several problems exist with regard to the study of dental caries. Firstly, teeth are often lost or damaged postmortem. This is especially true for single rooted teeth in archaeological samples (Hillson, 1998; Ortner, 2003). A positive correlation exists between teeth lost postmortem and the amount of roots the tooth has; anterior teeth are accordingly lost more frequently (Hillson, 1998). Anterior teeth are normally also least affected by carious lesions (Hillson, 1998; Ortner, 2003). Since the incidence of dental caries is calculated by dividing the total number of teeth affected by carious lesions by the number of teeth investigated, it is obvious that a high incidence of postmortem loss of anterior teeth would cause an overestimation of the caries' intensity within the population (Hillson, 1998; Erdal & Duyar, 1999).

Antemortem tooth loss also has a significant influence on the evaluation of dental caries. Teeth lost antemortem due to carious activity cannot be investigated and dental caries frequency rates are solely based on the few teeth present, resulting in gross underestimation of the true frequency of carious lesions within the sample population being studied (Lukacs, 1995; Hillson, 1998; Erdal & Duyar, 1999; Ortner, 2003). Several authors such as Duyar (2003) and Lukacs (1995) have proposed methods to compensate for teeth lost antemortem and postmortem, in order to increase the accuracy of dental caries' frequencies within populations.

The earliest example of dental caries was found in South African Australopithecines (Henneberg, 1991). Dental caries has been studied ever since and it is known that the caries' prevalence is low within hunters and gatherers (Drennan, 1929; Turner, 1979; Morris, 1984; Walker & Hewlett, 1990; Henneberg, 1991; Sealy et al., 1992; Ortner, 2003). An increase in carious lesions were noticed after the introduction of agriculture as a major food source (Henneberg, 1991; Roberts & Manchester, 1995). Pre-agriculture and agriculture dentition was studied by Larsen (1984) and a 10% increase in the prevalence of carious lesions was noted in the dentitions of individuals producing food mainly from agricultural activities (Roberts & Manchester, 1995). The increase in dental caries can most likely be attributed to the agriculture of maize, which has a high sucrose content (Holm, 1990; Roberts & Manchester, 1995; Hillson, 1998; Ortner, 2003). A second increase in dental caries came about with the dietary conversion to refined foods high in carbohydrates (Davies, 1963; Holm, 1990; Henneberg, 1991). Thus, it can be said that dental caries is a disease caused by civilization (Larsen, 1997). This explains why the caries rate is generally higher in urban regions, where sugar is readily accessible, than in rural areas (Holm, 1990).

Several studies investigating dental health and dental caries in particular, have been conducted on populations from South Africa (Sealy et al., 1992). These include K2 and Mapungubwe, the Stone Age inhabitants of the Cape Province, the Griqua, Kakamas and Riet River populations, the 20th Century Venda and skeletal remains from Koffiefontein and Maroelabult, to name but a few (Patrick, 1989; Morris, 1992; Sealy et al., 1992; Steyn, 1994; Steyn et al., 2002; L'Abbé et al., 2003; L'Abbé, 2004).

Two studies have also been conducted on the modern South African Blacks. The first was by Oranje *et al.* (1935). It was concluded that individuals living in rural conditions with limited access to sugar had a lower caries incidence than those living on farms, mines and in towns. Other studies were done on mine labourers by Staz (1938) and Cleaton-Jones (1979), who found a caries frequency of 56% and 68% respectively (Richardson, 1982). It was eventually noted that Black South Africans, especially those from rural settings, have good teeth (Oranje et al., 1935; Richardson, 1982).

2.4.2 Antemortem tooth loss

Antemortem tooth loss (AMTL) is a non-specific indicator of pathological conditions involving the teeth and surrounding bone, and it therefore provides important information regarding the dental health of a population (Bonfigliolo et al., 2003). Several factors can be responsible for the antemortem loss of teeth, including the absence of treatment for dental diseases such as carious lesions, periodontal diseases and abscesses, severe dental attrition and continuous eruption, trauma and habitual or ritualistic tooth extraction (Turner, 1979; Morris, 1992;Hillson, 1998). Unfortunately, it is not always possible to distinguish between the abovementioned (Morris, 1989).

It has been shown that in the absence of dental treatment, the only way to relieve toothache was by tooth extraction. It can therefore be suggested that, under perfect conditions where variables such as AMTL due to trauma, extraction for cultural purposes and severe dental attrition are held constant, the incidence of AMTL should mirror the incidence of dental diseases within a population (L'Abbé, 2004).

Severe dental wear due to dental attrition can also cause AMTL (Hillson, 1979; Hillson, 1998). Due to destruction of the enamel and consequent exposure of the pulp chamber, bacterial infection of the tooth might develop, eventually leading to the loss of the affected tooth (Hillson, 1979; Lukacs, 1989; Hillson, 1998).

Tooth extraction for cultural purposes normally affects anterior teeth, such as the incisors and canines, since these teeth are visible (Morris, 1989; Steyn, 1994; Morris, 1998; L'Abbé, 2004). Dental mutilation in native population seems to be associated with beautification, initiation at the onset of puberty, or to indicate affiliation with certain groups (Van Reenen 1978; Morris 1998). Should habitual tooth extraction be present within a population, a very distinct pattern of AMTL, involving the anterior teeth, will be visible in the skeletal assemblage (Morris, 1998).

Severe dental wear and continuous eruption can also result in the antemortem loss of teeth (Whittaker, Parker & Jenkins, 1982; Danenberg et al., 1991). Severe dental wear causes a decrease in crown height. In order to compensate for this loss in tooth height, secondary eruption of teeth occurs (Baarregaard, 1949; Whittaker et al., 1982; Danenberg et al., 1991; Dean et al., 1992). It was shown by Baarregaard (1949) that severe attrition of teeth in the primitive Eskimo resulted in secondary tooth eruption, leaving only the root apices supported by bone. This usually results in maintenance of the height of the clinical crown as well as face height, at the expense of tooth support (Baarregaard, 1949; Danenberg et al., 1991). This process of secondary eruption results in loss of periodontal attachment, since the amount of root embedded in the bone gets smaller. Teeth accordingly become mobile and eventually the antemortem loss of the affected teeth will occur (Baarregaard, 1949; Whittaker et al., 1982; Danenberg et al., 1991).

Antemortem tooth loss has been studied in the Griqua, Kakamas and Riet River populations, K2 and Mapungubwe, the 20th century Venda, and the mining population from Koffiefontein (Morris, 1992; Steyn, 1994; L'Abbé et al., 2003; L'Abbé, 2004).

In general, it was noted that the incidence of carious lesions increased from Hunter-gatherers (Kakamas), where only 4.1% of individuals was affected by AMTL, to the agriculturalists (Griqua), where 17% were affected (Morris, 1992). The highest incidence of AMTL is observed in populations from mixed economies with access to refined carbohydrates and some dental care, such as the individuals from the Koffiefontein mine, where 21.2% were affected, and the 20th century Venda, with 64.9% of individuals presenting with AMTL (L'Abbé, 2004).

2.4.3 Enamel hypoplasia

Enamel hypoplasia can be recognized by an irregular linear horizontal groove or single or multiple pits in the enamel surface of the teeth, or a total absence of enamel in the most extreme cases (Lukacs, 1989a; Mann & Murphy, 1990; Goodman & Rose, 1990; Roberts & Manchester, 1995). These lesions are best visible on the buccal surface of the teeth and are caused by a deficiency in the enamel thickness due to a disruption in ameloblast activity (Goodman & Armelagos, 1985; Lukacs, 1989a; Goodman & Rose, 1990; Mann & Murphy, 1990; Lukacs & Nelson, 2001). Enamel hypoplasia seems to develop due to a disturbance of ameloblasts during the secretion of enamel matrix (Goodman & Rose, 1990). The defect provides a record of growth-disruptive stresses that occurred during early childhood (Lukacs, 1989a; Cucina, 2002; Goodman & Rose, 1990; Roberts & Manchester, 1995; King et al., 2002).

Three possible types of enamel defects can be distinguished by assessing the pattern of enamel hypoplasia across the teeth: Hereditary anomalies, trauma and stress (Goodman & Armelagos, 1985; Goodman & Rose, 1990; Hillson & Bond, 1997). Hereditary factors resulting in enamel defects are usually very severe and often affect the whole tooth crown. It affects all the teeth and the individual normally presents with other congenital problems in addition to the enamel defect (Winter & Brook, 1975; Goodman & Armelagos, 1985). The chances of survival of these individuals are rather small, and consequently very few such cases are present in archaeological skeletal assemblages (Goodman & Rose, 1990). Factors such as local trauma or non-systemic factors influencing enamel formation can cause lesions as severe as those caused by hereditary factors, but they normally only affect single or a few adjacent teeth (Goodman & Armelagos, 1985; Goodman & Rose, 1990). Defects resulting from metabolic stress will affect all teeth developing at the time the stress occurred. Therefore, the time at which the stress occurred will be reflected by the completeness of the rest of the crown (Goodman & Rose, 1990).

Enamel hypoplasia induced by trauma was recorded by William (1968). A child (eighteen months of age) fell and intrusion of the left maxillary deciduous central incisor took place. It was thought that re-eruption of the incisor would occur, but two years later, it was still intruded. A roentgenographic survey revealed that enamel hypoplasia was present on the maxillary left permanent incisor. The enamel defect was caused by the intruded deciduous incisor making contact with, slightly displacing and temporarily interrupting the blood supply of the permanent central incisor (William, 1968).

Research has indicated that the total absence of enamel can be linked to the death of the ameloblast. On the contrary, enamel hypoplasia, characterized by a decrease in the thickness of the enamel, develops due to the slowing down of secreting ameloblasts after a stressful event. The ameloblasts are thus not irreparably harmed by the insult. Should a cluster of bands therefore be present on a tooth, it can be interpreted that the individual experienced a sequence of stressful events, resulting in the temporary disruption of the ameloblasts, followed by a recovery period (Goodman & Rose, 1990).

Enamel hypoplasia has a multifactoral aetiology. The genetic susceptibility, nutritional status, as well as the type of stressors the individual is exposed to, all influence ameloblast activity, or the lack thereof. The first association between enamel hypoplasia and metabolic disturbances during development of the teeth was first made in 1895 (Goodman & Rose, 1990). Several factors can be associated with the development of enamel hypoplasia, such as nutritional deficiencies, infectious diseases such as rubella and syphilis, allergies and endocrine dysfunction such as hypothyroidism, to name but a few (Lukacs, 1989a; Goodman & Rose, 1990; Mann & Murphy, 1990; Roberts & Manchester, 1995; King et al., 2002). Although the specific cause of the enamel hypoplasia lesion can normally not be determined, it does indicate that a certain event during childhood was of sufficient magnitude to cause disruption of normal enamel development (Goodman & Armelagos, 1985; Lukacs, 1989a; Goodman & Rose, 1990; Blakey et al., 1994).

Since enamel does not have the ability to remodel and the chronological sequence of tooth development and eruption is known, it is possible to determine the developmental age at which the disruption in enamel growth occurred (Goodman & Armelagos, 1985; Lukacs, 1989a; Goodman & Rose, 1990; Blakey et al., 1994; Roberts & Manchester, 1995; King et al., 2002). The growth and development of dental enamel progresses at a fairly constant and predictable rate. During amelogenises, rows of microscopic enamel rods are produced by migrating ameloblasts. These rods are centrifugal and stretch from the dentino-enamel junction to the outer surface of the crown. The rods are arranged in transverse enamel bands around the tooth (Blakey et al., 1994). Since the developmental chronologies for enamel matrix formation in human dentition are known, the age at which a hypoplastic band occurred can be estimated (Blakey et al., 1994; Reid & Dean, 2000). This is done by measuring the relative distance between the cemento-enamel junction and the hypoplastic line.

It was found that the majority of enamel defects develop after stressful episodes in the first and fourth year of life. A possible hypothesis to explain the occurrence of enamel hypoplasia in these age groups is stress induced by weaning (Goodman & Rose, 1990; Blakey et al., 1994). The weaning process subjects the infant to two types of stress: firstly it is subjected to a possible nutritionally inadequate diet and secondly a compromised immune system (Blakey et al., 1994). However, a study conducted by Blakey et al. (1994) failed to support this theory and an alternative explanation for the consistency in the age of enamel hypoplasia was given. As was indicated by Goodman and Armelagos (1985), enamel hypoplasia in permanent teeth is most likely to occur in the middle third of the crown. Ameloblasts are described as being extremely sensitive to growth arrest in this section of the tooth, although no clear reason for the increased sensitivity can be given (Goodman & Armelagos, 1985; Blakey et al., 1994). Although stressors induced by weaning might have an influence on defect development, ameloblast sensitivity seems like a more plausible explanation for the tendency of enamel hypoplasia to develop during the second and fourth year of life (Blakey et al., 1994).

The frequency of the enamel defect is also described as being highest in the anterior teeth, followed by the premolars, with the molars being least affected (Cutress & Suckling, 1982; El-Najjar et al., 1978; Goodman & Armelagos, 1985). One possible explanation for this phenomenon is the "time of defect" hypothesis. According to this hypothesis, the number of teeth as well as the types of teeth affected by enamel hypoplasia will mirror the timing of the imposed stress. Therefore, insults occurring early in life will affect teeth developing early, and later insults will affect later developing teeth. The hypothesis assumed that all teeth developing at the time of the metabolic stress will be equally affected and that variation in the amount of teeth affected by hypoplasia is directly dependant on the development pattern of teeth (Goodman & Armelagos, 1985).

Goodman and Armelagos (1985) gave another possible explanation for the variation in distribution and frequency of enamel hypoplasia across different types of teeth. According to this hypothesis, teeth that are under more genetic control regarding their morphology and development time, such as the upper central incisors, lower lateral incisors, the upper and lower first premolars and molars, are more susceptible to developing hypoplastic lesions than those teeth under less control. Accordingly, teeth under less genetic control, including the upper lateral incisors, lower central incisors, second premolars and second and third molars, can respond to environmental stress by slowing development down or decreasing tooth size. Consequently, hypoplastic lines are less likely to develop (Goodman & Armelagos, 1985).

A study by Larsen (1984) indicates that the prevalence of enamel hypoplasia increased as the diet changed from hunter-gatherer to agricultural communities. The same results were obtained in a study conducted by Cucina (2002) on a Prehistoric skeletal sample from Trentino, Italy. It is thus suggested that the change in economy caused an increase in stress (Roberts & Manchester, 1995). The higher incidence of enamel hypoplasia in agriculturalists can most likely be attributed to two factors: firstly the dependence on agricultural products might have caused an increase in the occurrence of malnutrition and the increase in population size would have favoured the spread of diseases within these populations (Cucina, 2002).

Several studies on the incidence of enamel hypoplasia have been conducted on South African population groups. These include the Griqua, Kakamas and Riet River, K2 and Mapungubwe, Toutswe, Oakhurst as well as the 20th century Venda, Maroelabult and Koffiefontein samples (Patrick, 1989; Morris, 1992; Steyn, 1994; Steyn et al., 2002; L'Abbé et al., 2003; L'Abbé, 2004; Mosothwane, 2004).

2.4.4 Dental calculus

Dental calculus, or tartar, is caused by the mineralization of bacterial plaque (Lukacs, 1989a; Roberts & Manchester, 1995; Hillson, 1998; Whittaker et al., 1998). It can be recognized as a hard inorganic mass present on the crown or the root surface of the teeth (Lukacs, 1989a; Roberts & Manchester, 1995). Dental calculus is prone to develop near the opening of salivary glands; accordingly it is often found on the lingual aspect of the lower incisors as well as the buccal aspects of the upper molars (Roberts & Manchester, 1995; Whittaker et al., 1998; Hillson, 1998; Bonfigliolo et al., 2003).

The aetiology of dental calculus formation is still mostly unknown. It seems that the regular consumption of high-protein foods causes an increase of the alkalinity in the mouth. This change in pH favours the precipitation of minerals in the saliva and crevice fluid (Bonfigliolo et al., 2003). It should be kept in mind that the initiation of mineralization is related to the amount of plaque present on the teeth, since the organisms present in plaque destroy the inhibitors of mineralization (Bonfigliolo et al., 2003). Accordingly, poor oral hygiene and carbohydrate consumption also has an influence on tartar development (Hillson, 1998; Whittaker et al., 1998; Bonfigliolo et al., 2003).

The amount and severity of tartar deposits has a clear connection with periodontal disease. In life, these calculus deposits will irritate the gingiva, causing gingivitis and eventually periodontal disease (Lukacs, 1989a; Greene et al., 2005).

2.4.5 Periodontal disease

Dental calculus and plaque accumulating between the teeth, gingiva and bone lead to inflammation of the surrounding tissue (gingivitis) (Roberts & Manchester, 1995; Hillson, 1998; Whittaker et al., 1998). Untreated gingivitis may develop into periodontal disease, which might eventually cause resorbtion of bone and exposure of the dental roots and ultimately the antemortem loss of teeth (Turner, 1979; Roberts & Manchester, 1995; Hillson, 1998; Ortner, 2003).

Common irritants causing gingival infections and ultimately periodontal disease include plaque and calculus deposits (Davies, 1963; Ortner, 2003). Nevertheless, it is multi-factorial in origin and genetic factors as well as nutritional and metabolic disturbances such as scurvy can also be a cause of periodontitis (Hillson, 1998; Ortner, 2003). Scurvy causes a weakening of the connective tissue associated with the teeth, resulting in bleeding of the gingiva. The inflammatory response initiated by scurvy leads to periodontal disease and eventually tooth loss. A protein deficiency may also cause weakening of the supporting tissue and periodontitis (Ortner, 2003).

Periodontal disease can be recognized by destructive remodelling of the alveolar bone, causing an increase in the distance between the cemento-enamel junction and the alveolar crest (Ortner, 2003). Significant root exposure, signs of inflammation with new bone and lacking evidence of abscess formation (which might in turn be responsible for the new bone growth) can also be seen (Roberts & Manchester, 1995; Ortner, 2003).

Assessing the incidence of periodontal disease within a population is problematic due to the lack in description of standardized methods of diagnosis and grading. Therefore, no grading of periodontal disease was done in this study; it was only noted as present or not.

2.4.6 Periapical abscesses

In advanced stages of dental caries, the pulp cavity of the affected tooth can be infiltrated and an apical dental abscess is caused. Another cause for abscess formation is periodontal disease and a periodontal pocket initiated by the accumulation of plaque between the soft tissue of the gingiva and the teeth. The accumulation of bacteria in the pulp cavity initiates inflammation and puss develops (Roberts & Manchester, 1995). A sinus will eventually form at the apex of the tooth root in the bone, in order to allow the drainage of puss (Mann & Murphy, 1990; Hillson, 1998). Periapical abscesses are normally diagnosed by the presence of a sinus or fistula in the maxilla or mandible (Hillson, 1998). The margins of the fistula will be smooth and rounded and sometimes a periosteal reaction with new bone deposition, due to the inflammation, will be visible (Mann & Murphy, 1990). It should be kept in mind that postdepositional destruction of bone can have a similar appearance and great care should be taken not to misdiagnose the pseudopathology (Roberts & Manchester, 1995).

2.4.7 Supernumerary teeth

Due to developmental defects, an abnormal number of teeth can develop. These are normally seen in permanent dentition and most often affect maxillary teeth. Supernumerary teeth, or hyperdontia, can be recognized by the presence of more than 32 teeth (Ortner, 2003; Proff et al., 2006). Hyperdontia can develop either due to the retention of deciduous teeth, or the development of extra permanent teeth (Ortner, 2003). The development of extra permanent teeth can be classified as "heterotopic", which are teeth developing outside the alveolar region or "normotopic", which includes teeth that develop in the alveolar region and erupt in a relatively normal orientation (Ortner, 2003).

2.4.8 Pipe-smoker's wear

Apart from the fact that the regular use of tobacco can cause a discolouration of the user's teeth, long-term habitual smoking of a clay pipe can produce a certain pattern of dental wear (Davies, 1963; Morris, 1988; Hillson, 1998; Ortner, 2003). The clenching of a pipe between the teeth causes occlusal wear of the teeth in an elliptical or round shape, known as pipe smoker's wear (Morris, 1988; Hillson, 1998).

Several examples of "pipe-smoker's wear" have been recorded in South Africa, such as an individual excavated in Cape Town (UCT313b) dating to A.D. 1790 and an individual excavated in Abrahamsdam (NMB 1408), who passed away during the late 18th century, to name but a few (Morris, 1988).

2.5 COMPARATIVE POPULATIONS

Several skeletal samples from South Africa have been studied with regards to health and pathology. These include prehistoric, proto-historic as well as modern populations. The incidence of pathological conditions observed in the Gladstone population will be compared to these populations, as well as a skeletal sample from the Mariana Islands. This was done in order to make some inferences on health between the study population and other previously studied populations and to identify similarities and differences regarding health.

Prehistoric populations that were used for comparison included K2, Oakhurst and Toutswe. Proto-historic samples included the Riet River burials, Kakamas as well as the Griqua studies. Modern studies included investigations done on skeletal samples from Koffiefontein, Maroelabult and the 20th century Venda. The skeletal population from the Mariana Islands includes both prehistoric and proto-historic remains. These sites will be briefly introduced here.

2.5.1 K2 and Mapungubwe

K2 and Mapungubwe is situated in the Northern Transvaal (today the Limpopo Province), South Africa, and was occupied between A.D. 1000 and 1300 (Steyn & Henneberg, 1995b; Meyer, 1998). A total of 106 skeletons were exhumed at K2 (N = 96) and Mapungubwe hill (N = 12) and investigated in order to reconstruct the health and demography of this Iron Age population (Steyn, 1994; Steyn & Henneberg, 1995b; Steyn, 1997). These remains included 25 adult skeletons, of which nine were male, seven female and nine of unknown sex (Steyn, 1994). Ten adolescents and 71 juveniles were also investigated (Steyn, 1994).

Enamel hypoplasia, Harris lines as well as non-specific periostitis indicated that this population was not free of disease (Steyn, 1994; Steyn & Henneberg, 1995b). Parasitic diseases may have been common in this population, due to possible overcrowding, poor sanitation and sometimes restricted availability of water (Dittmar & Steyn, 2004). A possible case of treponemal infection was also noted (Steyn, 1994; Steyn & Henneberg, 1995b). It was suggested that this population was in general good health and well adapted to their environment (Steyn, 1994; Steyn, 1997; Steyn & Henneberg, 1995b). A high caries intensity was noted in this study, suggesting a carbohydrate rich diet typical of agriculturalists (Steyn, 1994; Steyn, 1997).

2.5.2 Oakhurst

Skeletal remains were excavated from Oakhurst rock shelter situated along the south coast of South Africa (Patrick, 1989). Remains from this site have been dated between 10 000 and 6 000 BP. A total of 42 skeletons were excavated and analyzed.

Cribra orbitalia, Harris lines, osteoarthritis, fractures and enamel hypoplasia were noted in this population (Patrick, 1989). It was concluded that these individuals experienced generalized nutritional stress. It was suggested by Sealy, et al. (1992) that the general poor health in this population could be attributed to their overdependence on a marine diet, which lacks essential nutrients. This resulted in lower fertility and maybe parasitic infestation and infection (Patrick, 1989).

A high prevalence of a dental caries was recorded in this population. The caries incidence was ascribed to low levels of fluoride in drinking water, resulting in a unusually high caries incidence for this hunter-gatherer population (Patrick, 1989).

2.5.3 Toutswe

A total of 84 skeletons was excavated from 10 Toutswe tradition sites in east and central Botswana (Mosothwane, 2004). These included 54 juveniles and 30 adults of whom 17 were male, seven female and six of unknown sex. The adults were between 17 and 75 years of age, with the majority (80%) being between 20 and 60 years of age. This prehistoric agricultural population dated between AD 700 and 1250.

Congenital conditions such as spina bifida, degenerative disease, a possible case of DISH as well as some healed and unhealed trauma were noted in this population. Low levels of cribra orbitalia and porotic hyperostosis were found. The low frequency of stress markers and the absence of infectious diseases within this population suggested that the population was in general good health. Investigations on the dental health of the population yielded a relatively low caries intensity[1] (3.41%). It was accordingly suggested that the diet of the Toutswe people was non-cariogenic and unrefined and that the levels of fluoride in drinking water were within normal limits (Mosothwane, 2004).

2.5.4 Riet River

Skeletal remains excavated from Riet River, South Africa, are believed to date from before AD 1820. The majority of these remains were excavated in the region between Jacobsdal in the west to approximately 5km east of Koffiefontein along the Riet River (Morris, 1992). A total number of 83 skeletons were investigated, of which 19 were juveniles and 64 adults (34 males, 28 females and 2 individuals of unknown sex).

Various pathological conditions such as cribra orbitalia, enamel hypoplasia, arthritis, variation in the number of lumbar vertebrae, spina bifida, craniostenosis and fractures were noted. A high incidence of carious lesions was also noted in this population, with

[1] Caries intensity: Total number of carious lesions observed in the population divided by the total number of teeth investigated, multiplied by 100.

over 50% of individuals being affected. Although the pattern of tooth decay in this population was typical of a hunter-gatherer population, the high incidence of lesions suggested a diet influenced by agricultural products. According to Morris (1992), this population was largely hunter-gatherers and the high incidence of carious lesions in this population could mainly be ascribed to low levels of fluoride and dissolved solids in the drinking water.

It was concluded that this population was in general good health and well adapted to their environment.

2.5.5 Kakamas

Skeletal remains known as the Kakamas population were excavated along the Orange River between Augrabies Falls and Upington, South Africa. These remains are believed to be dating to the 18th and early 19th centuries. A total number of 56 skeletons were investigated. This included 22 adult males, 24 adult females and 10 juveniles (Morris, 1992).

Enamel hypoplasia, cribra orbitalia, spondylolysis, infective arthritis and fractures were recorded in this skeletal sample. An extremely low incidence of carious lesions was also noted in this population, with only 20% of individuals being affected by the condition. This is typical of a hunter-gatherer lifestyle.

It was concluded that this population was in general good health, and that the low incidence of cribra orbitalia suggests that the population was well nourished.

2.5.6 Griqua

Skeletal remains in the Griqua sample population are believed to date between 1815 and 1862. Skeletal remains were obtained from an early historic cemetery, 4km northwest of Campbell and west of the Papkuil road, South Africa. A total of 35 skeletons were investigated in this study, comprising of 17 adult males, 11 adult females and 13 juveniles (Morris, 1992).

Pathological conditions such as enamel hypoplasia, cribra orbitalia, spondylolysis, craniostenosis as well as a fracture were noted. Up to 5.2% of teeth from adults were affected by carious lesions. It was accordingly suggested by Morris (1992) that these individuals' economic mode allowed a diet that was dependent on a large amount of agricultural foods such as maize meal.

It was concluded that this population was in general good health as well adapted on nutritional level.

2.5.7 Maroelabult

A total of 47 graves were discovered during impact studies done preceding the development of a new mine. All graves were exhumed and 47 skeletons were investigated for any signs of pathology and trauma. This included 26 individuals younger than 10 years of age, 5 between 10 and 20 years and 16 adults, of which 7 were male and 9 female. These individuals are believed to date from the last decade of the 19th Century and the early 20th Century (Steyn et al., 2002). They were part of the farming community and worked as labourers on White-owned farms around the end of the second Anglo-Boer War.

Some form of medical treatment was available to this population. This was deducted from the presence of a surgically treated fracture of the right forearm. Infectious diseases such as a possible case of treponemal disease, tuberculosis, and osteomyelitis were also noted. Other pathological lesions included cribra orbitalia, non-specific periostitis and arthritis (Steyn et al., 2002).

Dental investigations yielded evidence of carious lesions, antemortem tooth loss and enamel hypoplasia. The relatively high incidence of carious lesions suggested a diet mainly composed of refined carbohydrates. Many individuals presented with dental abnormalities, such as supernumerary teeth, the non-development of teeth and abnormal morphology of the incisors and molars (Steyn et al., 2002).

It was suggested that the high incidence of arthritic diseases and joint degeneration indicated participation in regular strenuous labour. It was concluded that this population was under considerable stress and had poor health in general (Steyn et al., 2002).

2.5.8 *Koffiefontein*

In April 2002, 36 skeletons were exhumed, most likely mine workers, at the Koffiefontein diamond mine in the Free State. These individuals were excavated from a mine dump at the Koffiefontein diamond mine in the Free State Province, South Africa. This included 33 males, two females and one individual of unknown sex. The mean age of death was between 25 and 33 years of age.

Enteric fever broke out among mineworkers in February 1896. The epidemic continued until August and many Black mineworkers died. Historical documents reveal that these remains belonged to individuals who died during the typhoid epidemic. According to records, hospitals were "overwhelmed by the number of graves required" and accordingly some natives, who died in the compounds, were disposed of in shallow graves, which were later "covered by tailings from the washing gears" (L'Abbé et al., 2003).

Various pathological conditions were noted on the skeletal remains, including vertebral osteophytes, Schmorl's nodes, periostitis, cribra orbitalia and enamel hypoplasia, to name but a few. The high incidence of vertebral osteophytes, Schmorl's nodes and osteochondrosis suggested that these individuals participated in regular strenuous physical activity, most likely associated with mining (L'Abbé et al., 2003).

Poor living conditions and malnutrition made this population more susceptible to infectious diseases. These conditions most likely contributed to the typhoid epidemic.

2.5.9 *20th Century Venda*

In 1999, the development of the Nandoni Dam was initiated in Venda and consequently rural villages had to be relocated. Approximately 1 000 graves, dating to the 20th century, had to be exhumed and resettled in the process. A total of 160 skeletons, comprising of 118 adults and 42 juveniles, were measured and assessed for any indications of pathology and trauma (L'Abbé, 2004).

Although written documents suggest a high incidence of infectious diseases and parasite infestation in the 20th Century Venda, few skeletal lesions indicative of pathology were found. This was attributed to the availability of medical services and the administration of medicine, which would have inhibited the development of skeletal lesions associated with disease. The dental health of the population was found to be relatively good. Tooth decay was attributed to the regular consumption of refined carbohydrates (L'Abbé, 2004).

2.5.10 Mariana Islands

The last population investigated for comparative purposes was a study conducted by Pietrusewsky et al. (1997) on prehistoric skeletal remains obtained from the various Mariana Islands, including Guam, Rota, Tinian and Saipan. The Mariana Islands (also known as the Chomorro), are located approximately 2 400km east of the Philippine Islands in the western Pacific (Pietrusewsky et al., 1997). Although this is not a South African population, this study was chosen for the great variety of pathological conditions observed and documented in these populations. Secondly, it was chosen specially for the attention given to stress markers observed in the population.

A total of 247 skeletons from Guam, 14 from Rota, 20 from Tinian and 102 from Saipan were investigated. These remains date to AD 590 - 1521. This time period in the Mariana Islands is characterized by an increase in population growth, the building of latte structures (paired stone pillars architecture used to support houses, meeting halls and religious structures), agriculture and reef or deep water fishing (Pietrusewsky et al.,1997).

Pathological lesions such as cribra orbitalia, fractures, arthritic changes and signs of infectious diseases were noted. It was suggested that these populations participated in regular strenuous activities and that accidental injuries were the main source of trauma. The low incidence of carious lesions in this population was ascribed to the chewing of Betel-nuts. It was concluded that this population was in general good health (Pietrusewsky et al., 1997).

Table 2.1 Various types of diseases treated and the number of resulting deaths in Kimberley Hospital during 1897.

Type of disease	Number of cases admitted	Number of deaths	% of deaths
Respiratory system	233	81	34.8
Circulatory system	55	16	29.1
Zymotic	866	186	21.5
Nervous	107	21	19.6
Genito - Urinary system	93	7	7.5
Alimentary system	166	10	6.0
Injury and Violence	322	16	5.0
Dietetic	354	11	3.1
Constitutional	155	4	2.6
Bones and joints	39	1	2.6
Skin	38	0	0.0
Diseases of the eye, nose and ear	78	0	0.0

Table 2.2 Various types of diseases treated and the number of resulting deaths in Kimberley Hospital during 1898.

Type of disease	Number of cases admitted	Number of deaths	% of deaths
Respiratory system	290	104	35.9
Circulatory system	109	33	30.3
Zymotic	895	196	21.9
Alimentary system	165	20	12.1
Constitutional	97	8	8.2
Genito - Urinary system	74	5	6.8
Nervous	64	4	6.3
Injury and Violence	241	12	5.0
Dietetic	539	20	3.7
Bones and joints	54	0	0.0
Skin	20	0	0.0
Diseases of the eye, nose and ear	70	0	0.0

Table 2.3 Various types of diseases treated and the number of resulting deaths in Kimberley Hospital during 1899.

Type of disease	Number of cases admitted	Number of deaths	% of deaths
Circulatory system	94	34	36.2
Respiratory system	267	57	21.3
Nervous	62	11	17.7
Zymotic	979	169	17.3
Alimentary system	135	21	15.6
Genito - Urinary system	157	20	12.7
Dietetic	264	21	8.0
Constitutional	270	18	6.7
Injury and Violence	330	12	3.6
Diseases of the eye, nose and ear	95	2	2.1
Bones and joints	25	0	0.0
Skin	40	0	0.0

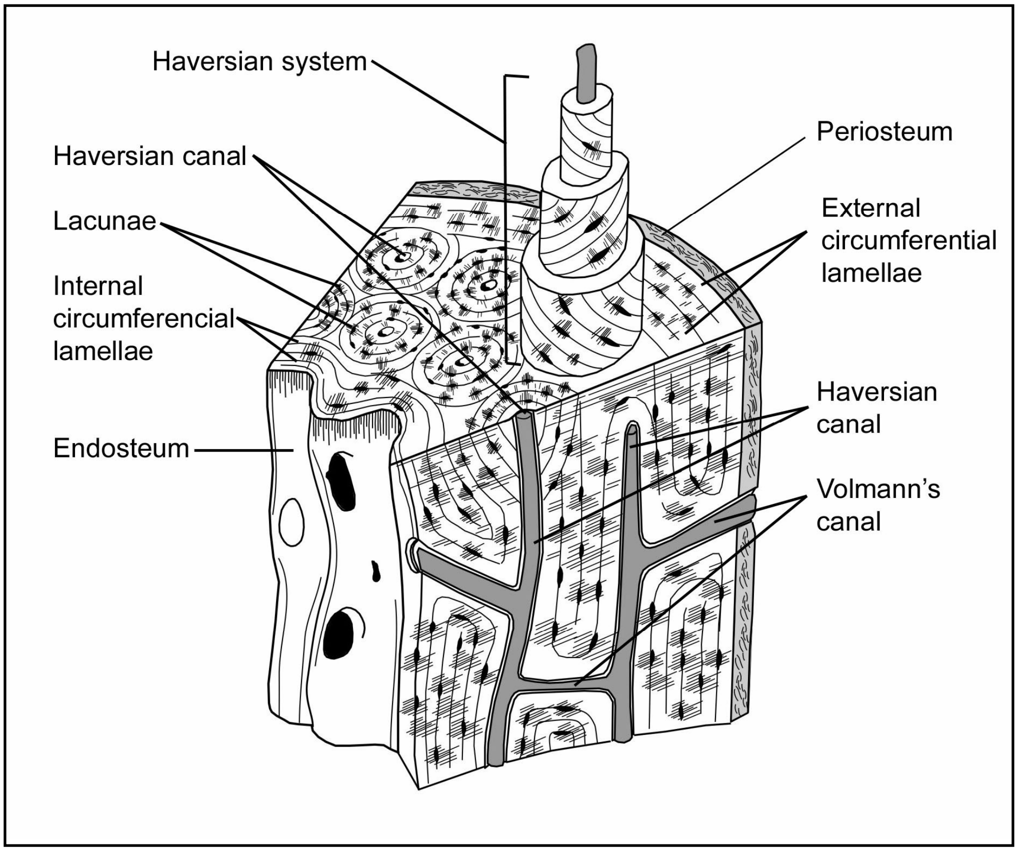


Figure 2.1 General bone histology.

CHAPTER 3

MATERIALS AND METHODS

3.1 MATERIALS

3.1.1 Origin of the skeletal remains

On the afternoon of Friday, 25 April 2003, the Sol Plaatjie Municipality unknowingly disturbed 180 m of unmarked graves outside the fenced Gladstone cemetery next to the De Beers boundary fence, as can be seen in Figure 3.1, while digging a proposed storm-water trench. No impact study had been carried out prior to commencing with the project. The McGregor Museum in Kimberley became involved through the South African Heritage Resources Agency (SAHRA), who asked them to investigate the graves and to follow the procedures as stipulated by law.

Two sites were involved in the examinations and later excavations that followed: Firstly, the trench itself, where the burials were disturbed, and secondly, a diamond washing plant halfway to Kenilworth, where material dug out of the trench had been dumped.

3.1.2 Approval for excavation and investigation

SAHRA required that notices be distributed at the site, announcing the public process. Thus, notices were erected alongside the site in the four official languages of the Northern Cape Province (Afrikaans, SeTswana, IsiXhosa and English). These notices invited members of the public to join the public participation process by leaving their details at the Department of Archaeology at the McGregor Museum. The leaflet also outlined the legal procedures for dealing with unmarked graves and burial grounds.

According to the National Heritage Resources Act (NHRA), no. 25 of 1999: "Any burial that is older than 60 years, which is outside a formal cemetery administered by the local authority, is protected in terms of Section 36(3b) of the NHRA. No person shall destroy, damage, alter, exhume or remove from its original position, remove from its original site, or export from South Africa any such grave without a permit from SARHA."

Accordingly, a permit was issued by SAHRA (permit 80/03/04/004/51) to the McGregor museum, allowing them to professionally exhume and investigate the graves and their content. It also included an agreement to provide a temporary storage place for the human and artefact remains excavated from the site.

After anthropological investigations commenced, it became evident that it would be of great advantage to sample re-occurring pathological lesions in order to increase the accuracy of diagnoses. A public meeting was held with the local community in order to discuss and explain the situation. The community granted permission, and after an application to SAHRA, a permit to allow sampling as well as export of the skeletal remains was received.

As was required by SAHRA, regular public meetings as well as press releases were done in order to inform the community of the progress being made with the study.

3.1.3 Excavation of the graves

Exhumation of the graves in the trench started on 3 May 2003. It was clear that the trenching seriously damaged or displaced remains in at least seven graves. It seemed possible that some skeletons could have been entirely removed by the machinery and carried away to the dumpsite, where a large amount of human bones were also being found. Preservation of the remains was found to be remarkable in most cases.

The burial pattern varied between the different graves. Many of the graves contained more than one individual, and up to 14 individuals were found in the same grave. Within the graves, several individuals were decorously laid out on their backs and separated by a layer of soil, while others lay face-down, on their sides, or squeezed into corners or crammed in one on top of the other. It appeared that the primary concern was disposal, rather than laying the individuals to rest, with little attention being given to formal burial rights and traditional burial rituals.

Recovery of human remains from the dumpsite commenced on 12 May 2003. The dump was divided into ten sectors and excavated accordingly. A large number of bones were salvaged from the dump. Work at the dumpsite stopped on 12 June, when it was believed that the greatest portion of the human remains had been recovered.

After the excavation, all skeletal material as well as artefacts were taken to the McGregor museum, where it was tagged and kept for further analyses.

3.1.4 Accession numbers for the skeletons

Each grave was assigned a number in relation to a gap, which was probably a roadway between the graves, as either being North or South of the gap, for example S1 (South 1), N34 (North 34) or SE7 (South-East 7) (Figure 3.2). The accession numbers for the skeletons were constructed from the grave from which it had been excavated, as well as a number indicating after which skeleton it was removed from the grave, for example S1.2 would indicate the second skeleton in grave S1.

Soil excavated from the trench was dumped at a diamond washing plant halfway to Kenilworth. The dump was divided into sections A – H, as can be seen in Figure 3.3, and skeletal elements were numbered according to the section it was excavated from.

3.2 METHODS

3.2.1 Sex determination

A combination of skeletal non-metric morphological characteristics, as well as several discriminant functions derived from modern South African populations, was used to determine sex from adult skeletal remains in this study. This multi-disciplinary approach to sex determination has been shown to be more reliable than a single non-metric trait or method used alone (Morris, 1984; St Hoyme & İşcan, 1989). The reason for this multi-factorial approach is that accuracy of sexing unknown skeletal material depends on the relative completeness as well as the preservation of the remains (Morris, 1984; Meindl et al., 1985; Krogman & İşcan, 1986; Berrizbeitia, 1989; Loth & İşcan, 2000b; Asala et al., 2004). Metric analyses of skeletal elements enhance the accuracy of sex determination in situations where skeletal material is poorly preserved, incomplete and non-metric characteristics are consequently not diagnostic, provided that the landmarks from which measurements should be taken, are present (Asala et al., 2001). It is important to note that non-metric as well as metric differences between males and females are spread across a continuum with a large amount of overlap between sexes, with only extreme cases showing only male or female features. It is therefore advisable to use more than one technique in order to obtain reliable results (Meindl et al., 1985; Loth & İşcan, 2000b).

3.2.1.1 Non-metric morphologic techniques

Non-metric morphological techniques used to determine the sex of an individual comprises of a visual assessment of the shape of a certain bony feature, which differs between sexes. Therefore, the degree of sexual dimorphism between the sexes dictates the accuracy of the methods. Non-metric morphological methods of sex determination are effective, because they are developmental in nature. For example, the expansion of the subpubic angle is a pelvic feature that develops during adolescence to accommodate childbirth (Loth & İşcan, 2000b). The only difficulty with these methods is that experience is needed in order to judge what is relatively large or small, or narrow or wide, for the specific population group being studied (Meindl et al., 1985; Loth & İşcan, 2000b).

The most diagnostic elements for sex determination by non-metric means are the skull and pelvis (Berrizbeitia, 1989; Loth & İşcan, 2000b). Cranial features such as a prominent supraorbital torus, sloping forehead when viewed laterally, large mastoids processes and rounded orbital margins, suggest possible masculine development. Feminine development is indicated by a small supraorbital torus and mastoid processes, straight forehead and sharp orbital margins (De Villiers, 1968; Krogman & İşcan, 1986; Loth & İşcan, 2000b).

Several characteristics in the mandible, such as the size and shape of the mandibular chondyles, the shape of the chin (squared or angular), degree of gonial eversion as well as mandibular ramus flexure, aided in the sex determination (De Villiers, 1968; Krogman & İşcan, 1986; Kemkes-Grottenthaler et al., 2002). Some of these methods are more accurate than others. For example, Loth and Henneberg (1996) found that mandibular ramus flexure at the level of the occlusal plane is a good indicator of sex in the South African population, with an average accuracy of 94%. A study by Kemkes-Grottenhaler et al. (2002) indicated a 59% overall accuracy in sex determination when mandibular ramus flexure was used and 69% accuracy using gonial eversion. It was also indicated that these mandibular non-metric morphological features are greatly influenced by antemortem tooth loss (Kemkes-Grottenthaler et al., 2002). Nevertheless, mandibular ramus flexure, gonial eversion as well as the shape and size of the mandibular condyles were assessed in situations where only the mandible was available, or in conjunction with other methods (Loth & İşcan, 2000b; Loth & Henneberg, 2001).

In the pelvis, non-metric features, such as a wide subpubic angle, wide sciatic notches, a round pelvic inlet, broad and flat sacrum, elongated pubic bones and a pre-auricular sulcus suggest possible feminine development (Day, 1975; Flander, 1978; St Hoyme & İşcan, 1989;

Patriquin et al., 2003). Masculine developmental characteristics include a narrow subpubic angle and sciatic notches, a heart-shaped pelvic inlet, narrow and curved sacrum as well as triangular pubic bones (Loth & İşcan, 2000b; Patriquin et al., 2003). A study by Partiquin *et al.* (2003) indicated that the assessment of the shape of the greater sciatic notches, as well as the pubic bones, yielded the most dependable results in the black South African population.

3.2.1.2 Osteometric techniques

Although differences in non-metric morphology are clearly visible on the skull and pelvis, they are not easily visually assessable on other bones such as the long bones (Loth & İşcan, 2000b). Accordingly, metric investigation of these bones is needed to determine differences in dimensions between male and female individuals. The technique is based on the fact that within various population groups, males tend to be more robust than females (Meindl et al., 1985; St Hoyme & İşcan, 1989; Loth & İşcan, 2000b). The drawbacks of these methods are that the formulae are population specific and the metric overlap between the sexes can be as high as 85% (Steyn & İşcan, 1997; Loth & İşcan, 2000b; Franklin et al., 2005). Secondly, all landmarks needed to make the necessary measurements should be intact.

Different metric techniques are available for the South African Black population. Standards for sex determination of Black South Africans from single long bone measurements are available for the humerus, femur and tibia (Berrizbeitia, 1989; Loth & İşcan, 2000b; Asala et al., 2004). Of these measurements, the maximum diameter of the femoral and humeral heads prove to be the most accurate (91%) (Asala, 2001). Other dimensions such as the humeral epicondylar breadth, femoral midshaft circumference, femoral distal breadth, proximal tibial breadth and tibial circumference at the nutrient foramen, are between 85.3% and 88.6% accurate (Kieser et al., 1992; Loth & İşcan, 2000b). Franklin et al. (2005) recently developed cranial multivariate discriminant functions for the Black South African population. These formulae proved 75-80% accurate. Bizygomatic breadth, cranial length and cranial height turned out to be the most sexually dimorphic.

Taking the location of Kimberley into consideration, it can be expected that some of the skeletal remains within this population might belong to individuals of Khoisan racial affinity. As mentioned previously, osteometric techniques are race specific and therefore results obtained from osteometric analysis to determine sex, based on standards for South African Negroids, might not prove very useful (De Villiers, 1968; Morris, 1984; Meindl et al., 1985; Patriquin et al., 2003).

3.2.1.3 Juveniles

Sex differences in the skeleton are not observed before puberty is reached, making sex determination in young individuals very difficult (Krogman & İşcan, 1986; St Hoyme & İşcan, 1989; Loth & İşcan, 2000b; Schutkowski, 1993; Loth & Henneberg, 2001). A study of the sexual dimorphism in the mandible for individuals between 7 months and 5 years of age proved successful (Loth & İşcan, 2000b; Loth & Henneberg, 2001). Differences were observed on the inferior symphyseal border and corpus of the mandible, beginning with the eruption of the lower central incisors. A rounded inferior symphyseal border and mandibular corpus suggested a possible feminine development, whereas an angular symphyseal border and corpus indicated masculine development (Loth & İşcan, 2000b; Loth & Henneberg, 2001). An accuracy level of 81% was obtained with this technique (Loth & Henneberg, 2001). A study by Schutkowski (1993) indicated that visual assessment of the protrusion of the chin, shape of the anterior dental arcade, gonial eversion, the angle of the greater sciatic notches, depth of the greater sciatic notches and the curvature of the iliac crest can aid in sex determination of individuals up to five years of age. The techniques developed for sex determination for juvenile skeletal remains, tend to be unreliable, and no attempts were made to determine sex from immature skeletons in this study.

3.2.2 Age determination

Exact determination of age from skeletal remains without documentation, such as a birth certificate, is difficult due to the huge variability in the expression of various age markers during the aging process. The human lifespan can be divided into three distinct phases, i.e. early childhood (1 to 12 years), adolescence (13 to 18 years) and adulthood (Loth & İşcan, 2000a). Various techniques for age determination will accordingly be discussed for each phase.

3.2.2.1 Infants and early childhood

Only three infants were excavated from the trench: one foetal skeleton and two full term infants who died within a year after birth. Prenatally, age can be estimated from the diaphyseal lengths of the long bones. These methods are relatively accurate, and can provide an age estimation within a month of the infant's true age at death (Ubelaker, 1987; Kosa, 1989; Loth & İşcan, 2000a; Scheuer & Black, 2000). Measurements taken from the scapulae, clavicles, humeri, ulnae, radii and femurs were used in association with standards set by Fazekas and Kosa (1978) to estimate the age of the foetal remains in this study.

The most reliable method available to estimate the age of children is by assessing the different stages of deciduous and permanent tooth development and eruption (Massler et al., 1941; Ubelaker, 1987; Ubelaker, 1989b; Johnston & Zimmer, 1989; Loth & İşcan, 2000a; Scheuer & Black, 2000; Foti et al., 2003;). Teeth are consistent in the sequence and rate of eruption and are therefore a very reliable indicator of age (Loth & İşcan, 2000a; Foti et al., 2003). Deciduous lower central incisors start erupting between six and seven months of age, and a full set of deciduous teeth is visible around three years of age (Ubelaker, 1987; Ubelaker, 1989b; Scheuer & Black, 2000). A chart developed by Ubelaker (1987) was used to estimate age at death in cases where deciduous tooth eruption had commenced (Scheuer & Black, 2000). The eruption chart by Ubelaker (1987) is of great value, especially when estimating the age of individuals between five months in utero and four years, since it can estimate age with relative accuracy, based on dental development and eruption of deciduous teeth. After four years of age, the age estimations based on the dental eruption of permanent teeth gets wider and it is therefore suggested that this method be used in association with other aging methods in the older age groups.

Other methods include fusions of the various bones of the skull and mandible, for example union of the mandible at the mandibular symphysis between six and nine months, development of the tympanic ring and its eventual fusion with the temporal bone, closure of the fontanels and fusion of the metopic suture, which normally occurs around two or three years of age (Weaver, 1979; Becker, 1986; Johnston & Zimmer, 1989; Scheuer & Black, 2000). Development of the vertebral column is also a valuable indicator of age. Fusion of the two segments of the neural arch normally occur during the first year of life and fusion of the vertebral arch to the vertebral body (neurocental fusion) usually takes place between the ages of two and three years (Scheuer & Black, 2000).

The diaphyseal lengths of long bones were used as an indicator of age in conjunction with estimates given by tooth eruption charts, or in cases where no eruption was visible (Scheuer & Black, 2000). No X-rays were used in the study of dental eruption; all investigations were done through macroscopic visual assessment. Methods such as the assessment of fontanelle closure could not be used, due to the young age of the individuals, as well as the fragmentary condition of the remains.

3.2.2.2 Adolescence

Two methods were used for the estimation of age at death for adolescence. Firstly, the eruption of permanent teeth, which proceeds at a very predictable rate (Scheuer & Black, 2000; Foti et al., 2003). Although the majority of permanent teeth erupts before the age of 11 years, the canines and second molars erupting around 11 and 12 years, aid in classifying a juvenile as an adolescent (Massler et al., 1941; Ubelaker, 1989a; Hillson, 1998; Loth & İşcan, 2000a).

Bone formation and growth can also be used as a reliable indicator of age, especially in adolescence (Loth & İşcan, 2000a). Bone formation from ossification centres proceeds in an organized manner, with a specific sequence and timing, to form diaphyses and epiphyses. During adolescence, metaphysis are replaced with bone, eventually leading to fusion between diaphysis and epiphysis. In the major long bones, union starts at the elbow (distal humerus and proximal radius and ulna) between 12 and 14 years of age. It then proceeds throughout the skeleton in an orderly fashion, with the medial clavicle being the last epiphysis to unite in the late teens and early twenties (Krogman & İşcan, 1986c; Ubelaker, 1989b; Loth & İşcan, 2000a).

Union of other bones and epiphyses, such as the union of the primary elements of the Os coxa (ilium, ischium and pubis), occurring between 13 and 14 years of age and fusion on the iliac crest and ischial tuberosity between 17 and 23 years of age, can also be investigated. Other bones include fusion of epiphyseal ends on the metacarpals and phalanges occurring between 14 and 17 years of age; the lesser trochanter of the femur and medial condyle of the humerus unites between 15 and 18 years; and the auricular surface of the sacrum at approximately 18 years of age, to name but a few (Krogman & İşcan, 1986c).

More than one method was utilized to estimate age at death wherever possible, since it should be considered that although the ossification of metaphyses proceed in a predictable sequence, the rate at which it proceeds can be influenced by factors such as nutrition, climate and sex (Scheuer & Black, 2000)

3.2.2.3 Adults

The estimation of age is extremely challenging once adulthood has been reached and growth and development had ceased (İşcan & Loth, 1986; Loth & İşcan, 1994; Loth & İşcan, 2000a; Oettle & Steyn, 2000). It is therefore suggested that more than one method of age determination should be employed to increase the accuracy of the estimation (Lovejoy et al., 1985). Skeletal structures are maintained and modified during adulthood in a process referred to as bone remodelling. The rate of remodelling is highly variable, since it is greatly influenced by the environment, genetics and human behaviour (Loth & İşcan, 2000a).

Several methods are available to estimate the age of a young adult, which can be conducted with relative accuracy. These include the examination of the sternal ends of the clavicle, fusion and obliteration of the spheno-occipital synchondrosis, ossification between the first and second sacral segments, ossification of the vertebral epiphyseal rings, as well as unity between the various parts of the scapula (Krogman & İşcan, 1986; Scheuer & Black, 2000). The epiphyses of the medial ends of the clavicles fuse between 20 and 30 years of age, with the spheno-occipital synchondrosis uniting at around 20 to 29 years of age (Krogman & İşcan, 1986; Scheuer & Black, 2000). In the vertebral column, vertebral epiphyseal rings unite with the vertebral body in individuals older than 18 years and ossification between the first and second sacral segments indicates an individual older than 27 years of age. The various parts of the scapula, including the acromion, vertebral margin and inferior angle, unite between the ages of 18 and 21 years (Krogman & İşcan, 1986).

Estimation of age from the sternal ends of the ribs is currently the most reliable, non-intrusive technique available for age estimation of adult skeletal remains (Loth & İşcan, 1994; Oettle & Steyn, 2000). The ribs of the remains excavated from the trench were very well preserved and therefore the investigation of sternal ends was the method of choice in this study (Loth & İşcan, 2000a). The sternal ends of the ribs are not affected by physical activity or environmental conditions and therefore remodelling in this region proceeds at a relatively constant rate as age increases, provided that no pathological conditions such as DISH influence the ribs (İşcan & Loth, 1986; Loth & İşcan, 1989; Oettle & Steyn, 2000). This method was first developed by Loth and İşcan (1989), and includes the assessment of the pit depth, shape, rim and wall configuration of the sternal end of the rib (İşcan & Loth, 1986; Loth & İşcan, 1989; Loth & İşcan, 1994; Oettle & Steyn, 2000). Oettle and Steyn (2000) developed standards for determining age at death from the sternal ends of the ribs from the South African Negroid population. They obtained the same reliable result as was seen by Loth and İşcan (1989). Ribs depicting the different stages as well as written descriptions of bone changes as described by Oettle and Steyn (2000) were used in this study.

Other techniques that were employed include the assessment of changes present on the pubic symphysis, the closure of cranial sutures, and dental wear on the first, second and third molars (Loth & İşcan, 1994; Loth & İşcan, 2000a).

Non-metric morphological changes to the pubic symphysis were investigated wherever it was preserved. The six phase Suchey-Brooks technique, which includes written descriptions of each phase as well as pictures, was the method of choice. Although this method is reasonably accurate within the younger age groups, the age estimate becomes very wide in the older age ranges (Lovejoy et al., 1985; Brooks & Suchey, 1990). It was therefore used in conjunction with other methods, where available (Lovejoy et al., 1985).

An assessment of the degree of cranial sutures closure can also be used as an indication of age at the time of death (Krogman & İşcan, 1986; Masset, 1989; Ubelaker, 1989a; Loth & İşcan, 1994). A technique developed by Nemeskeri (1960) was used. This entails dividing the length of the coronal suture in six equal parts, the saggital suture in four parts, and the lambdoid in six equal sections (Krogman & İşcan, 1986). Each of these sections are then scored between 0 and 4 according to the degree of suture closure; 0 representing an open suture and 4 a cranial suture that is totally obliterated (Krogman & İşcan, 1986; Masset, 1989; Loth & İşcan, 1994). Age can then be estimated by calculating the mean for the 16 scores and comparing it to set standards (Krogman & İşcan, 1986). This method does not allow close aging of skeletal remains, but it does aid in putting the individual within an age group being a juvenile to young adult, young adult to middle-aged adult or middle-aged to old-aged adult (Lovejoy et al., 1985; Krogman & İşcan, 1986; Loth & İşcan, 1994).

Molar teeth were also assessed as an indication of possible age. This was based on the assumption that the molars erupt at intervals of six years. Thus, the difference in occlusal wear between the first molar and second molar will represent the amount of wear obtained in six years. This way it is possible to estimate how long a tooth has been in use (Brothwell, 1989). Although this allows only broad assumptions about age, this method is valuable when used in conjunction with other aging techniques (Loth & İşcan, 1994).

Other methods available for the estimation of age, such as bone histology, dental microscopy and radiographic techniques were not used in this study due to limited funds, time and the intrusive nature of some of these methods.

3.2.3 Stature estimation

Stature provides a factor of individualization for each skeleton investigated. The estimation of antemortem stature is based on the relationships between skeletal elements and total body length (Sjovold, 2000). Thus, it can be assumed that the larger the skeletal elements are, the taller was the individual.

For the purpose of this study, a method devised by Lundy and Feldesman (1987) for South African Negroids was used. Lundy and Feldesman (1987) developed regression formulae for Negroid males and females to estimate antemortem stature from single long bone measurements. A correction factor was also added to compensate for soft tissue. Long bones, which add to the body length (tibia, fibula, and femur), yield more accurate estimations than those of the arm. Of the single measurements, bicondylar length of the femur is the most reliable (Lundy & Feldesman, 1987; Wilson & Lundy, 1994). Accordingly, femoral measurements were used to estimate antemortem stature in this study.

According to a study by Tobias (1971), the mean stature for black Southern African males is between 159 cm to 171.9 cm. A more recent study by Steyn and Smith (2006) reports the mean stature for South African males to be 171.01 cm ± 6.16 cm and 159.6 cm ± 6.8 cm for females.

3.2.4 Macroscopic evaluation of palaeopathology

Each skeleton was visually assessed for gross bone pathology. All bones, regardless of their preservation, were visually assessed for any macroscopic indication of pathological bone alterations. Diagnoses were made, based on the bony characteristics of the defects as well as the distribution of the lesions across the skeleton. All lesions were compared to standard palaeopathological texts and photographs as can be found in Steinbock (1976), Roberts and Manchester (1995), Mann and Murphy (1996), Larsen (1997), Aufderheide and Rodriguez-Martin (1998) and Ortner (2003).

X-rays were not part of the routine investigation due to time and financial constraints. A single X-ray was taken of a mandible with several embedded teeth.

The incidence of pathological conditions or skeletal lesions indicative of disease or trauma was determined in relation to the number of individuals within the sample population, as well as the number of bony elements investigated. These frequencies were compared to other populations such as K2, Toutswe, Oakhurst, Griqua, Kakamas, Koffiefontein, Venda, Maroelabult and samples from the Mariana Islands. Chi-square tests were done in order to determine if significant differences existed in the presence of pathological conditions between these comparative populations and the Gladstone sample. Chi-squared tests were also performed in order to test for significant differences in the incidence of lesions between males and females, where possible.

A detailed description of the pathological evidence observed on each skeleton can be found in Appendix 1 for remains recovered from the trench and Appendix 2 for bone material excavated from the dumpsite. All grave goods are listed in Appendix 3.

3.2.4.1 Diagnosis of specific pathological condition

Infectious diseases, metabolic and nutritional disorders, traumatic lesions, degenerative conditions as well as congenital abnormalities were diagnosed, based on visual assessment of the lesions and comparisons to descriptions of diseases found in standard palaeopathological text such as Ortner (2003), Steinbock (1976), Mann and Murphy (1996), Roberts and Manchester (1995) and Larsen (1997).

The location as well as measurements of the lesion were included in a careful description of the pathological defect, as can be seen in Appendix 1.

Special attention was given to the presence of musculoskeletal stress markers within this population. They were selected from markers suggested by Mann and Murphy (1990) as well as for their comparability to other studies, such as al-Oumaoui (2004). Stress markers were only scored as present or not.

3.2.4.2 Diagnosis of non-specific indicators of pathology and stress

Several methods have been described to investigate cribra orbitalia (Fairgrieve & Molto, 2000). Welcker (1888) introduced a method by which cribra orbitalia were classified as being weak, stronger or strongest, based on the relative porosity size of the lesions in the roof of affected the orbits (Jacobi & Danforth, 2002).

Another method for the classification of cribra orbitalia involves the morphological appearance of lesions in the orbital roof (Steinbock, 1976). Three types of lesions can be distinguished, i.e. the porotic type, cribrotic type and lastly the trabecular type (Steinbock, 1976; Fairgrieve & Molto, 2000). The porotic type can be recognized by scattered fine openings in the orbital roof, whereas the cribrotic type exhibits larger and more numerous openings. The trabecular type is characterized by the merging of the small holes associated with the porotic or cribrotic type of cribra orbitalia resulting in large, irregular apertures (Steinbock, 1976; Fairgrieve & Molto, 2000).

The last method of classification was developed by Stuart-Macadam (1982). Three levels could be distinguished, i.e. light, medium and severe (Stuart-Macadam, 1982; Jacobi & Danforth, 2002). Lesions were classified as light when only fine scattered foramina could be observed; medium lesions were recognized by large and small isolated foramina as well as foramina that merged; and sever lesions included those where outgrowths of the trabecular structure could be seen (Stuart-Macadam, 1982; Jacobi & Danforth, 2002).

A study was done by Jacobi and Danforth (2002) to test the reliability as well as interobserver correlation when scoring cribra orbitalia and porotic hyperostosis. It was found that using a specific scoring method does not increase inter-observer reliability and thus does not make different studies more comparable (Jacobi & Danforth, 2002).

Taking all of the above into account, it was decided not to classify orbital lesions in this study, and they were simply recorded as being present or not. Classification of orbital lesions in this study would not have been meaningful, due to the low incidence of lesions in this population. Only well-preserved orbits were included in the study.

3.2.5 Palaeohistopathology

3.2.5.1 Sampling of pathological lesion

A 3-4 mm section of bone was removed from lesions on the anterior tibia of 14 individuals. All 14 individuals were diagnosed with either treponemal disease or ossified haematomas, which developed due to scurvy, after macroscopic investigation of the skeleton. Sampling of the pathological lesion was done by making two parallel cuts, halfway through the medulla of the bone, with a hacksaw. These cuts were made perpendicular to the long axis of the bone. Care was taken not to damage the often-visible layer of subperiosteal bone growth on top of the original bone surface. By inserting a thin metal device into one of the cuts and bending it towards the second cut, the sample broke loose at the base of the two cuts, and could be removed. The section was bagged and labelled with the number of the individual, the location from where the sample was taken as well as an initial macroscopic diagnosis of the pathological lesions.

3.2.5.2 Slide preparation

Pathological samples were prepared for microscopic investigations, using a technique described by Maat et al. (2000) in a manual for the preparation of ground sections for microscopy of bone tissue. Using petroleum jelly, a sheet of abrasive paper was stuck onto a glass slab with the abrasive side up. The central area of the abrasive paper was then moistened and grinding of the sample by hand on the abrasive paper started. Frost's gripping device was used to grind the sample against the abrasive paper. By applying pressure to the Frost's device and grinding the sample with a circular motion, the section was ground down until it was transparent. The sample was then washed in distilled water and left to dry on filter paper in a Petri dish. After drying, the section was mounted on a glass microscope slide using mounting medium (Entellan) and covered with a cover slip (Maat et al., 2000).

3.2.5.3 Microscopic investigations

After sectioning of the lesions in order to obtain a sample, each section was first inspected macroscopically. As suggested by Schultz (2003), the form, distribution and nature of the new bone growth was documented, since structural evidence obtained on cross section might be important for diagnosis.

After preparation of the microscopic slides, each section was investigated under both normal and polarized light. Attention was given to the architecture of the compact bone structure, the structure of the external circumferential lamellae as well as the architecture of the appositional bone in cases where it was present.

3.2.6 Dental health

The aim of this section was to describe the dental pathology observed within the remains excavated from Gladstone cemetery. Dental caries, enamel hypoplasia, antemortem tooth loss, dental calculus, periodontal disease and dental abscesses were investigated. In addition, unusual oral conditions such as pipe-smoker's wear and supernumerary teeth were described. The results were compared to various other South African studies.

3.2.6.1 Dental caries

All permanent teeth were visually examined under good lighting for any signs of carious activity. Due to the possibility of post-depositional damage of the teeth mimicking early stages of lesion development, a carious lesion was only recorded when a clear cavity was present. The location of carious lesions was recorded according to tooth type as well as the surface of the tooth primarily affected by the lesion (Lukacs, 1989). Multiple lesions on one tooth were treated as a single occurrence.

Calculations described by Lukacs (1989) and Henneberg (1991) were used to analyze the data. The individual count method was done by dividing the frequency of individuals with carious lesion by the total number of individuals investigated. It should be kept in mind that this method generates the assumption that all teeth were preserved for investigation, or that those teeth lost antemortem and postmortem were not affected by dental caries (Roberts & Manchester, 1995; Erdal & Duyar, 1999).

The second method of investigation is called the tooth count method. Using this method, the caries intensity was calculated by dividing the number of carious lesions by the total number of teeth investigated. Accordingly, the percentage of teeth analyzed and affected by dental caries can be determined (Roberts & Manchester, 1995). The mean number of carious lesions per mouth was also calculated. This was done by dividing the total number of carious lesions observed by the total number of individuals presenting with this condition. The intensity of carious lesions on the various teeth was investigated by dividing the number of carious lesions present on a specific type of tooth by the total number of the specific teeth observed. Lastly, the distribution of lesions on the teeth (buccul, lingual, occlusal or interdental) was analyzed by dividing the total number of lesions observed on a specific surface by the total number of carious lesions recorded. The percentages were recorded separately for each sex. Formulae for the calculations described above are better described as:

Individual caries frequency =

$$\frac{\text{Number of individuals affected by carious lesions}}{\text{Number of individuals in the sample}} \times 100$$

Tooth count method (Caries intensity) =

$$\frac{\text{Number of carious lesions}}{\text{Number of teeth present in the sample}} \times 100$$

Carious teeth per mouth =

$$\frac{\text{Number of carious lesions}}{\text{Total number of individuals affected by carious lesions}} \times 100$$

Caries intensity per tooth =

$$\frac{\text{Total number of tooth type (x) affected by dental caries}}{\text{Total number of tooth type(x) investigated}} \times 100$$

Caries intensity per tooth surface =

$$\frac{\text{Total number of carious lesions on tooth surface (x)}}{\text{Total number of carious lesions recorded}} \times 100$$

The antemortem loss of teeth has a great influence on the accuracy of the intensity of dental caries within a population, and can lead to the underestimation of the caries intensity, as was explained earlier (Lukacs, 1995). Therefore, using a method described by Lukacs (1995), antemortem tooth loss was taken into account and a "corrected" intensity for dental caries within this population was estimated. Individuals were assessed and the total number of teeth with exposure of the pulp chamber was calculated. Teeth with pulp chamber exposure were then divided into two groups, i.e. those with exposure due to carious lesions and those exhibiting exposure caused by dental attrition. Accordingly a 'caries correction factor' was calculated by dividing the number of teeth with pulp exposure due to carious lesions by the total number of teeth observed with pulp exposure. By multiplying the total number of teeth lost antemortem with the caries correction factor, the number of teeth lost antemortem due to carious lesions could be estimated. Adding the observed number of carious lesions to the estimated number of teeth lost antemortem due to dental caries, yielded an estimated incidence of dental caries. Thus, a 'corrected caries rate' was calculated by dividing the total number of estimated teeth with carious lesions by the total number of original teeth prior to antemortem loss (number of observed teeth plus the number of teeth lost antemortem). A representation of all the calculations can be seen here:

Caries correction factor =

$$\frac{\text{Total number of teeth with pulp exposure due to dental caries}}{\text{Total number of teeth with pulp exposure}} \times 100$$

Estimated number of teeth lost due to caries =

Total number of teeth lost antemortem X caries correction factor

Estimated number of teeth with caries =

Estimated number of teeth lost due to caries + number of carious teeth observed

Total number of teeth =

Number of teeth observed + number of teeth lost antemortem

Corrected caries rate =

$$\frac{\text{Total estimated number of teeth with caries}}{\text{Total number of original teeth}} \text{X100}$$

A method described by Erdal (1999), termed the 'proportional correction factor', includes calculating the corrected caries rate for anterior (incisors and canines) and posterior teeth (premolars and molars) separately, and then multiplying it with 3/8 and 5/8 respectively to compensate for teeth lost postmortem (Duyar & Erdal, 2003). Since most individuals in this study had all their teeth and results obtained by calculating the corrected caries rate were only slightly higher than the original caries intensity, a decision was made not to apply this method.

Further statistical analyses included Chi-squares to determine if there was any significant difference in the incidence of carious lesions between males and females, between various teeth, different tooth surfaces, between the observed caries intensity and estimated caries intensity, as well as to test for compatibility with results obtain from other studies.

3.2.6.2 Antemortem tooth loss

Antemortem tooth loss can be recognized by the resorption of the alveolus, socket filling and mesial drift (Turner, 1979; Lukacs, 1989). It should be kept in mind that teeth lost just before death will show no signs of alveolar resorption and therefore these will be interpreted to have been lost postmortem (Turner, 1979).

Methods described by Lukacs (1989) and Henneberg (1991) were used in this study. In this study, the frequency of antemortem tooth loss was determined by calculating the individual AMTL frequency (total number of individuals who lost one or more teeth antemortem divided by the total number of individuals investigated). The AMTL intensity was also calculated. This was done by dividing the total number of teeth lost antemortem by the total number of teeth present in the sample before AMTL. By dividing the total number of teeth lost antemortem by the number of individuals affected by AMTL, the mean number of teeth lost antemortem per individual could be calculated. The incidence of specific types of teeth lost antemortem was also determined by dividing the total number of a specific type of tooth lost antemortem by the total number of the specific teeth present.

The following formulae are a description of the calculations described above:

Individual AMTL frequency =

$$\frac{\text{Number of individuals affected by AMTL}}{\text{Number of individuals in the sample}} \times 100$$

Tooth count method (AMTL intensity)

$$\frac{\text{Number of teeth lost antemortem}}{\text{Number of teeth present in the sample + Number of teeth lost antemortem}} \times 100$$

Number of teeth lost antemortem per mouth

$$\frac{\text{Number of teeth lost antemortem per mouth}}{\text{Total number of individuals affected by AMTL}} \times 100$$

AMTL intensity per tooth =

$$\frac{\text{Total number of tooth type (x) affected by AMTL}}{\text{Total number of tooth type (x) investigated}} \times 100$$

3.2.6.3 Enamel hypoplasia

Dental enamel hypoplasia (EH) was recorded for each individual, on all permanent teeth, whenever observed macroscopically to be present. The lesions were detected by scraping the sharp point of a sliding calliper along the enamel surface of the teeth. If the calliper encountered resistance, EH was recorded as present (L'Abbé, 2005). No resistance indicated an absence of the defect. Enamel hypoplasia can manifest as horizontal lines, vertical grooves, pits and areas of missing enamel (King et al., 2002). Therefore, the type of hypoplasia was also specified.

In cases where more than one defect was present on the tooth surface, it was still recorded as a single event. The prevalence of hypoplastic defects were recorded using the individual count method (proportions of individuals displaying the defect in relation to the total number of individuals examined), as well as the tooth count method. The calculations used are described below:

Frequency of EH (individuals count) =

$$\frac{\text{Number of individuals with the defect}}{\text{Total number of individuals examined}} \times 100$$

EH intensity (Tooth count) =

$$\frac{\text{Number of a specific tooth affected by enamel hypoplasia}}{\text{Total number of the specific tooth examined in the sample}} \times 100$$

Wherever possible, the relative distance between the defect and the cemento-enamel junction was measured in order to determine the age at which the production of enamel was disturbed (Obertova, 2005). Although the measurement of these lesions presents the opportunity of assessing childhood stress, several problems are still associated with the technique (King et al., 2002). Most of the crown-formation schedules used to determine the age at which enamel defects occur assume a constant rate of growth for the tooth crown, even though it is known that different parts of the crown form at different rates and variations in the rate of crown formation exists between individuals (King et al., 2002). Conventional methods do not take appositional enamel into account, which is hidden beneath the cusps. It ignores the individual variation in crown height and it does not take the position of the defect on the tooth surface and the duration of the growth disruption associated with the lesions into consideration (King et al., 2002).

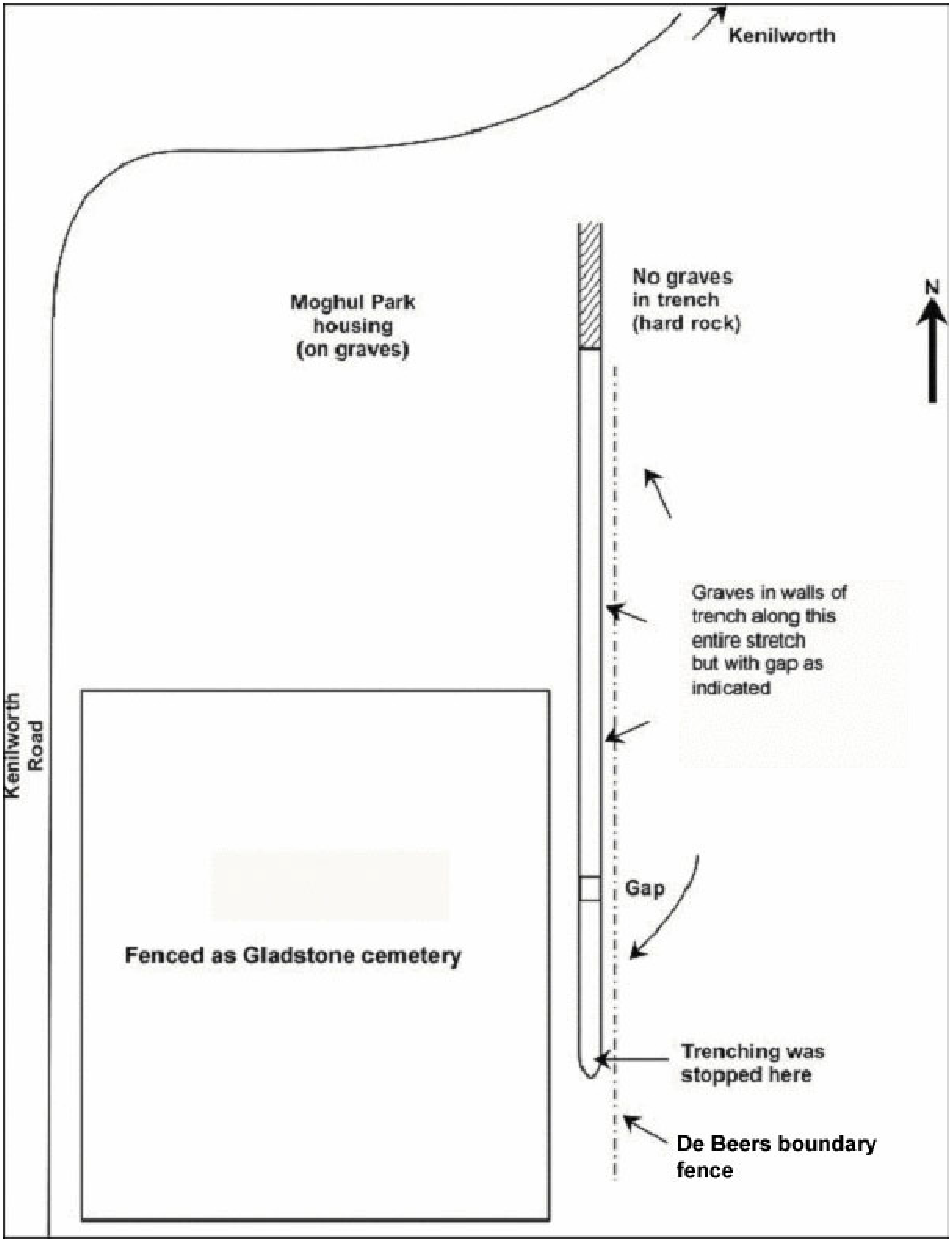


Figure 3.1 Map indicating the current fenced Gladstone cemetery, the location of the trench that uncovered the graves, as well as the De Beers boundary fence.

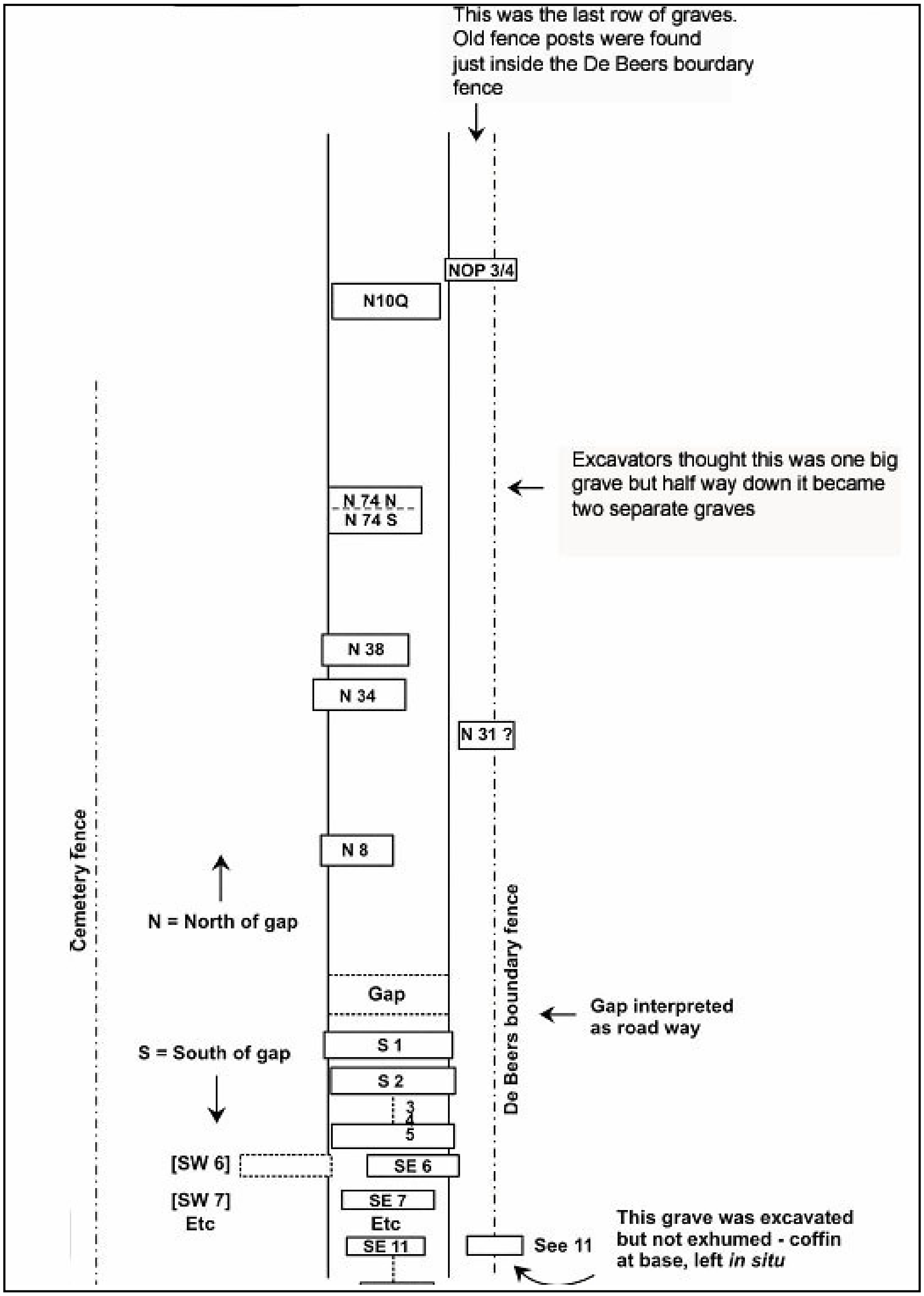


Figure 3.2 Map indicating the location of the graves in relation to the gap.

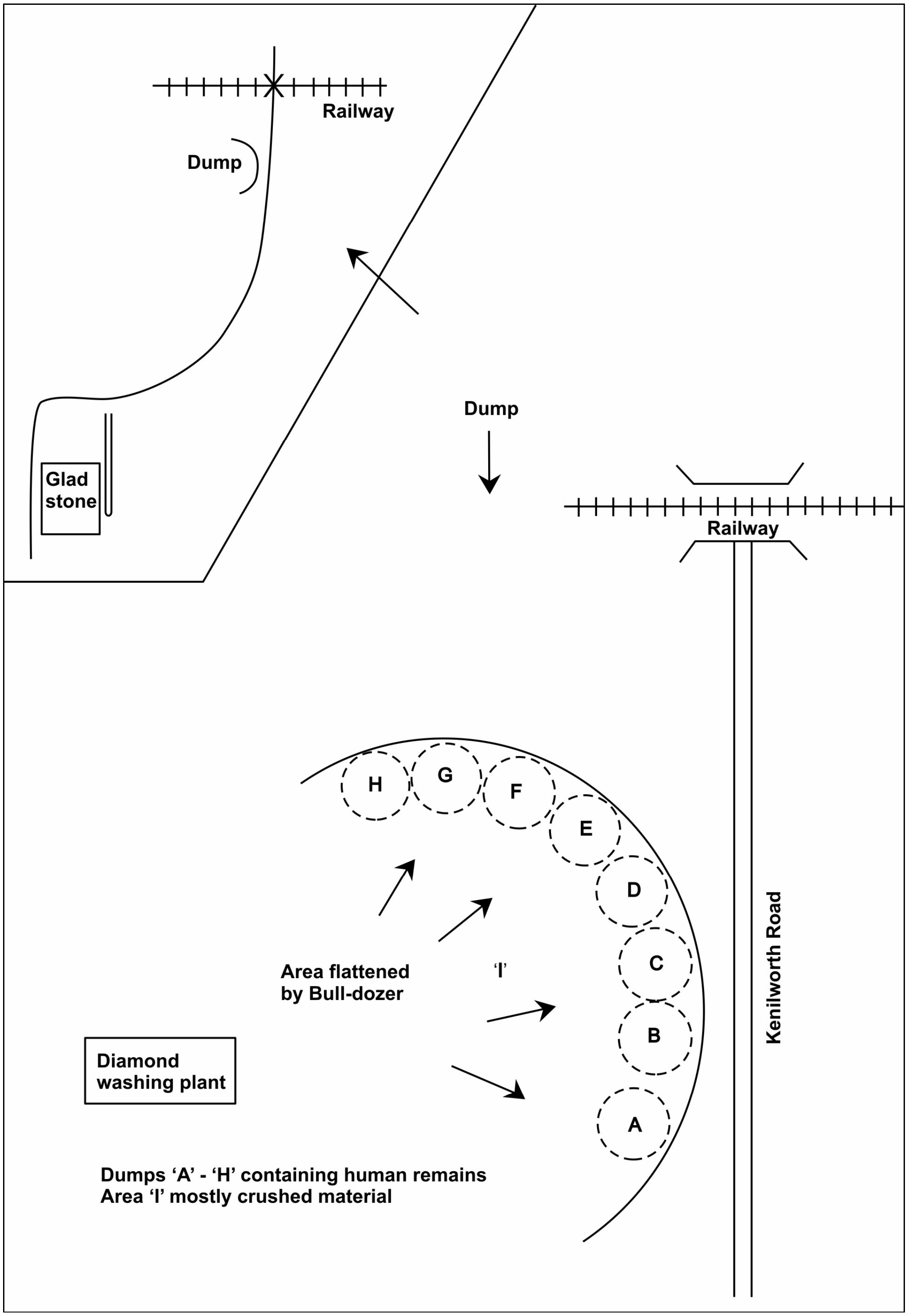


Figure 3.3 Map indicating the location of the dump site (top left corner) as well as the different areas of excavation A - H.

CHAPTER 4

RESULTS

4.1 DEMOGRAPHIC CHARACTERISTICS OF THE GLADSTONE POPULATION

A description of the burial position, preservation of the remains, age, sex, stature and pathology of each skeleton can be found in Appendix 1 for remains from the trench and Appendix 2 for bone material excavated from the dumpsite.

4.1.1 Sex distribution

A total of 107 skeletons were excavated from the trench and included 86 males, 15 females and 6 individuals of unknown sex (Table 4.1). A minimum number of 37 persons were excavated from the dumpsite and was composed of 20 males, 5 females and 12 individuals of unknown sex (Table 4.2.) It is important to consider that some of the remains excavated from the dumpsite might belong to an individual who was partly exhumed from the trench and is therefore already accounted for. Thus, although remains from the dump represent at least 37 individuals, it cannot be assumed that these bones increase the sample size to 144 skeletons. The main focus of this study fell on the persons excavated from the trench and only these will be discussed further.

4.1.2 Age distribution

The majority of individuals (71%) excavated from the trench were between 19 and 45 years of age (Table 4.3). One premature baby and two infants (both younger than one year of age) were the only children observed in this study and eight juveniles between 11 and 19 years were recorded. The highest number of individuals was observed to be between 19 and 30 years of age (n = 44). A large number of persons were also estimated to have been 31 to 45 years of age at the time of death. Only 10 individuals were estimated to have been older than 45 years of age.

Due to the fragmentary condition of some of the remains investigated in this study, eight individuals could only be described as being adult and two were of unknown age.

4.1.3 Stature

Antemortem stature was estimated for 87 of the 107 individuals excavated from the trench. Due to the fragmentary condition of the remains, stature could not be determined in some cases.

Males were estimated to have been between 153.3 and 180.7 cm tall, with a mean height of 165.3 cm (Table 4.4). This is comparable to results reported by Tobias (1971), indicating a mean stature for Southern African Negroids of 160 - 170 cm. Female antemortem stature was estimated between 146.5 and 164.2 cm, with a mean height of 154.4 cm. Unfortumately no comparable female result were available from the study by Tobias (1971).

A recent study by Steyn and Smith (in print) on the antemortem stature of living individuals measured between 2000 and 2005, indicates a mean stature of 171.0 cm for Black males and 159.6 cm for Black females. When comparing the mean stature of the Gladstone population to that observed in this recent study, it can be seen that the labourers in this 19th century mining community was on average about 5cm shorter.

4.2 PALAEOPATHOLOGY: MACROSCOPIC OBSERVATIONS

4.2.1 Infectious diseases

4.2.1.1 Treponemal disease

Possible treponemal infection was noted in 9 (8.4%) of the 107 individuals investigated in this study (Table 4.5). All affected individuals were male. Due to the small sample size of females in this study, no significant difference ($\chi^2 = 2.15$, p-value > 0.1) could be found in the incidence of treponemal infection between males and females.

Osteomyelitic changes and subperiosteal bone growth on the anterior tibia (Figure 4.1), resulting in sabre-shin tibiae, osteomyelitic changes of the fibula and/or caries sicca on the cranial vault (Figure 4.2), were observed in all individuals diagnosed with treponematosis. Sabre-shin tibiae were noted in 77.8% of individuals diagnosed with treponematosis. Osteomyelitic changes and subperiosteal bone growth on the fibula (66.7%) and gummatous lesions on the cranial vault (55.6%) were also often recorded. Lesions associated with treponemal infection were least frequent on the humerus (1/9 or 11.1%) (Figure 4.3) and radius (1/9 or 11.1%). Three individuals presented with osteomyelitic lesions on the ulna (Figure 4.4); two cases were seen in which the femur was affected (Figure 4.5); and two cases in which softening and deterioration of the nasal bones and nasal septum were observed, giving the nose an "empty" appearance. Only one individual, as will be discussed later, presented with possible gummatous lesions on the long bones.

Only one affected individual was estimated to have been younger than 20 years of age (GLD N74.3). In this case, the left radius, ulna, tibia and fibula had a slightly blown-up appearance due to advanced osteomyelitic changes and subperiosteal bone growth. The left tibia presented with a sabre-shin appearance. No gummatous lesions or other lesions suggestive of treponemal infection were found on the skull of this individual. A possible differential diagnosis is non-specific osteomyelitis, but no cloaca formations were present and primary osteomyelitis rarely affects more than one bone.

Two cases of possible treponemal infection were observed in individuals between 20 and 25 years of age. Individual GLD S1.3 had clear striations on both tibiae, with a prominent sclerotic lesion, giving the bone a sabre-shin appearance, in the middle-anterior right tibia. Lesions suggestive of gummatous periostitis (Figure 4.6) were also present on the right tibia. Possible differential diagnoses for this individual include non-specific osteomyelitis and scurvy. No cloacae formations were observed in the affected bones and the sclerotic nature of the lesions as well as the possible gummatous periostitis made treponemal infection a more plausible diagnosis. GLD SE7.7 presented with slightly blown-up tibiae with secondary bone deposition and striations. Striations and bone deposition were also present on the anterior aspect of the left fibula in the proximal half. Defects very suggestive of gummatous lesions were observed on the cranial vault.

Four individuals between 25 and 35 years of age presented with skeletal lesions suggestive of treponemal infection. Individual GLD N100.2 presented with subperiosteal bone growth on the proximal half of the anterior aspect of the left femur, and the lateral surface of the proximal half of the right fibula, giving the bones a slightly blown-up appearance. Striations with patches of subperiosteal bone growth were present on the tibiae and a possible gummatous lesion was visible on the lateral aspect on the proximal right fibula. No cloacae formations were observed to suggest osteomyelitis.

GLD N31.E.3 had early gummatous lesions on the left parietal bone and subperiosteal bone growth was present on both tibiae, giving it a sabre-shin appearance. The nasal bones of this individual also seemed softened and eaten away.

Individual GLD NOP3/4.2 had widespread striations with subperiosteal bone deposition on both tibiae. The left tibia was more affected and it had a sabre-shin appearance. The left fibula was also affected and appeared inflated. Softening of the nasal bones, making them thin and atrophic, was also noted.

The fourth affected individual, aged between 25 and 35 years, was GLD SE7.3. He presented with osteomyelitic changes and a moderate amount of subperiosteal bone growth on the anterior surface of both tibiae, giving them a slightly blown-up and striated appearance. These lesions were very sclerotic. They may have developed due to the ossification of haematomas caused by scurvy, or may have been an early sabre-shin formation due to treponematosis. No other lesions to confirm any of the above-mentioned conditions were observed.

The last three individuals affected by possible treponemal infection were older than 35 years of age. The first individual, GLD N38.7, was between the ages of 38 and 46 years at the time of death. Possible gummatous lesions suggestive of treponematosis were recorded on the frontal as well as the left parietal bones. The distal ends of the right fibula, left tibia and femur as well as the right ulna were extremely blown-up, with clear signs of secondary bone deposition.

GLD N74.7 was between 35 and 50 years of age at the time of death. Both fibulae, the right humerus and left ulna had a blown-up appearance with marked sabre-shin formation of both tibiae. Although no lesions supporting the diagnosis of treponemal infection were found on the cranial vault, the very characteristic sabre-shin tibiae as well as the absence of cloacae supported the diagnosis.

The last individual with probable treponemal disease was GLD S2.9. He was a male between 35 and 45 years of age. Striations with subperiosteal bone growth were present on the anterior surface of both tibiae, giving it a slightly inflated appearance. These could have developed either due to the presence of an ossified haematoma as a result of scurvy, trauma to the anterior tibiae or may be early signs of treponemal infection.

Patterns of skeletal involvement in South African sites similar to those seen in Kimberley, were noted in an individual from Maroelabult, as well as a male from K2 (Steyn & Henneberg, 1995; Steyn et al., 2002). Both these skeletons presented with lesions indicative of osteomyelitic changes and subperiosteal bone growth on the tibia, fibulae, femora, ulnae and radii, giving the bones a blown-up appearance. Gummatous lesions were noted on the skull of the skeleton from Maroelabult (Steyn et al., 2002). No individuals presented with skeletal lesions suggestive of treponemal infection in the Riet River, Kakamas, Toutswe, Griqua, Koffiefontein, Oakhurst and Venda samples.

Skeletal evidence indicating possible treponematosis was seen in the skeletal samples from the Mariana Islands. No venereal syphilis was present on these Islands during this time period, and it is thus suggested that the lesions were indicative of yaws. A total number of 30 (10.5%) adults were affected by the condition. Lesions affecting the tibia were also found most frequently with other elements, such as the ulna and femur, also being involved (Pietrusewsky et al., 1997). No gummatous lesions of the cranial vault were recorded.

Lesions suggesting treponemal infection have also been noted in several other populations across the world, such as the Dominican Republic, Metaponto (Italy), Guam, Suriname, Gognga-Gun beach (Guam) as well as the Hamann-Todd Collection (Khudabux, 1991; Lewis, 1994; Henneberg & Henneberg, 1993; Douglas et al., 1997; Rothschild et al., 2001). The prevalence of treponemal disease in each of these populations can be seen in Table 4.6. It can be seen that the prevalence of treponemal infection within the Gladstone population is comparable to that of the Mariana Islands ($\chi^2 = 0.11$, p-value > 0.2), Guam ($\chi^2 = 0.63$, p-value > 0.2), the Dominican Republic ($\chi^2 = 0.02$, p-value > 0.2) and Metaponto ($\chi^2 = 3.78$, p-value > 0.05) populations. The Gognga-Gun populations ($\chi^2 = 4.81$, p-value < 0.05) as well as the remains from Suriname ($\chi^2 = 29.7$, p-value < 0.05) are significantly more affected by syphilis and the Hamann-Tod sample is significantly less affected by the disease ($\chi^2 = 4.98$, p-value < 0.05).

According to Rothchild (2001), venereal syphilis affects the skeleton in only a few individuals suffering from the disease, whereas yaws affects bone in approximately 25 - 33% of cases. This explains why significantly more individuals presented with lesions from the Gognga-Gun site when compared to the Gladstone population, since all of these individuals were diagnosed as suffering from yaws (Douglas et al., 1997). The Gladstone population is most likely less affected than the Hamann-Todd sample due to the fact that these individuals come from an early 20th Century sample, and some form of treatment was most likely available (Rothschild et al., 2001). The extremely high incidence of treponemal infection in the sample population from Suriname was ascribed to a low number of females in this population, as well as unstable matrimonial relationships favouring the spread of the condition (Khudabux, 1991).

Although the incidence of treponemal disease is not significantly higher than what has been observed in other populations across the world, it is of great significance when comparing it to the South African population, since only case studies have been reported.

4.2.1.2 Non-specific osteomyelitis

One case of osteomyelitis was noted. Severe osteomyelitis was observed on the right tibia and fibula of an adult male (GLD SE11.2). A huge cloaca was present on the medial aspect of the right tibia, with abundant new infectious bone growth on the affected tibia and fibula. Evidence of new bone formation was present throughout the right tibia and fibula, causing a change in the morphology of the affected bones as well as ankylosis of the proximal and distal ends (Figure 4.7). The infection also spread to the right foot and accordingly, severe infection and bone regeneration was seen in the right talus and calcaneus.

No indication of trauma, such as a fracture, was observed in the area surrounding the lesions or in any other part of the skeleton. Taking the age of this individual into account, as well as the location of the lesion, it may also be suggested that the lesions did not develop due to haematogenous osteomyelitis. The osteomyelitis observed in this individual most likely originated as secondary complications due to soft tissue infection of the surrounding soft tissue of the right ankle or other infectious diseases that were present.

Osteomyelitis was also noted in the mandible of an individual from Maroelabult (Steyn et al., 2002). This infection most likely originated from a dental abscess (Steyn et al., 2002). Osteomyelitis was also seen in four (2.65%) individuals from the Venda population (L'Abbé, 2005). This included two cases in which the osteomyelitis most likely developed secondary to trauma and it is suggested that the other cases probably developed in hospital while they were being treated for other illnesses (L'Abbé, 2005). No evidence of non-specific osteomyelitis was found in the Toutswe, Riet River, Kakamas, Griqua, Koffiefontein, Oakhurst, K2 and Mariana Islands populations.

4.2.1.3 Tuberculosis

A male between 30 and 40 years of age (GLD N8.3) most likely suffered from tuberculosis. The preservation of these remains was excellent and all skeletal elements were present. The inferior aspect of the vertebral bodies of L4 and L5 presented with huge lytic lesions. These lesions caused almost total destruction of the vertebral body (Figure 4.8). The same lytic lesions, with indications of infectious bone growth, were seen on the superior margin of the left patella (Figure 4.9) as well as the right olecranon process (Figure 4.10).

The differential diagnoses of the lesions observed in GLD N8.3 include possible brucellosis, non-specific osteomyelitis, certain fungal infections and a possible avulsion injury. Taking the distribution of the lesions across the vertebral column into account, the lytic lesions on the lumbar vertebrae were most likely not caused by brucellosis. This infection affects the supero-anterior margins of the vertebral bodies and both lesions in this individual were found on the inferior aspect of the vertebrae (Spigelman et al., 2002). The infection also rarely affects the appendicular skeleton, as was seen in this individual.

Non-specific osteomyelitis often affects the lumbar vertebrae of adults. The infection normally spreads from there to adjacent vertebrae and the pelvis. Osteomyelitis of the spine causes lytic lesions on the vertebral bodies, resulting in eventual collapse of the vertebral body with consequent kyphosis. Ankylosis of the spine can also develop (Spigelman et al. 2002). The vertebral lesions observed in individual GLD N8.3 may be associated with non-specific osteomyelitis. The distribution of lytic lesions across the skeleton, with involvement of the right olecranon process and patella, on the other hand, does not support the presence of osteomyelitis in this individual.

Another possible cause for the skeletal lesions may be infection with actinomycosis. Skeletal lesions associated with this condition are extremely rare, and should they occur, the cervical spine is normally affected. It usually affects the vertebral body as well as the posterior elements of the vertebra. Other fungal infections, such as those caused by *Aspergillus* and *Cryptococcus,* should also be considered, since they can cause vertebral lesions, although they are rare. These fungi can be found in soil and they normally only infect individuals with compromised immune systems, such as those suffering from AIDS. Skeletal manifestations of *Aspergillus* and *Cryptococcus* infection are seen in only 10% of individuals affected by the fungi (Tayles & Buckley, 2004). Although these organisms cannot be excluded as a possible cause for the lytic lesions observed in this individual, the rarity of the diseases in association with the low incidence of skeletal involvement might argue for the exclusion of these infections.

The lesions observed in the vertebrae are also very suggestive of a "step-off" avulsion injury resulting from sudden hyperextension-hyperflexion of the vertebral column (Maat & Mastwijk, 2000). When taking into consideration though that these lesions on the vertebrae were associated with lytic lesions elsewhere in the skeleton, trauma is a less likely possibility.

The last and possibly most likely cause for the skeletal defects is tuberculosis. Taking the previously discussed characteristics of the infection into consideration, the skeletal lesions observed in GLD N8.3 can most probably be associated with this disease. Vertebral lesions, as those described for this individual, are the most common and most characteristic lesion observed in tuberculosis (Ortner, 2003). Although no rib lesions were observed in this individual, it does not defy a diagnosis of tuberculosis. According to a study on modern human skeletons of individuals who suffered from tuberculosis, rib lesions were only observed in 9% of individuals (Roberts et al., 1994; Ortner, 2003).

No possible cases of tuberculosis were found in any of the comparative populations from South Africa or the Mariana Islands.

A possible case of tuberculosis was reported from Makgope, a Botswana settlement in the Bankeveld. This individual dates from the late 18th or 19th centuries. Although the skeletal remains of this individual were poorly preserved, rib lesions in particular led to the possible diagnosis of tuberculosis (Pistorius et al., 1998).

4.2.2 Metabolic and nutritional disorders

4.2.2.1 Scurvy

A total of 107 individuals were investigated for skeletal indications suggesting scurvy. This included 86 males, 15 females and six individuals of unknown sex. Possible scurvy was diagnosed in 16 (14.9%) individuals, comprising of 13 (15.1%) males and three (20%) females. There was no significant difference in the incidence of scurvy between males and females ($\chi^2 = 0.22$, p-value > 0.2).

All individuals presenting with lesions were younger than 45 years of age. One (2.2%) individual was between 11 and 18 years of age, six (13.3%) between 19 and 30 years and nine (29%) between 31 and 45 years at the age of death. No significant differences were observed regarding the distribution of scurvy between the various age groups.

Scurvy was identified by the presence of ossified haematomas, widespead subperiosteal bone growth (most likely associated with slight subperiosteal bleeding) and periodontal disease, as discussed in the literature review. Although all of the above-mentioned characteristics are indicative of other diseases when viewed separately, combinations of these lesions were interpreted as possible scurvy.

Individual GLD N31.E.1 presented with striations and patches of new porous bone formation, bilaterally on the anterior tibiae. Indications of periodontal disease were also observed on the maxilla and mandible. Possible differential diagnoses for these lesions are trauma to the anterior tibia and treponemal disease. This would suggest that the periodontal disease could be ascribed to poor oral hygiene. No indications of carious lesions or tartar deposits indicating poor oral hygiene were noted in this individual and scurvy is accordingly a plausible explanation.

The same pattern of striated bone surfaces with subperiosteal bone lesions in association with periodontal disease was noted in individuals GLD S2.1 and GLD S2.9. In individual GLD S2.1, subperiosteal lesions were only present on the left tibia.

Possible lesions suggestive of ossified haematomas were noted in 10 individuals (Table 4.7). These lesions were sometimes slightly osteoporotic on the transverse section. They seemed localized with clear borders, separating it from the original bone (Figure 4.11). Apart from the ossified haematomas and periostitic lesions on the tibiae, skeletons GLD SE7.6 and GLD SE7.9 presented with indications of periodontal disease.

Cribra orbitalia, possibly associated with scurvy in children, was noted in individual GLD N31.E.4. Striations were seen on the left tibia and femur with some subperiosteal bone growth on the anterior aspect of the left tibia. This individual also suffered from periodontal disease.

The ossified haematomas were bilateral in seven (70%) of the cases. Two (20%) individuals presented with lesions only on the left tibia and one individual (10%) had a haematoma affecting only the right tibia.

No scurvy was recorded in any of the comparative South African populations or the remains from Mariana Island. The only population in which the incidence of adult scurvy has been reported, is that of the whalers by Maat (2004). A total of 50 individuals were examined, of which 39 suffered from scurvy.

Although the incidence of scurvy in the Gladstone population is significantly less than what was observed among the whalers ($\chi^2 = 59.5$, p-value <0.0001), this does not indicate that there was a low incidence of scurvy in Kimberley during the late 19th century. It was well documented historically that scurvy was a constant problem. These results are extremely significant, taking into consideration that this is the first documentation of the frequency of scurvy among adult skeletons in South Africa.

4.2.3 Trauma

4.2.3.1 Fractures

A total of 33.7% (n = 34) of the individuals excavated from the trench (Table 4.8) presented with well-healed, healing or perimortem fractures. Thirty of those were male and four female. No significant difference in the incidence of fractures between males and females exists ($\chi^2 = 0.386$, p-value >0.2), probably due to the small sample size. A total of 52 fractured bones were observed. Single fractures were noted in 21 individuals, ten individuals had two fractures, two individuals had three fractured bones each and one male had a total of five fractures. A summary of the various fractures can be seen in Table 4.8, and detailed descriptions of all fractures are given in Appendix 1, for each individual.

Perimortem fractures were observed in 7 individuals. These are fractures that occurred just prior to, in or around the time of death and consequently show no signs of healing. None of these fractures showed any signs of healing, and it could be established that they did not occur due to damage by the trenching machinery. One individual (GLD N38.2), who is discussed in more detail later, did show some partial healing of a cranial fracture as well as infection of a compound fracture to the right femur. No healing was observed on the spiral fracture of the right tibia. This individual most likely died due to the severity of his injuries, and therefore these fractures are described as most likely being perimortem.

Several well-healed and remodelled fractures were noted. These included a parry fracture (Figure 4.12), also known as a defence fracture since it is usually the consequence of a blow to the ulna when lifting the arm in a defence position (Mann & Murphy, 1990; Smith, 1996). A Colles' fracture (Figure 4.13) and Pott's fracture (Figure 4.14) were also noted. A sprinter's fracture was recorded in a male between 15 and 18 years of age (Figure 4.15). This fracture of the anterior inferior iliac spine is an avulsion fracture caused by sudden strain on the rectus femoris (Merbs, 1989).

Fractures to the skull encompassed 36.5% (n=20) of all the fractures that were observed and were by far the most frequent fracture. This included six healed fractures of the nasal bone, one of the orbital margin, four fractures of the zygomatic bone, four depressed fractures of the frontal bone and five of the parietal bone. Although these lesions might be due to accidents, their similarities in size and shape are suggestive of a weapon and they may be associated with interpersonal violence (Kilgore et al., 1997). Fractures such as those seen in Figures 4.16 and 4.17 are very suggestive of an injury due to a knobkierie. This is a traditional South African weapon in the form of a club or stick with a rounded end.

The worst of these fractures were seen in a male person 25 to 29 years of age (GLD N38.2). A depression fracture, showing only partial healing, was seen in the frontal bone above the left orbit (Figure 4.17). A fracture showing advanced stages of infection was observed on the right third metacarpal. There was also an antemortem spiral fracture of the right femur (Figure 4.18). Severe signs of infection are present at this fracture (Figure 4.18b), which evidently led to the amputation of the femur 106 mm below the proximal end. A spiral fracture of the right tibia (Figure 4.19) as well as a fracture of the distal end of the right fibula was also observed, with no signs of healing were present there. The absence of healing can most likely be ascribed to the fact that the leg was amputated perimortem. This individual most probably died during the amputation, thus leading to the fact that the amputated leg was found with the rest of the remains.

The limbs were second most affected by fractures, with no significant difference between fractured bones of the upper or lower limbs ($\chi^2 = 0.502$, p-value>0.2).

Fractures have been recorded in several archaeological studies in South Africa, such as K2, Toutswe, Riet River, Kakamas, Venda, and Maroelabult (Morris, 1984; Steyn, 1994; Steyn et al., 2002; L'Abbé et al., 2003; L'Abbé, 2005; Mosothwane, 2004). Very few fractures were observed in these studies. A single fracture was observed in the K2 population, three healed fractures were noted in the Toutswe sample, two fractured metatarsals in the Riet River populations, three fractures in the Kakamas sample and nine fractures in the Venda (Morris, 1984; Steyn, 1994; L'Abbé, 2005; Mosothwane, 2004). Steyn (2002) observed a single fracture in the individuals excavated at Maroelabult and no fractures were recorded for the mining population at Koffiefontein (L'Abbé et al., 2003). It is evident that the incidence of fracture in the Gladstone population is much higher as was noted in these populations. Fortunately, intensive studies on the incidence of fractures have been done on other populations (Table 4.9).

Studies from other areas of the world include the analysis of fractures in skeletal remains from Libben. Here, extremely high incidences of fractures were found, and it was concluded that these fractures most likely occurred as a consequence of accidents (Lovejoy & Heiple, 1981).

Another study was conducted by Standen (2000), where 144 individuals from a pre-ceramic coastal population of Northern Chile were examined. All signs of trauma were recorded in order to determine if trauma in this population could be ascribed to violence or occupational hazards. A high incidence of well-healed semi-circular cranial fractures as well as trauma to the upper extremities, lower extremities and trunk was observed. It was concluded that fractures in this population were mostly the result of interpersonal violence, rather than accidents (Standen & Arriaza, 2000). Unfortunately, the incidence of fractures in this population was calculated in relation to the number of individuals in the study, rather than according to the presence of skeletal elements, making comparison to other studies difficult.

A valuable study was also conducted by Jurmain (2001) and Jurmain et al. (1997) on the patterns of trauma in a prehistoric population from Central California. A total of 162 adults were investigated for signs of cranial and postcranial trauma. It was concluded that interpersonal violence was quite common in prehistoric California (Jurmain & Bellifemine, 1997; Jurmain, 2001).

When comparing the incidence of fractures in the Gladstone population to that of the Venda, California and Libben samples respectively, it can be seen that no significant differences can be observed when comparing the incidence of fractured bones in relation to the number of bones that were investigated (Venda, $\chi^2 = 1.71$,California, $\chi^2 = 1.3$, Libben, $\chi^2 = 1.57$, p-value >0.1 for all). It is important to note, though, that significantly more cranial fractures were observed in the Gladstone population when compared to the Venda ($\chi^2 = 10.9$, p-value <0.001), as well as the California populations ($\chi^2 = 65.3$, p-value <0.0001).

The incidence of fractures to the ulna was significantly higher in both the California ($\chi^2 = 6.7$, p-value <0.01) and Libben ($\chi^2 = 7.17$, p-value <0.01) samples when compared to the Gladstone population. Significantly more fractures of the radius ($\chi^2 = 5.06$, p-value <0.05) and clavicle ($\chi^2 = 7.4$, p-value <0.01) were also recorded in the Libben population.

As mentioned earlier, 33.7% of individuals excavated from the trench presented with fractures. Approximately the same percentage of individuals was affected by this condition in the sample from Chile (30%). As was also seen in the Gladstone population, 24.6% of skulls from this population, presented with semi-circular cranial fractures.

4.2.3.2 Myositis ossificans (acuta)

A total of nine (8.9%) individuals presented with traumatic exostosis, or myositis ossificans acuta (Table 4.10). These exostoses affected the femur (n=5) (Figure 4.20), tibia (n=2) and humerus (n=2) respectively. Although the femur seems to be more affected, the difference between its incidence compared to the tibiae and humeri affected was not statistically significant ($\chi^2 = 1.78$, p-value >0.2).

Myositis ossificans was noted in six males (7%) and three females (20%). Although it seems like females were more affected by the condition, the difference was not statistically significant ($\chi^2 = 2.01$, p-value > 0.1). This is most likely due to the few females in this study.

No evidence of myositis ossificans was noted in any of the comparative populations from South Africa or from the Mariana Islands.

4.2.3.3 Amputations

A total of six (5.6%) amputations were noted. This included one amputation through the femur, two through the tibia and fibula, one of the foot at the ankle, one through the humerus and one through the proximal radius and ulna (Table 4.11).

A 30 to 35 year old male (GLD N38.2) showed an amputation of the right femur 106 mm from the proximal end (Figure 4.21), The cause for this amputation was most likely a compound fracture of the distal femur (Figure 4.18), which got severely infected as is indicated by the infectious new bone growth present around the fracture. This person did not survive long after the procedure, as there is no indication of healing of the amputated limb.

Examples of well-healed amputations included an amputation of the left tibia, fibula and foot (GLD N34.3) just distal to the proximal end of the left tibia and fibula (Figure 4.22), as well as an amputation of the left foot (GLD S2.6). These amputations developed into the very characteristic peg shape associated with healed amputations, accompanied by closure of the medullary cavity (Mann & Murphy, 1990). Ankylosis of the distal ends of the left tibia and fibula occurred, following the amputation of the foot.

Apart from the above-mentioned individuals who showed signs of amputations, several amputated limbs were excavated. These amputations were of great interest, since some the yielded information regarding the reason for the amputation.

The first amputated limb was composed of a left tibia, fibula and foot amputated just distal to the knee (GLD N1.8(b)). The limb was found in a coffin with the complete skeleton of a 15 to 19 year old female. The cause for this amputation was severe infection of the lower leg, which most likely commenced at the foot. Serious signs of infection with extensive remodelling and new bone formation of the left talus and calcaneus was observed (Figure 4.23). Signs of infectious new bone formation were also present on the tibia and fibula. Other amputated limbs included a radius and ulna amputated just distal to the elbow (GLD S2.7c). Signs of infectious new bone formation were present on the proximal half of the bones. The last amputated element was a humerus (GLD S2.7b). This fragment of bone was amputated at both the distal and proximal end, as can be seen in Figure 4.24. The initial distal amputation most likely got infected shortly after the procedure and a decision was made to extend it proximally.

No amputations were noted in any of the comparative South African populations or in the remains from the Mariana Islands. Most literature dealing with amputation gives only case reports of single amputations and the incidence of amputation in populations is rarely described. Case reports include the amputation of a distal right forearm from Egypt dating to approximately 2000 BC, and an amputation of the distal left forearm in Sicily, dating to the 17th Century (Brothwell & Moller-Chritensen, 1963a; Brothwell & Moller-Chritensen, 1963b; Ortner, 2003)

4.2.3.4 Spondylolysis

Spondylolysis was noted in 6.5% (n = 7) of the individuals within the sample (Table 4.12). There was no significant difference in the occurrence of this lesion between males and females ($\chi^2 = 0.001$, p-value>0.2). All of the lesions showed bilateral separation of the neural arch (Figure 4.25) and occurred on L4 (n = 3) and L5 (n = 4). Spondylolysis associated with spondylolithesis was seen in one individual (GLD NOP 3/4.1).

Spondylolysis was noted in one adult male from the Kakamas population and two individuals (7.1%), male and female, from the Griqua sample (Morris, 1984). An investigation into the incidence of this condition among Black South Africans found that 3% of the sample presented with the condition (Eisenstein, 1978). According to a study by Arriaza (1997), spondylolysis was observed in 21% of individuals examined from the prehistoric period of Guam. He related the high incidence of this condition to high levels of traumatic events to the lower back, most likely associated with the dragging and lifting of heavy stones (Arriaza, 1997). Skeletal remains from the Mariana Islands presented with a mean incidence of 4.3% for the all island (Pietrusewsky et al., 1997).

4.2.3.5 Dislocation and subluxation

Longstanding subluxation was noted in two individuals (Table 4.12). Longstanding subluxation was noted in the right sternoclavicular joint of individual GLD S2.6, resulting in remodelling and the formation of an articulation facet on the inferior surface of the sternal end of the clavicle.

The last and worst case was noted in a 40 to 55 year old male (GLD N74.5). A fracture of the left humerus was most likely the cause for this subluxation. The non-reduced fracture caused shortening of the humeral shaft as well as lateral rotation of the distal end of the humerus. In order to attain some functionality of the arm, subluxation of the shoulder joint occurred (Figure 4.26). The subluxation caused a false articulation facet to develop between the acromion and the posterior surface of the humeral head. This most probably led to an unstable shoulder joint, with the humerus in a position of hyperextention and posterolateral rotation.

No evidence of longstanding dislocation was recorded in any of the comparative South African populations or the sample from the Mariana Islands. Literature concerning dislocations is mostly case reports of single observations, rather than discussion of the incidence of the condition within a specific population. An example of such a report is the description of a dislocated left hip observed in a medieval Nubian skeletal individual. This dislocation was ascribed to possible trauma to the right thigh (Kilgore et al., 1997).

4.2.4 Congenital abnormalities

4.2.4.1 Spina bifida

Out of 87 individuals with partially to complete vertebral columns examined in this study, three (3.4%) individuals presented with spina bifida of one vertebra. One of these was a 25 to 30 year old male (GLD N8.2), who presented with a bifid spine of T12 (Figure 4.27). This condition was most likely asymptomatic.

GLD N8.8 was the remains of a 20 to 25 year old male. A rare case of spina bifida of the atlas was observed in this individual (Figure 4.28). The anterior neurocentral portion of the atlas as well as the posterior spine did not fuse, resulting in the atlas being comprised of two halves. It is also proposed that the non-union of the anterior portion of the arch might be due to post-traumatic bone resorption.

The next case was that of a 40-50 year old male (GLD S3.1a). Nonfusion of the anterior arch of the atlas was also seen in this individual. Although the arch was unfused, the two ends were in close contact with each other and this condition was most likely asymptomatic.

Spina bifida has also been noted in other studies conducted on South African populations (Mosothwane, 2004;Steyn, 1994b). About a third of adults with preserved vertebrae presented with the condition in skeletal remains excavated from K2 (Steyn, 1994b). The Toutswe population presented with an incidence of spina bifida occulta of 3.5%. Three individuals from the Riet River population presented with spina bifida, i.e. 5.4% of the available post-juvenile vertebral columns (Morris, 1984). Two cases were also reported from Kakamas and one (3.6%) from the Griqua sample population (Morris, 1984). In a study conducted by Shore (1930) in South African Negroids, it was observed that up to 28% of individuals were affected by the condition.

The incidence of spina bifida in the Gladstone population is similar to that of the Toutswe and Kakamas samples. This population was significantly less affected by the condition when compared to the sample investigated by Shore (1930), as well as the K2 population.

4.2.4.2 Supernumerary vertebrae

A variation in the number of thoraco-lumbar vertebrae were observed in 11 (14.9%) of the 87 partial to complete vertebral columns examined. No significant difference was observed between in the incidence of extra vertebrae between males and females (χ^2 = 0.33, p-value>0.2), with 10 males being affected and only one female (Table 4.13).

An extra thoracic vertebra was observed in two (2.3%) cases (GLD N100.4 and GLD N31.E.2), while an extra lumbar vertebra was observed in nine (10.3%) cases. Accordingly, a significant difference in the distribution of extra vertebrae was observed, with the condition being more prominent in the lumbar region (χ^2 = 4.75, p-value < 0.05).

De Beer Kaufman (1974) indicated that a sixth lumbar vertebra is present in 8.2% of South African Negroids and 14.3% of San individuals. Variations in the number of presacral vertebrae were also observed in the Riet River, Kakamas and Griqua samples (Morris, 1984). According to Morris (1984), 8.3% of individuals from the Riet River sample, 12.5% from Kakamas and 3.6% of skeletons from the Griqua sample presented with this phenomenon. The prevalence of a sixth lumbar vertebra in the Gladstone population is comparable to the Riet River (χ^2 = 0.47, p-value > 0.2), Kakamas (χ^2 = 0.0001, p-value > 0.2) and Griqua (χ^2 = 1.87 p-value > 0.1) populations.

4.2.4.3 Craniostenosis

A total of 84 skulls were investigated and craniostenosis was noted in two individuals (2.4%). Both of these occurred in male skulls (Table 4.13).

Premature closure of the sagittal suture was seen in a male of 18 to 23 years of age (GLD N100.4). The sagittal suture was completely fused and obliterated (Figure 4.29). The coronal and lambdoid sutures were strongly interdigitated, but no ectocranial fusion could be seen.

The second case was seen in GLD N74.11. This individual was a 17-20 year old male. Complete fusion and obliteration of the sagittal suture, as was noted in the previous case, was also seen in this individual. The lambdoid and coronal sutures were tightly interdigitated, but very little fusion could be seen ectocranially.

Only minimal malformation of the skulls was noted in both cases, and it is therefore suggested that brain growth had ceased before the premature closure of the sutures commenced. The craniostenosis observed in these two individuals were most likely asymptomatic.

Two cases of craniostenosis have been observed in the South African comparative populations, one from Riet River and one from the Griqua population (Morris, 1984). An incidence of 1% was observed in a living population of South African Negroids (Gordon, 1959). There was no statistically significant difference in the prevalence of this condition between what was recorded by Gordon (1959) and observed in the Gladstone population ($\chi^2 = 1.21$, p-value >0.2).

4.2.5 Degenerative diseases

4.2.5.1 Schmorl's nodes

Schmorl's nodes (which is an early sign of degenerative disc disease), were noted in 27.7% (n = 24) of males and 25.7% (n = 3) of females in the Gladstone population. This difference was not statistically significant ($\chi^2 = 0.40$, p-value >0.2). A total of 637 vertebrae were investigated and 4.9% (n = 31) of these presented with Schmorl's depressions. These lesions were mostly observed in the thoracic and lumbar spine, with only three individuals presenting with Schmorl's nodes in the cervical region (Table 4.14). All persons affected by the condition were younger than 45 years of age, with the majority estimated to have been between 25 and 35 years of age.

Schmorl's nodes have also been noted in the Venda (2.6%) and Koffiefontein (13.9%) populations (number of individuals affected by the condition). The incidence of Schmorl's nodes observed in the Gladstone population is significantly higher than the incidence among the Venda ($\chi^2 = 33.81$, p-value<0.0001). No significant difference exists in the incidence of Schmorl's nodes between the Gladstone population and the Koffiefontein sample ($\chi^2 = 2.7$, p-value >0.01).

4.2.5.2 Arthritic observations

Arthritic changes[2] were noted in 21 (24.4%) males and three (20%) females. No significant difference (χ^2 = 0.13, p-value > 0.2) in the incidence of arthritic changes was observed between males and females.

Osteoarthritic changes in the acetabulum were noted bilaterally in five individuals (Table 4.15). This comprised of a total of ten (7.5%) of the 133 investigated acetabulums.

Arthritic changes to the sacro-iliac joint were observed in two individuals, GLD N74.5 and GLD S2.6. GLD N74.5 was a male estimated to have been between 40 and 55 years of age at the time of death. Ossification of the left sacro-iliac joint (Figure 4.30) as well as arthritic changes to the right sacro-iliac joint was observed. These lesions may be associated with the initial stage of development of ankylosing spondylitis. As described previously, this condition is recognized by ossification of the sacro-iliac joint. DISH might also be considered as a possible cause for the skeletal lesion observed. The internal surface of the sacro-iliac joint was relatively unaffected by the disease and other enthesopathies, such as heel spurs and enthesophytes on the anterior surface of both patellae, were also observed. It must be mentioned, though, that the vertebral column did not present with any lesions indicative of DISH, in particular the very characteristic osteophyte formations. Although seronegative spondylarthropathies (which includes conditions such as Reiter's syndrome and psoriatic arthritis) should also be considered, this condition is extremely rare among African Blacks, since they do not possess the B27 antigen and seronegative spondylarthropathies are therefore most likely not responsible for the lesions (Olivieri, et al., 1998). The condition could also have developed due to traumatic arthritis. The latter is most likely, taking into consideration that no evidence of fusion between vertebrae was noted in the spine of this individual and well-healed fractures were present, which may be indicative of a traumatic incident.

Individual GLD S2.6 was a 35 to 46 year old male. Degenerative changes were observed bilaterally in the sacro-iliac joints. This individual also had an amputation of his left foot as well as a longstanding subluxation of the right clavicle. As mentioned in the previous case, seronegative spondylarthropathies such as psoriatic arthritis and Reiter's syndrome could not be responsible for the lesions, since these conditions are extremely rare among African Blacks (Olivieri et al., 1998). DISH can also be excluded as a possible cause for the changes

[2] The terms arthritic changes or arthritic observations are used here to refer to the general changes observed in joints, without specifying the disease responsible for the change.

to the sacro-iliac joint, since it was the internal surface of the joint that was affected. The lesions could be indicative of early stages of ankylosing spondylitis, although no other lesions were observed to support this diagnosis. Therefore, taking all of the aforementioned conditions as well as the traumatic lesions observed in this individual into consideration, it is suggested that the arthritic changes in the sacro-iliac joint were most likely trauma-related.

Osteoarthritis of the acromioclavicular joint (Figure 4.31) was noted in 8 individuals (7.9%). The majority of individuals with this condition were between 30 and 45 years of age. A total of 134 costoclavicular joints were investigated, of which 16 (11.9%) showed indications of osteoarthritic changes.

Ossification of the left tibio-talar joint was seen in a young male (GLD S2.3). Although it was difficult to ascertain whether the internal surface of the joint was affected by the ossification, it did seem that the articular surfaces of the joints were also affected by ankylosis. This will exclude DISH as a possible cause for the ossification of the tibio-talar joint, since DISH would only have resulted in the ossification of the capsule of the joint. It is suggested that the arthritic changes associated in this joint (Figure 4.32) are most likely trauma-related.

Osteoarthritis of the temporo-mandibular joint was seen in a 40-55 year old male (GLD N8.3). The condition most likely developed due to increased biomechanical stress associated with chewing, especially when considering the antemortem loss of teeth, leaving the maxilla and mandible of this individual edentulous (Ortner, 2003).

Vertebral osteophytosis[3] were noted in 11 (12.7%) males and two (13%) females. There were no significant difference in the incidence of osteophytes between males and females ($\chi^2 = 0.003$, p-value > 0.2). The majority of these spurs occurred in individuals older than 35 years of age (Table 4.15). It is therefore suggested that these lesions are the result of normal degenerative changes associated with aging.

Arthritic changes have also been observed in the K2 population where almost half of the individuals presented with vertebral osteophytes, while two cases of osteoarthritic changes in the apendicular skeleton were observed. Of the two, one presented with osteoarthritic changes of the first metatarsal, while in the second, osteoarthritis of the temporomandibular joint was observed (Steyn, 1994). Eleven individuals presented with arthritic changes in the skeletal sample from Toutswe. This included changes to the vertebrae, shoulders, hips, knees

[3] Vertebral osteophytosis refers to bony outgrowths affecting the fibrocartilaenous joints of the vertebral bodies, developing due to degenerative disc disease.

and feet (Mosothwane, 2004). All individuals were older than 40 years of age, and arthritic changes in this sample can most likely be ascribed to normal aging processes.

Osteoarthritic changes were observed in 16.1% of young adults (21 - 40 years) in the Riet River, 8% of young adults from the Kakamas sample and 18.2% of young adults from the Griqua sample. It was found that in general, older individuals from the three mentioned populations were more affected by osteoarthritis than the young adults, as can be expected. Osteoarthritic lesions were observed in the temporomandibular joint, shoulder, elbow, carpo-metacarpal joints, hip, knee, tarso-metatarsal joints as well as the phalangeal joints (Morris, 1984). No statistical significant differences were observed when comparing the incidence of arthritic changes in the Gladstone population to that of the Riet River (χ^2 = 1.00, p-value >0.05), Kakamas (χ^2 = 3.34, p-value >0.1) and Griqua (χ^2 = 0.23, p-value > 0.05) populations. It should be mentioned that the sample size for young adults was relatively small in the Riet River, Kakamas as well as Griqua populations, and as was indicated by Morris (1984), might not be representative of the populations as a whole.

Arthritic changes were noted in eight (7.07%) individuals from Venda. This included lesions on the vertebrae, temporomandibular joint, elbows, knees and phalanges of the hand (L'Abbé, 2005). One case of possible traumatic arthritis was also recorded. All individuals showing arthritic changes were older than 40 years of age, and degenerative changes can therefore most likely be due to normal aging processes.

Vertebral osteophytosis was recorded in 22.2% (n = 8) of individuals from the Koffiefontein population. No statistical signficance (χ^2= 1.78, p-value > 0.05) were found when comparing the incidence of vertebral osteophytosis observed in the Gladstone population to that of the Koffiefontein sample. Osteoarthritic changes were observed in two individuals (5.5%) from the Koffiefontein sample (L'Abbé et al., 2003). Individuals from Maroelabult also presented with arthritic changes (56.2%), but all were older than 40 years of age (Steyn et al., 2002).

Osteoarthritic changes were noted in 9.1% of individuals from the Mariana Islands (Pietrusewsky et al., 1997). These lesions were mostly ascribed to normal degeneration due to advancing age.

4.2.5.3 Occupational stress markers: enthesopathies and cortical defects

A list of all the musculoskeletal stress markers as well as their frequency within the population can be seen in Tables 4.16 and 4.17. No significant difference was seen in the enthesophyte distribution between the right and left side in any of the elements studied.

No significant difference were noted in the incidence of markers between male and female individuals, except for the incidence of enthesophytes on the popliteal line, which were higher in females than in males ($\chi^2 = 7.2$, p-value < 0.01).

The stress marker observed most was the formation of enthesophytes between the distal ends of the tibia (26.5%) and fibula (43.3%), which most likely developed due to strain on the interosseous membrane.

Three studies are available on the incidence of enthesopathies in South African populations (Churchill & Morris, 1998; Ledger et al., 2000; Peckman, 2002). Unfortunately, results obtained in these studies were not comparable to those of the Gladstone population due to the different in methods used to assess the lesions. Various other populations have been studied, such as the Stone Age population on the island of Gotland in the Baltic Sea (Molnar, 2006). Peterson (1998) investigated enthesopathies in the Natufian sample, in order to determine if spears and atlatl or bows were used regularly in hunting, and Stirland (1988) linked the development of these lesions to certain occupations from a sample obtained from a shipwreck, the Mary Rose.

A similar study was also done by al-Oumaoui et al. (2004), where the incidence of musculoskeletal stress markers in various Iberian populations was compared. The incidence of enthesopathies in the Argar culture can be seen in Table 4.18. This population stayed in villages on steep hills, where they made a living through herding and mining (al-Oumaoui et al., 2004).

Enthesopathies were also examined in the Neolithic Saharan populations (Dutour, 1986). It was found that up to 20% of individuals in the study presented with enthesopathies involving the arms and the feet (Table 4.18)

Comparisons between the two above-mentioned populations and some of the stress markers observed in the Gladstone sample reveal that the Argar presented with a much higher incidence of enthesophytes than the Gladstone population. Results obtained from the Neolothic Saharan populations seem comparable.

4.2.6 Non-specific indicators of pathology

4.2.6.1 Periostitis

A total of 107 individuals were investigated for indications of non-specific periosteal bone lesions. This included 86 males, 15 females and six individuals of unknown sex. Non-specific periostitis was present in 20 (18.7%) individuals, comprising of 18 (20.9%) males and two (13.3%) females (Table 4.19). No significant differences existed in the incidence of these lesions between males and females ($\chi^2 = 0.49$. p-value > 0.2).

The tibia was significantly more affected by lesions of periosteal bone growth than any of the other skeletal elements (χ^2 = 15.9, p-value<0.001), with lesions being observed in 13 individuals. This included 52.7% of all the lesions observed (Table 4.19). Lesions suggestive of foot infections were noted in seven (6.5%) individuals. Both feet showed signs of infection in most cases, with only one foot being infected in two individuals. Periosteal lesions were also noted on the humerus (n = 3) and femur (n = 2).

The incidence of periostitis in various population groups can be seen in Table 4.20. It is important to note that the highest incidence of non-specific periostitis was observed in the Gladstone, Koffiefontein and Maroelabult populations, whereas the Venda and individuals from K2 and Mapungubwe were less affected.

Although comparative data for the incidence of non-specific periostitis on specific bones were only available for the Venda and K2 populations, it seems that the pattern of distribution seen in the Gladstone sample is comparative to that of the Venda, with the tibia being most affected.

4.2.6.2 Cribra orbitalia

The orbits of 82 individuals (69 males, 13 females) were investigated for cribra orbitalia. A total of nine (11%) individuals were affected by the condition. This included two (15.3%) females and seven (10.1%) males. Orbits were affected bilaterally (Figure 4.33) in most cases (Table 4.21), except in two individuals (GLD SE7.8 and GLD N34.4). In both these cases, only the left orbit was affected. No porotic hyperostosis were noted in any of the affected individuals.

The incidence of cribra orbitalia in various South African populations can be seen in Table 4.22. Only the incidence of cribra orbitalia in adults was quoted from these studies, and numbers presented here does not include the cases of juvenile cribra orbitalia noted by researchers. This was done to increase the comparability to the Gladstone population, since no juvenile remains were investigated. No evidence of the condition was found in adult remains from Venda, the Griqua, Kakamas and Toutswe, and therefore these populations were not included in the comparison. Although cribra was noted in the Maroelabult population, the exact incidence of the condition is not stated. No significant difference existed in the incidence of cribra orbitalia in adults between the Gladstone population and any of the South African comparative samples.

Peckmann (2003) conducted a study on the incidence of cribra orbitalia and its association to a smallpox epidemic. Three South African communities, namely the Griqua, Khoe (Colesberg) and 'Black' peoples (Wolmaransstad) living during the nineteenth and early twentieth century were investigated. Cribra orbitalia was observed in 34.6% of Griqua individuals, 36.1% of the Khoe and 46.6% of 20^{th} Century 'Black' peoples (Peckmann, 2003). The prevalence of cribra orbitalia in the populations studied by Peckmann (2003) is significantly higher than that observed in the Gladstone population (Griqua χ^2 = 11.1, Khoe χ^2 = 11.8, 'Black' peoples χ^2 = 14.9, P-value <0.05 for all). The high incidence of cribra orbitalia in these populations was ascribed to a smallpox epidemic (Peckmann, 2003).

A study was conducted by Fairgrieve et al. (2000) on the incidence of cribra orbitalia in a population from Dalklek Oasis in Egypt. Up to 82% of adult crania investigated presented with orbital lesions (Fairgrieve & Molto, 2000). It was evident that the incidence of the lesions in this population is significantly higher (χ^2 = 130.2, p-value<0.0001) than what was observed in the Gladstone population.

4.3 PALAEOHISTOPATHOLOGY

A total of 14 bone sections were studied. For the purpose of this chapter, macroscopic findings and its associated differential diagnosis, macroscopic morphological features of the bone sample on cross section, as well as histological characteristics obtained after microscopic investigations for each individual examined, will be given in the individual skeletal reports in Appendix 1. Only general histological characteristics of the conditions observed in these samples will be described here, namely ossified haematomas, bone changes due to infectious diseases and a combination of the two afore-mentioned conditions.

Ossified haematomas were identified in seven individuals (GLD N8.4, N8.5, N34.13, N38.5, S2.4, SE7.3, SE7.9) as can be seen in Table 4.23. As described earlier in the literature review, these lesions were characterized by normal cortical bone, unaffected by the pathological condition. With histological investigation, the original periosteal surface, represented by the original external circumferential lamellae (Figure 4.34), was intact in all of these samples and could be followed through the section. In some cases it was interrupted, but still easy to visualize. The newly formed bone on the outside of the original periosteal surface was composed of radiating trabeculae (Figure 4.35), as was also described by Murray (1949). These trabeculae were perpendicular to the periosteal surface of the bone.

Three phases of remodelling could be distinguished during the examination of the ossified haematomas bone. Recently ossified haematomas presented with the very characteristic radiating trabeculae as can be seen in GLD SE7.9 (Figure 4.36). The newly formed bone seemed porous and many resorption holes were present. The second stage (for example GLD SE7.3), is characterised by remodelling of the trabeculae and filling in of the openings between the trabeculae, giving rise to a relatively homogenous structure (Figure 4.37). Although the various original trabeculae cannot be distinguished anymore, the appositional bone still retains its radiating structure. The last phase characterizes very longstanding lesions, and can be seen in GLD S1.3 and GLD N8.4. Although the appositional bone still retains its radiating structure (Figure 4.38), bone remodelling into haversian systems has commenced in the appositional bone.

The second type of histopathological characteristics observed was indicative of osteomyelitis (Table 4.23). It should be mentioned here that this term includes all infectious bone changes such as lesions caused by haematogenous non-specific osteomyelitis, treponematosis and leprosy. Clear histological indications of infectious bone changes were observed in one case (GLD N74.7). The bone seemed extremely thickened and inflated on cross section (Figure 4.39). On histological level, numerous resorption holes were present (Figure 4.40), giving the section a porous appearance and making distinction between the internal spongy bone and the cortical bone almost impossible. No original circumferential lamellae, as was seen in the ossified haematomas, were present in this section. No bone apposition or radiating bone structures were visible.

The histological features of the last group of individuals were indicative of both the afore-mentioned conditions (haemorrhagic bone reactions and infectious bone reactions)(Table 4.23). These histological features were noted in three individuals (NOP3/4.2, S1.3, SE7.7). In all of these sections, the bone was extremely thickened on cross section and histological investigation revealed different severities of resorption holes indicative of infectious bone changes. Apart from these lytic changes to the cortical bone, a still clear original periosteal surface, represented by the original circumferential lamellae, was present with radiating appositional bone on top of it. It is accordingly suggested that individuals presenting with this combination of histological features most likely suffered from more than one pathological condition; one being infectious in nature, and the second causing haemorrhagic changes in the bone.

Histological results proved macroscopic diagnoses wrong in three cases (GLD N31.E.1, S2.9, SE7.4). In all of these cases, striated bone surfaces and slight subperiosteal bone reactions were observed during macroscopic investigation. These lesions were thought to be indicative of non-specific periostitis or early haemorrhagic bone reactions. Histological investigation revealed that no pathological changes were present in the bone, and that the striated appearance on the bone surface was due to normal morphological variation in the external circumferential lamellae.

4.4 DENTAL HEALTH

4.4.1 Dental caries

A total of 90 adult individuals comprising of 76 males, 13 females and 1 individual of unknown sex were investigated. As can be seen in Table 4.24, 50% of males, 30.8% of females as well as the individuals of unknown sex showed signs of one or more carious lesion. An average of 2.7 and one carious lesion per mouth were calculated for males and females respectively. It was concluded that a dental caries intensity of 4.48% was recorded for males and 3.20% for females. No significant differences existed in the intensity of carious lesions between males and females (χ^2 = 1.370, p -value>0.2). Since no significant differences were observed between males and females, the calculations that followed were pooled.

Using the method described by Lukacs (1995) a 'corrected caries intensity' was calculated for males and females to compensate for teeth lost antemortem due to dental caries. The caries intensity increased by 2.01% for males, totalling up to 6.49%, and 0.79% for females, totalling up to 3.99% (Table 4.25). A significant difference between the observed dental caries intensity and the corrected caries rate (χ^2 = 9.115, p -value = 0.005) was observed.

The caries intensity was also calculated per tooth type. In general, carious lesions affected anterior teeth (incisors and canines) significantly less than posterior teeth (premolars and molars), as was expected ($\chi2$ = 43.8, p -value < 0.0001). It can be seen in Table 4.26 that the second molars were significantly more affected by carious lesions than any of the other teeth ($\chi2$ = 52.2, p -value < 0.0001), followed by the second premolar, first molar and third molar, with no significant difference amongst them, and then the anterior teeth. The canine was the least affected ($\chi 2 = 3.86$, p -value = 0.05). No significant difference in the distribution pattern of carious lesions was observed between males and females (Table 4.26).

The distribution of carious lesions on the teeth was investigated. No significant difference existed between the distribution of dental caries found on the occlusal and interproximal surfaces of the teeth ($\chi 2 = 0.28$, p -value > 0.2). It was also seen that no significant difference existed between carious lesions found on the buccal and lingual aspects of teeth ($\chi 2 = 3.5$, p -value > 0.05). It was evident that lesions affecting the occlusal and interproximal surfaces of teeth were significantly more prevalent than those affecting the buccal (Figure 4.41) and lingual aspects of teeth (Table 4.27) ($\chi 2 = 66.3$, p -value < 0.0001).

Lastly, the caries intensity obtained in this study was compared to various other studies in South Africa (Table 4.28). It was concluded that no significant difference existed between the results obtained from the Gladstone remains and those computed for the Riet River ($\chi 2 = 0.001$, p -value > 0.2), Griqua ($\chi 2 = 0.9$, p -value > 0.2) and Maroelabult ($\chi 2 = 0.0001$, p -value > 0.2) populations.

4.4.2 Antemortem tooth loss

A total of 90 individuals, consisting of 76 males, 13 females and one individual of unknown sex, were investigated for signs of antemortem tooth loss (AMTL) (Figure 4.42). One or more teeth lost antemortem was observed in 30.3% and 15.4% of males and females respectively (Table 4.29). This yielded an AMTL intensity of 2.5% for males and 1.0% for females. Individuals who suffered from AMTL had an average of 2.5 teeth lost per mouth. No significant differences existed in the incidence of individuals affected by AMTL between males and females ($\chi 2 = 1.23$, p -value > 0.1). This can most likely be ascribed to the few females present in this study. A significant difference was however present concerning the AMTL intensity between males and females, with males being significantly more affected ($\chi 2 = 3.88$, p -value < 0.05).

As can be seen in Table 4.30, the AMTL of the first molar (5.1% in total) was in general significantly more prevalent than that of the anterior teeth and premolars ($\chi 2 = 18.76$, p -value < 0.0001) when testing the frequency of AMTL of M1 against all the other teeth. In females, however, the second molar was most often affected by AMTL ($\chi 2 = 5.31$, p -value < 0.05), where males showed most frequent loss of the first molar ($\chi 2 = 18.9$, p -value < 0.0001). It should be kept in mind though that only 2 females were affected by AMTL, making any conclusions regarding the distribution of AMTL among females impossible. The rest of the molars and incisors followed the first molar, all being almost equally affected. Canines (0.57% in total) as well as the premolars (0.57% in total) were significantly less affected by AMTL than the other teeth ($\chi 2$ = 12.11, p -value < 0.001), when testing the incidence of AMTL of these teeth against all the others.

When comparing the incidence of antemortem tooth loss to that of other studies in Southern Africa, such as the Griqua, Kakamas, Riet River, Oakhurst, 20th Century Venda and Koffiefontein populations, to that observed in Gladstone, it can be seen (Table 4.31) that the Venda and Koffiefontein samples were significantly more affected by antemortem tooth loss ($\chi 2$ = 21.8, p -value < 0.001 and $\chi 2$ = 8.82, p -value < 0.01 respectively). The Kakamas population was significantly less affected when compared to the Gladstone population ($\chi 2$ = 24.51, p -value < 0.0001). The prevalence of antemortem tooth loss in the Gladstone population seems to be comparable to that observed in the Griqua population ($\chi 2$ = 2.29, p -value > 0.1).

4.4.3 Enamel hypoplasia

A total of 90 individuals, comprising of 76 males, 13 females and one individual of unknown sex, were investigated. Enamel hypoplasia (EH) was noted in 18.42% (N = 14) of male persons (Table 4.32). Of the 14 individuals with lesions, 12 showed evidence of linear enamel hypoplasia (Figure 4.43) and 2 were cases of pitted enamel hypoplasia (Figures 4.44). No EH was observed within the female sample. No significant difference exists between the incidence of the defect in males and females. This can most probably be due to the small sample size.

The incidence of specific teeth affected by EH can be seen in Table 4.33. Anterior teeth (incisors and canines) were significantly more affected by EH ($\chi 2$ = 51.167, upper teeth and $\chi 2$ = 20.606, for lower teeth, p -value < 0.001) than posterior teeth (premolars and molars). No significant difference was present for the distribution of EH between the maxillary and mandibular teeth.

Comparisons between the prevalence of EH observed in the Gladstone population to that reported for other South African populations such as the Venda, Mapungubwe, Oakhurst, Maroelabult and Koffiefontein samples, can be seen in Table 4.34. It can be seen here that the incidence of EH in the Gladstone population is comparable to the 20th century Venda ($\chi 2$ = 0.18, p -value > 0.2) and Maroelabult ($\chi 2$ = 0.10, p -value > 0.2) sample populations.

4.4.4 Dental calculus

Of the 90 individuals investigated, moderate to advanced calculus deposits (Figure 4.45) were noted in 32.2% (N = 29). This included 24 males (31.6%) and five females (38.5%). No significant differences existed in the incidence of dental calculus between males and females ($\chi 2 = 0.24$, p -value > 0.2).

In a study by Mosothwane (2004) on the Toutswe population, it was indicated that 12 individuals (26.1%) presented with tartar deposits on their teeth. No significant difference existed in the incidence of tartar between the Gladstone and Toutswe populations ($\chi 2 = 0.54$, p -value >0.2).

Studies concerning the incidence and severity of dental calculus have also been done in the pre-Hispanic population from Gran Canaria (Canary Islands). A total of 791 individuals were investigated and 88.5% presented with dental calculus, with no significant difference between male and female individuals. It is obvious that this population was significantly more affected by dental calculus than the Gladstone population ($\chi 2 = 179.2$, p -value < 0.0001). The high incidence of dental calculus was ascribed to consumption of a protein rich diet and neglected dental care (Delgado-Darias et al., 2006).

In a study conducted by Greene (2005), it was indicated that up to 93% of individuals between the ages of 18 and 35 years in the Egyptian population dating between 4400 - 3200 BC showed dental calculus formation (Delgado-Darias et al., 2006). It is clear that the prevalence of dental calculus in the Gladstone population is relatively low.

4.4.5 Periodontal disease

Periodontitis, as can be seen in Figure 4.45, was noted in 39.5% (N=30) of males and 53.8% (N=7) of females (Table 4.35). No significant differences were observed in the prevalence of periodontal disease between males and females ($\chi 2 = 0.94$, p -value > 0.2). When only looking at individuals possibly suffering from scurvy, periodontal disease was noted in 7 of the 16 individuals (43.8%). No significant difference existed in the prevalence of periodontal disease between individuals suffering from scurvy and those who don't. It should be kept in mind that periodontal disease also develops due to neglected oral hygiene, which will have a big influence on the incidence of this condition in all individuals.

4.4.6 Periapical abscesses

A total of 76 males and 13 females were investigated for any indications of periapical abscesses. Abscesses (Figure 4.46) were observed in 14.4% (N=11) of males and 15% (N=2) of females. No significant difference was observed in the prevalence of abscesses between males and females ($\chi 2 = 0.007$, p -value >0.2).

A total of 22 abscesses were observed in the 13 individuals, with the majority presenting with 2 or more lesions. In general, posterior teeth (19 of the 22 abscesses) were significantly more affected than anterior teeth ($\chi 2 = 4.6$, p -value < 0.05). The first molar was significantly more affected by abscesses than any of the other teeth, with nine of the 22 lesions ($\chi 2 = 11.17$, p -value < 0.05), followed by the second molar with five lesions. No abscesses were found on the canines and third molars.

Periapical abscesses were observed in 7 individuals in the 20^{th} Century Venda population. All periapical abscesses observed in the Venda could be associated with severe dental attrition (L'Abbé, 2005). There were no significant difference in the incidence of periapical abscesses between the 20^{th} Century Venda and the Gladstone population ($\chi 2 = 2.64$, p-value > 0.05), although most cases of periapical abscesses in the Gladstone population could be ascribed to neglected oral hygiene.

4.4.7 Supernumerary teeth

Supernumerary teeth were noticed in 5.5% (N = 5) of the study population. This is high when considering that incidences between 0.1 and 3.7% have been recorded for other population groups. It has been reported that males are significantly more affected by this condition than females (Proff et al., 2006). Unfortunately, this could not be tested in this study, due to the few females present, although all cases in this study were observed in males. A single supernumerary tooth (Figure 4.47) is found more often than two or multiple extra teeth. In this study, two individuals had multiple supernumerary teeth (Figure 4.48). This is significant, as it is reported that only 1% of the population presents with multiple extra teeth. Besides the normal variation in tooth number amongst the "normal" population, this condition occurs as part of a pathological syndrome disease such as a cleft lip and palate and dysostosis cleidocranialis (Gardner syndrome) (Proff et al., 2006). Individual GLD SE7.7 had three extra hypoplastic molars and individual GLD SE11.5 had several impacted teeth in the mandibular body (Figure 4.49). At least three crowns could be distinguished macroscopically and by x-ray. Macroscopic investigations of the crowns suggest that these were extra premolars.

4.4.8 Pipesmoker's wear

Dental wear caused by the regular smoking of a pipe was noted in four individuals within this sample (GLD N74.1, N74.7, N38.2 and H.74), of which two were male, one female and one of unknown sex (Figure 4.50). These lesions were all unilateral and elliptical in shape.

Table 4.1 Summary of the sex distribution of individuals excavated from the trench.

Sex	n	Percent
Male	86	80.4
Female	15	14
Unknown	6	5.6
Total	107	100

Table 4.2 Summary of the sex distribution of individuals excavated from the dumpsite

Sex	n	Percent
Male	20	54.0
Female	5	13.5
Unknown	12	32.5
Total	37	100.0

Table 4.3 Summary of the age distribution of skeletons excavated from the trench.

Age in years	n	Percent	Cumulative percent
Antenatal	1	0.9	0.9
0-10	2	1.9	2.8
11-19	9	8.4	11.2
19-30	44	41.1	52.3
31-45	31	29.0	81.3
45-60	10	9.3	90.7
Adult	8	7.5	98.1
Unknown	2	1.9	100.0
Total	107	100	

Table 4.4 Summary of the estimated antemortem stature for males and females.

Sex	n	Minimum (cm)	Maximum (cm)	Mean (cm)	Std. Deviation (cm)
Male	73	153.3	180.7	165.3	5.2882
Female	14	146.5	164.2	154.4	5.3521

Table 4.5 The incidence of treponematosis and the bones affected by the infection.

Case no	Sex	Age (years)	Skull	Nose	Hum	Ulna	Radius	Tibia	Fibula	Femur
GLD N74.3	male	17-22				1	1	1	1	
GLD S1.3	male	20-24						1		
GLD N100.2	male	28-38						1	1	1
GLD N31.E.3	male	25-32	1	1				1		
GLD N38.7	male	38-46	1			1		1	1	1
GLD N74.7	male	35-50			1	1		1	1	
GLD NOP 3/4.1	male	25-35	1							
GLD NOP 3/4.2	male	25-35		1				1	1	
GLD SE7.7	male	20-25	1					1	1	
Total			4	2	1	3	1	8	6	2
% affected n=9			44.4	22.2	11.1	33.3	11.1	88.8	66.7	22.2

Hum - humerus

Table 4.6 The incidence of treponematosis in various other populations

Sample	n	na	%	Chi	Source	Context
Gladstone	107	10	9.3		This study	19th Century
Mariana Islands	286	30	10.5	0.11	Pietrusewsky M. *et al.*(1997)	AD 1-1000, AD 1000-1521
Dominican Republic	440	39	8.8	0.02	Rothschild *et al.*(2001)	AD 800 - 1400
Metaponto	272	47	17.3	3.78	Henneberg and Henneberg (1993)	580 - 250 BC
Guam	152	10	6.6	0.64	Douglas *et al.* (1997)	AD 100 - 1521
Suriname	25	14	56	29.56	Khudabux (1991)	18th Century
Gognga-Gun	213	40	18.7	4.81	Rothschild et al.(1993)	AD 1500
Hamann-Tod	2906	135	4.6	4.98	Rothschild *et al.* (1995)	1920 -1960

n - total number of individuals investigated

na - total number of individuals affected by the condition

Chi - Chi-squared value comparing the incidence of treponematosis in the Gladstone population to that of the comparative population

Table 4.7 The incidence of skeletal lesions in individuals with possible scurvy in the Gladstone population

Case no	Sex	Age (years)	Periosteal lesions	Ossified haematomas	Periodontal disease
GLD N31.E.1	male	30-40	Present		Present
GLD N74.8	male	16-20	Present		
GLD N74.9	male	25-29	Present	Present	
GLD N31.E.4	male	35-45	Present		Present
GLD N34.13	male	22-30	Present	Present	
GLD N38.5	male	22-25	Present	Present	
GLD N8.5	male	17-22	Present	Present	
GLD N8.10	male	20-25	Present	Present	
GLD S2.1	male	30-40	Present		Present
GLD S2.9	male	35-45	Present		Present
GLD SE7.3	male	28-32	Present	Present	
GLD SE7.6	male	25-30	Present	Present	Present
GLD SE7.9	male	35-45	Present		Present
GLD SE7.4	female	30-40	Present		
GLD SE7.5	female	30-43	Present	Present	Present
GLD S2.4	female	33-43	Present	Present	
Total			16	9	7

Table 4.8 The incidence and location of healed fractures

Number	sex	Age (years)	n	C	Fe	Ti	Fi	Oc	Ra	Ul	Hu	Cl	Ri	Vb	Total	%
Ne				84	181	173	166	161	164	164	169	159	**	**	Nia	
GLD N31.E.1	male	30-40		3												
GLD N74.2	male	18-21		1												
GLD N74.5	male	40-55									1					
GLD N100.2	male	28-38										1				
GLD S1.2	male	25-35		1												
GLD N100.1	male	40-55		1												
GLD N34.3	male	30-35		2												
GLD N34.5	male	15-18						1								
GLD N34.6	male	22-28		1												
GLD N34.9	male	22-30		1												
GLD N34.12	male	22-30		1												
GLD N38.1	male	23-30											1*			
GLD N38.2	male	25-29		1*	1*	1*	1*									
GLD N38.3	male	30-40					1		1							
GLD N74.6	male	30-45		2									1			
GLD N74.4	male	30-40								1						
GLD N8.2	male	25-30												1*		
GLD N8.10	male	20-25		1												
GLD S2.3	male	20-25			1*				1							
GLD S2.9	male	35-45			1								1			
GLD S3.2	male	30-40											1			
GLD S3.5	male	25-30			1*											
GLD S5.1	male	28-34		2												
GLD SE7.9	male	35-45								1						
Total male			86	16	4	1	2	1	2	2	1	1	4	1	30	34.9
GLD SE11.6	female	30-37			1											
GLD N74.1	female	40-50		1												
GLD S2.4	female	33-43		1								1				
GLD SE7.5	female	30-43		1												
Total female			15	3	1	0	0	0	0	0	0	1	0	0	4	26.7
Total nba			101	20	5	1	2	1	2	2	1	2	4	1	34	33.7
Fracture incidence %				24	2.8	0.6	1.2	0.6	1.2	1.2	0.6	1.3	-	-		

*Fractures showed no signs of healing; ** Due to the fragmentary condition of ribs and vertebrae, the total number of elements were not determined.

[1]Total number of fracture of a specific element /total number of specific elements investigated.

n - total number of individuals investigated, nba - number of bones affected by fractures, Nia - Number of individuals affected by fractures, Ne - Number of elements investigated; C - Cranial; Fe - femur; Ti - tibia; Fi - fibula; Oc - Os coxa; Ra - radius; Ul - Ulna; Hu - humerus; Cl - clavicle; Vb - vertebra; Ri – rib.

Table 4.9 Comparison of the incidence of antemortem fractures in other populations to the Gladstone sample

Table 4.9 Comparison of the incidence of antemortem fractures in other populations to the Gladstone sample

Population	Gladstone			Venda				Central California				Libben			
Source	This study			L'Abbé (2005)				Jurmain (1997,2001)				Lovejoy (1981)			
Element	n	Na	%	n	Na	%	χ^2	n	Na	%	χ^2	n	Na	%	χ^2
Cranial	84	20	23.8	77	2	2.6	10.9**	365	5	1.4	65.3**	-	-	-	-
Femur	181	5	2.8	91	2	2.2	0.1*	119	2	1.7	0.4*	347	9	2.6	0.3*
Tibia	173	1	0.6	82	1	1.2	0.3*	164	1	0.6	0.001*	349	5	1.4	0.7*
Fibula	166	2	1.2	50	1	2.0	0.2*	129	1	0.8	0.1*	257	9	3.5	2.1*
Humerus	169	1	0.6	76	2	2.6	2.2*	142	3	2.1	1.8*	450	3	0.7	0.1*
Ulna	164	2	1.2	58	0	0.0	0.7*	144	10	6.9	6.7**	153	11	7.2	7.2**
Radius	164	2	1.2	58	0	0.0	0.7*	161	6	3.7	2.1*	369	20	5.4	5.1**
Clavicle	159	1	0.6	44	1	2.3	0.9*	159	0	0.0	1.0*	260	15	5.8	7.4**
Total	1260	34	2.7	536	9	1.7	1.7	1383	28	2.0	1.3	2185	72	3.3	1.6

n - number of skeletal elements investigated

Na - number of skeletal elements affected

χ^2- Chi-squared value comparing the incidence of fracture observed in the Gladstone population to the fractures observed in the comparative sample

% - percentage of people affected by the condition

* No significant differences existed, P>0.05

**Significant difference at the level of P < 0.05

Table 4.10 The incidence of exostosis observed in the Gladstone population

Case no	Sex	Age (years)	Femur Ne - 181	Tibia Ne - 174	Humerus Ne - 169	Total 524
GLD N74.4	male	30-40	1			1
GLD N34.7	male	30-40	1			1
GLD N34.12	male	22-30	1			1
GLD N34.13	male	25-30		1		1
GLD SE7.6	male	25-30	1			1
GLD SE7.9	male	35-45			1	1
GLD S2.4	female	33-43	1			1
GLD SE7.5	female	30-43			1	1
GLD SE11.3	female	45-60		1		1
Total number affected			5	2	2	9
Incidence of exostosis %			2.8	1.1	1.2	1.7

Ne - number of elements investigated

Incidence of exostosis = total number affected/Ne

Table 4.11 The incidence and location of amputations

Number	Sex	Age(years)	Femur	Tibia & Fibula	Foot	Humerus	Ulna & Radius	Total	%
GLD N34.3	male	30-35		1					
GLD N38.2	male	25-29	1						
GLD N8.1amp	male	Adult		1					
GLD S2.6	male	35-45			1				
GLD S2.7b	Unknown	unknown				1			
GLD S2.7c	Unknown	unknown					1		
Total n = 107			1	2	1	1	1	6	5.6

Table 4.12 The incidence of spondylolysis, spondylolythesis and subluxation in the Gladstone population

Number	sex	age(years)	Spondylolysis	Subluxation	Spondylolythesis
GLD N31.E.1	male	30-40	1		
GLD N74.3	male	17-22	1		
GLD N74.8	male	16-20	1		
GLD N74.5	male	40-55	1	1	
GLD N34.8	female	20-23	1		
GLD N34.4	male	18-21			
GLD N34.6	male	22-28			
GLD N38.3	male	30-40			
GLD N74.7	male	35-50	1		
GLD NOP 3/4.1	male	25-35	1		1
GLD S2.6	male	35-45		1	
Total n = 107			7	2	1
%			6.5	1.8	0.91

n - total number of individuals investigated

Table 4.13 The incidence of congenital abnormalities in the Gladstone population

Case no	Sex	Age (years)	SN	CrS	SB
GLD N100.4	male	18-23	1	1	
GLD N31.E.1	male	30-40	1		
GLD N31.E.2	male	30-40	1		
GLD N31.E.3	male	25-32	1		
GLD N31.E.4	male	35-45	1		
GLD N34.1	male	18-21	1		
GLD N34.5	male	15-18			
GLD N34.9	male	22-30			
GLD N38.6	male	23-32			
GLD N74.11	male	17-20		1	
GLD N8.2	male	25-30			1
GLD N8.5	male	17-22	1		
GLD N8.8	male	20-25			1
GLD N8.10	male	20-25	1		
GLD NOP 3/4.1	male	25-35			
GLD S2.8	male	20-30	1		
GLD S3.1a	male	40-50			1
GLD S3.2	male	30-40			
GLD SE7.9	male	35-45	1		
GLD SE11.6	female	30-37			
GLD N8.1	female	15-19	1		
Total			11	2	3

SN - Supernumerary vertebra
CrS - Craniostenosis
SB - Spina bifida

Table 4.14 The incidence of Schmorl's nodes in the Gladstone population

Case no	Sex	Age (years)	Nv =2010	Nva	Location	Nia	%
GLD N8.2	male	25-30	24	6	T6 - T11		
GLD N8.5	male	17-22	24	5	L1-L5		
GLD N31.E.2	male	30-40	25	2	L4, L5		
GLD N31.E.5	male	25-37	24	1	L2		
GLD N34.1	male	18-21	24	16	T2 - L5		
GLD N34.2	male	25-35	24	1	L1		
GLD N34.4	male	18-21	24	1	T12		
GLD N34.6	male	22-28	24	3	C3-C5		
GLD N34.10	male	22-30	24	5	C5-T2		
GLD N34.13	male	25-30	24	7	T5-T10, L1		
GLD N34.14	male	22-28	24	4	T8,T9,T11,L4		
GLD N38.1	male	23-30	24	2	L3,L4		
GLD N38.6	male	23-32	24	5	L1-L5		
GLD N38.8	male	30-37	24	1	L5		
GLD N74.4	male	30-40	24	5	T7-T11		
GLD N74.10	male	20-24	24	8	T8-L3		
GLD N74.11	male	17-20	24	3	L3-L5		
GLD S1.4	male	20-25	23	2	L3,L4		
GLD S2.7a	male	35-45	24	3	T7-T9		
GLD S2.9	male	35-45	24	3	L1-L3		
GLD S3.5	male	25-30	24	3	L1-L3		
GLD S3.6	male	16-20	24	1	L4		
GLD SE7.9	male	35-45	25	4	C3-C6		
GLD SE12.1	male	Adult	12	2	L1,L2		
Total males n = 86			565	93		24	27.9
GLD SE7.4	female	30-40	24	5	T1,T8,T12,L3,L4		
GLD SE7.5	female	30-43	24	1	L4		
Total females n = 15			48	6		2	17
Total n = 101			613	99		26	25.7
Total incidence in population %			4.9				

n-number of vertebrae present
Na-number of vertebrae affected
Nv - total number of vertebrae investigated
Nva - number of vertebrae affected by Schmorl's nodes
Nia – number of individuals affected
% - total Nva/Nv x 100

Table 4.15 The incidence of arthritic changes observed in the Gladstone population

		Age	Arthritic changes						Total	
Case no	Sex	(years)	Tmj	Acj	Ac	Sij	Ttj	Vo	Nia	%
GLD N8.3	male	40-55	1							
GLD N74.5	male	40-55				1				
GLD N100.2	male	28-38						1		
GLD N100.1	male	40-55						1		
GLD N31.E.4	male	35-45						1		
GLD N34.12	male	22-30			1					
GLD N34.13	male	25-30						1		
GLD N38.7	male	38-46						1		
GLD N74.6	male	30-45		1				1		
GLD N74.7	male	35-50		1	1			1		
GLD N74.10	male	20-24		1						
GLD NOP 3/4.1	male	25-35						1		
GLD S1.5	male	35-45		1						
GLD S2.3	male	20-25					1			
GLD S2.6	male	35-45				1				
GLD S2.7a	male	35-45		1				1		
GLD S2.9	male	35-45		1						
GLD S3.3	male	25-30		1						
GLD SE7.7	male	20-25			1					
GLD SE7.8	male	35-45						1		
GLD SE15.2	male	45-55						1		
Total Males n=86			1	7	3	2	1	11	21	24
GLD N74.1	female	40-50						1		
GLD SE7.2	female	44-60		1	1					
GLD SE11.3	female	45-60			1			1		
Total Females n=15			0	1	2	0	0	2	3	20
Total n=101			2	8	10	1	1	13	25	25

Tmj-temporomandibular joint
Acj-acromio-clavicular joint
Ac-acetabulum
Sij-sacro-iliac joint
Ttj-tibio-talar joint
Vo-vertebral osteophytes
Nai-number of individuals affected
n-total number of individuals investigated
%-Nai/n x 100 = the incidence of arthritic changes within the population

Table 4.16 The various musculoskeletal stress markers observed in the Gladstone population

Bone	Markers
Humerus	Cortical defect in attachment of pectoralis major
	Roughened and raised area at attachment of deltoid (anterior)
Radius	Attachment of biceps on radial tuberosity
Ulna	Triceps insertion on olecranon
Clavicle	Insertion of costoclavicular ligament
Femur	Enthesophyte formation on linea aspera
	Cortical pitting caused by gastrocnemius
	Enthesophyte formation in attachment of iliofemoral ligament
Tibia	Enthesophyte formation on popliteal line
	Enthesophyte formation on distal attachment of interosseous membrane
	Enthesophytes on medial maleolus
Fibula	Enthesophathy formation on distal attachment of interosseous membrane
Calcaneus	Attachment of achilles tendon
	Attachment of abductor hallucis and flexor digitorum brevis tendon

Table 4.17 The incidence of various enthesopathies in the Gladstone population

	Male					Female					Total				
	n	Na (L)	Na (R)	Na(T)	%	n	Na (L)	Na (R)	Na(T)	%	n	Na (L)	Na (R)	Na(T)	%
Femur	153					28					181				
Gastrocnemius		2	4	6	3.9		1	0	1	3.5		3	4	7	3.8
Iliofemoral ligament		3	2	5	3.2		1	2	3	10.7		4	4	8	4.4
Linea aspera		0	1	1	0.6		0	0	0	0		0	1	1	0.5
Tibia	145					28					173				
Medial malleolus		1	2	3	2.0		0	0	0	0		1	2	3	1.7
Popliteal line		2	0	2	1.4		1	2	3	10.7		3	2	5	2.9
Interosseous membr.		19	19	38	26.2		4	4	8	28.6		23	23	46	26.5
Fibula	142					24					166				
Interosseous membr.		29	31	60	42.2		6	7	13	54.2		35	38	72	43.3
Calcaneus	87					28					115				
Abd.hallucis, flex.dig.br.		1	4	5	5.7		0	0	0	0		1	4	4	3.4
Achilles tendon		9	9	18	20.6		2	2	4	14.2		11	11	22	19.1
Humerus	143					26					169				
Deltoid		0	1	1	0.6		0	0	0	0		0	1	1	0.6
Pectoralis major		2	3	5	3.4		1	0	1	7.6		3	3	6	3.5
Os coxa	133					28					161				
Ischial tuberosity		1	1	2	1.5		1	1	2	7.1		2	2	4	2.4
Obturator foramen		10	10	20	15.0		3	3	6	21.4		13	13	26	16.1
Ulna	140					24					164				
Triceps		1	3	4	2.8		0	0	0	0		1	3	4	2.4
Radius	139					24					163				
Biceps (RT)		2	4	6	4.3		0	0	0	0		2	4	6	3.7
Clavicle	134					23					157				
Costoclavicular lig		2	1	3	2.2		0	0	0	0		2	1	3	1.9
Scapula	119					22					141				
Acromion process		-	-	2	1.6				0	0				2	1.4

n - number of skeletal elements investigated. Na - number of elements affected by the enthesophyte on the Left (L), Right (R) as well as the Total (T) number of observations, membr. - membrane, Abd. - abductor, flex.dig.br. - flexor digitorum brevis, RT -radial tuberosity, lig. – ligament.

Table 4.18 The incidence of enthesophytes in various skeletal populations

Population	Gladstone			Argar			Saharan		
Source	This study			al-Oumaoui (2004)			Dutour (1986)		
	n	Na	%	n	Na	%	n	Na	%
Femur	181			60					
Linea aspera		1	0.6		6	10.0			
Tibia	173			41					
Popliteal line		5	2.9		9	22.0			
Calcaneus	115			41			41		
Abd.hallucis, flex. dig.br.		3	2.6		6	14.6		3	7.3
Achilles tendon		22	19.1		16	39.0		1	2.4
Humerus	169			48					
Deltoid muscle		1	0.6		5	10.4			
Ulna	164			49			41		
Triceps muscle		4	2.4		8	16.3		2	4.8
Radius	163			51			41		
Biceps muscle		6	3.7		8	15.7		3	7.3

n - number of skeletal elements examined
Na - number affected by the specific type of enthesophyte
Abd. - abductor
flex.dig.br. - flexor digitorum brevis

Table 4.19 The incidence of non-specific periostitis in the Gladstone population

Case no	Sex	Age (years)	Tibia	Humerus	Femur	Feet
n			173	169	181	174
GLD N8.2	male	25-30	1			
GLD N8.4	male	19-24	2			
GLD N8.8	male	20-25	1	1	1	
GLD N31.E.1	male	30-40	2			
GLD N31.E.2	male	30-40	2			
GLD N31.E.5	male	25-37	1			
GLD N34.10	male	22-30				2
GLD N34.14	male	22-28				2
GLD N38.1	male	23-30	1			
GLD N74.8	male	16-20	1			
GLD N74.9	male	25-29	2			
GLD N100.1	male	40-55				2
GLD S1.3	male	20-24	2			2
GLD S2.2a	male	Adult				1
GLD SE7.4	male	30-40	1			1
GLD SE7.7	male	20-25				2
GLD SE7.8	male	35-45		1		
GLD SE11.2	male	Adult			1	
GLD S2.4	female	33-43	2			
GLD N8.6	female	15-18	1	1		
Total			19	3	2	12
% of element affected			11.0	1.8	1.1	6.9

n - number of elements examined

Table 4.20 The incidence of non-specific periostitis in various South African populations

Population	Tibia (%)	Femora (%)	Humerus (%)	Individuals (%)	Source
Gladstone	11	1.1	1.8	18.7	This study
K2 and Mapungubwe	7	9.1	8.2	7	Steyn et al. (1995b)
Koffiefontein	-	-	-	11.1	L'Abbé et al. (2003)
Venda	7	1.1	-	6.2	L'Abbé (2005)
Maroelabult	-	-	-	17	Steyn et al. (2002)

Table 4.21 The incidence of cribra orbitalia in the Gladstone population

Case no	sex	Age (years)	Right Orbit	Left orbit
n			82	82
GLD N100.4	male	18-23	Present	
GLD N31.E.2	male	30-40	Present	Present
GLD N31.E.3	male	25-32	Present	Present
GLD N31.E.4	male	35-45	Present	Present
GLD N34.3	male	30-35		Present
GLD N8.3	male	30-40	Present	Present
GLD SE7.8	male	35-45		Present
GLD SE15.1	female	15-18	Present	Present
GLD S4.1	female	28-32	Present	Present

n - total number of individuals with assessable orbits

Table 4.22 Comparison of the incidence of cribra orbitalia in various populations

Population	n	Na	%	Chi-Squared	source
Gladstone	82	9	11		This study
K2 and Mapungubwe**	6	2	33.3	2.55*	Steyn et al. (1995b)
Riet River**	47	2	4.3	1.72*	Morris (1984)
Oakhurst**	10	2	20	0.69*	Patrick (1989)
Griqua**	52	18	34.6	11.1***	Peckmann (2003)
Colesberg**	47	17	36.1	11.8***	Peckmann (2003)
Wolmaransstad**	21	10	47.6	14.9***	Peckmann (2003)
Egypt**	210	174	82.8	130.2***	Fairgrieve (2000)
Koffiefontein**	36	3	8.3	0.19*	L'Abbé et al. (2003)

* P-value > 0.1
** Results only include adults
*** P-value <0.05
n - number of individuals investigated
Na - number of individuals affected by the condition

Table 4.23 Differential diagnosis on macroscopic level and microscopic findings of pathological lesions on the anterior tibiae

Individual	Differential diagnosis on macroscopic level	Microscopic findings	Final diagnosis
GLD N8.4	Osteoid osteoma, osteoblastoma, ossified haematoma	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD N34.13	Osteochondroma, benign tumor ossified haematoma	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD N38.5	Corical osteoblastoma, ossified haematoma treponemal disease	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD S2.4	Ossified haematoma treponemal disease	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD SE7.3	Ossified haematoma associated with scurvy	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD SE7.9	Non-specific osteomyelitis, osteosarcoma, ossified haematoma associated with scurvy	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD N74.7	Treponematosis, nonspesific osteomyelitis	Non-specific osteomyelitic bone reaction	Treponematosis
GLD N8.5	Healed periostitis, ossified haematoma from scurvy	Haemorrhagic bone reaction	Ossified haematoma associated with scurvy
GLD NOP3/4.2	Treponematosis	A combination of haemorrrhagic and non-specific osteomyelitic bone reactions	Possible treponematosis as well as haemorrhagic bone reaction (scurvy)
GLD S1.3	Osteoid osteoma, osteoblastoma, ossified haematoma, treponemal disease	A combination of haemorrrhagic and non-specific osteomyelitic bone reactions	Possible treponematosis as well as haemorrhagic bone reaction (scurvy)
GLD SE7.7	non-specific periostitis	A combination of haemorrrhagic and non-specific osteomyelitic bone reactions	Possible treponematosis as well as haemorrhagic bone reaction (scurvy)
GLD N31.E.1	Ossified haematoma, scurvy, posttraumatic haematoma	Normal	Normal
GLD S2.9	Osteochondroma, non-specific periostitis	Normal	Normal
GLD SE7.4	Non-specific periostitis	Normal	Normal

Table 4.24 Summary of the incidence of dental caries

Variables	Per individual[1]			Per mouth[2]			Per tooth[3]		
	n	NAI	%	NAI	NTA	C/m	NT	NTA	%
Male	76	38	50.0	38	102	2.0	2277	102	4.5
Female	13	4	30.8	4	13	1.0	406	13	3.2
Unknown	1	1	100.0	1	1	1.0	11	1	9.1
Total	90	43	47.8	43	116	1.3	2694	116	4.3

1 - total number of individuals affected by dental caries/ total number of individuals present

2 - total number of carious teeth/ total number of individuals affected by dental caries

3-total number of carious teeth/ total number of teeth present

n – total number of individuals investigated

NAI - Total number of individuals affected with dental caries

NTA - Total number of teeth affected by dental caries

C/ M - Average number of a carious lesions per mouth

NT – total number of teeth present

Table 4.25 Corrected caries rate

Sex	AMTL	P	Ena	Ona	n	Ne	Ec	Ccr %
Male	59	0.84	49.56	102	2277	2336	151.56	6.49
Femlae	4	0.84	3.36	13	406	410	16.36	3.99
Unknown	0	0.84	0	1	11	11	1	9.09
Total	63	0.84	52.92	116	2694	2757	168.92	6.13

AMTL = Number of teeth lost antemortem

P = Proportion of teeth with pulp exposure due to caries

Ena = estimated number of teeth affected by carious lesions

Ona = Number of carious teeth observed

n = Observed number of teeth

Ne = Estimated number of teeth

Ec = Total estimated number of carious lesions

Ccr % = Corrected caries rate

Table 4.26 Caries intensity sorted by sex and tooth type

Tooth	Male			Female			Unknown			Total			
	n	Na	%	n	Na	%	n	Na	%	n	Na	%	χ^2
I1	273	2	0.7	51	1	2.0	2	0	0	326	3	0.9	0.7
I2	278	3	1.1	51	1	2.0	2	0	0	331	4	1.2	0.27
C	293	1	0.3	52		0.0	2	0	0	347	1	0.3	0.17
PM1	295	8	2.7	52	2	3.9	1	0	0	348	10	2.9	0.2
PM2	291	19	6.5	52	2	3.9	1	0	0	344	21	6.1	0.55
M1	278	17	6.1	52	1	1.9	2	0	0	332	18	5.4	1.49
M2	290	33	11.4	50	6	12.0	1	1	100	341	40	11.7	0.01
M3	279	19	6.8	46	0	0.0	0	0	0	325	19	5.9	3.32
Total	2277	102		406	13		11	1		2694	116		

n - Number of teeth investigated
Na - Number of teeth affected by carious lesions
I- incisor
C- canine
PM- premolar
M- molar

Table 4.27 The incidence of carious lesions of different tooth surfaces

Tooth Surface	Male			Female			Unknown			Total		
	n	Na	%	n	Na	%	n	Na	%	n	Na	%
Buccal	102	14	14	13	0	0	1	0	0	116	14	12.1
Lingual	102	6	6	13	0	0	1	0	0	116	6	5.2
Occlusal	102	43	42	13	7	54	1	0	0	116	50	43.1
Interdental	102	39	38	13	6	46	1	1	100	116	46	39.7

n - total number of carious teeth

Na - number of tooth surfaces affected by carious lesions

Table 4.28 The incidence of dental caries among various other South African populations

	n	Na	Caries Frequency %	Caries intensity %	Carious teeth per mouth	Chi-squared	Source
Gladstone	2694	116	47.8	4.31	1.3		This study
Riet River	1061	46	41.7	4.3	1	0.0016*	Morris (1992)
Kakamas	989	13	18.8	1.3	0.3	19.153**	Morris (1992)
Oakhurst	192	34	-	17.7	-	65.336**	Sealy et al. (1992)
K2 & Mapungubwe	306	56	54.5	18.3	1.4	99.57**	Steyn (1994)
Griqua	575	30	42.3	5.2	1.2	0.922*	Morris (1992)
Modern Xhosa	3043	219	68	7.2	2.5	21.72**	Cleaton-Jones (1979)
Maroelabult	582	26	56.6	4.5	2	0.0001*	Steyn et al. (2002)
Venda	2016	157	60.8	7.8	1.6	25.601**	L'Abbé (2005)
Koffiefontein	1016	76	86.1	7.48	3.22	15.149**	L'Abbé et al.(2003)
Urban 'bantu'	-	-	68	-	3.1	-	Staz (1938)
Urban negro	9178	1312	90	14.3	4.4	196.3**	Staz (1938)

* p-value>0.20, no significant difference between previous study and results from Gladstone

** p-value<0.0001, significant difference between previous study and results from Gladstone

n- number of individuals investigated

Na- number of individual affected

Table 4.29 Summary of the incidence of antemortem tooth loss

Sex	Individual frequency[1]			Per mouth[2]			Intensity[3]		
	n	Nai	%	Nai	Na	C/M	NT	Na	%
Male	76	23	30.26	23	59	2.57	2336	59	2.53
Female	13	2	15.38	2	4	2.00	410	4	0.98
Unknown	1	0	0.00	1	0	0.00	11	0	0.00
Total	90	25	27.78	25	63	2.52	2746	63	2.29

1- total number of individuals with one or more teeth lost antemortem/ total number of individuals present

2 - total number of teeth lost antemortem/ total number of individuals present

3 - total number of teeth lost antemortem/ total number of teeth present

n - Number of individuals investigated

Nai - total number of individuals with one or more teeth lost antemortem

Na - number of teeth lost antemortem

C/M - average number of carious lesions per mouth

Nt – Total number of teeth present before AMTL

Table 4.30 Antemortem tooth loss per tooth type

Tooth	Male			Female			Unknown			Total		
	n	Na	%	n	Na	%	n	Na	%	n	Na	%
I1	280	7	2.50	52	1	1.92	2	0	0	334	8	2.40
I2	285	7	2.46	52	1	1.92	2	0	0	339	8	2.36
C	295	2	0.68	52	0	0.00	2	0	0	349	2	0.57
PM1	297	2	0.67	52	0	0.00	1	0	0	350	2	0.57
PM2	298	7	2.35	52	0	0.00	1	0	0	351	7	2.00
M1	296	18	6.08	52	0	0.00	2	0	0	350	18	5.14
M2	298	8	2.68	52	2	3.84	1	0	0	351	10	2.84
M3	287	8	2.79	46	0	0.00	0	0	0	333	8	2.40
Total	2336	59	2.53	410	4	0.98	11	0	0	2757	63	2.29

n - total number of teeth present before AMTL
Na - total number of teeth lost antemortem

Table 4.31 Antemortem tooth loss in various South African populations

Population	n	Na	%	Chi	Source
Gladstone	2757	63	2.3		This Study
Venda*	335	30	9.0	21.80**	L'Abbé (2005)
Griqua*	418	9	2.2	2.29***	Morris (1992)
Koffiefontein	1079	63	5.8	8.82**	L'Abbé et al. (2003)
Kakamas*	1006	6	0.6	24.51**	Morris (1992)
Riet River*	1162	49	4.2	0.8***	Morris (1992)

* Represent results for individuals younger than 40 years of age
** - significant difference, p-value <0.05
*** - significant difference, p-value >0.05
n - total number of teeth present before AMTL
Na - total number of teeth lost antemortem

Table 4.32 Summary of the incidence of enamel hypoplasia

Sex	n	Na	%
Male	76	14	18.42
Female	13	0	0.00
Unknown	1	0	0.00
Total	90	14	15.56

n - total number of individuals
Na - total number of individuals with enamel hypoplasia

Table 4.33 The incidence of enamel hypoplasia sorted by tooth type for males

Maxilla			
Tooth	n	Na	%
I1	135	14	10.4
I2	137	14	10.2
C	149	13	8.7
PM1	150	3	2.0
PM2	148	0	0.0
M1	141	0	0.0
M2	148	0	0.0
M3	139	4	2.9
Total	1147	48	4.2
Mandible			
Tooth	n	Na	%
I1	138	4	2.9
I2	141	5	3.5
C	144	20	13.9
PM1	155	4	2.6
PM2	143	4	2.8
M1	137	1	0.7
M2	142	2	1.4
M3	140	1	0.7
Total	1140	41	3.6

n - number of teeth investigated
Na - number of teeth affected by EH
I – incisor
C – canine
PM – premolar
M – molar

Table 4.34 Comparison of enamel hypoplasia (EH) in various South African populations

Population	n	Na	%	Chi	Source
Gladstone	90	14	15.6		This study
Venda	90	12	13.3	0.18*	L'Abbé (2005)
K2/Mapungubwe	60	38	63.3	36.28**	Steyn (1994)
Oakhurst	22	11	50.0	12.10**	Patrick (1989)
Maroelabult	16	3	18.8	0.10*	Steyn et al. (2002)
Koffiefontein	37	22	59.5	24.88**	L'Abbé et al. (2003)

n - Number of individuals investigated
Na - Number of individuals affected by EH
* p-value>0.05, no significant difference between gladstone and the other population
** p-value<0.001, significant difference between Gladstone and other population

Table 4.35 The incidence of various other dental pathological conditions in the Gladstone population

Pathological Condition	Male n = 76		Female n = 13		Total n = 90	
	Na	%	Na	%	Na	%
Tartar deposition	22	28.9	7	53.8	29	32.2
Peg-shaped incisors	3	3.9	0	0.0	3	3.3
Crowding of teeth	5	6.6	0	0.0	5	5.6
Pipe-smokerswear	3	3.9	1	7.7	4	4.4
Discolouration of teeth	1	1.3	2	15.4	3	3.3
Congenital abnormality	5	6.6	0	0.0	5	5.6
Abscess	11	14.4	2	15.3	13	14.4
Supernumerary teeth	5	6.6	0	0.0	5	5.6
Enamel pearl	1	1.3	0	0.0	1	1.1
Retained deciduous teeth	2	2.6	0	0.0	2	2.2
Periodontal disease	30	39.5	7	53.8	37	41.1

n - total number of individuals

Na - number of individuals affected by the condition

Figure 4.1 Possible treponemal involvement of the tibia resulting in a very characteristic sabre-shin in a male between 35 and 50 years of age (GLD N74.7).

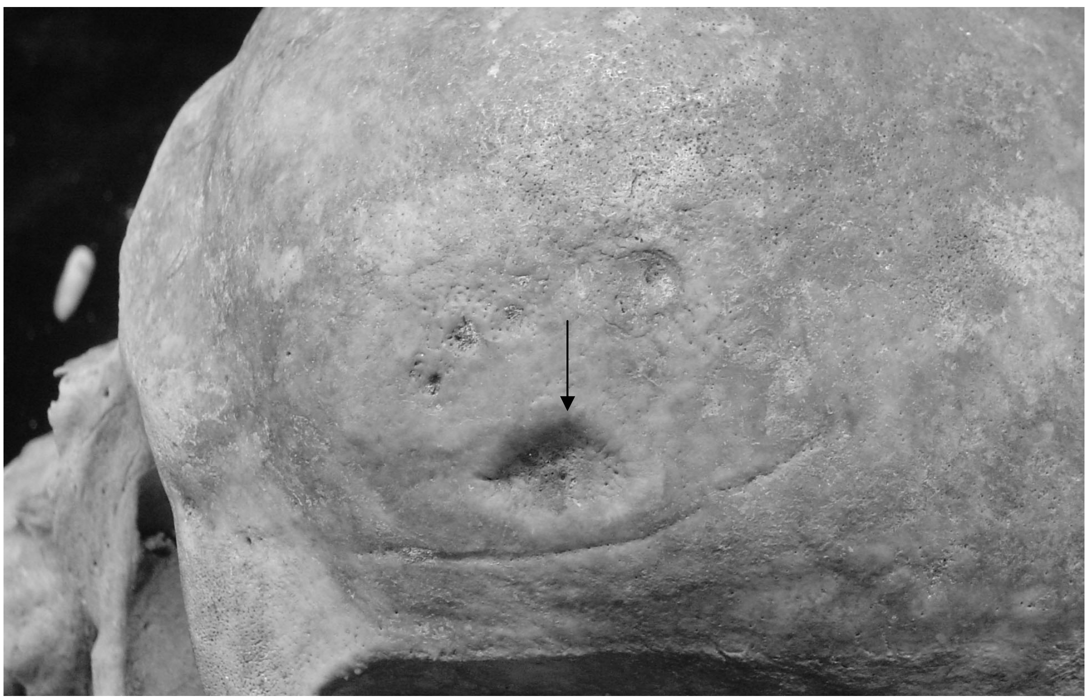


Figure 4.2 Gummatous / stellate lesion (indicated by the arrow) due to possible treponemal infection on the frontal bone in a male between 38 and 46 years of age (GLD N38.7). Note the porotic floor and sclerotic rim of the lesion.

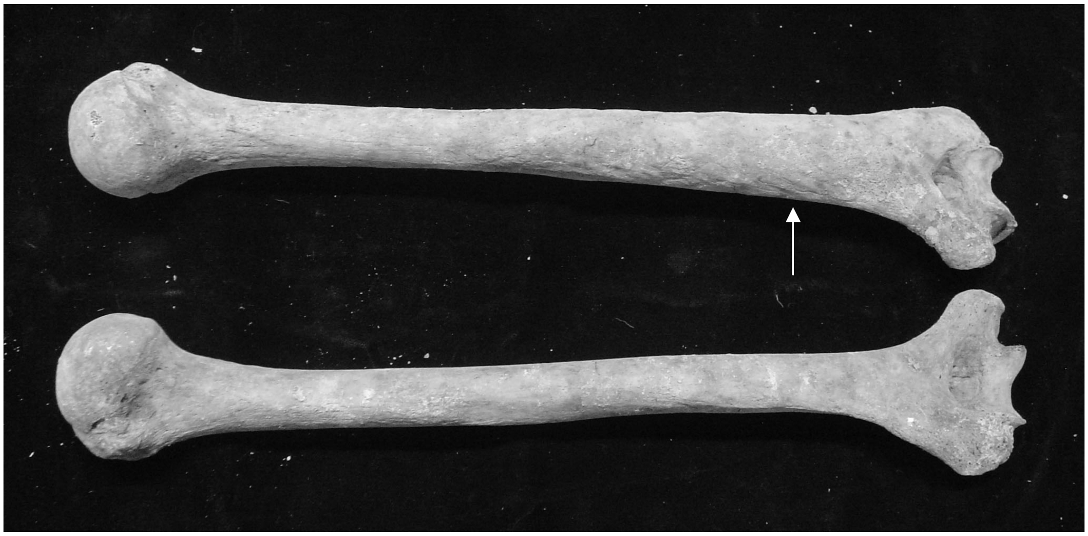


Figure 4.3 Possible treponemal involvement of the left humerus (indicated by the arrow) in a male between 35 and 50 years of age (GLD N74.7).

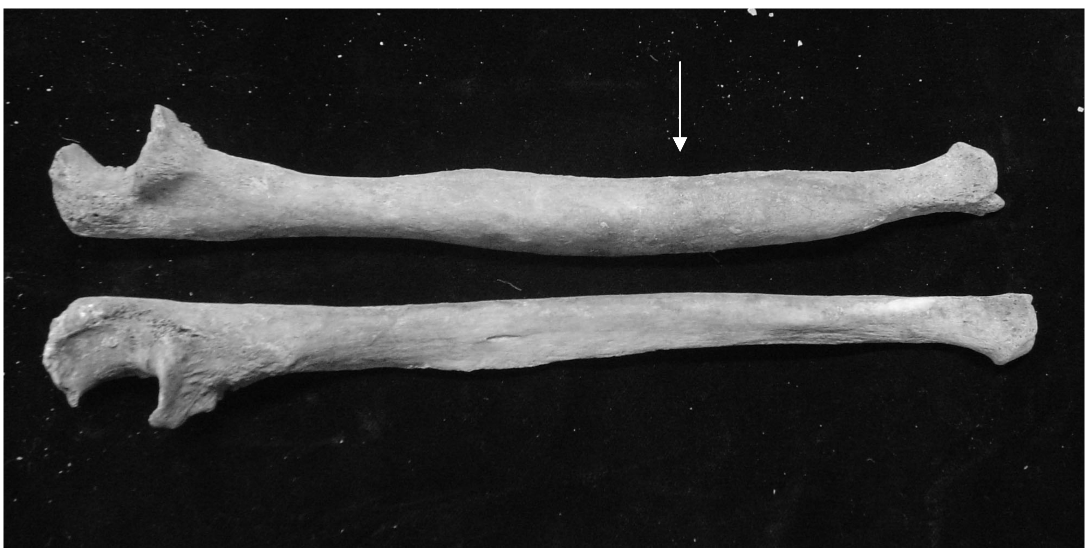


Figure 4.4 Possible treponemal involvement of the left radius (indicated by the arrow) in a male between 35 and 50 years of age (GLD N74.7).

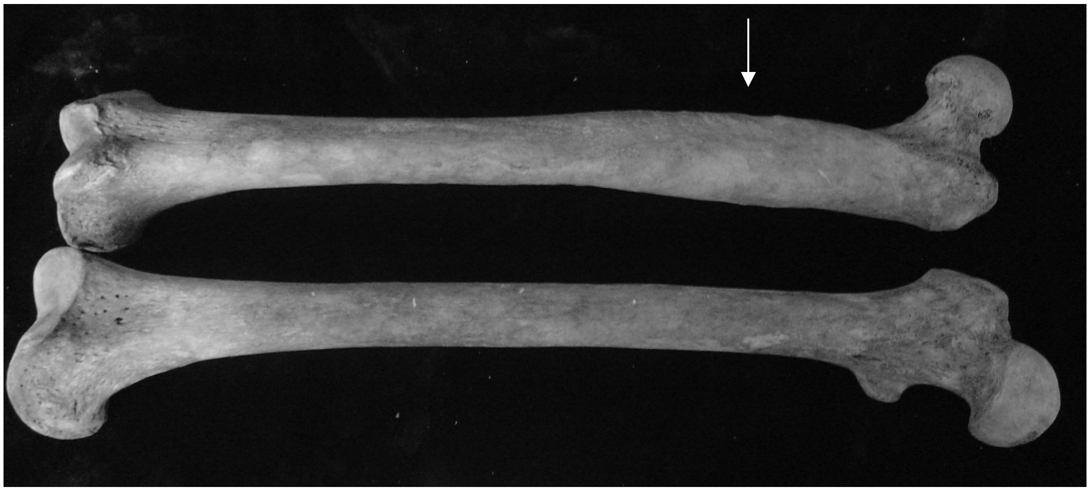


Figure 4.5. Thickening of the left femur (indicated by the arrow) giving it a blown-up appearance most likely associated with treponemal disease in a male of 38 - 46 years (GLD N38.7)

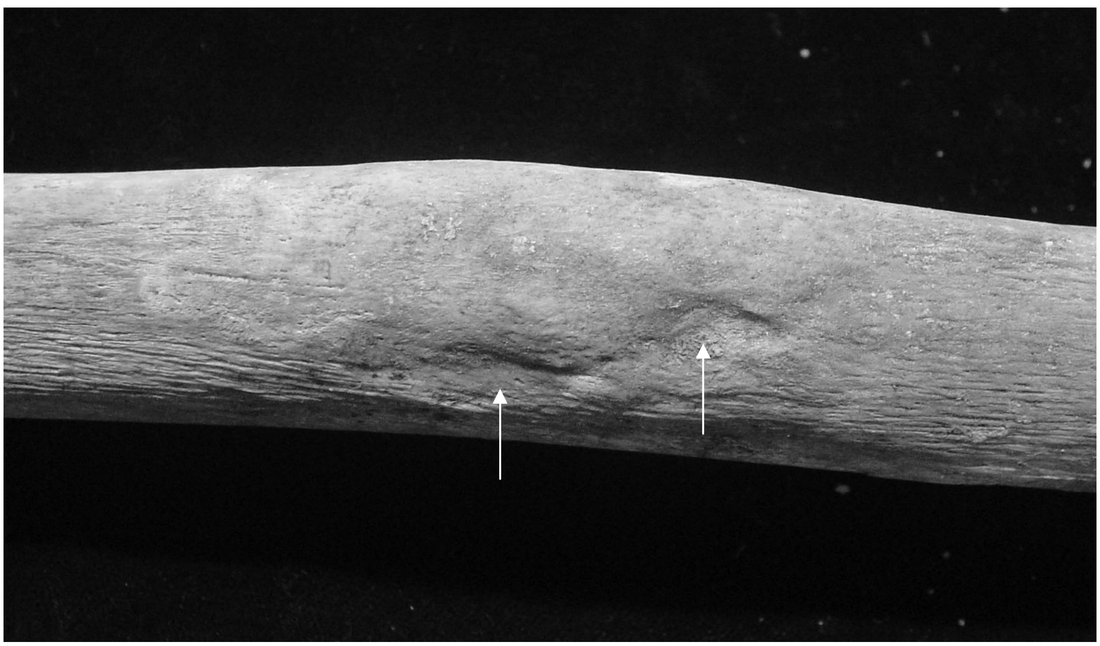


Figure 4.6 A possible example of gummatous periostisis (indicated by the arrows) of the tibia in a 20 - 24 year old male (GLD S1.3)

Figure 4.7. Osteomyelitis of the left tibia with cloaca (arrow) formation as well as infectious involvement of the fibula causing widespread new bone formation as well as proximal and distal ankylosis in an adult male (GLD SE11.2).

Figure 4.8 Vertebrae of a male between 30 and 40 years of age affected by possible tuberculosis. (GLD N8.3). Note the lytic lesions (arrows) in the vertebrae. b. Lytic lesions on the anterior inferior surface of L4. c. Lytic lesion on the inferior surface of L5

Figure 4.9 The superior surface of the patella with possible patellar involvement in tuberculosis seen in GLD N8.3

Figure 4.10 Possible involvement of the olecranon process in tuberculosis (GLD N8.3) a. Superior view of a lytic lesion of the olecranon process most likely associated with tuberculosis. b. Posterior view

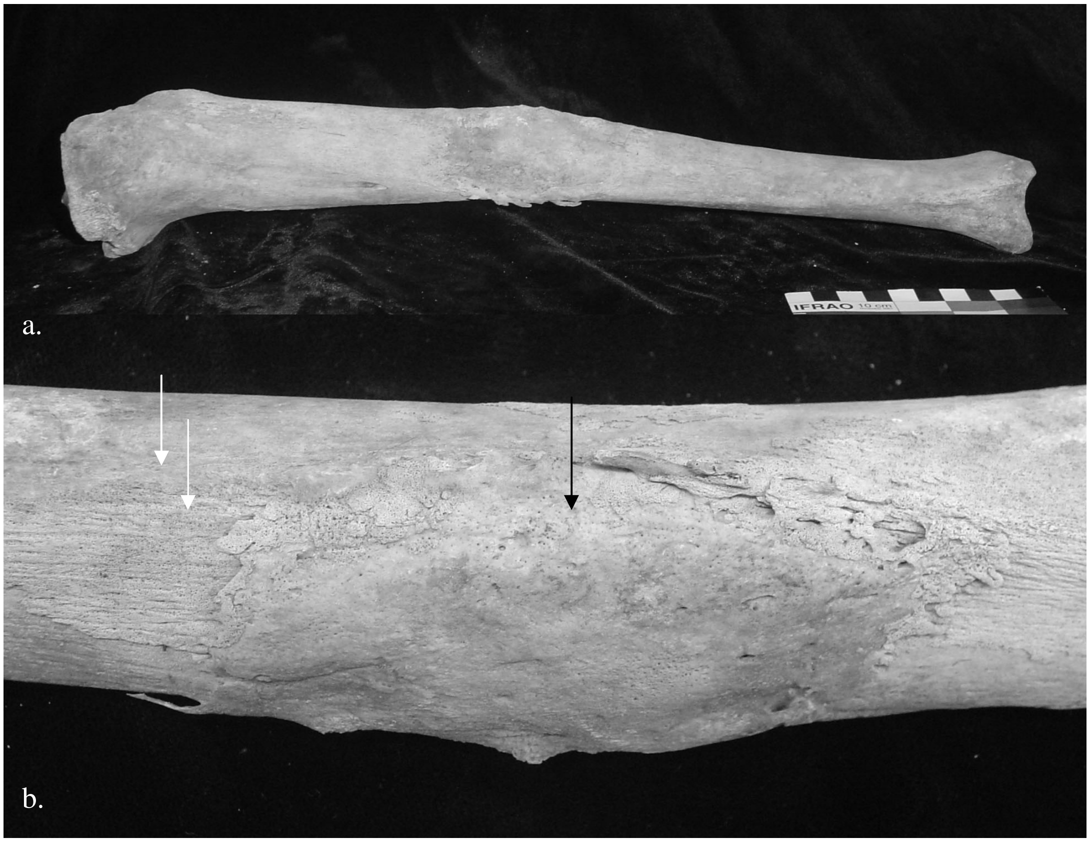


Figure 4.11 An ossified haematoma (a), with a closer view of the lesions (b), indicated by the black arrow, and signs of subperiosteal bone apposition (white arrow) which most likely developed due to scurvy in a male of 25 - 30 years (GLD SE7.6)

Figure 4.12 A well-healed parry fracture (defence fracture) (arrow) of the right ulna observed in a 30-40 year old male (GLD N74.4)

Figure 4.13 A well healed Colles' fracture (arrow) of the left radius observed in a 30-40 year old male (GLD 38.3).

Figure 4.14. A well-healed Pott's fracture of the right fibula observed in a male between 30 and 35 years of age (GLD N38.3)

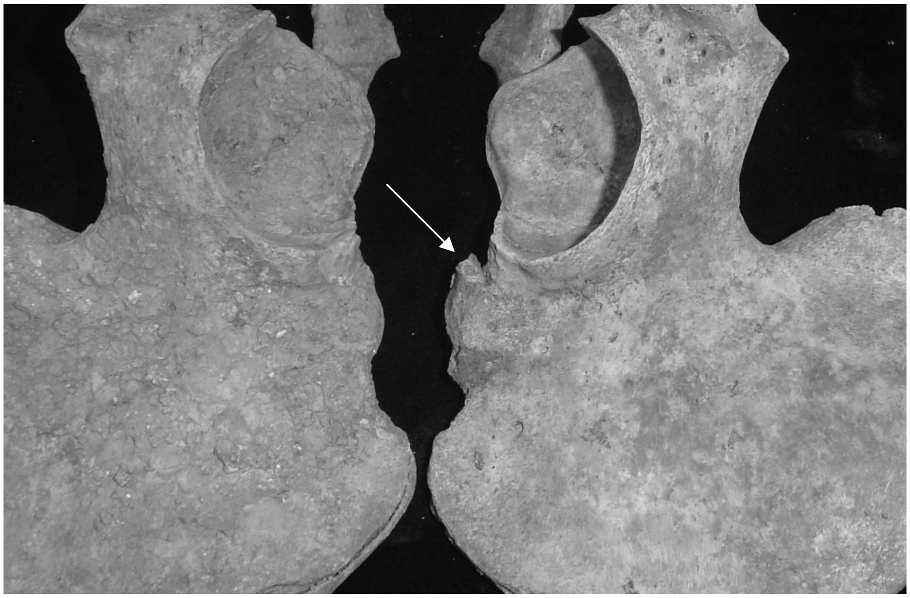


Figure 4.15 A healed sprinter's fracture of the anterior inferior iliac spine observed in a male between 15 and 18 years of age (GLD N34.5)

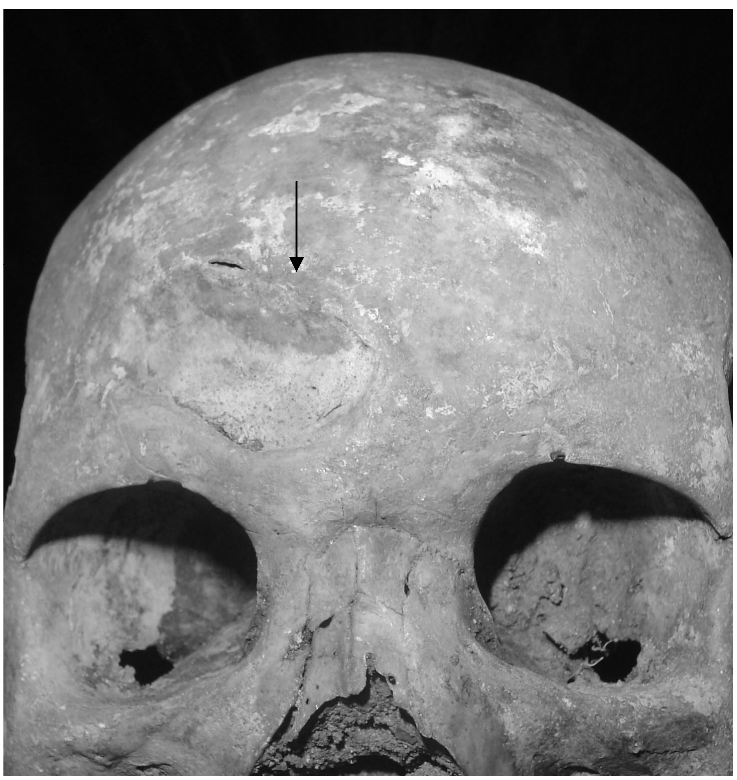


Figure 4.16. Healed depressed fracture of the frontal bone noted in a 30 – 40 year old male (GLD N31.E.1)

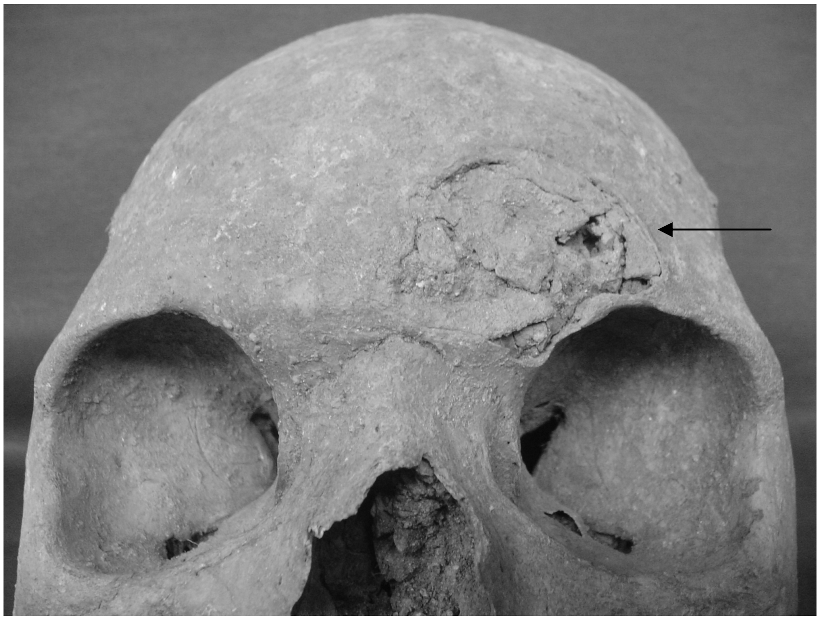


Figure 4.17 A partially healed cranial fracture in the frontal bone in a male between 25 and 29 years of age (GLD N38.2)

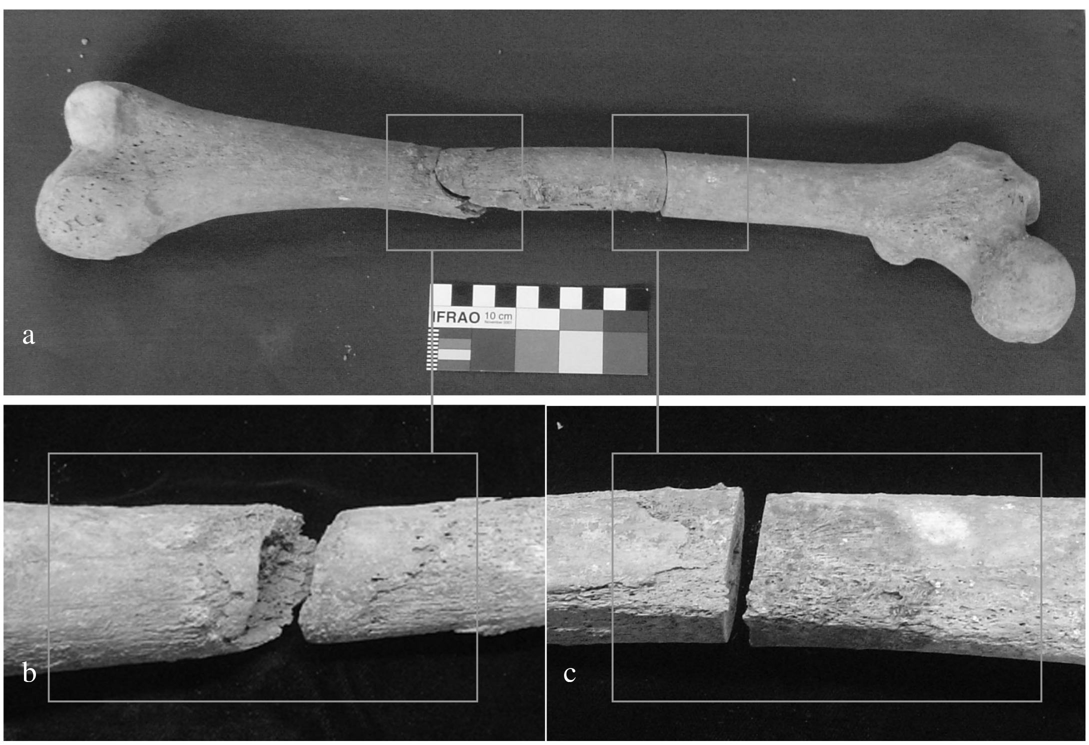


Figure 4.18 A compound fracture of the right femur (a)(b) of a 25-29 year old male. Infection (b) of the fracture led to the amputation (c) of the femur. (GLD N38.2)

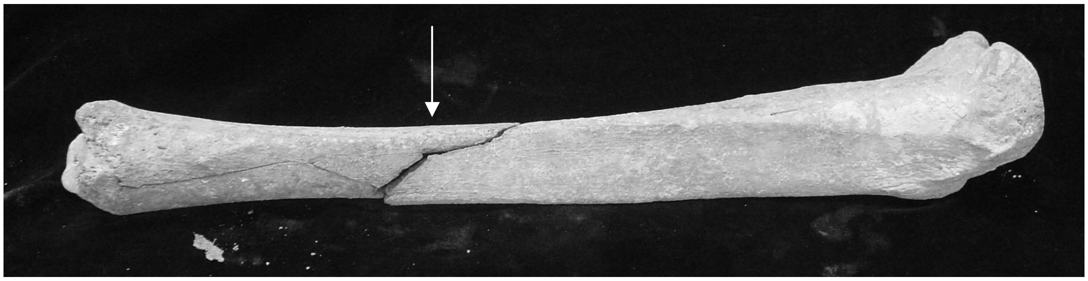


Figure 4.19. Unhealed fracture (arrow) of the right tibia seen in a male between 25 and 29 years of age (GLD N38.2)

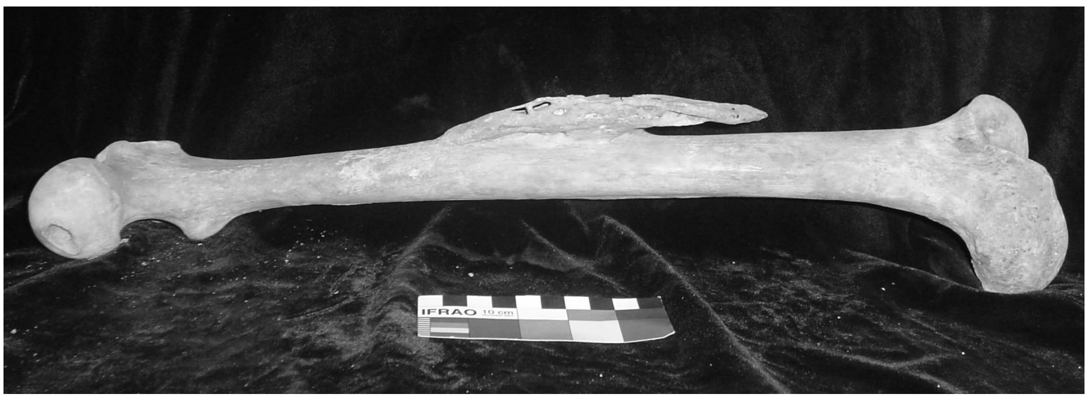


Figure 4.20 Myositis ossificans of the left femur observed in a male between 25 and 30 years of age (GLD SE7.6)

Figure 4.21 The amputated femur of a male between 25 and 29 years of age following severe trauma and infection to the right leg.(GLD N38.2)

Figure 4.22 A well-healed amputation of the left tibia and fibula observed in a 30 - 35 year old male (GLD N34.3).

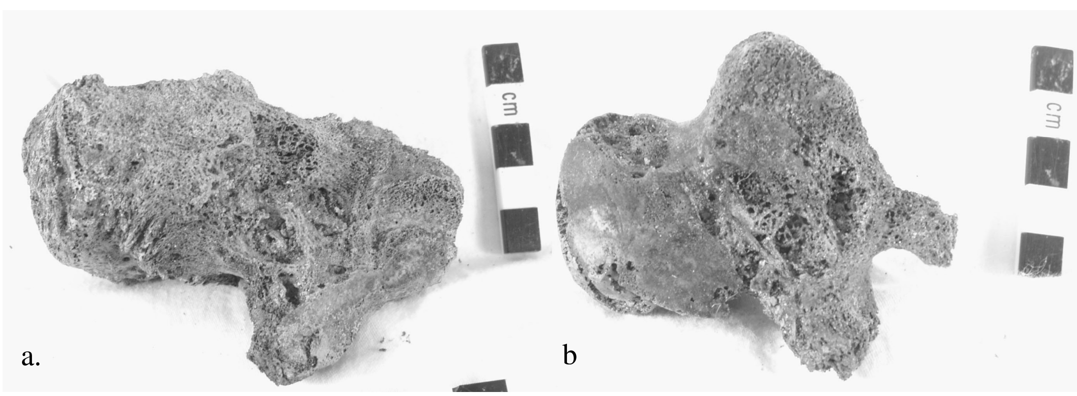


Figure 4.23 A severely infected left talus (a) and calcaneus (b), which eventually resulted in the amputation of the left leg in an adult male (GLD N8.1).

Figure 4.24 A humeral shaft with evidence of amputation on the proximal as well as distal end. Signs of infection (arrow) can be seen on the distal end of the bone (GLD S2.7b)

Figure 4.25 Bilateral spondylolysis of L5 in a 35 - 50 year old male (GLD N74.7).

Figure 4.26 Longstanding dislocation of the gleno-humeral joint caused the formation of an articulation surface between the humeral head and the inferior surface of the acromion process in a 40 - 55 year old male (GLD N74.4). A fracture of the humerus (a) caused lateral rotation of the distal end of the bone. The articulation surface between the inferior acriomion (c) and the humeral head (b) can also be seen.

Figure 4.27 Asymptomatic spina bifida occulta of T12 in a 25 - 30 year old male (GLD N8.2)

Figure 4.28 An abnormality in the formation of the atlas resulting in non-union of the posterior as well as the anterior arch. Observed in a 20 - 25 year old male (GLD N8.8)

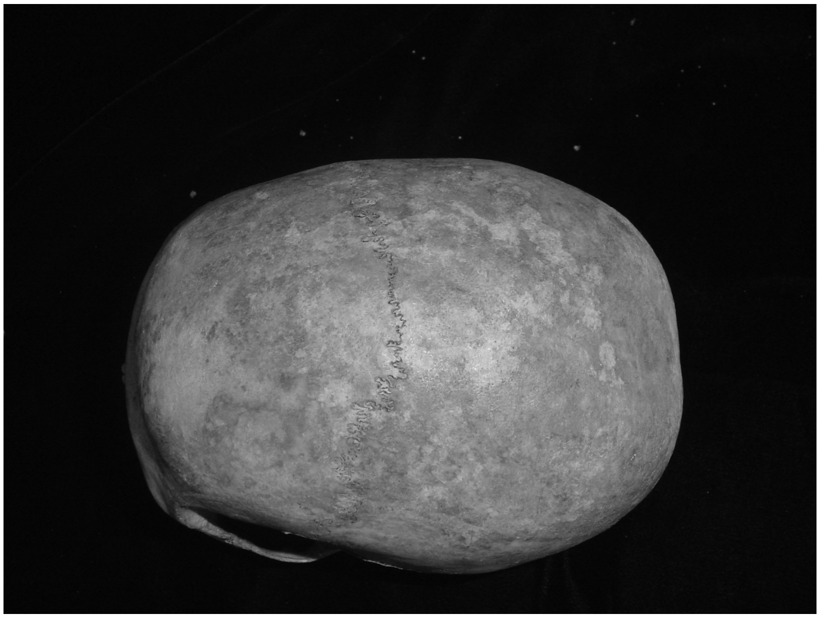


Figure 4.29 Premature fusion of the sagittal suture of a 18 - 23 year old male (GLD N100.4)

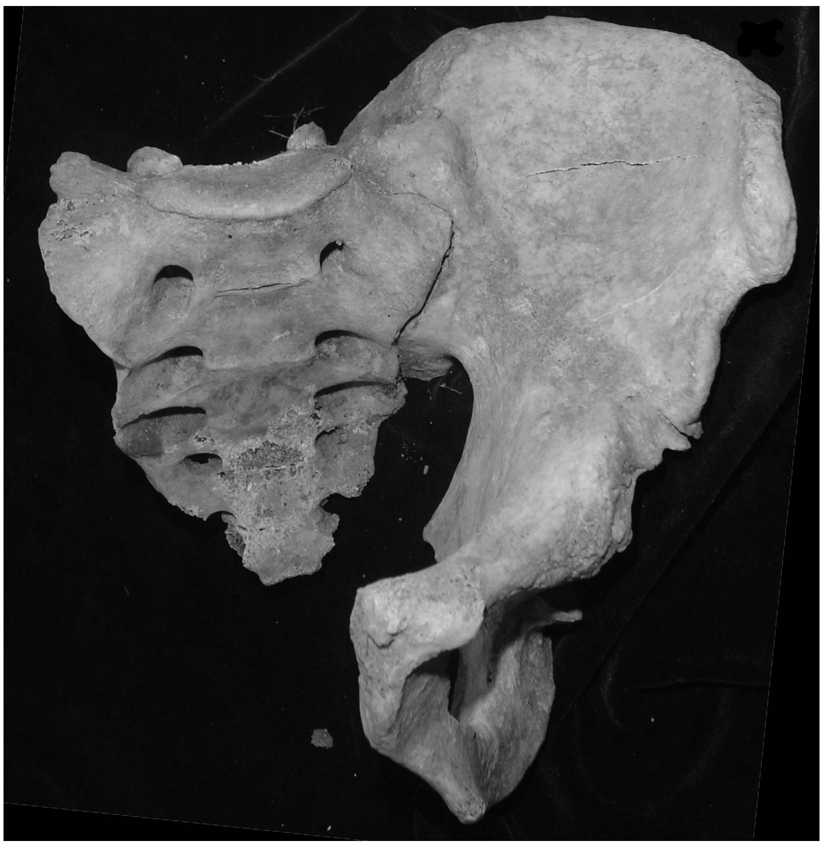
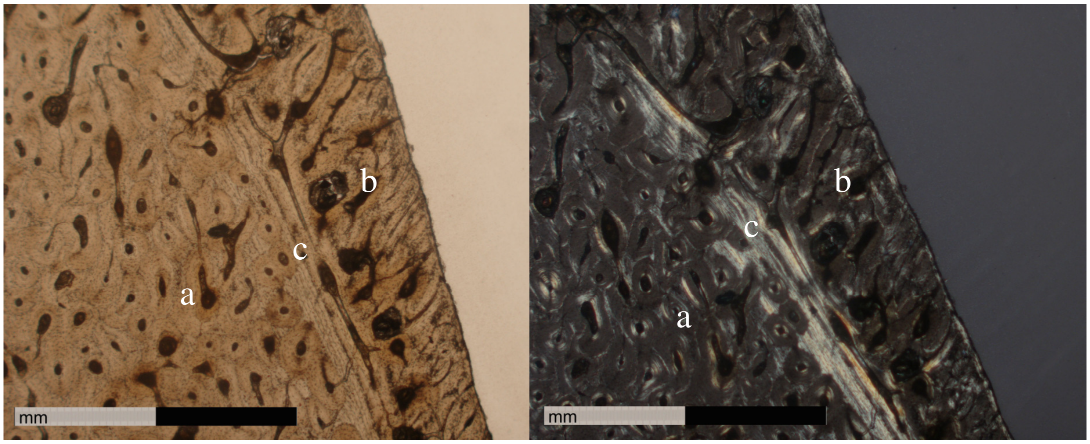


Figure 4.30 Ankylosis of the sacro-iliac joint, (arrow) most likely due to traumatic osteoarthritis, observed in a 40 - 55 year old male (GLD N74.5)

Figure 4.31 Osteoarthritis of the acromio-clavicular joint recorded in a 44 - 60 year old female (GLD SE7.2)

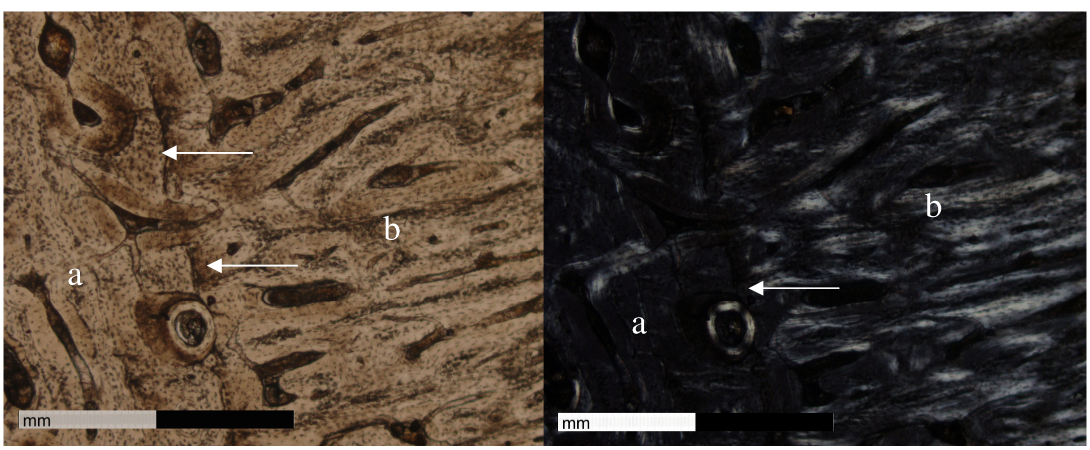
Figure 4.32 Post-traumatic osteoarthritis of the tibio-talar joint causing ankylosis of the joint in a 20-25 year old male (GLD S2.3)


Figure 4.33 Cribra orbitalia of both orbits noted in a 30 - 40 year old male (GLD N 31.E.2)



A B

Figure 4.34. The histological structure of a bone lesion most likely caused by a haemorrhagic incident. Figure A shows the original cortical bone structure (a), the original periosteal surface represented by the original circumferential lamellae (c) and the appositional bone (b) when viewed under normal bright light, and Figure B when viewed with polarized light.



A B

Figure 4.35. The radiating structure of appositional bone caused by a haemorrhagic bone reaction. The original cortical bone (a), original periosteal surface (indicated by arrows) and the appositional bone (b) can be seen here. Note the radiating structure of the appositional bone when viewed under bright light in Figure A and, maybe better visible when viewed with polarized light, Figure B.

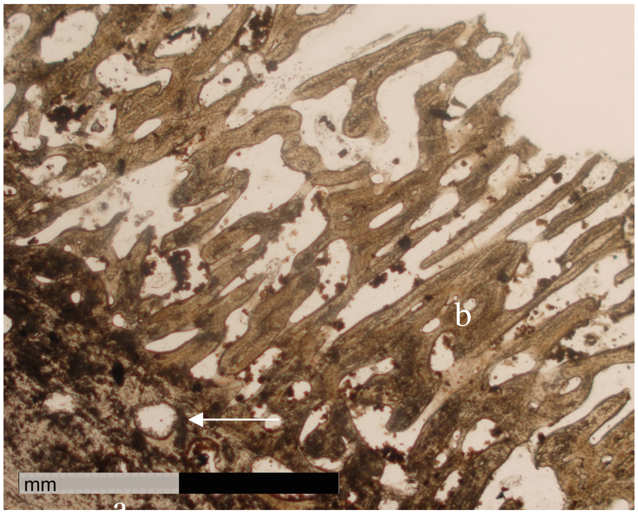
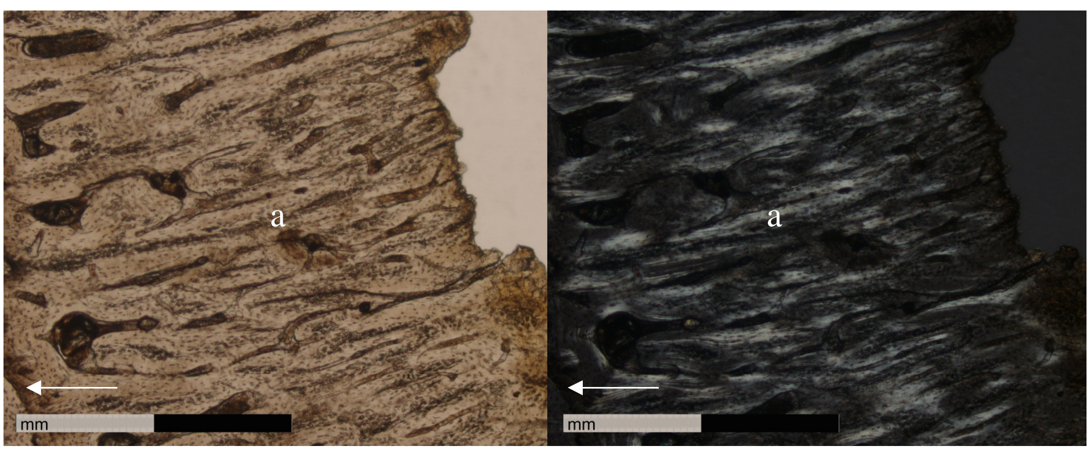
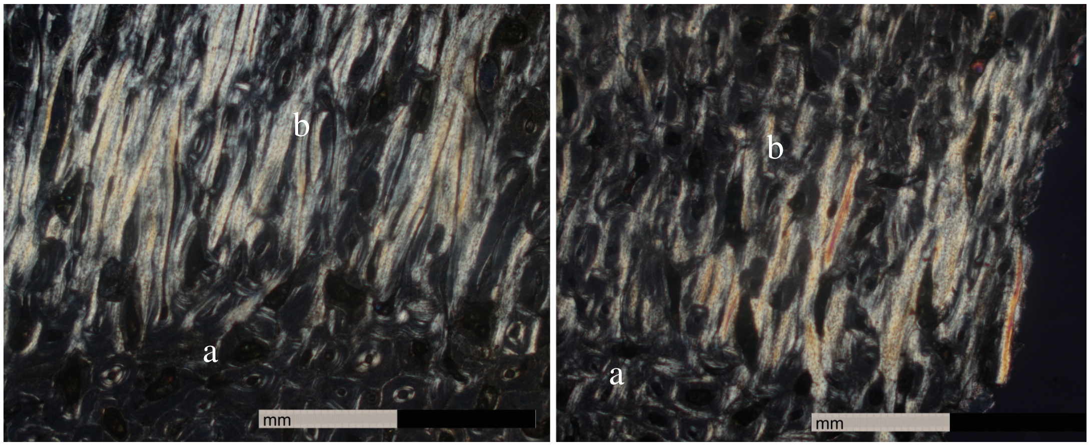


Figure 4.36 Phase I of ossification of a subperiosteal haematoma. The unaffected original cortical bone (a), original periosteal surface (arrows) and very characteristic radiating trabeculae of the appositional bone (b) can be identified.



A B

Figure 4.37. Phase II of ossification of a subperiosteal haematoma. The original periosteal surface (arrows) as well as the appositional bone (a) can be seen when viewed with bright light (A) and polarized light (B). Note that although the spaces between the original radiating trabeculae in the appositional bone had been filled in, the new bone still retains a radiating structure.



A B

Figure 4.38. Phase III of ossification of a subperiosteal haematoma. Longstanding ossified haematomas of GLD S1.3 (A) and GLD N8.4 (B) viewed with polarized light. Although the original cortical bone (a) and the radiating structure of the appositional bone (c) can still be clearly distinguished, the original periosteal surface had become vague and remodelling of the appositional bone into the haversian bone resembling the cortical bone had begun.

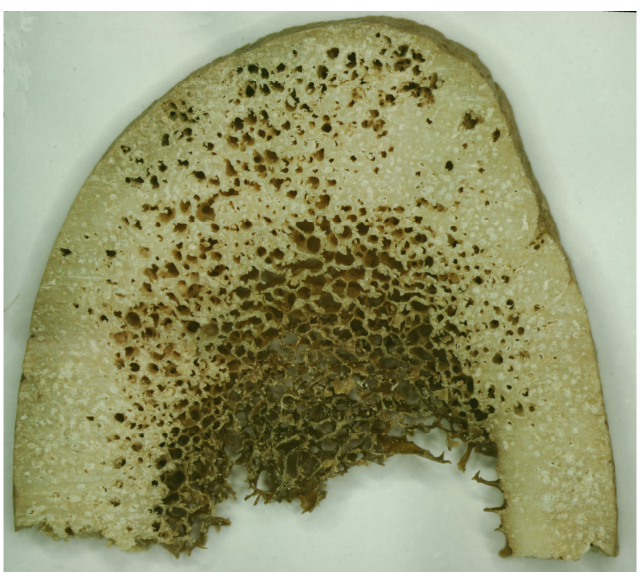
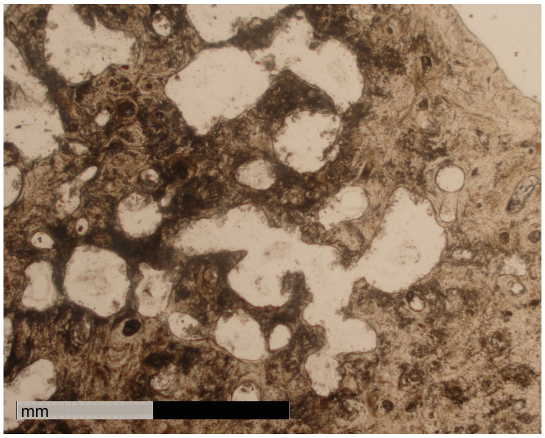
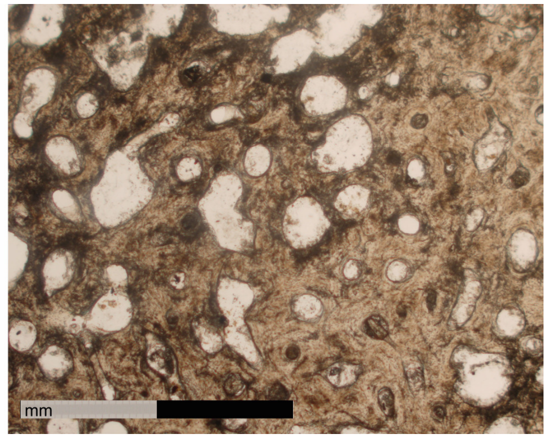


Figure 4.39. A cross section through the anterior tibia of GLD N74.7 affected by treponemal disease.



A



B

Figure 4.40 Destruction of the cortical bone caused by an infectious condition. The periosteal surface is indicated by an arrow in A.

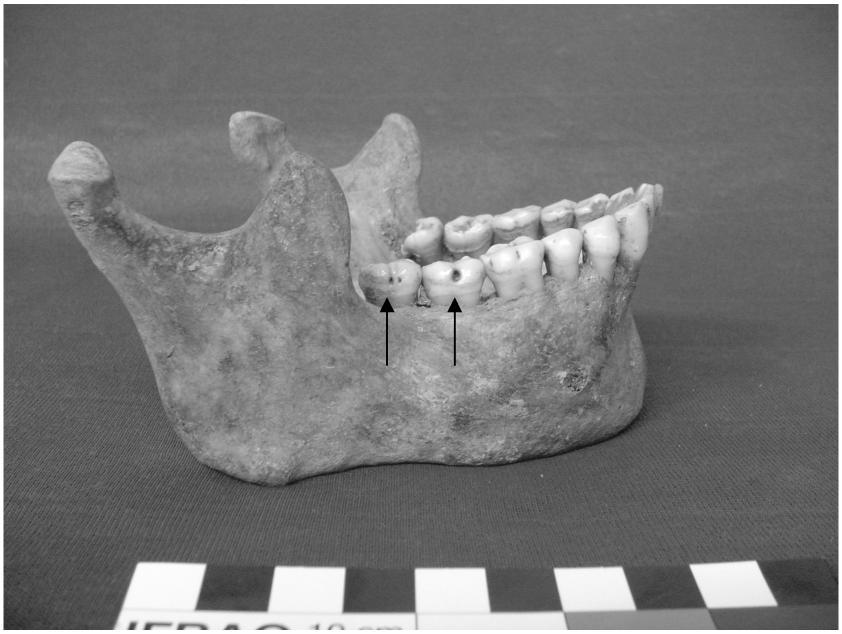


Figure 4.41. Carious lesions on the buccal surfaces of M2 and M3. The mandible of a male between 22 and 30 years of age (GLD N34.10). Carious lesions can be seen on the buccal surfaces of the second and third molar.

Figure 4.42. Antemortem tooth loss. The mandible of a male between 25 and 35 years of age (GLD N34.3). Antemortem tooth loss just prior to death of M3 on the left as well as old antemortem tooth loss of M1 and M2 on the right can be seen. (Note alveolar resorption)

Figure 4.43. Linear enamel hypoplasia. The mandible of a 50 - 60 year old male (GLD S3.1). Linear enamel hypoplasia can be seen from the canine to the second molar on the right.

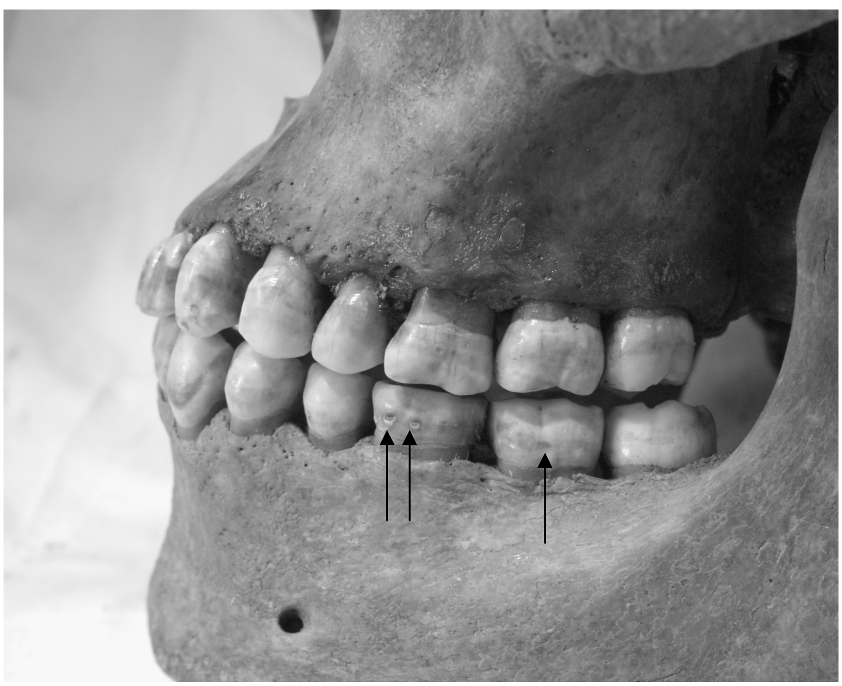


Figure 4.44 Pitted enamel hypoplasia. Mandible of a 22 - 24 year old male (GLD N34.6). Pitted enamel hypoplasia can be seen on the mandibular M1 and M2 on the left.

Figure 4.45 Dental calculus and periodontal disease. The mandible of a 30 - 40 year old male (GLD S3.2). Dental calculus and periodontal disease is present, as well as an abscess at the first premolar on the right.

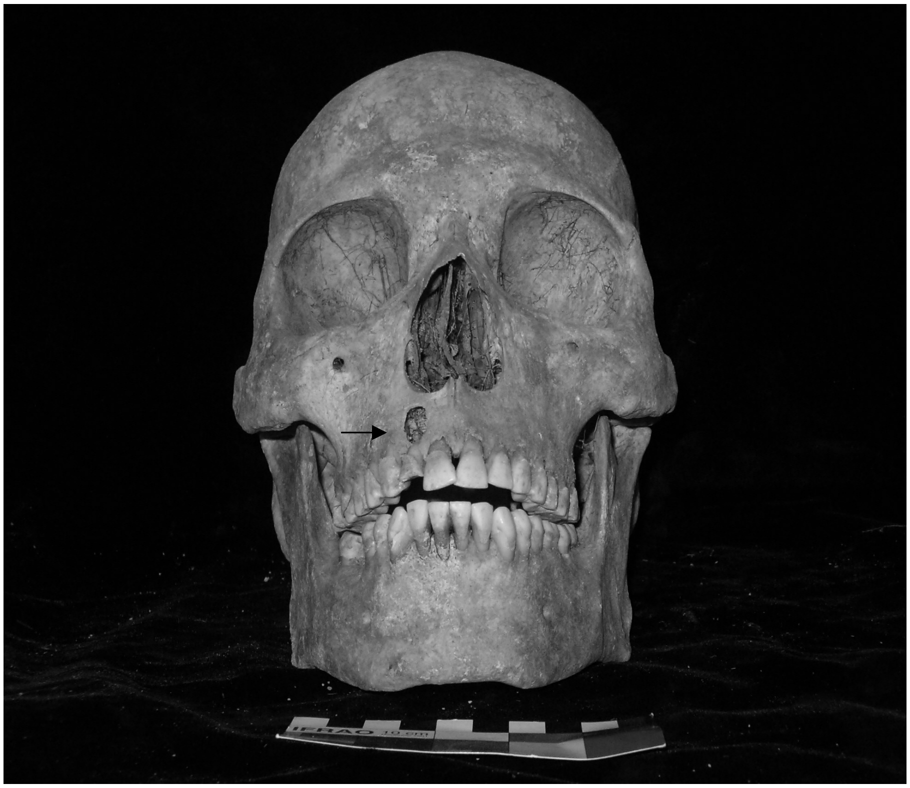


Figure 4.46 A periapical abscess with fistula. The skull and mandible of a 40 - 55 year old male (GLD N74.5). A periapical abscess with fistula is present at the maxillary lateral incisor on the right.

Figure 4.47. A supernumerary premolar. Maxillary teeth of a female between 19 and 23 years of age (GLD N100.5). An extra second premolar is present on the right.

a b

Figure 4.48a. Supernumerary teeth. The maxillary teeth of a male between 20 and 25 years of age (GLD SE7.7). Two extra teeth can be seen on the left and a probable fourth molar on the right. b. A lateral view of the supernumerary teeth on the left.

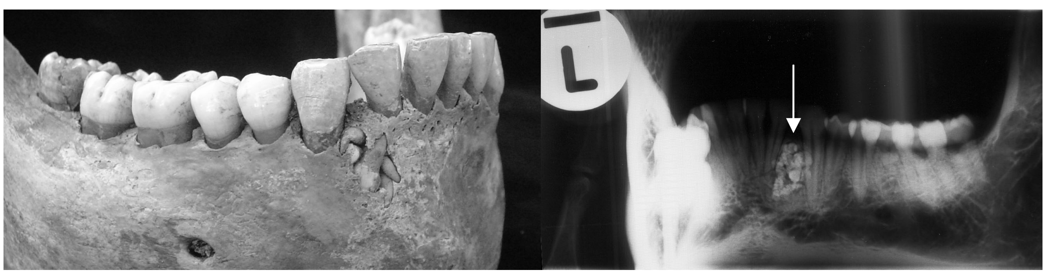


Figure 4.49 Embedded supernumerary teeth. The mandible of a male between 20 and 25 years of age (GLD SE11.5). Several extra teeth are embedded underneath the lateral incisor and canine on the right. The lesion is indicated by the arrow on the x-ray.

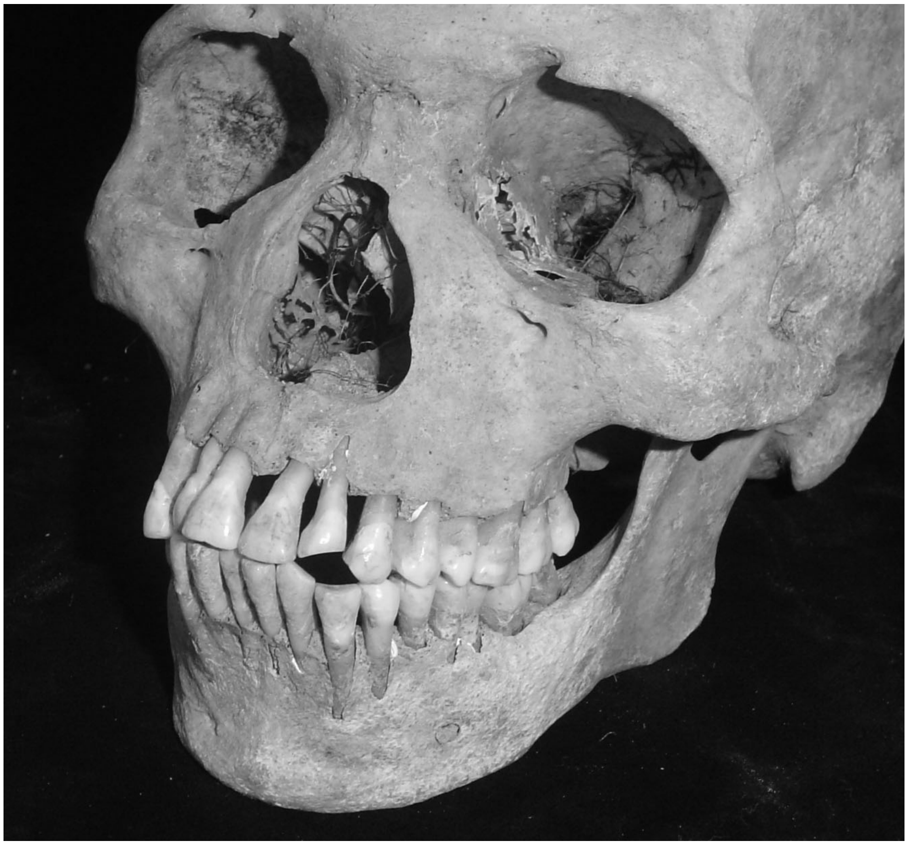


Figure 4.50 Pipe-smoker's wear. The skull and mandible of a female between 40 and 50 years of age (GLD N74.1). Pipe-smoker's wear can be seen on the maxillary and mandibular lateral incisors and canines on the left.

CHAPTER 5

DISCUSSION

5.1 DEMOGRAPHIC COMPOSITION OF THE GLADSTONE SAMPLE

The demographic composition of this population is typically what one would expect from a migrant working population. By far, the majority of individuals within this study were male, with only a few females and three children. It is likely that most individuals within this population were migrant workers, as confirmed by reports that native individuals flooded to Kimberley during the late 19th Century in search of work. It was reported that the number of Black labourers in Kimberley were extremely changeable and dependant on the demand for labour in the mines (Stoney, 1900a)(McNish, 1970)(Jochelson, 2001). Black labourers "from almost every tribe south of the Zambezi" (Roberts, 1976: 15) were brought to Kimberley to work, and when their contract expired, returned to their "kraals" (Leary, 1891; Roberts, 1976:294)(McNish, 1970). Men most likely left their families at home (be it another town, or even another country) and came to Kimberley in the hope of finding fortune or maybe merely an extra income to sustain their families (McNish, 1970). This will explain why the majority of individuals within this sample population were male and why very few woman and children were found.

It may also be suggested that these individuals came from compounds. It is known that only "Native" male persons stayed in this accommodation, where they had access to a compound hospital. This hypothesis would, however, not explain the presence of females and children.

It can therefore be suggested that although the sex distribution within this skeletal sample does not represent a normal population distribution, it is most likely representative of the migrant working population present in Kimberley at the end of the 19th Century. It is plausible that mostly young males came to seek work on the diamond mines, since the physical labour was extremely strenuous and older, sickly individuals would most likely not have been employed. Therefore, it can be assumed that it is possible that the majority of individuals in Kimberley were young adults. These findings were supported by a census held in 1898, in which it was reported that 65% of Black individuals within Kimberley were between the ages of 15 and 45 years (Stoney, 1900a).

The high death rate of "Natives" between 30 and 45 years of age was well documented in archival reports from the Officer of Health (Stoney, 1900a). According to these reports, the high death rate of these individuals was ascribed to mining accidents associated with shaft blasting by De Beers, the poor living conditions of the "Natives" as well as their increased susceptibility to Western diseases.

It was however noted that the Gladstone population was on average 5cm shorter than the modern South African Black population. Three possible reasons for this discrepancy could be given. Firstly, a method devised by Lundy and Feldesman (1987) was used to estimate the antemortem stature of individuals, using the bicondylar length of the femur. According to this method, 10cm, 10.5cm or 11cm was added to the estimate in order to compensate for soft tissue (Lundy & Feldesman, 1987). It has recently been shown that the correction factors for soft tissue added to estimate antemortem stature from skeletal remains are too small causing the underestimation of antemortem stature (Raxter et al., 2006). Results obtained by Steyn and Smith (in print) were from a living population and therefore underestimation due to a too small correction factor may be the reason for the discrepancy. Secondly, these individuals might have been malnourished during childhood, and growth was accordingly stunted, resulting in the affected persons not reaching their potential genetic antemortem stature. Lastly, taking the geographic location of Kimberley into consideration, it can be hypothesized that some individuals in this population might have been Khoisan, who are generally shorter than individuals of Negroid descent. Unfortunately, this was not investigated further, as it falls beyond the scope of this study.

5.2 PALAEOPATHOLOGY: MACROSCOPIC INDICATIONS OF HEALTH

5.2.1 Infectious diseases

Tertiary stages of syphilis are not often seen in modern populations, since it can be treated effectively during the primary and secondary phases with chemotherapy and antibiotics (Ortner, 2003). Although treatment of skin lesions associated with syphilis was common during the 19th century, treatment with antibiotics was only implemented around 1941

(Ortner, 2003). Therefore, advanced stages of infectious disease could be observed in the Gladstone population.

The prevalence of skeletal involvement during treponemal infection has been shown to vary greatly. Some authors have found that 1% of patients present with skeletal lesions, whereas others reported up to 20% of infected individuals showing bone involvement (Ortner, 2003). Care should therefore be taken when reconstructing the prevalence of treponematosis in the Gladstone population, since the prevalence of skeletal indications of syphilis might not be representative of the true incidence of the disease within the living population.

Skeletal lesions suggesting treponemal infection were observed in 9.3% of individuals within this population. As stated in the Results section (Chapter 4), the prevalence is not necessarily higher than what has been observed in other populations, but is extremely high when compared to South African populations, where only single cases have been reported from studies such as Maroelabult and K2.

It should be kept in mind that the high incidence of treponemal infection in this population is not representative of the greater population in Kimberley. As stated earlier, the individuals studied here most likely came from the Kimberley or compound hospitals and they would accordingly present with a much higher incidence of pathological changes than the population they represent. The high prevalence does, however, correlate with the incidence of syphilis within Kimberley during the late 19^{th} Century (Jochelson, 2001). Although no clear numbers were stated, it was reported by the Senior House Surgeon in 1899 that "syphilis are playing havoc among the coloured races" (Cape of Good Hope Votes and Proceedings of Parliament, 1900: 42). It can therefore be assumed that many individuals were affected by the condition (jochelson, 2001).

The high incidence of treponemal disease within this population can most likely be associated with five factors:

1) The high incidence of skeletal lesions associated with treponemal infection can be ascribed to the absence of treatment for this disease. Individuals suffering from syphilis were most likely treated with mercury. Although no reference to the specific method of treatment could be found in archival documents, treatment with mercury was the only available method until the introduction of penicillin in 1941. Mercury was applied to the body in the form of an ointment or it was administered orally and as anti-viral enemas (Quetel, 1990). In modern

populations, medical intervention prevents the disease to develop to the tertiary stage, and therefore skeletal involvement is rarely seen.

2) The extremely good preservation of the skeletal remains might also be responsible for the high incidence of treponemal infection when compared to other South African studies. If skeletons are poorly preserved and incomplete, the frequency of treponemal infection can be grossly underestimated.

3) These individuals came from a hospital and therefore the incidence of the disease in this sample might not be representative of the disease patterns of the wider community from whom the workers were drawn.

4) The population, as it was described in archival documents and observed in this study, was composed mainly of males, with only a few females (Jochelson, 2001). As was also suggested by Khudabux (1953), this population composition in conjunction with promiscuous behaviour, well described in the archival documents, favoured the spreading of syphilis (Jochelson, 2001).

5) It is also possible that the majority of individuals suffered from endemic syphilis (Joshelson, 2001). The living conditions in the mines and compounds were extremely poor and overcrowded and working miners were also usually scantily dressed while working closely together (Joshelson, 2001). All of these factors would favour the spread of endemic syphilis within a population.

Other diseases such as non-specific osteomyelitis, ossified haematomas on the anterior tibiae due to scurvy, venous stasis, hypertrophic osteoarthropathy and fluorosis can cause lesions suggestive of treponemal infection (Rothschild et al., 2001). All diagnoses of possible treponemal disease within this study were based on a combination of lesions in the individual suggesting syphilis, and it is therefore suggested that other conditions can be excluded as a possible cause for the skeletal defects observed.

The absence of proper treatment with penicillin as well as the overcrowded, ill ventilated and unhygienic living conditions, described so well in archival documents, is clearly the reason why this disease flourished in Kimberley during the late 19th Century. Another factor that can be considered is that the gender composition of the population in

Kimberley, characterized by the majority male and only a few female individuals, encouraged the spread of venereal diseases, as was the case at mines in the Witwatersrand a few years later (Harries, 1994).

Other infectious diseases observed in the Kimberley remains included a person suffering from advanced non-specific osteomyelitis of the right leg as well as a possible case of tuberculosis. These infectious diseases are expected in a population receiving medical treatment in the period preceding antibiotics.

Shandling reported in 1960 that, at that stage, South Africa had the highest incidence of acute non-specific osteomyelitis is the world. He noted that the condition had the highest incidence in children between 6 and 10 years of age, and was more frequently observed in individuals of low socio-economic status. This could not be tested in the Gladstone population, due to the poor sample distribution and absence of children.

Non-specific osteomyelitis is considered to be more common in rural, tropical environments with poor sanitation. Archival documents have indicated that sanitation in the pauper wards of Kimberley Hospital was extremely poor. According to reports, the "Native Medical Ward" was in an appalling state in 1897 (Medical Officer of Health, 1897). The report states that the ward was "low, hot, badly lighted and badly ventilated, and worst of all there [was] a scullery opening into it" (Cape of Good Hope Votes and Proceedings of Parliament, 1898).

Although only one case of non-specific osteomyelitis was observed, it is possible that some of the osteomyelitis cases admitted to hospital were treated by amputation. In some of the amputated limbs observed, clear signs of infection were present. If all the amputations observed in this population were indeed the result of infection, the incidence of osteomyelitis would increase to 6.5%, which may be more representative of the true incidence of the condition. It should, however, be kept in mind that some of the amputations may have been the result of untreatable crushing injuries, without secondary infection present.

Several amputations (n = 6) were observed in this population, ranging from healed amputations to the actual, severely infected amputated limbs. Although the amputation of limbs is also done after trauma resulting in a crushed limb, the majority of these amputations could be associated with infection.

Archival documents indicate that tuberculosis, or phthisis as it was referred to in the archival literature, was the cause of as many as 20% of all deaths (Meyer et al,. 2002). Taking into consideration that skeletal lesions due to tuberculosis only develop in 5-7% of individuals infected by the disease, the incidence of tuberculosis in this sample population is probably a good presentation of the incidence of the once living population in Kimberley (Steinbock, 1976; Santos & Roberts, 2001).

According the Officer of Health, "the natives appear to be especially susceptible to the disease" (Stoney, 1900a: 7). Tuberculosis was introduced by the Europeans coming to Kimberley and it spread like wildfire among the Black labourers in the mine (Collins, 1982; Packard, 1989). Although the Officer of Health suggested increased susceptibility of the Black individuals as the reason for this condition, which was partly true, the overcrowded living conditions in the compounds and locations aided the spreading of the epidemic (Packard, 1989). As indicated by archival documents, huts in the location were situated extremely close together, with at least six individuals staying in one hut, and in the compounds, several individuals shared a shed (Stoney, 1900b; Packard, 1989). Such crowded conditions are favourable for the spreading of any infectious disease, not only tuberculosis. Another factor making these individuals more susceptible was general poor health, induced by exhaustion due to long working hours and poor nutrition (Harries, 1994; Packard, 1989).

Another important factor to discuss is lung diseases induced by the constant inhalation of microscopic particles of dust dislodged during shovelling, drilling and blasting (Harries, 1994; Packard, 1989). The term phthisis is given to the abovementioned condition in some archival texts, but according to the Oxford Medical Dictionary (2004), this is a former name for tuberculosis. The terminology is thus ambiguous. Nevertheless, the inhalation of these dust particles also leads to fibrosis, of which the symptoms may be mistaken for those of tuberculosis. This condition is extremely prevalent in individuals working in underground mines, due to the constant drilling and digging causing the dislodging of dust particles, and the lack of ventilation keeping them lodged in the air (Harries, 1994; Packard, 1989). A combination of underground and open mining was being done in Kimberley by the end of the 19^{th} Century.

Although several diseases can cause lesions indicative of the above-mentioned conditions, careful examination of all skeletal elements available in combination with archival documentation of more prevalent diseases increases the chances of accurate diagnoses. In general, the prevalence of infectious diseases, which included nine cases of syphilis, one of non-specific osteomyelitis and one possible individual suffering from tuberculosis in this population, mirrors the unhealthy, hot, overcrowded and malnourished condition in Kimberley, as well as the limited medical care available.

5.2.2 Metabolic and nutritional diseases

It is widely known that persons suffering from vitamin C deficiency have a tendency to bleed due to defective collagen and fragile vascular walls (Ortner & Ericksen, 1997; Ortner et al., 1999). Although haemorrhaging is normally associated with the joints and shafts of weight-bearing bones, Ortner (1997) indicates that the skull vault and orbits could also be affected by bleeding in children. According to Ortner (1997), strain on the temporalis muscle due to the normal mechanism of chewing, or normal movement of the eye, have the potential to initiate haemorrhage (Ortner & Ericksen, 1997; Ortner et al., 1999). According to Ortner et al. (1999), any mechanical strain on a defective blood vessel could result in bleeding.

In a study conducted on the "Johannesburg Bantu" in 1962, Seftel (1966) noted that individuals suffering from scurvy often presented with haemorrhagic swellings of the gums as well as bleeding into the muscle of the calf or posterior thigh (Grusin & Samuel, 1957; Seftel et al., 1966). Steinbock (1976) also states that pathological features are common in the diaphyses of adults, rather that the metaphyses, as seen in infantile scurvy (Steinbock, 1976; Maat, 2004). It can also be expected that skeletal sites, which receive regular minor trauma, such as the shin, will be more prone to the development of haematomas due to the increased susceptibility of the scorbutic individual to haemorrhage (Stuart-Macadam, 1989). Thus, although very little literature is available on the presence of haematoma formation on the surface of the tibia due to scurvy, it is proposed that the skeletal lesions of ossified haematomas, observed in the Gladstone remains, developed due to vitamin C deficiency.

The documentation of scurvy in adults is rarely seen in the description of the health status of archaeological populations. This is most likely due to ambiguous lesions caused by this condition. Haematomas on the diaphyses of bone can easily be mistaken for treponemal infection, non-specific osteomyelitis or an osteoblastoma. The pattern of skeletal manifestation of scurvy in the Gladstone population is very similar to what was observed by Maat (1982) in the whalers. In the Gladstone population, ossified haematomas were bilateral in most cases and lesions of subperiosteal bone apposition and periostitis were also often seen.

The prevalence of scurvy within the Gladstone population (14.9%) correlates well with the documented incidence of this disease among Black individuals being treated at the Kimberley Hospital. A high incidence of scurvy in the late 19th Century Kimberley has been well documented in archival documents. In 1897, 311 patients (16.7% of all admissions) were being treated for scurvy. According to the report, this could have been prevented if "employers [were] properly feeding their men" (Cape of Good Hope Votes and Proceedings of Parliament, 1898: D2). It was also stated that due to the neglect of the employers, it became the hospital’s responsibility to cure the malnourished "Natives" employed in the mines. During the last six weeks of 1899, up to 292 patients (17.8% of all admissions) were being treated for scurvy, of which 52 individuals died as a result thereof (Medical Officer of Health, 1900).

A high incidence of scurvy can be expected in groups following a diet consisting mainly of maize meal and occasional coarse meat, which was the only food supplied by the employers. There were even times when no food was being supplied to compound workers and they were responsible for buying and preparing their own meals (Harries, 1994). These diets were thus normally high in carbohydrates, low in animal proteins and low in fresh fruit and vegetables (Grusin & Samuel, 1957; Seftel et al., 1966). When considering the lack of fresh fruit and vegetables, Kimberley's climate should be kept in mind; the 19th century Kimberley, as is still the case, was unbearably hot and dry, plagued by fires and brutal duststorms (Roberts, 1976)(McNish, 1970). Therefore naturally growing fruit and vegetables were scarce and agricultural enterprises were difficult.

Another possible explanation for the high incidence of scorbutic individuals found in this population can be the regular consumption of homemade traditional beer and alcohol, as indicated earlier (McNish, 1970). The regular consumption of beer stored in iron tin cans caused the individuals to develop siderosis, which in turn may lead to the development of scurvy (Seftel et al., 1966). Historical documents indicate that alcoholic beverages were consumed in large quantities by the Black labourers in Kimberley. Although a liquor law existed, supposedly to prevent Black labourers from buying liquor without the permission of their employers, the law was hardly implemented and there was "practically a free trade of liquor" (Harries, 1994: 57). This liberal liquor policy attracted and kept labourers on the mine. It was stated that "liquor with a high ability to intoxicate... proved particularly popular" among the Black labourers (Harries, 1994: 57).

Sorghum beer was also prepared in large quantities and together with European liquors, it became the "cultural markers, binding Black workers together" (Harries, 1994: 58)(McNish, 1970). This habit of overindulging, which mainly occurred on weekends, resulted in a "large absentee rate on Mondays, when as many as 50% of the men failed to report for work" (Harries, 1994: 58).

5.2.3 Trauma

The frequency and various types of fractures within a population can yield important information regarding their lifestyle, their interaction with the environment as well as the amount of medical attention that was available at the time (Steinbock, 1976; Kilgore et al., 1997). Parry fractures of the ulna, blunt trauma to the skull, fractures of the metacarpals and evidence of cut marks by a sharp objects are all clear indications of interpersonal violence (Smith, 1996; Jurmain & Bellifemine, 1997; Kilgore et al., 1997; Lovell, 1997; Jurmain, 2001; Ortner, 2003; Judd, 2004). Femoral, tibial and humeral fractures, on the other hand, are usually related to accidental incidents such as a fall (Kilgore et al., 1997).

The extremely high incidence of cranial fractures within this population (24%, Table 3.8), is suggestive of interpersonal violence, as was also suggested in the samples from Chile and California (Jurmain & Bellifemine, 1997; Standen & Arriaza, 2000). Most of the fractures observed on the cranial vaults were circular in shape and suggestive of a weapon like a South African "knobkierie", although this cannot be said with any certainty. All cranial fractures were due to "blunt-force" trauma and several other weapons or even rocks can produce the same skeletal results (Jurmain & Bellifemine, 1997). It should therefore also be considered that the high prevalence of cranial fractures might be related to mining accidents such as rock falls, which were recorded in archival documents.

The incidence of lesions suggesting interpersonal violence concurred with historical documentation of violence amongst the Black labourers in Kimberley. The notion of violence as a symbol of masculinity and group affiliation existed on the mines, and fights between various groups were often seen. These fights were a means by which leaders were selected and justice was served. An Anglican clergymen reported that "tribal fights and murders occurred every weekend" (Harries, 1994: 58). According to records, weapons such as knobkieries, fighting sticks and pick handles were used (Harries, 1994).

It has been noted that some societies develop rules for acceptable interpersonal violence. According to these rules, certain parts of the body might be attacked and weapons are specified. An example of such practice can be seen in the indigenous Australian Mangrove - fighting sticks are available for females, and they are allowed to strike each other on the legs, arms and fingers. It is obvious that such practices will produce a specific fracture pattern within a population. This is unfortunately not a plausible explanation for the high incidence of cranial fractures within the study population. Rules devised for the location of strikes in the Mangrove were certainly described in order to prevent fatalities, explaining why attacking the head and chest was strictly forbidden (Judd, 2004). Judging by the severity of the fractures, it is suggested that the cranial fractures observed in the Gladstone population were intended to cause serious injury or fatality. It should also be kept in mind that this was a migrant working population and complicated social structures and rules as seen in the Mangrove would probably not have been present.

It is suggested that the levels of interpersonal violence within a population increase when the population is affected by periods of environmental deterioration, sudden population growth and an increase in competition for resources (Torres-Rouff & Costa Junqueira, 2006). The discovery of diamonds in Kimberley caused just this. Several individuals went to Kimberley in the search of fortune for some and work for others, causing a dramatic growth in population numbers (Roberts, 1976; Harries, 1994). When considering that the study population was most likely a migrant working population, aggressive behaviour might also have been spurred by cultural differences (Harries, 1994). Furthermore, the increase in population numbers would inevitably have caused competition for resources, especially among the lower class labourers. The high incidence of scurvy reported in archival documents for this population supports a state of limited nutritional resources. Few women were present in Kimberley, as suggested by the few female skeletons excavated as well as the archival records, and this might have increased the level of social conflict and competition. Other factors such as the regular over-indulgence in liquor, skirmishes over the theft and illegal selling of diamonds, as well as friction regarding the amount of work done per day, also caused violent events between labourers and their employers or overseers (Turrell, 1987; Harries, 1994).

According to Lovell (1997) high fracture risks are associated with occupations generally restricted to men, such as agriculture, mining and forestry. It is also stated that household activities in developing countries such as carrying water and firewood pose a high risk of fractures (Lovell, 1997).

Mining accidents accurred frequently in Kimberley. These included falling down mine shafts, getting killed by rock falls, drowning in mud rushes and getting run over by wagons, carts or trams to name but a few (Cape of Good Hope Votes and Proceedings of Parliament 1901; Turrell, 1987; Harries, 1994). It is thus suggested that the incidence of fractures of the long bones, and possibly the cranial fractures, within the Gladstone population is representative of the high-risk environment these individuals were working in. Thus, the occurrence of post-cranial fractures in the Gladstone population can most likely be associated with strenuous mining activities.

The presence of well-healed and reduced fractures within this population indicates that some medical care was available in the situation of a fracture. This is expected, since hospital records refer to the treatment of injuries and violence, which most likely would have included fractures (Cape of Good Hope Votes and Proceedings of Parliament, 1898; Cape of Good Hope Votes and Proceedings of Parliament, 1899). It may be suggested that some fractures, such as the misaligned fracture of the left clavicle (GLD N100.2) and the large amount of callus formation associated with it, is suggestive of limited medical attention. However, it should be considered that displacement of clavicular fractures is common, since treatment of these fractures is limited to the use of a sling, and therefore healed clavicular fractures often show some deformities (Lovell, 1997).

The high incidence of myositis ossificans acuta observed in the Gladstone population is of great interest. As mentioned earlier, these bony outgrowths do not develop due to constant strain on the origin or insertion of a muscle, but are more likely associated with a single traumatic event. It is suggested that the high frequency of these lesions might be associated with occupational injuries attained during strenuous physical labour.

Separation of the neural arch or spondylolysis is a condition mostly recognized by the bilateral fracture of the pars articularis of L4 or L5 (Figure 3.25) (Merbs, 1989; Arriaza, 1997). This was observed in 6.5% of the population. As mentioned earlier, the incidence of this condition varies greatly between different population groups, with six percent of White Americans, 5.5% of Japanese and 25% of Eskimos found to be affected (Morris, 1984). According to Eisenstein (1978), 3% of Black South African individuals present with the condition. The incidence of this condition was slightly higher in the Gladstone population when compared to what was observed in the study by Eisenstein (1978).

Lane (1893) noted that this condition is associated with strenuous physical activity and stated that it occurs frequently in "people doing heavy labour". It has since been said that spondylolysis is also associated with strenuous athletic activities such as rowing and football, as well as physical labour involving heavy weight-lifting (Merbs, 1989; Stirland, 1996; Arriaza, 1997; Lovell, 1997).

A high incidence of spondylolysis is associated with increased compression of the posterior elements of the vertebrae due to hyperextension of the back, or increased shearing forces due to repeated flexion. During hyperextension of the back, the joints of adjacent vertebrae become locked together, causing an increase in stress exerted on the bone (Arriaza, 1997). This may explain the incidence of spondylolysis within this population. Activities associated with open mining will include a higher than average incidence of hyperflexion and hyperextension of the back. This will inevitably increase the likelihood of spondylolysis in individuals who is susceptible (Earl, 2002; Lovell, 1997). The high incidence of spondylolysis within this sample is thus suggestive of participation in the strenuous physical activities most likely associated with mining. The incidence of spondylolysis is described to be higher among males than females (Arriaza, 1997; Lovell, 1997). No significant difference was seen in this study, most likely due to the small sample size and poor sample distribution.

The treatment of shoulder dislocations goes back to the time of Hippocrates (Ortner, 2003), and chances are that this condition was commonly treated in Kimberley Hospital. Therefore, the incidence of this condition only reflects a portion of the actual prevalence of this type of trauma within the Gladstone population. Dislocation observed in this population was most likely trauma-related, be it accidental or violent.

The clear evidence of sawing marks perpendicular to the long axis of the bone observed on the amputated limbs (Figure 3.23), supports the fact that the Gladstone cemetery was used as burial ground by the Kimberley Hospital (Mays, 1996). Several archival documentations of amputations are available from Kimberley Hospital (Cape of Good Hope Votes and Proceedings of Parliament, 1885). According to these records, up to 35 amputations were done a year, which amounted to approximately 50% of all operations performed in Kimberley Hospital (Cape of Good Hope Votes and Proceedings of Parliament, 1885). Unfortunately, no documentation suggesting the possible reasons for these amputations is available.

Two therapeutic reasons for the amputation of a limb can be suggested: the first is amputation after injury, resulting in such severe crushing of the limb that there are no chances of healing. When considering the types of mine accidents reviewed earlier, fractures such as these may have often been encountered in Kimberley. The second reason for amputation is severe infection of a part of a limb. The evidence of infectious lesions found on amputated limbs (such as GLD N38.2, GLD N8.1b, GLD S2.7b and GLD S2.7c) suggests that the amputation of a limb may have been done in some cases of severe infection. This is plausible when considering that no antibiotics were yet available for the treatment of infectious conditions (Quetel, 1990). The amputation of the infected body part was thus the only way to prevent spreading of the infection.

5.2.4 Congenital abnormalities

As described earlier, the occurrence of congenital abnormalities of the atlas is extremely rare, only occurring in 1% of individuals (Motateanu et al., 1991). Although the 2.3% incidence of this condition is not higher than what was observed by Schulze (1979), it is an interesting occurrence. Lesions such as these, especially the one seen in GLD N8.8, are rarely recorded in archaeological studies.

The overall incidence of spina bifida was low in the Gladstone population when compared to the results obtained by Shore (1930), but within normal limits when compared to other archaeological findings (Morris, 1984; Steyn, 1994; Mosothwane, 2004). These lesions were all compatible with life and most likely asymptomatic, except for the atlas observed in GLD N8.8. This defect was obviously compatible with life, but the individual might have suffered from an unstable atlanto-occipital joint.

The high incidence of variation in the number of presacral vertebrae observed in the Gladstone population is within normal limits. It is comparable to results obtained by Morris (1984). The prevalence of this condition is higher than that described for the South African Negroid population by De Beer Kaufman (1974). The high incidence does suggest that some individuals within this study population were most likely of Khoisan affinity. Unfortunately, this will not be further investigated, since the assessment of racial affinity lies beyond the scope of this study.

The incidence of craniostenosis noted in the Gladstone population is within normal limits when considering other studies done in "Native" Africans. It is suggested that females are less often affected by the condition (Gordon, 1959). This was also seen in the Gladstone sample with both individuals affected being male. The individuals affected by craniostenosis in this sample were most likely asymptomatic. As mentioned earlier, premature fusion of one or more cranial sutures after growth of the brain had ceased, or when it only proceeds slowly, will only cause minimal deformation (Gordon, 1959). It can be seen from the skulls of individuals suffering from craniostenosis in the Gladstone population, that brain growth had probably neared completion by the time the premature fusion of the cranial sutures occurred, and therefore little deformity of the skull was observed in all cases.

5.2.5 Degenerative diseases

Although lesions indicative of degenerative disease, either caused by disease or stress exerted on certain bones or joints, are not fatal, or nearly as serious as the afore-mentioned pathological conditions, the incidence of these lesions provides us with general information regarding the population. Since this population most likely came from hospitals, serious trauma and pathology can be expected. Lesions such as Schmorl's nodes, osteoarthritis, myositis ossificans acuta and enthesopathies, on the other hand, are not related to illnesses in need of hospitalization and therefore they are more representative of the population as a whole.

Before discussing the high incidence of stress markers within the Gladstone population, it is necessary to briefly describe the activities related to mining. In the early years of the mine, when claims were still privately owned, a pick, spade, wheelbarrow and sieve were needed to extract the diamonds from the ground. But with the amalgamation of the claims into a company and the deepening of the quarry, slight changes in the mining procedure came along. A single claim was worked by at least 18 black labourers and one supervisor (Harries, 1994). Two individuals were responsible for loosening the diamondiferous ground using a pick and shovel, two others filled the buckets and four individuals were responsible for working the windlass, which hoisted the buckets out of the quarry via a wire rope roadway. Once the ground was outside the quarry, it was carted to the depositing floor by two labourers, where it was left in the sun for several months. Here, at least 10 individuals were responsible for breaking up and sifting the ground (Turrell, 1987; Harries, 1994). In later years, steam engines and tramlines were used to increase productivity, along with the underground mining that had started. Although this increased the amount of ground removed from the mine, workers were still subjected to intense physical labour (Turrell, 1987).

The incidence of Schmorl's nodes (24.7%) in the Gladstone population is extremely high, taking their age distribution into consideration, with the majority of individuals being young adults. The high incidence of these lesions in this population can most likely be ascribed to regular participation in strenuous physical activities, as was also the case in the Koffiefontein population. Individuals from Koffiefontein also came from mining compounds and the majority of these individuals were also young persons. Schmorl's nodes were observed in 13.9% of the population (L'Abbé et al., 2003). When comparing the prevalence of Schmorl's nodes in these two populations to the incidence of this condition in other populations such as the Venda, where 2.6% of the population was affected, it is evident that these populations were exposed to more physical stress.

Taking the age distribution of the Gladstone population into account, it is obvious that factors other than the usual degeneration patterns related to aging had an influence on the degenerative changes observed on the skeletons. The pattern of arthritic changes in the Gladstone population is comparable to that of the Koffiefontein sample. A relatively high incidence of arthritic changes were observed in both of these mining communities composed of generally young individuals. It should be mentioned that arthritic changes in the appendicular skeleton of the Gladstone population was higher than what was observed in Koffiefontein, but slightly less vertebral osteophytes were visible.

The majority of arthritic changes observed in the Gladstone population were in individuals older than 35 years of age. Yet, the incidence of these lesions was higher than what was observed in the Toutswe and Venda communities (L'Abbé, 2004; Mosothwane, 2004). Although the results obtained in the Gladstone population were comparable to that observed by Morris (1984) in the Riet River, Kakamas and Griqua populations, the sample sizes of these groups were most likely too small to be representative of the population as a whole. The reason for the high incidence of arthritic changes in the Gladstone population can most likely be associated with regular physical work, although normal degenerative changes due to aging should not be excluded.

It was shown that no significant difference in enthesophyte development existed between the left and the right sides. This is expected when examining the lower extremities, since legs normally do equal work during locomotion. In general, around 95% of people are right-handed in the modern population, and it is thus expected that the incidence of enthesopathies will be higher on this extremity. The absence of a difference in the frequency of spurs thus indicates that the individuals participated in labour where both arms were participating equally (al-Oumaoui et al., 2004).

Enthesophytes present on the upper limbs as well as other arthritic changes of the acromioclavicular joint and cortical defects at insertion of the sternoclavicular ligament on the clavicle, suggest that these joints and muscles were strained. Such changes were noticed in 7.9% of the Gladstone population. Typical activities associated with these changes are stress due to carrying and lifting heavy loads, elevation of the arms and digging, as was recorded in archival documents to be associated with diamond mining in Kimberley (Kennedy, 1989; Lai & Lovell, 1992). Evidence of cortical defects in the lower limbs has also been linked to pronounced muscular exertion in other population groups, such as soldiers who fought in the British-American war (Lai & Lovell, 1992).

The high incidence of enthesopathy development between the distal ends of the tibia and fibula is most likely due to constant strain on the interosseous membrane. It is hypothesized that stress can be exerted on this part of the skeleton by regular and continuous walking on uneven ground, causing constant eversion and inversion of the feet. Working on uneven territory, such as can be expected during mining activities in Kimberley, may accordingly be responsible for these lesions.

Authors such as Jurmain (1990) express an opinion that no conclusions regarding specific habitual or occupational activities in a population can be made through the study of musculoskeletal markers within the population. He states that this may even prove impossible in cases where historic records of activities are available. Although the identification of habitual activities and occupation cannot always be identified through the analyses of stress markers, some general conclusions might be made (Larsen, 1997a): the relatively high incidence of enthesopathies indicate regular participation in strenuous physical activities most likely associated with mining, since the majority of Black individuals in Kimberley during the late 19th Century were employed by the mine.

5.2.6 Non-specific indicators of pathology

The high incidence of non-specific periostitis in this population (18.7% of individuals investigated) was comparable to the incidence of these lesions seen in the Koffiefontein as well as Maroelabult populations. This is significant, taking into consideration that both these groups were exposed to high levels of physical activity in conjunction with poor living conditions and malnutrition (Steyn et al., 2002; L'Abbé et al., 2003).

Non-specific periostitis can result from a high pathogen load in the environment and trauma or regular participation in strenuous labour (Steyn et al., 2002). As was shown in the Koffiefontein and Maroelabult populations, the Gladstone population was most likely exposed to high levels of stress in the form of strenuous work, malnutrition and a high pathogen load.

The incidence of cribra orbilatia in the Gladstone population (11% of individuals with orbits) was much lower than the frequency of this condition observed in K2 (33.3% of individuals) and Oakhurst (20% of individuals), although these differences were not statistically significant. The difference between these populations compared to the Gladstone sample can most likely be ascribed to the small sample size of adult orbits that was available for investigation in both the K2 and Oakhurst populations. The high incidence of cribra orbitalia in the Oakhurst sample was also ascribed to the presence of fish-borne parasites, which resulted in a hymolytic anaemia in those affected by it (Patrick, 1989).

It should be kept in mind that cribra orbitalia normally develop during childhood due to the ability of bone to rapidly remodel and change its overall form. (Steinbock, 1976; Mann & Murphy, 1990; Fairgrieve & Molto, 2000). Therefore, the incidence of cribra in this population should be interpreted with caution. Three possible reasons for the criba orbitalia in this population can be given: firstly, the lesions may be the remnants of a childhood condition

, and are therefore not representative of conditions (nutritional resources and pathogen load) around Kimberley in the time these individuals were working there, since this is a migrant working population. It does indicate, though, that the majority of individuals within the Gladstone population came from population groups that were relatively well adapted to their environment and where the pathogen load was relatively low (Larsen, 1997; Wapler et al., 2004).

Secondly, should it be possible for cribra orbitalia to develop in adults, a high incidence of infectious diseases and parasites, such as the ankylostomiasis worm, which started causing anaemia in individuals once underground mining commenced, could be the reason for cribra orbitalia in this population (Harries, 1994). And lastly, although malaria is not endemic to Kimberley, some of the labourers may have come from an area where the disease occurs and may accordingly be responsible for the lesions.

5.3 PALAEOHISTOPATHOLOGY

According to Schultz (2003), pathological conditions affecting bone can be distinguished from each other on the basis of their morphology on microscopic level (Von Hunnius et al., 2006). According to Schultz (2001), diseases such as non-specific osteomyelitis, leprosy and treponemal disease, have identifiable characteristics on microscopic level, making differentiation between these conditions more reliable (Schultz, 2001; Schultz, 2003; Von Hunnius et al,. 2006). Earlier studies, such as those by Martin (1979) and Putschar (1966), however, suggest that bone can only react in only two ways. According to this argument, two types of cells are responsible for the morphological structure of bone on microscopic level: osteoblasts and osteoclasts. The first is responsible for the formation of new bone, and the second for the resorption of bone (Putschar, 1966; Martin & Armelagos, 1979). Remodelling of bone, be it due to a normal or pathological stimulus, is accordingly controlled by the relationship between the osteoblasts and the osteoclasts, one causing the deposition of bone and the other the resorption. Thus, according to Martin and Amelagos (1979), bone can only react in one of two ways and special histomorphological features for each disease are not present.

Results obtained in this study agree with the second standpoint, in the fact that the distinction between specific diseases, such as non-specific osteomyelitis and treponematosis, can not be made solely on the basis of histomorphological investigations. It was, however, found that broad distinctions, such as distinguishing between lesions caused by haemorrhagic bone reactions and lesions due to infectious disease, could be done through histological investigations.

In this study, the diagnosis of ossified haematoma, most likely related to scurvy and lesions caused by treponematosis on the anterior surface of the tibia, was done on macroscopic level. Although other conditions can also cause such lesions to form, archival documents support the presence of these two conditions in the Kimberley population. It was reported in archival documents that syphilis spread like wildfire amongst the African labourers and that several workers died annually due to scurvy.

When considering the two diseases investigated in this histological analysis, being ossified haematomas due to scurvy and treponemal infection, it is clear that they are in two very different categories of diseases. Individuals suffering from scurvy often develop subperiosteal haematomas on their weight-bearing bones, especially the tibiae (Murray & Kodicek, 1949; Auferheide & Rodriguez-Martin, 1998; Maat, 2004). The details regarding this condition can be seen in the section on scurvy. What is important to notice though, is that the lesions developing due to the haemorrhagic reaction occur due to the calcification of the haematoma on top of the original bone surface. It therefore only involves the haematoma and the underlying bone is not affected. This is exactly what can be seen on microscopic level. The original cortical bone as well as the external circumferential lamellae are unaffected by the condition. The only indication of pathology in sections made from ossified haematomas is the appositional bone on top of the original periosteal surface.

Ossified haematoma formation induced by scurvy was well described in guinea pigs by Murray (1949) in a study on mid-diaphyseal thickenings of the tibia. Although this is an animal study, it is very valuable, since it describes changes occurring during the ossification of a haematoma. According to this study, once the animals recovered from the scorbutic state, the appositional bone, which had a radiating trabecular structure, was remodelled into compact bone while still retaining radiating characteristics. Thus, once normal levels of vitamin C were restored, the density of the appositional bone increased (Murray & Kodicek, 1949).

Results obtained during the investigation of pathological lesions from the Kimberley population showed that the same pattern of trabeculae formation. remodelling of the appositional bone by filling in the openings between the trabeculae as was observed in animals, can be seen in humans. Three stages of ossified haematoma formation and remodelling was accordingly proposed.

In phase I, the bony trabeculae radiate from the original periosteal surface to the periosteum. The original cortical bone as well as the external circumferential lamellae is still intact and unaffected by the pathological process. Looking at a cross-section with the naked eye, the appositional bone will seem extremely porous and clearly visible. This phase is present during the early stages of ossification of a haematoma and shortly after the restoration of normal levels of vitamin C in the diet.

Phase II can be recognized by the filling in of the openings between the trabeculae. The original cortical bone, circumferential lamellae and appositional bone will still be clearly distinguishable from each other. Although the appositional bone will now have a compact bone structure, it will still retain its radiating architecture and will seem like a relatively homogenous mass of bone on top of the external circumferential lamellae. In addition, horizontal plates of bony lamellae interconnect the radiating structure, giving it a 'polster'-pillow-like appearance. This phase characterizes the early stages of remodelling of an ossified haematoma after normal levels of vitamin C have been restored in the diet.

In phase III, extensive remodelling of the appositional bone can be observed. The relatively homogenous structure observed in phase II, has been replaced by the scattered formation of Haversian systems in the appositional bone. The external circumferential lamellae, which represented the original periosteal surface in the previous two phases, are interrupted and often not visible. Regardless of the extensive remodelling, the radiating structure of the appositional bone will still be visible under polarized light. In addition, horizontal plates of bony lamellae interconnect the radiating structure, giving it a 'polster'-pillow-like appearance. This phase is characteristic of very longstanding ossified haematomas; the older the haematoma, the more extensive the remodelling of the appositional bone.

Although haemorrhagic bone reactions have been described by Schultz (2001) and Maat (2004), this is the first study, to our knowledge, describing the various stages of bone remodelling that can be observed in an ossified haematoma in humans.

As described in the literature review, Schultz (2003) identified certain histological structures termed "grenzstreifen" and "polsters" respectively as “useful indicator[s] with which to diagnose chronic treponematoses by microscopy" (Schultz, 2003: 92). These structures could not be identified in the section taken from the tibia of an individual affected by treponemal disease. Several reasons for the absence of these structures are proposed.

Firstly, the section (Figure 4.40) was slightly infested with a fungus making the visualization of the morphological structures difficult. It also limited the use of polarized light, which would have made visualization of the original circumferential lamellae easier and more reliable, should it be present. Secondly, it is possible that these structures simply weren't present in the specific part of the lesion from which the section was taken. In a study conducted by Von Hunnius et al. (2006) on the histological identification of syphilis, it was found that the structures described by Schultz (2003) are extremely variable in shape. Another important observation was that the "polsters" and "grenzstreifen" were found to be very localized, accordingly making positive diagnoses by using the presence of these features highly dependant on the part of the section investigated (Von Hunnius et al., 2006). Lastly, these structures might not be exclusively associated with treponematosis. As already mentioned by Schultz (2003), these characteristic structures are also visible in lesions caused by leprosy and haematogenous osteomyelitis. Features very suggestive of the described features were also noted in the sections made from lesions caused by ossified haematomas in this study. It could also be that the structures described by Schultz (2003) merely represent the usual and regular circumferential lamellae remaining due to cortical remodelling with advancing age (Maat et al., 2003). Various stages of bone remodelling associated with age is clearly described by Maat et al. (2003) in an atlas showing the stepwise remodelling of bone by age.

Results obtained in this study are supportive of the latter view. Microscopic investigations of lesions that developed due to treponemal disease, revealed that the section was extremely porous with huge resorption holes scattered throughout the sample. No clear distinction could be made between the original internal trabeculae and the cortical bone due to the porous nature of the section. Although the section was clearly enlarged on cross-section, no original periosteal surface or new appositional bone could be identified; only general osteoclastic resorption (lysis).

It is proposed that a similar histological picture will be observed in samples taken from lesions caused by haematogenous osteomyelitis, treponematosis and leprosy, since the development of the osteomyelitic process is characteristic in all of these diseases (Blondiaux et al., 1994; Ortner, 2003). According to Blondiaux et al. (1994), bone affected by leprosy presented with a large amount of osteoclastic lacunae, giving the bone a porous appearance. Little to no normal Haversian bone was observed (Blondiaux et al., 1994).

This picture is very similar to that seen in the treponemal lesions from Kimberley and it is therefore proposed that infectious changes in bone are most likely very similar on histological level, regardless of the specific condition that caused the osteomyelitis. It is therefore proposed that osteomyelitis in general can be identified through microscopic investigation of the lesion. It is only in conjunction with macroscopic investigation and a clear description of the distribution pattern of the lesions across the skeleton that the osteomyelitis can be attributed to specific infectious diseases such as treponematosis and leprosy.

Four individuals in this study presented with a histological picture indicative of more than one pathological condition. It emphasises the importance of differential diagnoses of lesions observed during macroscopic investigations.

It was interesting to note that, in three cases, an incorrect diagnosis of the presence of disease was made, based on gross morphological analysis. Striations were observed on these bones. Histological sections indicated no pathological changes to the structure of the bone, suggesting that these tibiae were, in fact, normal. This has far-reaching implications for palaeopathological studies, since it may be possible that pathological conditions are over-diagnosed. This observation needs to be followed up in future studies.

Fungus had infested most of the histological sections studied. This can be expected in archaeological remains. Although the fungus make visualization of haversian systems extremely difficult, it does not destroy the general histomorphological picture of the section when viewed on low magnification, and diagnostic features can still be identified.

Although specific pathological conditions can most likely not be diagnosed based purely on histological observations, the technique is clearly valuable when used in association with macroscopic investigations and other available methods.

5.4 DENTAL HEALTH

5.4.1 Dental Caries

Results obtained for the caries intensity within the Gladstone population was compared to various other South African populations, such as the Riet River, Kakamas, Griqua, Mapungubwe and Venda populations (Table 3.27). It was seen here that the caries intensity of the Gladstone population is much higher than those found among hunter-gatherer populations.

The higher caries intensity in the Gladstone population when compared to groups known to have had a hunter-gatherer lifestyle, such as the Riet River, Kakamas and Oakhurst populations, can be expected. Only a small proportion of the hunter-gatherer diet consists of sugars and carbohydrates, therefore these individuals have an extremely low caries intensity (Klaysky & Klatell, 1943; Morris, 1992). Turner (1979) indicates that approximately 1.6% of teeth are carious in hunter-gatherer populations, compared to an average of 10.4% of teeth presenting with carious lesions in populations who rely mainly on agricultural products.

When looking at archival documentation of diets for the Black population in Kimberley around the end of the 19th Century, it is clear that these individual did not have a hunter-gatherer diet. They were confined to the compounds and their diet was composed of maize meal and occasionally coarse meat (Harries, 1994).

It was shown in Table 3.27 that the incidence of carious lesions in the Gladstone population is not significantly different to the Riet River population, although this group is known to have had a hunter-gatherer lifestyle. The extremely high caries intensity for the Riet River population can be explained as follows: the Riet River population was hunter-gatherers and pastoralists, as was supported by their dental wear (Morris, 1992). The high incidence of carious lesions within this population in comparison with other hunter-gatherer groups is due to the chemical content of their drinking water. The low fluoride concentrations in the drinking water made the teeth of the Riet River population more susceptible to carious activity, and consequently resulted in a high number of carious lesions in this population (Morris, 1992).

Results obtained for the intensity of carious lesions was shown to be comparable to those of the Griqua population as well as the Maroelabult sample (Table 3.27). The incidence of dental caries in both the abovementioned populations as well as the Gladstone sample suggests a diet high in carbohydrates, most likely consisting of a diet dominated by agricultural products and refined foods such as maize meal (Morris, 1992; Steyn et al., 2002).

It may be suggested that the prevalence of carious lesions is rather low for a carbohydrate rich diet. This can possibly be explained by the young age of most individuals within this sample, as well as the fluoride levels in the drinking water. Investigations showed that the fluoride concentrations of naturally occurring water in and around Kimberley are between 0.1 mg/l and 0.9 mg/l. These are within the optimal concentration levels to aid in the prevention of carious lesions (Silverstone et al., 1981). It should however be considered that most individuals within this sample did most likely not originate from Kimberley, and therefore they might not have been exposed to optimal levels of fluoride in their drinking water. The young age of the sample is therefore a more plausible explanation for the low caries rate. It has been shown that high levels of dental attrition can also be associated with a low incidence of dental caries (Maat & Van der Velde, 1987). This relationship between caries and attrition could however not be confirmed by this study, since all individuals in this sample were still young and attrition was minimal.

The method applied to compute the corrected caries rate functions on the assumption that all teeth lost antemortem were due to the effects of either dental caries or dental wear (Lukacs, 1995). This is not the only precursors for antemortem tooth loss. Factors such as extraction of teeth for cultural purposes and group affiliation, dental trauma, secondary eruption due to high attrition levels and periodontal disease should also be considered (Lukacs, 1995; Hillson, 1998; Morris, 2003; Ortner, 2003). Although the majority of the afore-mentioned factors associated with antemortem tooth loss (AMTL) were not observed within this population, it should be considered before applying this method to other samples. It should also be mentioned that determining which of the above-mentioned causes were responsible for antemortem tooth loss is extremely difficult, if not impossible, and therefore the decision by Lukacs (1995) to only evaluate dental caries and attrition as a reason for AMTL is considered reasonable (Duyar & Erdal, 2003). As was seen in the study done by Lukacs (1995) on the Harappa population, an increase of the caries intensity was observed with the calculation of the corrected caries rate. The caries intensity doubled in the Harappa sample (from 6.8% to 12.1%). Only a small increase in intensity was observed in this study (from 4.31% to 6.13%). The reason for only this slight increase can most likely be associated with the relatively low intensity of teeth lost antemortem (2.34%). It is obvious that with a low intensity of antemortem tooth loss, the teeth present will be well representative of the intensity of carious lesions within the population.

The first permanent molar is known to be the tooth mostly affected by the formation of carious lesions in population with a diet mainly consisting of refined carbohydrates and sugar (Henneberg, 1991). Generally, it can be said that molars are the most affected, followed by premolars, incisors and lastly canines (Hillson, 1998; Henneberg, 1991). The same distribution of carious lesions was observed in this study. In general, posterior teeth (molars and premolars) were significantly more affected by carious lesions than anterior teeth (incisors and canines). This can most probably be explained by the differences in morphology of the teeth, with posterior teeth having more fissures and crevices for plaque to adhere to and also having restricted salivary flow (Bonfigliolo et al., 2003). In cases of severe dental attrition, though, the distribution of carious lesions will be different, since severe dental wear on molar teeth will remove the fissures and crevices from the molar teeth, making it difficult for plaque to adhere to the teeth (Maat & Van der Velde, 1987).

The highest incidence of carious lesions was found on the second molar, and not on the first molar as described by Henneberg (1991). It is important to keep the antemortem loss of teeth in mind. The antemortem loss of the first molar was observed most frequently in this study. As explained earlier, the antemortem loss of teeth causes an underestimation of the caries intensity. Therefore, the high incidence of antemortem loss of the first molar is most likely responsible for the discrepancy.

In modern diets, carious lesions are also mostly present on the occlusal surfaces of teeth, followed by the interdental surfaces. Buccal and lingual lesions, such as seen in Figure 3.34, are fairly uncommon (Hillson, 1998b), in contrast to populations with a high attrition diet, where buccal and lingual lesions will be more prevalent (Maat & Van der Velde, 1987). Results suggesting a modern diet were obtained in this study, with the occlusal and interdental surfaces of the teeth being most affected. This pattern most likely develops due to the complicated morphology of the occlusal surfaces of molar teeth, making them more susceptible to carious activity than the buccal or lingual aspects. Restricted salivary flow between adjacent teeth is responsible for the higher incidence of carious lesions interproximally than on the buccal or lingual aspects of the teeth (Bonfigliolo et al., 2003).

5.4.2 Antemortem tooth loss

Large carious lesions, severe periodontal disease, advanced dental attrition and trauma are usually responsible for the antemortem loss of teeth (Bonfigliolo et al., 2003). In this study population, the antemortem loss of teeth can most probably be largely ascribed to carious activity.

Due to the young age of the individuals within this sample and the regular consumption of refined carbohydrates, as indicated by archival documents, very little dental attrition was observed, and it can therefore most likely be excluded as a reason for AMTL. Although periodontal disease was observed within this population, it was in its initial stages of development in most cases and could not have been the main cause for the antemortem loss of teeth.

A study by Lukacs (1992) showed that the antemortem loss due to dental caries mostly affects molars, with anterior teeth such as incisors and canines being seldom affected. An opposite pattern of tooth loss, on the other hand, is observed in cases where teeth are willingly extracted for decorative or ritualistic purposes. When extractions were done for cosmetic purposes, the antemortem loss of anterior teeth is most often seen, since these teeth are the ones that are visible (Morris, 1998). The pattern of antemortem tooth loss within this population, with posterior teeth being more affected than anterior teeth, therefore supports a hypothesis of antemortem tooth loss related to carious lesions. It is suggested that teeth were most likely not willingly extracted for decorative purposes, since the prevalence of AMTL of anterior teeth would have been higher. Nevertheless, the loss of incisors and canines within this population may be due to dental mutilation (Morris, 1989).

It has been shown that carious lesions most often affect the first molar. This is probably because this is the first permanent molar to erupt and it is thus more exposed to cariogenic factors than the other molars (Henneberg, 1991; Steyn, 1994). Therefore, results indicating most frequent loss of M1 in this study are possibly indicative of tooth extraction, following dental caries, to alleviate pain. A second explanation is that since M1 is the first molar to erupt, it is obviously exposed to carciogenic factors for longer than the other teeth and avulsion might have occurred naturally due to severe carious activity.

Although dental trauma cannot be excluded as a reason for AMTL within this population, it can be said that it did not have a significant influence. Anterior teeth are most often affected by trauma and, as can be seen in Table 3.29, the majority of teeth lost antemortem in this population were posterior teeth, with only a few anterior teeth being affected. It is generally accepted that the frequency of AMTL increases with age (Morris, 1992; Hillson, 1998a; L'Abbé, 2004). Unfortunately, this could not be assessed in this study, due to the poor sample distribution.

When assessing the prevalence of antemortem tooth loss in other South African populations, it was observed that the Venda and Riet River populations were significantly more affected by the condition than the Gladstone population. The high incidence of antemortem tooth loss in the Riet River population can most likely be ascribed to the low fluoride level in drinking water, which was also discussed in the section on dental caries, resulting in poor dental health (Morris, 1992). The unusually high incidence of AMTL among the Venda was ascribed to degenerative dental changes, wilful extraction and dental mutilation (L'Abbé, 2004). The lower incidence of AMTL in the younger age groups of the Kakamas population, when compared to the Gladstone population, can most likely be explained by the pure hunter-gatherer diet followed by this population (Morris, 1992).

In conclusion, it can thus be said that the antemortem loss of teeth in the Gladstone population can most probably be associated with the destruction of teeth due to carious lesions, periodontal disease associated with poor dental health and scurvy, and dental trauma. No pattern suggesting dental mutilation was observed in this population. It is therefore suggested that individuals within this sample possibly came from within South Africa, since dental mutilation is a common practice in other African populations

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5.4.3 Enamel hypoplasia

Infectious diseases such as syphilis and tuberculosis, as well as metabolic and endocrine disorders, are known to affect the formation of dental tissue. The presence of enamel hypoplasia is evidence of the disturbance of amelogenesis (enamel formation) during childhood (Ortner, 2003).

It was noted that the prevalence of enamel hypoplasia is lower than 10% in populations with good living conditions in developed countries. This frequency is higher in disadvantaged populations experiencing malnutrition and disease (Obertova, 2005). Taking all of the above-mentioned into account, it can be said that the frequency of enamel hypoplasia within this population (15.5%) indicates exposure to a high level of childhood sickness.

When assessing the incidence of EH in relation to other South African populations, such as those seen in Table 3.33, it can be seen that it is comparable to the frequency of EH found in Maroelabult (18.7%) and Venda (13.3%). The incidence of EH in all three these populations are fairly low when compared to the frequency of the defect in other populations, such as the prehistoric population of K2 and mineworkers in Koffiefontein (Steyn et al., 2002; L'Abbé et al., 2003).

The general health of the 20th Century Venda and Maroelabult samples has been discussed in Chapter 2. Although the incidence of EH in the abovementioned populations as well as the Gladstone sample is slightly higher that the 10% proposed by Obertova (2005), it can be said that both these groups had a comparatively low prevalence of enamel hypoplasia, suggesting relatively good adaptation to the environment and nutrition during the early years of development (Steyn et al., 2002; L'Abbé, 2004).

Since various causes for this defect exists, it can be said that these lesions are non-specific indicators of a metabolic or nutritional disruption during childhood (Obertova, 2005; Steyn et al., 2002). The conclusion can thus be made that although childhood disease was present within the Gladstone population, living conditions and nutritional resources were sufficient to cope with it during their youth.

It should be considered that individuals within this sample population were migrant workers, and more than likely did not come from Kimberley. The prevalence of enamel hypoplasia is therefore not an indication of the pathogen load and nutritional resources in Kimberley, but rather the various places these individuals came from. As described earlier in Chapter 1, the conditions in Kimberley during the late 19th Century were somewhat different. Infectious diseases were numerous, nutritional resources were hard to come by and the infant mortality rate was extremely high. It can be hypothesized that children developing in these conditions will have a much higher prevalence of enamel hypoplasia. Unfortunately no children were available in the sample to confirm this notion.

5.4.4 Dental calculus

It is known that the incidence of dental calculus increases with age. Since the majority of individuals in this sample were below 40 years of age, it can be suggested that the relative low incidence is due to the poor age distribution in the sample population. It should also be considered that some amount of dental hygiene might have been practiced.

It should be kept in mind, however, that the frequency of dental calculus present in archaeological samples is often underestimated. The deposits can easily disappear due to taphonomic agents or excavation and cleaning methods (Bonfigliolo et al., 2003).

5.4.5 Periodontal disease and periapical abscesses

It is apparent that the oral hygiene of the individuals in the study population was very poor. The high incidence of periodontal disease and periapical abscesses also supports the hypothesis that this population had a diet consisting mainly of carbohydrates. Very little dental wear was observed in this population, and the majority of periapical abscesses formed as a result of periodontal disease and advanced stages of dental caries.

The association between scurvy and periodontal disease should also be discussed. During the Siege of Kimberley in the second Anglo-Boer War, scurvy was a huge problem, mainly among the black people. During the last six weeks of 1899, 52 individuals died due to scurvy. During the last three months of the siege, there were 1 500 known cases of scurvy, of which 483 were fatal. Therefore, the high incidence of periodontal disease within this population may be due to the presence of scurvy.

5.4.6 Supernumerary teeth

The condition of hyperdontia seems to be due to a complex combination of hereditary factors and developmental processes influenced by the environment (Proff et al., 2006). A total of 5.5% of the Gladstone population presented with one or more extra teeth. It is likely that the high incidence of supernumerary teeth in this population indicates that some of the individuals were genetically related.

5.4.7 Pipesmoker's wear

Although the presence of these lesions is not of any clinical importance, they do indicate that pipes were commonly used in Kimberley during the late 19th Century. It has been suggested that habitual pipe smokers tend to keep the pipe in the exact same place in their mouth when smoking, eventually causing dental wear of the teeth it touches (Morris, 1984). Wear often almost identically matches the diameter of the pipe stem. An individual presenting with pipe smoker's wear was noted by Peckmann (2002) in the Danielskuil population. Another case includes the Abrahamsdam specimen described by Morris (1984).

The elliptical shape of the dental wear (Figure 3.44) resembles the cross-section of the mouth piece attached to briar pipes, commonly manufactured after the 1870's (Dunhill, 1969; Morris, 1984). It is suggested though that the briar pipes were very expensive and clay pipes, with circular stems, were most probably still commonly used.

It should also be considered that regular pipesmoking can result in the formation of dental calculus and eventually periodontal disease (Van Reenen, 1954). Therefore, the relatively high incidence of dental calculus and periodontal disease within this population may also be the result of a common pipe smoking habit.

CHAPTER 6

CONCLUSION

1. Skeletal remains excavated from Gladstone cemetery in Kimberley were most likely those of migrant mine workers. This was indicated by the high incidence of male individuals in the sample as well as the population age distribution, with the majority of individuals being young adults. This was supported by archival reports indicating that "native" individuals flooded to Kimberley during the late 19th Century in search of work (Stoney, 1900a). Therefore, although the sex distribution within this skeletal sample does not represent a normal population distribution, it is most likely representative of the migrant working population present in Kimberley at the end of the 19th century.

2. Investigated individuals were most likely of low socio-economic status, malnourished, and exposed to a high pathogen load. The low socio-economic status of these individuals was clearly illustrated by their burial positions, with the majority of persons being laid to rest without coffins in graves containing more than one individual.

3. A high incidence of skeletal lesions suggestive of malnourishment, such as scurvy, was observed in this population. It is proposed that skeletal lesions of ossified haematomas on the anterior surface of the tibia developed due to vitamin C deficiency. A high incidence of scurvy can be expected in a population following a diet consisting mainly of maize meal and occasional course meat, which was the only food supplied by the employers (Harries, 1994). The documented regular consumption of homemade beer and alcohol most likely also had an influence on the high incidence of scurvy within this population. The harsh climate also contributed to the lack of fresh fruit and vegetables.

4. The relatively low prevalence of cribra orbitalia and enamel hypoplasia, conditions that normally develop in children, is not representative of the conditions (nutritional resources and pathogen load) in Kimberley during the late 19th century, since this is a migrant working population. It does indicate, however, that the majority of individuals within the Gladstone population came from population groups that were relatively well adapted to their

environment and where the pathogen load was relatively low (Larsen, 1997b; Wapler, Crubezy & Schultz, 2004).

5. The high incidence of myositis ossificans acuta, spondylolysis, Schmorl's nodes, degenerative changes and enthesopathy formations observed in young individuals indicate regular participation in strenuous physical activities.. Since these lesions are not in need of hospitalization, they are more representative of the population and their daily physical demands as a whole.

6. A high incidence of infectious diseases, with specific reference to treponemal disease, was observed. Other infectious diseases observed in the Kimberley remains included advanced, non-specific osteomyelitis as well as a possible case of tuberculosis.

This was a pre-antibiotic era, and coupled with the overcrowded, unhygienic living conditions, were clearly the reason why these diseases flourished in Kimberley during the late 19^{th} century. Gender composition of the population in Kimberley, characterized by the male majority and only a few female individuals, can be considered to have encouraged the spread of venereal diseases.

7. Very high incidences of cranial fractures within this population are suggestive of high levels of interpersonal violence (Jurmain & Bellifemine, 1997; Standen & Arriaza, 2000). Cultural differences amongst migrant workers, competition for resources, few females, regular overindulgence in alcohol, skirmishes over theft and illegal selling of diamonds, as well as friction regarding the amount of work done per day, all most likely contributed to the occurrence of violent events within and amongst labourers and their employers (Harries, 1994; Turrell, 1987).

8. The incidence of fractures of long bones, and possibly some of the cranial fractures, was representative of the high-risk environment these individuals worked in. The presence of well-healed and reduced fractures and amputation within this population indicates that some medical care was available to these individuals.

9. The incidence of dental caries suggests a diet high in carbohydrates, most likely dominated by agricultural products and refined foods such as maize meal. Although it may be suggested that the prevalence of carious lesions is rather low for a carbohydrate rich diet, the

young age of individuals within this population as well as the fluoride levels in the drinking water may be responsible. Antemortem loss of teeth can most probably be associated with the destruction of teeth due to carious lesions, periodontal disease associated with poor dental health and scurvy, and dental trauma. No pattern suggesting dental mutilation was observed in this population.

In general, the high incidence if periodontal disease and periapical abscesses observed in this study suggested poor oral hygiene. Very little dental wear was observed, and the majority of periapical abscesses formed as a result of periodontal disease and advanced stages of dental caries.

A high incidence of hyperdontia suggesting possible familial affiliation between the individuals in the sample and pipesmoker's wear was also noted.

10. Histological investigations of bone samples taken from lesions diagnosed as ossified haematomas and possible lesions due to treponemal infection indicated that distinctions between specific diseases, such as non-specific osteomyelitis and treponematosis, cannot be made solely on the basis of histomorphological investigations. It was, however, found that broad distinctions such as distinguishing between lesions caused by haemorrhagic bone reactions and lesions due to infectious disease, could be made.

Scurvy could be characterized by unaffected original cortical bone and external circumferential lamellae. The only indication of pathology in sections made from ossified haematomas was the appositional bone on top of the original periosteal surface.

Three phases of ossified haematoma formation and remodelling was proposed, with each stage resulting in gradual bone remodelling from radiating trabecular bone to Haversian bone, while still retaining a radiating bone structure.

Histological features such as the "grenzstreifen" and "polsters" described by Schultz (2003) could not be identified in the sections thought to be affected by treponematosis, and it was suggested that these structures may not be exclusively associated with treponemal infection. It was proposed that the same histological picture will be observed in samples taken from lesions caused by haematogenous osteomyelitis, treponematosis and leprosy, since thedevelopment of the osteomyelitic process is characteristic to all of these diseases (Blondiaux et al. 1994; Ortner, 2003b).

It was concluded that although specific pathological conditions can most likely not be diagnosed purely based on histological observations, the technique is valuable when used concurrently with macroscopic investigations and other available methodology.

More than 14 million carats of diamonds were extracted from a hole with an outside diameter of 1200 m, approximately 800 m deep, which used to be Colesberg Kopje. It is hoped that this study gave some recognition to those unnamed labourers who unknowingly played a crucial role, not only in the history of our country, but also in the economic growth of South Africa.

References

al-Oumaoui I, Jimenez-Brobeil S, and du Souich P (2004) Markers of activity patterns in some populations of the Iberian Peninsula. *International Journal of Osteoarchaeology* 14: 343-359.

Anderson JR (1985) *Muirs textbook of pathology.* London: Edward Arnold Pty Ltd.

Anderson T (1997) Documentary and artistic evidence for congenital conditions from sixteenth century England. *International Journal of Osteoarchaeology* 7: 625-627.

Angel JL (1964) Osteoporosis: thalassemia? *American Journal of Physical Anthropology* 22: 369-374.

Antal GM, Lukehart SA, and Meheus AZ (2002) The endemic treponematoses. *Microbes and Infection* 4: 83-94.

Ariaze BT (1993) Seronegative spondyloarthropothies and diffuse idiopathic skeletal hyperostosis in ancient Northern Chile. *American Journal of Physical Anthropology* 91: 263-278.

Ariaze BT, Merbs CF, and Rothschild BM (1993) Diffuse idiopathic skeletal hyperostosis in Meroitic Nubians from Semma south, Sudan. *American Journal of Physical Anthropology* 92: 243-248.

Arriaza BT (1997) Spondylolysis in prehistoric human remains from Guam and its possible etiology. *American Journal of Physical Anthropology* 104: 393-397.

Asala SA (2001) Sex determination from the head of the femur of South African whites and blacks. *Forensic Science Internationa.* 117: 15-22.

Asala SA, Bidmos MA and Dayal MR (2004) Discriminant function sexing of fragmentary femur of South African blacks. *Forensic Science Internationa*l 145: 25-29.

Auferheide AC and Rodriguez-Martin C (1998) *The Cambridge Encyclopedia of human paleopathology* Cambridge: Cambridge University Press.

Baarregaard A (1949) Dental conditions and nutrition among natives in Greenland. *Oral Surgery, Oral Medicine, Oral Pathology* 2: 995-1007.

Barber CG (1929) Immediate and eventual features of healing in amputated bones. *Annals of Surgery* 90: 985-992.

Barber CG (1930) The detailed changes characteristic of healing bone in amputation stumps. *Journal of Bone and Joint Surgery* 12: 353-359.

Barnes GW (1895) Divisions of Kimberley. In *Blue book of Native affairs G8*.

Becker MJ (1986) Mandibular symphysis (medial suture) closure in modern *Homo sapiens*: Preliminary evidence from archaeological populations. *American Journal of Physical Anthropology* 69: 499-501.

Bennett KA (1967) Craniostenosis: A review of the etiology and a report of new cases. *American Journal of Physical Anthropology* 27: 1-10.

Berrizbeitia EL (1989) Sex determination with the head of the radius. *Journal of Forensic Sciences* 34(5): 1206-1213.

Bird H (1990) When the body takes the strain. *New Scientist* 7: 385-394.

Blakey ML, Leslie TE and Reidy JP (1994) Frequency and chronological distribution of dental enamel hypoplasia in enslaved African American: A test of the weaning hypothesis. *American Journal of Physical Anthropology* 95: 371-383.

Blondiaux J, Duvette J, Eisenberg L and Vatteoni S (1994) Microradiographs of leprosy from an osteoarchaeological context. *International Journal of Osteoarchaeology* 4: 13-20.

Bonfigliolo B, Brasili P and Belcastro MG (2003) Dento-alveolar lesions and nutritional habits of a Roman imperial age population (1st-4th c.AD):Quadrella (Molise, Italy). *HOMO* 54(1): 36-56.

Booth JR (1929) *The Care of the Sick, Yesterday and Today.* Kimberley: The Diamond fields advertiser. Limited.

Bouwman AS and Brown TA (2005) The limits of biomolecular paleopathology: ancient DNA cannot be used to study venereal syphilis. *Journal of Archaeological Science* 32: 703-713.

Brace CL and Ryan AS (1980) Sexual dimorphism and human tooth size differences. *Journal of Human Evolution* 9: 417-435.

Brickley M and Ives R (2006) Skeletal manifestations of infantile scurvy. *American Journal of Physical Anthropology* 120: 163-172.

Brooks S and Suchey JM (1990) Skeletal age determination based on the os pubis: a comparison of the Acsadi-Nemeskeri and Suchey-Brooks methods. *Journal of Human Evolution* 5(3): 227-238.

Brothwell D (1989) he relationship of tooth wear to ageing. in *Age markers in the human skeleton*, ed. İşcan MY. Springfield: Charles C Thomas.

Brothwell D and Moller-Chritensen V (1963a) A possible case of amputation dated to c.2000 BC. *Man* 58: 192-194.

Brothwell D and Moller-Chritensen V (1963b) Medico-historical aspects of a very early case of mutilation. *Danish Medical Bulletin* 10: 21-25.

Buckley HR (2000) Subadult health and diseases in Prehistoric Tonga, Polynesia. *American Journal of Physical Anthropology* 113: 481-505.

Burrows EH (1958) *A History of medicine in South Africa up to the end of the 19th century*.

Buzon MR (2006) Health of the non-elites at Tombos: Nutritional and disease stress in New Kongdom Nubia. *American Journal of Physical Anthropology* 130: 26-37.

Capasso L (1999) Brucellosis at Herculaneum (79AD). *International Journal of Osteoarchaeology* 9: 277-288.

Cape of Good Hope Votes and Proceedings of Parliament 1893, *Hospitals and Asylums Report for 1892* Appendix I.

Cape of Good Hope Votes and Proceedings of Parliament 1898, *Hospitals and Asylums Report for 1897*.

Cape of Good Hope Votes and Proceedings of Parliament 1885, *Hospitals and Asylums report for the years 1884* G10 Appendix I.

Cape of Good Hope Votes and Proceedings of Parliament 1890, *Hospitals and Asylums Report for 1889* Appendix 1.

Cape of Good Hope Votes and Proceedings of Parliament 1899, *Hospitals and Asylums Report for 1898* Appendix I.

Cape of Good Hope Votes and Proceedings of Parliament 1900, *Hospitals and Asylums Report for 1899* Appendix I.

Cape of Good Hope Votes and Proceedings of Parliament 1901, *Hospitals and Asylums Report for 1900* Appendix I.

Cape of Good Hope Votes and Proceedings of Parliament 1902, *Hospitals and Asylums Report for 1901* Appendix I.

Chapman FH (1972) Vertebral osteophytosis in prehistoric populations of central and southern Mexico. A*merican Journal of Physical Anthropology* 36(1): 31-37.

Churchill SE and Morris AG (1998) Muscle marking morphology and labour intensity in prehistoric Khoisan foragers. *International Journal of Osteoarchaeology* 8:390 - 411.

Cockshott P and MacGregor M (1958) Osteomyelitis variolosa. *Quarterly Journal of Medicine* 27(107): 369-387.

Coetzee HL, Loots GP and Meiring JH (2003) Bone. In *Human Histology*. Pretoria: Van Schaik.

Collins TFB (1982) The history of southern Africa's first tuberculosis epidemic. *South African Medical Journal* 62:780 - 788.

Comstock CP, Carraggee EJ and O'Sullivan GS (1994) Spondylolithesis in the young athlete. *Physician and Sports Medicine* 22(12): 39-46.

Cook GC (1980). T*ropical Gastroenterology*. New York: Oxford University Press.

Crubezy E, Goulet J, Bruzek J, Rouge D and Ludes B (2002) Epidemiology of osteoarthritis and enthesopathies in a European population dating back 7700 years. *Joint Bone Spine* 69: 580-588.

Cucina A. (2002) Brief communication: Diachronic investigation of linear enamel hypoplasia in Prehistoric skeletal samples from Trentino, Italy. *American Journal of Physical Anthropology* 119: 283-287.

Cutress TW and Suckling GW (1982) The assessment of non-carious defects of enamel. *International Dental Journal* 32: 117-122.

Dalinka M.K, Rosenbaum AE and Van Houten F (1972) Congenital absence of the posterior arch of the atlas. *Radiology* 103: 581-583.

Danenberg PJ, Hirsch RS, Clarke NG, Leppard PI and Richards LC (1991) Continuous tooth eruption in Australian Aboriginal skulls. *American Journal of Physical Anthropology* 85: 305-312.

Davies G.N. 1963, "Social customs and habits and their effect on oral disease", *Journal of Dental Research*, vol. 1, pp. 209-232.

Day MH (1975) Sexual differentiation in the innominate bone studied by multivariate analysis. *Annals of Human Biology* 2(2): 143-151.

De Beer Kaufman P (1974) Variation in the number of presacral vertebrae in Bantu-speaking South African Negroes. *American Journal of Physical Anthropology* 40(3): 369-374.

De Luna RH, Judson Colley B, Smith K, Divers SG, Rinehart J and Marques MB (2003) Scurvy: An often forgotten cause of bleeding. *American Journal of Hematology* 73: 85-87.

De Villiers H. (1968) Sexual dimorphism of the skull of the South African Bantu-speaking Negro. *South African Journal of Science* 84: 118-124.

Dean MC, Jones ME and Pilley JR (1992) The natural history of tooth wear, continuous eruption and periodontal disease in wild shot great apes. *Journal of Human Evolution* 22: 23-39.

Debono L, Mafart B, Jeusel E and Guipert G (2004) Is the incidence of elbow osteoarthritis underestimated? Insights from paleopathology. *Joint Bone Spine* 71: 397-400.

Delgado-Darias T., Velasco-Vazquez J., Arnay-de-la-Rosa M., Martin-Rodriguez E., & Gonzalez-Reimers E. 2006, "Calculus, periodontal disease ad tooth decay among the perhistoric population from Gran Canaria", *Journal of Archaeological Science* 33: 663-670.

Dittmar K and Steyn M (2004) Paleoparasitological analysis of coprolites from K2, an Iron age archaeological site in South Africa: the first finding of Dicrocoelium sp. eggs. *Journal of Parasitology* 90: 171-173.

Douglas MT, Pietrusewsky M and Ike-Quebral RM (1997) Skeletal biology of Apurguan: a precontact chomorro site of Guam. *American Journal of Physical Anthropology* 104: 291-313.

Drennan MR (1929) The dentition of a Bushman tribe. *Annals of the South African Museum* 24: 61-87.

Dunhill A (1969) *The pipe book.* London.

Dutour O (1986) Enthesopathies (lesions of muscular insertions) as indicators of the activities of Neolithic Saharan populations. *American Journal of Physical Anthropology* 71: 221-224.

Duyar I and Erdal YS (2003) A new approach for calibrating dental caries frequency of skeletal remains. *HOMO* 54(1): 57-70.

Earl JE (2002) Mechanical aetiology, recognition, and treatment of spondylolithesis. *Physical Therapy in Sport* 3: 79-87.

Eisenstein SM (1978) Spondylolysis: A skeletal investigation of two population groups. *Journal of Bone and Joint Surgery* 60-B(4): 488-494.

El-Najjar MY, DeSanti MV and Ozebek L (1978) Prevalence and possible etiology of dental enamel hypoplasia. *American Journal of Physical Anthropology.* 48: 185-192.

Erdal YS (2006) A pre-columbian case of congenital syphilis from Anatolia (nicaea, 13th century AD). *International Journal of Osteoarchaeology* 16: 16-33.

Erdal YS and Duyar I (1999) Brief communication: A new correction procedure for calibrating dental caries frequency. *American Journal of Physical Anthropology* 108: 237-240.

Fain O (2005) Musculoskeletal manifestations of scurvy. *Joint Bone Spine* 72: 124-128.

Fairgrieve SI and Molto JE (2000) Cribra orbitalia in two temporally disjunct population samples from the Dakhleh Oasis, Egypt. *American Journal of Physical Anthropology* 111: 319-331.

Fazekas IGY and Kosa F (1978) *Forensic fetal osteology.* Akademiai Kiado, Budapest.

Flander LB (1978) Univariate and multivariate methods for sexing the sacrum. *American Journal of Physical Anthropology* 49: 103-110.

Foti B, Lalys L, Adalian P and Guistiniani J (2003) New forensic approach to age determination in children based on tooth eruption. *Forensic Science International* 132: 49-56.

Franklin D, Freedman L and Milne N (2005) Sexual dimorphism and discriminant function sexing in indigenous South African crania. *HOMO* 55: 213-228.

Frayer DW (1980) Sexual dimorphism and cultural evolution in the Late Pleistocene and Holocene of Europe. *Journal of Human Evolution* 9: 399-415.

Garland AN (1993) An introduction to histology of exhumed mineralized tissue. In *Histology of Ancient Human Bone: Methods and Diagnosis*. eds. Grupe G and Garland AN. Berlin: Springer-Verlag.

Garn SM (1992) The iron-deficiency anemias and their skeletal manifestations. In *Diet, Demography and Disease: Changing perspectives and anemia.* New York: Aldine De Gruyter.

Glencross B and Stuart-Macadam P (2000) Childhood trauma in the archaeological record. *International Journal of Osteoarchaeology* 10: 198-209.

Gloobe H and Nathan H (1971) Vertebral osteophytes in rats. *Journal of Comparative Pathology* 81: 575-579.

Goodman AH and Armelagos GJ (1985) Factors affecting the distribution of enamel hypoplasias within the human permanent dentition. *American Journal of Physical Anthropology* 68: 479-493.

Goodman AH and Rose JC (1990) Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. *Yearbook of Physical Anthropology* 33: 59-110.

Gordon H (1959) Craniostenosis. *British Medical Journal.* 5155: 792-795.

Grauer AL and Roberts CA (1996) Paleoepidemiology, healing, and possible treatment of trauma in the medieval cemetery population of St. Helen-on-the -walls, York.England. *American Journal of Physical Anthropology* 100: 531-544.

Gray JP and Wolfe LD (1980) Height and sexual dimorphism of stature among human societies. *American Journal of Physical Anthropology* 53: 441-456.

Greene TR, Kuba CL and Irish JD (2005) Quantifying calculus: A suggested new approach for recording an important indicator of diet and dental health. *HOMO* 56: 119-132.

Grusin H and Samuel E (1957) A syndrome of osteoporosis in Africans and its relationship to scurvy. *Journal of Clinical Nutrition* 5: 644-650.

Haas CJ, Zink A, Molnar E, Szeimies U, Reischl U, Marcsik A, Ardagna Y, Dutour O, Palfi G and Nerlich AG (2000) Molecular evidence of different stages of tuberculosis in ancient bone samples from Hungary. *American Journal of Physical Anthropology* 113: 293-304.

Hackett CJ (1978) Treponematoses (yaws and treponarid) in exhumed Australian Aboriginal bones. *Records of the South Australian Museum* 27: 387-405.

Harries P (1994) *Work, culture and identity. Migrant laborers in Mozambique and South Africa, c 1860 - 1910.* Johannesburg: Witwatersrand University Press.

Henneberg RJ (1991) Dental caries. In *Encyclopedia of Human Biology.* Academic Press.

Henneberg RJ and Henneberg M (1993) Possible occurrence of treponematosis in the ancient Greek colony of Mtaponto, Italy. *American Journal of Physical Anthropology* Suppl 16: 107-108.

Herrmann B (1993) Light microscopy of excavated human bone. In *Histology of ancient human bone: Methods and diagnosis,* eds. Grupe G and Garland AN. Berlin: Springer-Verlag.

Hickey G., Fricker PA and McDonald WA (1997) Injuries in elite rowers over a ten-year period. *Medicine and Science in Sports and Exercise* 29(12): 1567-1572.

Hillson S (1998) *Dental Anthropology,* United Kingdom: Cambridge University Press.

Hillson S and Bond S (1997) The relationship of enamel hypoplasia to the pattern of tooth crown growth: a discussion. *American Journal of Physical Anthropology* 104: 89-103.

Hillson SW (1979) Diet and dental disease. *World Archaeology.* 2(2): 147-162.

Holm AK (1990) Diet and caries in high-risk groups in developed and developing countries. *Diet, Nutrition and Dental Caries* 24(Suppl.1): 44-52.

İşcan MY and Loth SR (1986) Determination of age from the sternal rib in white females: a test of the phase method. *Journal of Forensic Sciences* 31(3): 990-999.

Jacobi KP and Danforth ME (2002) Analysis of interobserver scoring patterns in porotic hyperostosis and cribra orbitalia. *International Journal of Osteoarchaeology* 12: 248-258.

Jankauskas R (2003) The incidence of Diffuse Idiopathic Skeletal Hyperostosis and social status correlation in Lithuanion skeletal remains. *International Journal of Osteoarchaeology* 13: 289-293.

Jochelson K (2001) *The Colour of Diseases, Syphilis and Racism in South Africa 1880 - 1950*. Palgrave, New York.

Johnson RJ (1993) Low back pain in sports. *Physician and Sports Medicine* 21(4): 53-59.

Johnston FE and Zimmer LO (1989) Assessment of growth and age in the immature skeleton. In *Reconstruction of life from the skeleton.* ed. İşcan MY. Alan R. Liss, Inc.

Judd M (2004) Trauma in the city of Kerma: Ancient versus modern injury patterns. *International Journal of Osteoarchaeology* 14: 34-51.

Junqueira LC and Carneiro J (2005) Bone. 11 edn. McGraw-Hill Companies,Inc.

Jurmain R (2001) Palaeoepidemiolgical patterns of trauma in a prehistoric population from central Calafornia. *American Journal of Physical Anthropology* 115: 13-23.

Jurmain R and Bellifemine VI (1997) Patterns of cranial trauma in a prehistoric population from central California. *International Journal of Osteoarchaeology* 7: 43-50.

Jurmain R, Kilgore L, Trevathan W and Nelson H (2003) *Introduction to Physical Anthropology*, 9th edn. Australia: Thomson Wadsworth.

Kemkes-Grottenthaler A, Lobig F and Stock F (2002) Mandibular ramus flexure and gonial eversion as morphological indicators of sex. *HOMO* 52(2): 97-111.

Kennedy KAR (1986) The relationship between auditory exostoses and cold water: a latitudinal analysis. *American Journal of Physical Anthropology* 71: 401-415.

Kennedy KAR (1989) Skeletal markers of occupational stress. In *Reconstruction of Life From the Skeleton.* eds. İşcan MY and Kennedy KAR. New York: John Wiley & Sons Inc.

Kent S, Weinberg ED and Stuart-Macadam P (1994) The etiology of the anemia of chronic disease and infection. *Journal of Clinical Epidemiology* 47(1): 23-33.

Khudabux MR (1991) *Effects of life conditions on the health of a Negro slave community in Suriname.* Ph.D Thesis. Rijksuniversiteit, Leiden.

Kieser JA, Moggi-Cecchi J and Groeneveld HT (1992) Sex allocation of skeletal material by analusis of the proximal tibia. *Forensic Science International* 56: 29-36.

Kilgore L, Jurmain R and Van Gerven D (1997) Palaeoepidemiological patterns of trauma in a medieval Nubian skeletal population. *International Journal of Osteoarchaeology* 7: 103-114.

King T, Hillson S and Humphrey LT (2002) A detailed study of enamel hypoplasia in a post-medieval adolescent of known age and sex. *Archives of Oral Biology* 47: 29-39.

Klaysky M and Klatell JS (1943) Anthropological studies in dental caries. *Journal of Dental Research* 22(4): 267-274.

Kosa F (1989) Age estimation from the fetal skeleton. In *Age markers in the human skeleton.* ed. İşcan MY. Springfield: Charles C Thomas.

Kretsmar N (1973) An introduction to the history of medicine in the Diamond fields of Kimberley, South Africa.

Krogman WM and İşcan MY (1986a) *The human skeleton in forensic medicine*, 2 edn. Springfield, Illinois: Charles C Thomas.

L'Abbé EN, Henderson ZL and Loots M (2003) Uncovering the nineteenth-century typhoid epidemic at the Koffiefontein Mine, South Africa. *World Archaeology* 35(2):306-318.

L'Abbé' EN (2005) *A palaeodemographic, paleopathologic and macrophologic study of the 20th century Venda,* Ph.D. University of Pretoria.

Lai P and Lovell NC (1992) Skeletal markers of occupational stress in the fur trade: a case study from a Hudson's bay company fur trade post. *International Journal of Osteoarchaeology* 2: 221-234.

Lallo J, Armelagos GJ and Mensforth RP (1977) The role of diet, disease and physiology in the origin of porotic hyperostosis. *Human Biology* 49: 471-483.

Larsen CS (1997) *Bioarchaeology. Interpreting behavior from the human skeleton.* United Kingdom: Cambridge University Press.

Leary JG (1891) Divisions of Kimberley. *Blue book on Native affairs G4*.

Ledger M, Holtzhausen L, Constant D and Morris AG (2000) Biomechanical bean analysis of long bones from a Late 18th Century slave cemetery in Cape Town, South Africa. *American Journal of Physical Anthropology* 112:207 - 216.

Lewis B (1994) Treponematosis and Lyme Borreliosis connections: Explanation for Tchefuncte disease syndromes? *American Journal of Physical Anthropology* 93: 455-475.

Lipson SJ and Muir H (1980) Vertebral osteophyte formation in experimental disc degeneration: Morphological and proteoglycan changes over time. *Arthritis and Rheumatism* 23(3): 319-324.

Logan WE and Stuard ID (1973) Absent posterior arch of the atlas. *American Journal of Roentgenology* 118: 431-434.

Loth SR and Henneberg M (1998) Mandibular ramus flexure in a good indicator of sexual dimorphism. *American Journal of Physical Anthropology* 105: 91-92.

Loth SR and Henneberg M (2001) Sexually dimorphic mandibular morphology in the first few years of life. *American Journal of Physical Anthropology* 115: 179-186.

Loth SR and İşcan MY (1989) Morphological assessment of age in the adult: the thoracic region. In *Age markers in the human skeleton*. ed. İşcan MY. Springfield: Charles C Thomas.

Loth SR & İşcan MY (1994) Morphological indicators of skeletal aging: Implications for paleodemography and paleogerontology. In *Biological anthropology and aging: perspectives on human cariation over the life span.* eds. Crews DE and Garruto RM. New York: Oxford University Press.

Loth SR and İşcan MY (2000a) Morphological age estimation. In *Encyclopedia of Forensic Sciences*. eds. Siegel J, Saukko P and Knupfer G. London: Academic Press.

Loth SR and İşcan MY (2000b) Sex determination. In *Encyclopedia of Forensic Sciences*. eds. Siegel J, Saukko P and Knupfer G. London: Academic Press.

Lovejoy CO and Heiple KG (1981) The analysis of fractures in skeletal population with an example from the Libben site, Ottowa Count, Ohio. *American Journal of Physical Anthropology* 55: 529-541.

Lovejoy CO, Meindl RS and Mensforth RP (1985) Multifactorial determination of skeletal age at death: a Method and blind tests of its accuracy. *American Journal of Physical Anthropology* 68: 1-14.

Lovell NC (1997) Trauma analysis in paleopathology. *Yearbook of Physical Anthropology* 40: 139-170.

Lukacs JR (1989) Dental paleopathology: Methods for reconstructing dietary patterns. In *Reconstruction of Life from the Skeleton*, 1st edn. ed. İşcan MY. Alan R.Liss, Inc.

Lukacs JR (1992) Dental paleopathology and agricultural intensification in South Asia: New evidence from the Bronze age Harappa. *American Journal of Physical Anthropology* 87: 133-150.

Lukacs JR (1995) The 'caries correction factor': a new method of calibrating dental caries rates to compensate for antemortem loss of teeth. *International Journal of Osteoarchaeology* 5: 151-156.

Lukacs JR and Nelson GC (2001) Enamel hypoplasia and childhood stress in prehistory: new data from India and Southwest Asia. *Journal of Archaeological Science* 28: 1159-1169.

Lundy JK and Feldesman MR (1987) Revised equations for estimating living stature from the long bones of the South African Negro. *South African Journal of Science* 83: 54-55.

Maat GJR (1982) Scurvy in Dutch whalers buried at Pitsberge. *Proceedings of the Palaeopathology Association 4th European Meeting*.

Maat GJR (2002) History and pathology of a disregarded disease. *Histopathology*. 41: 460-462.

Maat GJR (2004) Scurvy in adults and youngsters: The Dutch experience. A review of the history and pathology of a disregarded disease. *International Journal of Osteoarchaeology* 14: 77-81.

Maat GJR, Aarents MJ and Nagelkerke NJD (2003). *Age prediction from replacement remodeling of circumferential lamellar bone tissue in the anterior cortex of the femoral shaft of the present Dutch population.* Leiden: Barge's Anthropologica.

Maat GJR and Mastwijk RW (2000) Avulsion injuries of vertebral endplates. *International Journal of Osteoarchaeology* 10: 142-152.

Maat GJR, Mastwijk RW and Van der Velde EA (1995) Skeletal distribution of degenerative changes in vertebral osteophytosis, vertebral osteoarthritis and DISH. *International Journal of Osteoarchaeology* 5: 289-298.

Maat GJR, Van den Bos RPM and Aarents MJ (2000) *Manual for the preparation of ground sections for the microscopy of bone tissue.* Leiden: Brage's Anthropologica.

Maat GJR, Van den Eynde G and Mastwijk RW (1997) De eerste Nassaus in Nederland: identificatie van en paleopathologische bevindingen bij de voorpuders van Willem Oranje, begraven in de Grote of Onze Lieve Vrouwe Kerk in Breda. *Ned Tijdschr Geneeskd.* 141(51): 2501-2513.

Maat GJR and Van der Velde EA (1987) The caries-attrition competition. *International Journal of Anthropology* 2(4): 281-292.

Mader JT and Calhoun JH (1989) Long bone osteomyelitis. *Journal of the American Podiatric Medical Association* 79(10): 476-481.

Mann RW and Murphy SP (1990a) *Regional Atlas of Bone Disease, A guide to Pathologic and Normal Variation in the Human Skeleton.* Springfield: Charles C Thomas.

Martin DL and Armelagos GJ (1979) Morphometrics of compact bone: An example from Sudanese Nubia. *American Journal of Physical Anthropology* 51: 571-578.

Masset C (1989) Age estimation on the basis of cranial sutures. In *Age markers in the human skeleton.* ed. İşcan MY. Springfield: Charles C Thomas.

Massler M, Schour I and Poncher H (1941) Developmental pattern of the child as reflected in the calcification pattern of teeth. *American Journal of Diseases of Children* 62: 33-67.

Mayor's Minutes (1888) City of Kimberley.

Mays S (1996) Healed limb amputations in human osteoarchaeology and their causes: a case study from Ipswich, UK. *International Journal of Osteoarchaeology* 6: 101-113.

McDermott JJ and Arimi SM (2002) Brucellosis in sub-Saharan Africa: epidemiology, control and impact. *Veterinary Microbiology* 90: 111-134.

McNish JT (1970) *The Glittering Road*. C.Struik, Cape Town.

Medical officer of Health (1897), *Ibid.*

Medical officer of Health (1900) *Medical Officer of Health reports for 1899 and 1900*.

Meindl RS, Lovejoy CO, Mensforth RP and Don Carlos L (1985) Accuracy and direction of error in the sexing of the skeleton: implications for paleodemography. *American Journal of Physical Anthropology* 68: 79-85.

Melikian M and Waldron T (2003) An examination of skulls from two British sites for possible evidence of scurvy. *International Journal of Osteoarchaeology* 13: 207-212.

Mensforth RP, Lovejoy CO, Lallo J and Armelagos GJ (1978) The role of constitutional factors, diet, and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children. *Medical Anthropology* 2: 1-59.

Merbs CF (1989) Trauma. In *Reconstruction of life from the human skeleton.* ed. İşcan MY. Alan R. Liss, Inc.

Merbs CF (1996) Spondylolysis and spondylolithesis: a cost of being an erect biped or a clever adaptation. *Year Book of Physical Anthropology* 39: 201-228.

Merbs CF (2002) Asymmetrical spondylolysis. *American Journal of Physical Anthropology* 119: 156-174.

Meyer A (1998) The archaeological sites of Greefswald. Pretoria: V & R Printing works (Pty) Ltd.

Meyer C, Jung C, Poenicke A, Poppe A and Alt KW (2002) Syphilis 2001 - a palaeopathological reappraisal. *HOMO* 53(1): 39-58.

Miller E, Ragsdale B and Ortner DJ (1996) Accuracy in dry bone diagnosis: A comment on palaeopathological methodology. *International Journal of Osteoarchaeology* 6: 221-229.

Moller-Chritensen V and Sandison AT (1963) Usura orbitae (cribra orbitalia) in the collection of the University of Glasgow. *Pathology and Microbiology* 26: 175-183.

Molnar P (2006) Tracing prehistoric activities: Musculoskeletal stress marker analysis of a stone-age population on the island of Gotland in the Baltic Sea. *American Journal of Physical Anthropology* 129: 12-23.

Morris AG (1984) *An osteological analysis of the protohistoric populations of the Northern Cape and Western Orange Free State, South Africa.* Ph.D. University of the Witwatersrand.

Morris AG (1988) Archaeological evidence of "pipe-smoker's wear". *Journal of the Dental Association of South Africa* 43: 361-364.

Morris AG (1989) Dental mutilation in historic and prehistoric South Africa. *Quaterly Bulletin of the South African Library* 43(3): 132-134.

Morris AG (1992) *The skeletons of contact. A study of protohistoric burials from the lower Orange river valley, South Africa.* Johannesburg: Witwatersrand University Press.

Morris AG (1998) Dental mutilation in Southern African history and prehistory with special reference to the "Cape Flats Smile". *Journal of the South African Dental Association* 53: 179-183.

Morris D (2003) *Salvage and investigation of graves disturbed by the Sol Plaatjie municipality outside Gladstone Cemetery, Kimberley*, McGregor Museum, Kimberley.

Mosothwane MN (2004) *Skeletal characteristics and population demography as reflected by material from Toutswe tradition sites in eastern Botswana, west of the Shashe-Limpopo basin.* MSc. University of Pretoria.

Motateanu M, Gudinchet F, Sarraj H and Schnyder P (1991) Diagnosis: Congenital absence of posterior arch of atlas. *Skeletal Radiology* 20: 231-232.

Murray PDF and Kodicek E (1949) Bones, muscles and vitamin C. II Partial deficiencies of vitamin C and mid-diaphyseal thickenings of the tibia and fibula in guinea-pigs. *Journal of Anatomy* 3: 205-223.

Nathan H (1962) Osteophytes of the Vertebral Column. *The Journal of Bone and Joint Surgery* 44-A(2): 243-268.

Nathan H and Haas N (1966) Cribra orbitalia, a bone condition of the orbit of unknown nature. *Israel Journal of Medical Sciences* 24: 351-360.

Neel JV (1958) A study of major congenital defects in Japanese infants. *American Journal of Human Genetics* 10: 398-445.

Neri R and Lancellotti L (2004) Fractures of the lower limbs and their secondary skeletal adaptations: a 20th century example of pre-modern healing. *International Journal of Osteoarchaeology* 14: 60-66.

Nozawa H, Watanabe-Suzuki K, Seno H, Ishii A and Suzuki O (2002) An autopsy case of human skeletal remains with a numerical variation in thoraco-lumbar vertebrae. *Legal Medicine* 4: 123-126.

O'Neill TW, McCloskey EV, Kanis JA, Bhalla AK, Reeve J, Reid DM, Todd C, Woolf, AD and Silman AJ (1999) The distribution, determinants, and clinical correlates of vertebral osteophytosis: A population based survey. *Journal of Rheumatology* 26(4): 842-848.

Obertova Z (2005) Environmental stress in the early mediaeval Slovic population at Borovce (Slovakia). *HOMO* 55: 283-291.

Oettle C and Steyn M (2000) Age estimation from sternal ends of ribs by phase analysis in South African blacks. *Journal of Forensic Sciences* 45(5): 1071-1079.

Olivieri I, Barozzi L, Padula A, De Matteis M and Pavlica P (1998) Clinical manifestations of seronegative spondylarthropathies. *European Journal of Radiology* 27: 83-86.

Oranje P, Noriskin JN and Osborn TW (1935) The effect of diet upon dental caries in the South African bantu. *South African Journal of Medical Sciences* 1: 57-62.

Ortner DJ (2003) *Identification of pathological conditions in human skeletal remains*, 2 edn. Amsterdam: Academic Press.

Ortner DJ, Butler W, Cafarella J and Millian L (2001) Evidence of probable scurvy in subadults from archaeological sites in north America. *American Journal of Physical Anthropology* 114: 343-351.

Ortner DJ and Ericksen MF (1997) Bone changes in the human skull probably resulting from scurvy in infancy and childhood. *International Journal of Osteoarchaeology* 7: 212-220.

Ortner DJ, Kimmerle EH and Diez M (1999) Probable evidence of scurvy in subadults from archaeological sites in Peru. *American Journal of Physical Anthropology* 108: 321-331.

Ortner DJ and Putschar WGJ (1981) *Identification of Pathological Conditions in Human Skeletal Remains.* Washington: Smithsonian Institution Press.

Packard RM (1989) *White Plague, Black labor. Tuberculosis and the Political Economy of Health and Disease in South Africa* University of California Press, California.

Pangan AL and Robinson D (2001) Hemarthrosisas initial presentation of scurvy. *Journal of Rheumatology* 23: 1923-1925.

Patrick MK (1989) *An archaeological and anthropological study of human skeletal remains from Oakhurst rock shelter, George, Cape province, Southern Africa,* MA Thesis, University of Cape Town.

Patriquin ML, Loth SR and Steyn M (2003) Sexual dimorphic pelvic morphology in South African whites and blacks. *HOMO* 53(3): 225-262.

Peckmann T (2003) Possible relationship between porotic hyperostosis and smallpox infections in nineteenth-century populations in the northern frontier, South Africa. *World Archaeology* 35(2): 289-305.

Pietrusewsky M, Douglas MT and Ike-Quebral RM (1997) As Assessment of health and disease in the Prehistoric inhabitants of the Mariana Islands. *American Journal of Physical Anthropology* 104: 315-342.

Pistorius JCC, Steyn M and Nienaber WC (1998) Two burials from Makgope - a Botswana settlement in the bankeveld. *South African Journal of Ethnology* 21(3): 115-124.

Plaut HF (1937) Fracture of the atlas or developmental abnormality? *Radiology* 29: 227-231.

Post RH (1966) Pilot study: Population differences in the frequency of spina bifida occulta. *Eugenics Quarterly* 13(4): 341-352.

Proff P, Fanghanel J, Allegrini Jr.S, Bayerlein T and Gedrange T (2006) Problems of supernumerary teeth, hyperdontia or dentes supernumerarii. *Annals of Anatomy* 188: 163-169.

Putschar WGJ (1966) Problems in the paleopathology of bone. In *Human paleopathology.*

Quetel C (1990) *History of Syphilis.* Maryland: Johns Hopkins University Press.

Raxter MH, Auerbach BM and Ruff CB (2006) Revision of the Fully technique for estimating stature. *American Journal of Physical Anthropology* 130:374 - 384.

Reichs KJ (1989) Treponematosis: A possible case from the late prehistoric of North Carolina. *American Journal of Physical Anthropology* 79: 289-303.

Reid DM and Dean MC (2000) Brief communication: the timing of linear hypoplasias on human anterior teeth. *American Journal of Physical Anthropology* 113: 135-139.

Reuler JB, Broudy V and Cooney T (1985) Adult scurvy. *Journal of the American medical Association* 253(6): 805-807.

Rhinelander FW, Phillips RS, Steel WM and Beer JC (1968) Microangiography in bone healing. *Journal of Bone and Joint Surgery* 50: 643-663.

Richardson BD (1982) The historical background of research on diet and dental caries in South Africa. *Journal of the Dental Association of South Africa* 37: 327-333.

Roberts B (1976) *Kimberley Tubulent City.* Capetown: Pioneer Press (PTY) LTD.

Roberts C, Lucy D and Manchester K (1994) Inflammatory lesions of ribs: an analysis of the Terry Collection. *American Journal of Physical Anthropology* 95L: 169-182.

Roberts C and Manchester K (1995) *The archaeology of disease*, 2 edn. United Kingdom: Alan Sutton Publishing Limited.

Ross MH and Pawlina W (2006) Bone. In *Histology, a text and atlas*, 6 edn.

Rothschild BM (1995) Origins of yaws in the Pleistocene. *Nature* 378: 343 - 344.

Rothschild BM, Luna Calderon F, Coppa A and Rothschild C (2001) First European exposure to Syphilis: The dominican Republic at the time of Columbian contact. *Clinical Infectious Diseases* 31: 936-941.

Rothschild BM and Martin LD (1992) *Paleopathology. Disease in the fossil record.* Florida: CRC Press.

Rothschild BM and Rothschild C (1995) Treponemal disease revisited: skeletal discriminators for yaws, bejel and venereal syphilis. *Clinical Infectious Diseases* 20:1402-1408.

Salo WL, Auferheide AC, Buikstra JE and Holcomb TA (1994) Identification of *Mycobacterium tuberculosis* DNA in a pre-columbian Peruvian mummy. *Proc Natl Acad Sci USA* 91: 2091-2094.

Santos AL and Roberts CA (2001) A picture of tuberculosis in young Portuguese people in the early 20th century: A multidisciplinary study of the skeletal and historical evidence. *American Journal of Physical Anthropology* 115: 38-49.

Santos AL and Roberts CA (2006) Anatomy of a serial killer: Differential diagnosis of tuberculosis based on rib lesions of adult individuals from Coimbra identified skeletal collection, Portugal. *American Journal of Physical Anthropology* 130: 38-49.

Scheuer L and Black S (2000) *Developmental juvenile osteology.* London: Academic Press Limited.

Schultz M (2001) Paleohistopathology of bone: A new approach to the study of ancient diseases. *Yearbook of Physical Anthropology* 44: 106-147.

Schultz M (2003) Light microscopic analysis in skeletal paleopathology. In *Identification of pathological conditions in human skeletal remains*, second edn. ed. D.J.Ortner. Amsterdam: Academic Press.

Schulze PJ and Burman R (1987) Absence of the posterior arch of the atlas. *AJR.* 134:178.

Schutkowski H (1993) Sex determination of Infant and juvenile skeletons: I. Morphognostic features. *American Journal of Physical Anthropology* 90: 199-205.

Scott JH (1957) Muscle growth and function in relation to skeletal morphology. *American Journal of Physical Anthropology* 15: 197-234.

Sealy JC, Patrick MK, Morris AG and Alder D (1992) Diet and dental caries among later stone age inhabitants of the Cape province, South Africa. *American Journal of Physical Anthropology* 88: 123.

Seftel HC, Malkin C, Schmaman A, Abrahams C, Lynch SR, Charlton RW and Bothwell TH (1966) Osteoporosis, scurvy and siderosis in Johannesburg bantu. *British Medical Journal* 1: 642-646.

Shandling B (1960) Acute haematogenous osteomyelitis: A review of 300 cases treated during 1952 - 1959. *South African Medical Journal* 34: 520-524.

Shore LR (1930) The abnormalities of the vertebral column in a series of skeletons of Bantu natives of South Africa. *Journal of Anatomy* LXIV: 206-238.

Shore LR (1934) Polyspondylitis marginalis osteophytica. *British Journal of Surgery* 22(88): 850-863.

Shrestha BM (1980) Use of ultraviolet light in early detection of smooth surface carious lesions in rats. *Caries Research* 14: 448-451.

Silverstone LM, Johnson NW, Hardie JM and Williams RAD (1981). *Dental caries, aetiology, pathology and prevention.* Hong Kong: Macmillan Press.

Sirvanci M, Ulusoy L and Duran C (2002) Pedicular stress fracture in lumbar spine. *Clinical Imaging* 26: 187-193.

Sjovold T (2000) Stature estimation from the skeleton. In *Encyclopedia of Forensic Sciences.* eds. Siegal J, Saukko P and Knupfer G. London: Academic Press.

Smith MO (1996) 'Parry' fractures and female-directed interpersonal violence: Implications from the later archaic period of west Tennessee. *International Journal of Osteoarchaeology* 6: 84-91.

Spigelman M and Lemma E (1993) The use of polymerase chain reaction to detect *Mycobacterium tuberculosis* in ancient skeletons. *International Journal of Osteoarchaeology* 3: 137-143.

Spigelman M, Matheson C, Lew G, Greenblatt C and Donoghue HD (2002) Confirmation of the presence of *mycobacterium tuberculosis* complex-specific DNA in three archaeological specimens. *International Journal of Osteoarchaeology* 12: 393-401.

St Hoyme LE and İşcan MY (1989) Determination of sex and race: Accuracy and assumptions. In *Reconstruction of life from the skeleton*, eds. İşcan MY and Kennedy KAR. New York: Wiley-Liss,Inc.

Standen VG and Arriaza BT (2000) Trauma in the pre-ceramic Coastal population of Northern Chile: Violence or occupational hazards? *American Journal of Physical Anthropology* 112: 239-249.

Steckel RH (1995) Stature and the standard of living. *Journal of Economic Literature* 33: 1903-1940.

Steckel RH, Rose JC, Larsen CS and Walker PL (2002) Skeletal health in the Western Hemisphere from 4000B.C. to the present. *Evolutionary Anthropology* 11: 142-155.

Steinbock RT (1976) *Paleopathological diagnosis and interpretation*. Springfield: Charles C. Thomas publishers.

Stewart TD (1932) The vertebral column of the Eskimo. *American Journal of Physical Anthropology* 17: 123-136.

Steyn M (1994) *An assessment of the health status and physical characteristics of the prehistoric population from Mapungubwe.* Ph.D. University of Witwatersrand.

Steyn M (1997) A reassessment of the human skeletons from K2 and Mapungubwe (South Africa). *South African Archaeological Bulletin* 52: 14-20.

Steyn M and Henneberg M (1995a) Pre-columbian presence of treponemal disease: A possible case from Iron Age Southern Africa. *Current Anthropology* 36: 869-873.

Steyn M and Henneberg M (1995b) The health status of the people from the Iron age sites at K2 and Mapungubwe (South Africa). *Rivista di Anthropologia (Roma)* 73: 133-143.

Steyn M and İşcan MY (1997) Sex determination from the femur and tibia in South African whites. *Forensic Science International* 90: 111-119.

Steyn M and İşcan MY (2000) Bone pathology and antemortem trauma in forensic cases. In *Encyclopedia of forensic Sciences*, eds. Siegel J, Saukko P and Knupfer G. London: Academic Press.

Steyn M, Nienaber WC, and Meiring JH (2002) An assessment of the health status and physical characteristics of an early 20th century community at Maroelabult in the North West Province, South Africa. *HOMO* 53(2): 131-145.

Steyn M and Smith JR (in print) Interpretation of antemortem stature stimates in South African. *Forensic Science International.*

Stirland AJ (1991) Diagnosis of occupationally-related paleopathology: can it be done? In *Human paleopathology.* eds. Ortner DJ and Auferheide AC. Washington: Smithsonian Institution Press.

Stirland AJ (1996) Patterns of trauma in a unique medieval Parish cemetery. *International Journal of Osteoarchaeology* 6: 92-100.

Stirland AJ and Waldron T (1997) Evidence for activity related markers in the vertebrae of the crew of the Mary Rose. *Journal of Archaeological Science* 24: 329-335.

Stock J and Pfeiffer S (2001) Linking structural variability in long bone diaphyses to hapitual behaviors: foragers from the Southern African later Stone Age and the Andaman Islands. *American Journal of Physical Anthropology* 115: 337-348.

Stoney WW (1900a) *Report of the Medical Officer of Health, Kimberley, for the years 1898.*

Stoney WW (1900b), *Annual Report of the Medical Officer of Health for the years, 1899.*

Stout SD (1978) Histological structure and its preservation. *Current Anthropology* 19(3): 601-604.

Stout SD and Teitelbaum SL (1976) Histological analysis of undecalcified thin sections of archeological bone. *American Journal of Physical Anthropology* 44: 263-270.

Stuart-Macadam P (1982) *A correlative study of a paleopathology of the skull.* Department of Physical Anthropology, University of Cambridge.

Stuart-Macadam P (1989) Nutritional deficiency diseases: A survey of scurvy, rickets and iron deficiency anemia. In *Reconstruction of life from the skeletal*, eds. İşcan MY and Kennedy KAR. Alan R. Liss, Inc.

Stuart-Macadam P (1992) Porotic hyperostosis: a new perspective. *American Journal of Physical Anthropology* 87: 39-47.

Swanepoel S (2003) *Gladstone Cemetery, 1880s to 1900s. Archival report*.

Tayles N and Buckley HR (2004) Leprosy and tuberculosis in Iron Age south Asia? *American Journal of Physical Anthropology* 125: 239-256.

Tobias PV (1971) Growth and stature in Southern African populations. In *The Human Biology of Environmental Change.* ed. Vorster DJM. England: Unwin Brothers Limited.

Torres-Rouff C and Costa Junqueira MA (2006). Interpersonal violence in prehistoric San Pedro de Atacama, Chile: Behavioral implications of environmental stress. *American Journal of Physical Anthropology* 130: 60-70.

Turner CG 1979 Dental anthropological indications of agriculture among the Jomon people of Central Japan. *American Journal of Physical Anthropology* 51: 619-636.

Turrell RV (1987) *Capital and labour on the Kimberley diamond fields 1871 - 1890.* Cambridge: Cambridge University Press.

Ubelaker DH (1987) Estimating age at death from immature human skeletons: an overview. *Journal of Forensic Sciences* 32: 1254-1263.

Ubelaker DH (1989a) *Human skeletal remains: Excavation, analysis and interpretation*, second edn. Washington D.C.: Taraxacum.

Ubelaker DH (1989b) The estimation of age at death from immature human bone. In *Age markers in the human skeleton.* ed. İşcan MY. Springfield: Charles C Thomas.

Van den Berg WB (1999) Osteophyte formation in osteoarthritis. *Osteoarthritis and Cartilage* 7: 333.

Van der Merwe AE, İşcan MY, & L'Abbé' EN 2006 The pattern of vertebral osteophyte development in a South African population. *International Journal of Osteoarchaeology* 16:459 - 464.

van Loveren C and Duggal MS (2002) The role of diet in caries prevention. *International Dental Journal* 52(2): 115-116.

Van Reenen JF (1954) Tobacco: the effects of its use with soecial reference to the mouth and dental elements. A survey of the literature. *Journal of the Dental Association of South Africa* 9(10): 334 - 347.

Van Reenen JF (1978) Tooth mutilating practices amongst the Ovambo and the West Caprivi Bushmen of South West Africa (Namibia). *Journal of the Dental Association of South Africa* 33: 665-671.

von Hunnius TE, Roberts CA, Boylston A and Saunders SR (2006) Histological identification of syphilis in pre-columbian England. *American Journal of Physical Anthropology* 129: 559-566.

Wakely J (1996) Limits to intepretation of skeletal trauma - Two case studies from medieval Abingdon, England. *International Journal of Osteoarchaeology* 6: 76-83.

Waldron T. and Rogers J (1991) Inter-observer variation variation in coding osteoarthritis in human skeletal remians. *International Journal of Osteoarchaeology* 1: 49-56.

Walker PL, Cook D and Lambert P (1997) Skeletal evidence for child abuse: a physical anthropological perspective. *Journal of Forensic Sciences* 42: 197-207.

Walker PL and Hewlett BS (1990) Dental health diet and social status among Central African foragers and farmers. *American Anthropologist* 92: 383-398.

Wapler U, Crubezy E and Schultz M (2004) Is cribra orbitalia synonymous with anemia? Analysis and interpretation of cranial pathology in Sudan. *American Journal of Physical Anthropology* 123: 333-339.

Weaver DS (1979) Application of the likelihood ratio test to age estimation using the infant and child temporal bone. *American Journal of Physical Anthropology* 50: 263-270.

Weiss E (2006) Osteoarthritis and body mass. *Journal of Archaeological Science* 33: 690-695.

Welcker H (1888) Cribra orbitalia, ein ethnologisch-diagnostisches merkmal am schädel mehrerer menschenrassen. *Archiv Fur Anthropologie* 17: 1-18.

Whittaker DK, Molleson T and Nuttall T (1998) Calculus deposits and bone loss on the teeth of Romano-British and eighteenth-century Londoners. *Archives of Oral Biology* 43: 941-948.

Whittaker DK, Parker JH and Jenkins C (1982) Tooth attrition and continuing eruption in a Romano-British population. *Archives of Oral Biology* 27: 405-409.

Wilczak CA (1998) Considerations of sexual dimorphism, age and asymmetry in quantitative measurement of muscle insertion sites. *International Journal of Osteoarchaeology* 8: 311-325.

William F (1968) Enamel defects induced by trauma during tooth formation. *Oral Surgery, Oral Medicine, Oral Pathology* 25(1): 49-54.

Wilson ES and Katz FN (1969) Stress fracture analysis of 250 consecutive cases. *Radiology* 92: 481-486.

Wilson ML and Lundy JK (1994) Estimated living statures of dated Khoisan skeletons from the South-western coastal region of South Africa. *South African Archaeological Bulletin* 49: 2-8.

Wiltse LL (1975) Fatigue fracture: the basic lesion in isthmic spondylolithesis. *Journal of Bone and Joint Surgery* 57(1): 17-22.

Winter SB and Brook AB (1975) Enamel hypoplasia and anomalies of the enamel. *Dental Clinics of North America* 19: 3-24.

Wolfe LD and Gray JP (1982) Subsistence practices and human sexual dimorphism of stature. *Journal of Human Evolution* 11: 575-580.

Wood JW, Milner GR, Harpending HC and Weiss KM (1992) The osteological paradox. *Current Anthropology* 33(4): 343-370.

Young B and Heath JW (2000) *Wheater's functional histology. A text and colour atlas*, Fourth edn. Edinburgh: Churchill Livingstone.

Appendix 1

Skeletal reports were written for each individual examined in this study. In each report the burial position and preservation of the individual were briefly described. Details regarding age, sex and antemortem stature determination were also be given. Since archival reports clearly indicate that the part of Gladstone cemetery from which these remains were excavated was used for "Native" burials, no reference will be made to the racial affinity of the persons. Dentition and any pathology or trauma were described as well as histological observations, in cases where bone samples were taken.

GLD N8.1

Burial position: GLD N8.1 was buried in a wooden coffin. The individual was in a supine position with the head in the west, the right arm extended on the side of the body and the left arm bent at the elbow across the thorax. An amputated limb, wrapped in dressing, was also found in the coffin.

Preservation: All skeletal remains were well preserved and complete, except for some missing phalanges. An amputated left tibia, fibula and foot were also found in the coffin. For the purpose of this report the complete individual will be labeled individual A, and the amputation individual B.

Age: *Individual A* - The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segment were still unfused, indicating a person younger than 25 years. Epiphyses of the shoulders, wrists and knees were still unfused. It was accordingly estimated that this individual was between 15 and 19 years of age at the time of death.

Individual B - All epiphyses were fused. Due to the absence of any other evidence, this individual could only be described as being adult.

Sex: *Individual A* - Sharp orbital margins, a vertical forehead, small mastoid processes, the absence of supraorbital tori, a round pelvic inlet and wide subpubic angle suggested a female. This was confirmed by metric analyses such as the maximum diameter of the humeral head (32.4 mm) and the maximum diameter of the femoral head (36.6 mm).

Individual B - Metric analysis of the distal epiphyseal breadth of the tibia (49.2 mm) revealed that this person was most likely male.

Antemortem stature: *Individual A* - An antemortem stature of 150.7 ± 2.789 cm was estimated from the physiological length of the femur.

Individual B - Due to the fragmentary condition of the remains, antemortem stature could not be determined.

Dentition: *Individual A* - Almost all teeth were present with no indication of carious lesions. The upper right second incisor seems to be congenitally absent.

Individual B - No teeth were available for analysis.

Pathology and trauma: *Individual A* - This person had 6 lumbar vertebrae, with partial sacralisation of L6 on the right side.

Individual B - The left tibia, fibula and foot were amputated just below the knee. All bones showed extensive signs of new bone growth due to infection, which most probably commenced in the foot.

Conclusion: The remains of two individuals were found in a coffin. Individual A was female, 15 - 19 years of age and approximately 150 cm tall. She had an extra lumbar vertebra. Individual B was only represented by an amputated left tibia, fibula and foot, which belonged to an adult male. The leg showed signs of infection.

GLD N8.2

Burial position: This individual was buried without a coffin. The remains were in a prone position with the head in the west end of the grave. The left arm was at the side of the body and the right radius, ulna and hand below the abdomen. Iron beads were found around the left wrist.

Preservation: All skeletal elements were well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and the first and second sacral segments were fused, suggesting an individual older than 25 years of age. Cranial sutures were still open, indicating a juvenile to young adult. The sternal ends of the third, fourth and fifth ribs fell in phase 1. This person was between 25 and 30 years of age at the time of death.

Sex: Madibular ramus flexure, a sloping forehead, narrow subpubic angle and narrow sciatic notches suggested a possible male. This was supported by metric analyses of the long bones such as the maximum diameter of the humeral head (41.8 mm) and the bicondylar breadth of the femur (75 mm).

Antemortem stature: An antemortem stature of 169.9 ± 2.8 cm was calculated from the physiological length of the femur.

Dentition: All teeth were present with no indication of carious lesions. Marked tartar deposits were noted.

Pathology and trauma: Schmorl's nodes were seen from T6 to T11. Spina bifida was present on T12, with the bifed spine bending to the left. An unhealed fracture of the left lamella, leading to separation of the left inferior articular facet from the rest of the vertebrae, was present on L5. Patches of periostitis were present on the left tibia. Pitting was present on both femora due to strain on the iliofemoral ligaments. Enthesophyte formations were seen bilaterally between the distal tibiae and fibulae, due to strain on the interosseous membrane.

Conclusion: These were the remains of a male, 25 - 30 years of age and approximately 169 cm tall. He suffered from several vertebral abnormalities and had skeletal lesions indicating participation in strenuous physical activity.

GLD N8.3

Burial position: This individual was buried without a coffin, next to GLD N8.2. The body was in a prone position with the head in the west end of the grave.

Preservation: All skeletal elements were complete and very well preserved.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segment had fused, indicating an individual older than 25 years of age. The coronal and lambdoid sutures were still partially open suggesting a young to middle - adult. The sternal ends of the ribs were in phase 4. This individual was most likely between the ages of 35 and 45 years at the time of death.

Sex: Large mastoid processes, prominent supraorbital tori, a sloping forehead, rounded orbital margins, a narrow subpubic angle and narrow sciatic notches suggested a male. These findings were confirmed by metric analyses, such as the maximum diameter of the humeral head (41.4 mm), the diameter of the femoral head (42.8 mm) and the distal epiphyseal breadth of the tibia (45 mm).

Antemortem stature: This person was estimated to have been 161.2 ± 2.789 cm tall (physiological length of the femur).

Dentition: The maxilla was edentulous except for a right canine. In the mandible the right premolars, left canine and second premolar were present, the rest were lost antemortem. Carious lesions were seen interdentally on all the premolars. An apical abscess was present in the root cavity of the lower left second molar. Severe periodontal disease was present.

Pathology and trauma: Criba orbitalia was present in both orbits. The inferior vertebral body of L4 and the superior body of L5 showed huge lytic lesions. These lesions caused almost total destruction of the vertebral body. The same lytic lesions with indications of infectious bone growth were seen on the superior margin of the left patella as well as the right olecranon process. Ossification of the right first rib cartilage was also noted. These lesions most likely developed due to tuberculosis, brucellosis or blastomyocosis. Erosion and pitting of the temporomandibular joint were noted, which could be associated with the tooth loss. A healed fracture was present on the distal end of the second metatarsal of the right foot. Enthesophytes were noted on the insertion of the achilles tendon on the calcanei, as well as the right radial notch. These stressmarkers indicate possible regular participation in strenuous physical activities.

Conclusion: This was the remains of a 30 - 40 year old male who had been 162 cm tall. He had most likely suffered from Tuberculosis. He also had a healed fracture of the second metatarsal of the right foot and temporomandibular joint disease.

GLD N8.4

Burial position: This individual was buried without a coffin. The remains were in a supine position, with the legs against the south wall of the grave and the upper body twisted northwest across the grave. A leather band and iron disc were found on the right radius.

Preservation: All skeletal elements were present and well preserved.

Age: The medial ends of the clavicles and the first and second sacral segments were still unfused, indicating an individual younger than 30 years of age. Cranial sutures were still open and the strenal ends of ribs fell in phase 1. Taking all of these into account, this individual was estimated to have been 20 - 25 years old at the time of death.

Sex: Rounded orbital margins, a sloping forehead, large mastoid processes, a narrow subpubic angle and madibular ramus flexure suggested a male. This was supported by metric analyses of the long bones such as the maximum diameter of the humeral head (42.2 mm) and the maximum diameter of the femoral head (48.4 mm).

Antemortem stature: An antemortem stature of 172 ± 2.789 cm was estimated using the physiological length of the femur.

Dentition: All teeth were present with no signs of carious lesions. Periodontal disease was noted.

Pathology and trauma: Schmorl's nodes were recorded on the lumbar vertebrae. Striations with signs of subperiosteal bone growth were visible on both tibiae. The left fibula was also affected and the right had a swollen appearance. This could be an indication of treponemal infection, non-specific osteomyelitis, haematoma formation as a result of scurvy or non - spesific periostitis.

Histological observations: A bone sample was taken from the anterior tibia for histological investigation. Macroscopic investigation of the transverse section through the lesion did not reveal any significant pathological changes. The compact bone appeared normal and no lines suggestive of the original periosteal surface could be seen.

Histological inspection showed clear circumferential lamellae representing the original periosteal surface, although this line was interrupted in some place. Bone apposition could be seen on the outside of the original external circumferential lamellae. The newly formed bone had a radiating collagen structure. The original compact bone was unaffected and normal. This section most likely came from a lesion caused by an ossified haematoma.

Conclusion: These were the remains a 20 - 25 year old male who had been approximately 172 cm tall. He most likely suffered from scurvy, as was supported by the histological investigations.

GLD N8.5

Burial position: This individual was buried without a coffin. The remains were in a supine position, with the skull in the west, facing south. The arms were extended with the left hand over the pelvis. Two strands of iron beads were found around the left wrist.

Preservation: All skeletal elements were present and well preserved, except for some missing carpal bones, metacarpals and phalanges.

Age: The medial ends of the clavicles were still unfused, indicating an individual younger than 30 years of age. Although the humeral heads were partially fused, the iliac crests, vertebral epiphyseal rings, medial margins of the scapulae, wrists and right knee were still unfused. This individual was most likely 17 - 22 years at the time of death.

Sex: A very robust mandible with a square chin and mandibular ramus flexure, narrow sciatic notches and large mastoid processes indicated a male. Measurements such as the maximum diameter of the humeral head (41.7 mm), maximum diameter of the femoral head (42.1 mm) and distal epiphyseal breadth of the tibia (42.7 mm) supported this.

Antemortem stature: Antemortem stature was estimated to have been approximately 161.7 ± 2.789 cm, using the physiological length of the femur.

Dentition: All teeth were present with no signs of carious lesions. Marked tartar deposits were present.

Pathology and trauma: An extra lumbar vertebra was recorded with a single Schmorl's node on T10. Clear striations were present on both tibiae with subperiosteal lesions. The right distal ulna also showed signs of subperiosteal bone growth. These lesions most likely developed due to scurvy or treponemal infection.

Histological observations: A bone sample was taken from the anterior tibia for histological investigation. On cross section the bone was extremely thickened. The outer surface of the bone seemed slightly porous although the original cortical bone seemed normal and a clear differentiation could still be made between the internal spongy bone and the compact cortical bone.

Unfortunately this section was infested with a fungus causing structural damage to the histological morphology of the sample. Nevertheless some diagnostic features could still be identified. Histological investigations revealed the presence of clear unaffected external circumferential lamellae representing the original periosteal surface underneath the new bone apposition. It was clear that the original compact bone was unaffected by the condition and only a few resorption holes were present. The newly formed bone had a radiating structure.

It was concluded that this lesion was most likely an ossified haematoma as indicated by the radiating new bone structure, the intact periosteal surface and the unaffected original compact bone. The absence of the periosteal surface on cross section and the presence of resorption holes found during histological investigation do however suggest that an infectious disease might also be present in this individual although expression of its characteristic is only slight.

Conclusion: These were the remains of a 17 - 22 year old male who had been approximately 161 cm tall. He most likely suffered from scurvy.

GLD N8.6

Burial position: This individual was buried without a coffin. The head was on the west side of the grave with the legs vertically against the eastern wall of the grave. The right arm was spread across the pelvis and the left was next to the body. Iron beads were found around the right wrist, a similar bracelet was in the vicinity upper body.

Preservation: All skeletal elements were present and well preserved. The skull was damaged and some carpal bones and phalanges were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were still unfused, suggesting an individual younger than 30 years of age. The third molars had erupted, but the roots were still open. The humeral heads, wrists, and knees were still unfused. Sternal ends of the third, fourth and fifth ribs were in phase 1. It was estimated that this person was 15 - 18 years of age at the time of death.

Sex: Small mastoid processes, a vertical forehead, round pelvic inlet and generally gracile skeleton suggested a female. The morphological traits were confirmed by the maximum diameter of the humeral head (36.6 mm) and the maximum diameter of the femoral head (40.2 mm). It should be kept in mind that the juvenile age of the individuals makes sex estimation difficult.

Antemortem stature: An antemortem stature of 157.6 ± 2.789 cm was calculated by using the physiological length of the femur.

Dentition: All teeth were present with no signs of carious lesions. The upper lateral incisors were shovel-shaped.

Pathology and trauma: Cortical pitting was observed on the popliteal lines of both tibiae. This most likely developed due to strain on the popliteus muscle. Subperiosteal bone growth was recorded on the posterior distal end of the right humerus as well as the anteromedial aspect of the distal right tibia. Slight enthesophyte formations were present on the mediodistal aspects of the fibulae, due to strain on the interosseous membrane. These lesions might be indicative of regular participation in strenuous physical activities.

Conclusion: These were the remains of a 15 - 18 year old female who had been approximately 157 cm tall. She had skeletal lesions suggesting regular participation in strenuous physical activities.

GLD N8.7

Burial position: This individual was buried without a coffin. Remains were found at the west end of the grave and were orientated north-south.

Preservation: All skeletal remains were extremely well preserved and complete.

Age: According to the length of various long bones such as the femur (44 mm), humerus (40.5 mm), tibia (39 mm) and fibula (38 mm), this individual was estimated to have been approximately six and a half to seven lunar months old.

Sex: Sex could not be determined due to the young age of the individual.

Antemortem stature: Antemortem stature could not be determined due to the young age of the individual.

Dentition: No teeth were present

Pathology and trauma: No signs of trauma of pathology were recorded.

Conclusion: These were the remains of a 6.5 - 7 lunar months old baby.

GLD N8.8

Burial position: This individual was buried without a coffin. The remains were in a prone position with the skull at the west end of the grave. The skull was twisted upward and the face was crammed into the southwest corner of the grave. An iron bracelet as well as a string with a single glass bead were found around the left radius and ulna. A copper bangle was found in the vicinity of the ankles.

Preservation: All skeletal remains were well preserved and complete, except for some missing carpal bones and phalanges.

Age: The medial ends of the clavicles as well as the first and second sacral segments were unfused, indicating an individual younger than 30 years of age. Third molars had erupted and the vertebral epiphyseal rings were fused. The degree of cranial suture closure indicated a juvenile to young adult (15 to 40 years). This person was most likely 20 - 28 years old at the time of death.

Sex: A narrow subpubic angle, eversion of the inferior pubic ramus, narrow sciatic notches, large mastoid processes and rounded orbital margins suggested a male. These morphological traits were supported by metric analyses such as the maximum diameter of the humeral head (41.4 mm), maximum diameter of the femoral head (45.4 mm) and distal epiphyseal breadth of the tibia (45.2 mm).

Antemortem stature: This individual was estimated to have been 165.2 ± 2.789 cm tall (physiological length of the femur).

Dentition: All teeth were present and no carious lesions were noted.

Pathology and trauma: The two halves of the atlas were congenitally unfused at the anterior neurocentral portion as well as at the posterior spine. Non-specific periostitic lesions were present on the right humerus, femur and tibia.

Conclusion: These were the remains of a 20 - 28 year old male who had been approximately 165cm tall. He had a congenitally unfused atlas.

GLD N8.9

Burial position: This individual was buried without a coffin, and had been placed in a prone position in the southwest corner of the grave with the head to the west. The skull was turned slightly to the south and the arms were extended next to the body. Iron fragments were found in the vicinity of the distal left tibia.

Preservation: All skeletal remains were well preserved and complete.

Age: All deciduous incisors had erupted and the first molars were in the process of erupting, indicating an age of 9 ± 3 months old. Diaphyseal lengths of the humerus, ulna, radius and femur suggested an infant between 3 - 6 months of age. This baby was most likely between 4 and 10 months of age at the time of death.

Sex: Sex could not be determined due to the young age of the individual.

Antemortem stature: Antemortem stature could not be determined.

Dentition: All deciduous incisors had erupted and first molars were in the process of eruption. No carious lesions were noted.

Pathology and trauma: No trauma or pathology.

Conclusion: There were the remains of an infant approximately 4 - 10 months old.

GLD N8.10

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head in the west, on the south side of the grave. A copper earring was found between the base of the cranium and the mandible, as well as iron beads, which were fused to the left arm.

Preservation: All skeletal elements were well preserved and complete.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused, indicating an individual younger than 30 years of age. Third molars had erupted but showed signs of wear. The sternal ends of the third, fourth and fifth ribs were in phase two. This individual was estimated to have been 20 - 25 years old at the time of death.

Sex: A narrow subpubic angle, narrow sciatic notches, a vertical forehead and mandibular ramus flexure suggested a male. Metric analyses of the long bones, such as the maximum diameter of the humeral head (40.7 mm) and maximum diameter of the femoral head (42.1 mm) supported this.

Antemortem stature: Physiological length of the femur was used to calculate an antemortem stature of 157.8 ± 2.789 cm.

Dentition: All teeth were present and showed no carious lesions. The front teeth had heavy calculus deposits. A supernumerary root was present anterior to the upper right second premolar. A lower left deciduous canine had been retained. Enamel hypoplastic lesions were present on the upper teeth, from the left canine to the right first premolar. The lower right canine was also affected.

Pathology and trauma: The femora, tibiae and fibulae showed subperiosteal lesions. The fibulae were slightly bent and swollen. The tibiae presented with a heavy concentration of new bone on the anterior aspects with clear striations. These lesions could be due to treponematosis infection or haematoma formation related to scurvy. The left calcaneus and talus also showed signs of bony spur development. A healed nasal fracture was noted, as well as an extra lumbar vertebra.

Conclusion: These were the remains of a 20 - 25 year old male who had been approximately 157.8 cm tall. He had an extra lumbar vertebra, healed nasal fracture as well as several subperiosteal lesions suggesting the presence of scurvy or treponematosis.

GLD N31.E.1

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the west end of the grave. Arms were extended alongside and under the body.

Preservation: The skeletal remains were very well preserved and 100% complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. All permanent teeth had erupted and were relatively worn. There were no signs of osteophytic development on the vertebrae. Cranial sutures indicated a young to middle-age adult. The sternal ends of ribs 3, 4 and 5 were in phase 4. This person was 30 - 40 years of age at the time of death.

Sex: A narrow subpubic angle, triangular pubic bones and narrow sciatic notches were observed. The mastoids were very large. The mandibular ramus was short and very thick, the chin was square and overall the mandible was extremely robust. All these morphological characteristics indicate a male. Metric analysis of the long bones such as the maximum diameter of the humeral head (44.1 mm), the maximum diameter of the femoral head (48.7 mm) and the proximal epiphyseal breadth of the tibia (81.4 mm) supported the morphological findings.

Antemortem stature: The physiological length of the femur was used to calculate an estimated antemortem stature of 171.6 ± 2.789 cm.

Dentition: All teeth were present except for the upper left third molar which was lost antemortem. Enamel hypoplasia was observed in the lower right first premolar and second molar, and the left canine and second molar.

Pathology and trauma: Bilateral distal femoral cortical defects were located above the medial condyle at the attachment of the medial head of the gastrocnemius muscle. The pits most probably developed due to repeated stress on the gastrocnemius muscle. Enthesophyte formations were also present on the right radial tuberosity as well as the patellae, with the left patella being more affected. The individual had sacralization of L5 with spondylolysis of L4. Several healed fractures were present on the skull. The first was a depression fracture in the right frontal bone above the right orbit. This lesion was 41.1 mm wide and 22.1 mm high. There were also healed fractures of the nose and the left zygomatic arch. Striations and patches of new porous bone formation, indicating possible scurvy or trauma, were present on both tibiae.

Histological observations: A sample was taken from the anterior tibiae for histological investigation. On transverse section the bone did not show any abnormalities. Histological investigations did not reveal any pathological changes in the bone. It is accordingly proposed that the striation observed in this individual can most likely be ascribed to normal morphological variation and that they did not occur due to an underlying pathological condition.

Conclusion: These were the remains of a 30 - 40 year old male who had been approximately 171cm tall. Vertebral pathologies, several cranial fractures and possible scurvy were noted. (Microscopy could not confirm the presence of an ossified haematoma.)

GLD N31.E.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body.

Preservation: Skeletal remains were very well preserved and complete, only some phalanges were missing.

Age: Third molars had erupted and showed little to no dental wear. Several epiphyses were still unfused such as the humeral heads, epiphyses of the knee and the vertebral epiphyseal rings. The degree of closure of cranial sutures indicated a young adult. This individual was estimated to have been 16 - 19 year of age at the time of death.

Sex: In general, the skeletal remains were robust. Mandibular ramus flexure, a relatively square chin, mastoids of intermediate size and a sloping forehead, suggested a male. Metric analysis of the skeletal remains, such as the maximum diameter of the humeral head (42.5 mm) and maximum diameter of femoral head (42.7 mm) supported this.

Antemortem stature: Using the physiological length of the femur, this individual was estimated to have been 161.2 ± 2.8 cm tall.

Dentition: All teeth were present with very little signs of dental wear. Enamel hypoplasia was observed. Only one carious lesion was recorded on the occulsal surface of the lower left second molar.

Pathology and trauma: Cribra orbitalia was present in both orbits. Schmorl's nodes were recorded on L4 and L5, the individual also had an extra thoracic vertebra. Slight striations were visible on the tibiae.

Conclusion: These were the remains of a male, 16 - 19 years of age who had been approximately 161 cm tall. He had cibra obitalia, an extra thoracic vertebra and Schmorl's nodes.

GLD N.31.E.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. An iron bangle was found around the left wrist of this individual.

Preservation: The remains were well preserved. The skeleton was almost complete with only three teeth and a few tarsal bones, carpal bones and phalanges missing.

Age: The medial end of the clavicles as well as the spheno-occipital synchondrosis were fused indicating a person of older than 25 years of age. All permanent teeth had erupted and were relatively worn. The sternal ends of ribs 3,4 and 5 fell between phases 2 and 3. This individual was 25 - 32 years of age at time of death.

Sex: Narrow sciatic notches, triangular pubic symphysis as well as a long and narrow pelvis suggested a male individual. Morphological traits such as the intermediate size of the subpubic angle and the supraorbital torus indicated a female. Metric dimensions of the bones did not aid much in the determination of sex, since all these measurements could be interpreted as either male or female. Based on the morphological traits of the pelvis this individual was most probably male.

Antemortem stature: The physiological length of the femur indicated a person of 155 ± 2.8 cm tall.

Dentition: All permanent teeth had erupted and were relatively worn. In the mandible the right incisors and the left third molar were lost postmortem. Periodontal disease as well as a very slight tartar deposit was observed. A carious lesion was visible on the buccal aspect of the upper right third molar. The upper left second incisor was peg - shaped.

Pathology and trauma: Criba orbitalia was present in both orbits. An early gummatous lesion was seen on the left parietal bone and osteomyelitic changes and subperiosteal bone growth was present on both tibiae giving them a saber-shin appearance. The nasal bones were softened and eaten away indicating that the individual had most probably suffered from treponemal disease. An extra lumbar vertebra was present.

Conclusion: These were the remains of a 25 - 32 year old male, who had been approximately 155 cm tall. Criba orbitalia was present in both orbits. He most likely suffered from treponematosis.

GLD N.31.E.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head in the west end of the grave. Arms were bent at the elbow and crossed over the chest.

Preservation: The skeletal remains very well preserved and complete. Only a single tooth, some carpal bones, tarsal bones and phalanges were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and sacral segments 1 and 2 were fused. All permanent teeth had erupted and were worn. The sternal ends of ribs 3,4 and 5 fell between phase 4 and 5. Initial stages of osteophytic development were present on the vertebrae. This person was most likely 35 - 45 years of age at the time of death.

Sex: Narrow sciatic notches, strong gonial angles, mandibular ramus flexure as well as a robust mandible were all suggestive of a male. The mastoids and supraorbital torus was medium in size and could indicate either a male or female individual. Metric analysis of the humeral head (38.5 mm) and femoral head (42.3 mm) also indicated that the individual could be either male or female. This individual is most probably male based on the morphological characteristics of the pelvis.

Antemortem stature: Physiological length of the femur indicated that this person was approximately 160 ± 2.8 cm tall.

Dentition: All permanent teeth but the upper and lower third molars, which seems to be congenitally absent, had erupted. Teeth were severely worn with total dentin exposure on some teeth. A tartar deposit was visible on most teeth. In the maxilla the left second incisor was lost postmortem and the first and second molars on the same side were lost antemortem. In the mandible carious lesions were seen interdentally between the right second premolar and first molar and the left second premolar, first and second molars. Periapical abscesses were present in the right second premolar as well and the left second premolar and first molar. Peg-shaped incisors were present in the mandible. Severe periodontal disease could be seen in the mandible and maxilla.

Pathology and trauma: Criba orbitalia were present in both orbits. Compression of the vertebral body of T11 was observed with some early stages of osteophytic development in the rest of the vertebral column. Straitions were seen on the left tibia and femur with some subperiosteal bone growth on the anterior aspect of the left tibia. The before mentioned lesions could have developed from a treponematosis infection, or an ossified haematoma formation associated with scury or trauma of the anterior tibia. An extra lumbar vertebra was present with sacralization of the last lumbar vertebra. There was a healed fracture of the second metacarpal.

Conclusion: These were the remains of a male, 35 - 45 years of age, who had been approximately 160 cm tall. Striations and new bone growth were present on the tibiae. An extra lumbar vertebra was noted as well as a healed fracture of the hand.

GLD N31.E.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head in the west end of the grave. Arms were bent at the elbows and crossed over the chest. A thin string of copper and a small piece of cloth was found in the vicinity of the remains.

Preservation: The preservation was fairly good. Bones were covered in a clayish deposit making it hard to see the bone surface and they were to fragile to brush. The skeletal remains were complete with only a few tarsals bones and phalanges missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and the first and second sacral segments were fused. All permanent teeth had erupted. The degree of closure of cranial sutures indicated a young to middle-aged adult. Sternal ends of the third, fourth and fifth ribs fell between phases 3 and 4. A final estimation of 25 - 38 years was made.

Sex: The pelvis of this individual had narrow sciatic notches and a narrow subpubic angle, these male traits were supported by madibular ramus flexure and a square chin. Female traits included supraorbital ridges and mastoids of intermediate size and a vertical forehead. Metric analysis of the humeral head (41.23 mm), femoral head (43.84 mm) and the maximum proximal epiphyseal breadth of the tibia (71.9 mm) supported the decision that this person was male.

Antemortem stature: According to the physiological length of the left femur this individual was estimated to have been 158.1 ± 2.8 cm tall.

Dentition: All teeth were present. Signs of periodontal disease as well as a tartar deposit were observed on most of the teeth. A single carious lesion was present on the occlusal surface of the upper right M3.

Pathology and trauma: The left tibia had a slightly striated appearance possibly indicating initial stages of scurvy or trauma. Schmorl's node was present on L2.

Conclusion: These were the remains of a 25 - 38 year old male, who had been approximately 158cm tall. Striated tibiae were noted.

GLD N34.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the east end of the grave. The right hand was on top of the pelvis and proximal femur and the left arm was extended next to the body. The skull of this individual was missing due to damage done by trenching.

Preservation: All postcranial remains were well preserved. The skull and mandible were fragmented.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were unfused. The third molars had erupted and slight indications of dental wear were present. Vertebral epiphyseal rings were unfused as was the epiphyses of the humeral heads, wrists and knees. The sternal ends of ribs 3, 4 and 5 were in phase 1. This person was most likely 18 - 21 years of age at the time of death.

Sex: This person was most probably a male when considering morphological features such as the very narrow sciatic notches, evertion of the inferior pubic rami, triangular pubic bones and a deep narrow pelvis. The bicondylar breadth of the humerus (60.05 mm), maximum diameter of the femoral head (43.01 mm) and the maximum proximal epiphyseal breadth of the tibia (71.2 mm) supported the morphological findings.

Antemortem stature: Physiological length of the femur indicated that this person was approximately 162.2 ± 2.8 cm tall.

Dentition: The left side and the central part of the maxilla were missing. Only right premolars and molars represented the mandibular teeth. In the mandible all teeth were present with a single carious lesion on the occlusal surface of the second molar on the right side.

Pathology and trauma: Schmorl's nodes were present an all the vertebrae from T2 - L5 on both the superior and inferior surface of the vertebral bodies. These nodes most likely developed due to constant participation in strenuous physical activities or acute trauma to the spine.

Conclusion: These were the remains of a male, 17 - 20 years of age, who had been approximately 162 cm tall. Schmorl's nodes were noted on the vertebrae.

GLD N34.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended next to the body. Trenching machinery damaged the skull and right hand. Remains of an iron bangle were found around the right radius as well as one green and one white bead.

Preservation: Skeletal remains were well preserved. The skull, mandible, tibiae, fibulae, hands, left foot and distal end of the right femur were missing.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused, indicating an individual younger than 30 years of age. The humeral heads and vertebral epiphyseal rings were already fused. The sternal end of the fourth rib was in phase 2. This individual is most probably 22 - 27 years of age at the time of death.

Sex: In general, the remains were extremely robust. A narrow subpubic angle, eversion of the inferior pubic ramus and narrow sciatic notches, suggested a possible male. This was supported by metric analysis of the femoral head (42.2 mm), circumference of the femur at midshaft (98 mm) and the maximum diameter of the humeral head (40.7 mm).

Antemortem stature: Physiological length of the femur indicated that this individual was approximately 172 ± 2.8 cm tall.

Dentition: No dentition was available for examination.

Pathology and trauma: The 11th rib on the left side had a lesion indicating possible sharp trauma. A single Schmorl's node was present on L1.

Conclusion: These were the remains of a 22 - 27 year old male, who had been approximately 172 cm tall. Possible sharp trauma was noted on the 11th rib on the left.

GLD N34.3

Burial position: This individual was buried without a coffin. The remains were in an extended position, on its left side, with both elbows bent and the hands together in front of the chest. A ring was found on the middle finger of the right hand, a metal bangle around the right wrist and a copper bangle around the upper right arm.

Preservation: The remains were well preserved and complete, except for the amputated part of the left femur, tibia, fibula and foot.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and first and second sacral segments were all fused indicating an individual over 25 years of age. Third molars had erupted and were relatively worn. The pubic symphyses could be compared to phase 4. The degree of cranial suture closure estimates this person to be a young adult. The sternal ends of ribs 3, 4 and 5 fell between phases 3 and 4. This person was most likely between 25 - 35 years of age at the time of death.

Sex: This individual had rounded orbital margins, triangular pubic bones, narrow sciatic notches and inferior pubic ramus eversion. All of these characteristics indicate a male individual. Female traits included a vertical forehead and small to medium sized supra orbital tori. The male morphological traits were supported by metric analysis of the bicondylar breadth of the humerus (59.5 mm), maximum diameter of the femoral head (44.4 mm) and proximal epiphyseal breadth of the tibia (74.1 mm). This person was most probably male.

Antemortem stature: Physiological length of the left femur indicated that this person was approximately 168.7 ± 2.8 cm tall.

Dentition: This individual suffered from severe periodontal disease. In the maxilla both premolars and the left first molar were lost antemortem. In the mandible the right first incisors, first premolar, and left second incisor were lost postmortem. The first and second molars on the right and the left third molar were lost antemortem. All the other teeth were present. Carious lesions were visible in the root of the upper right first molar, and interproximally at the upper right second molar and upper left first premolar. In the mandible carious lesions were noted on the occlusal surface of the right third molar, and on the left, on the lingual surface of the second premolar, occlusal surface of the first molar and the root of the second molar. A periapical abscess was present on the right lower second premolar.

Pathology and trauma: Criba orbitalia was present in the left orbit. An amputation of the left leg and foot just inferior to the proximal end of the left tibia and fibula was observed. This amputation was well healed. An extra lumbar vertebra was present. A healed round depression fracture 15.3 mm in length and 18.3 mm in width was seen in the left frontal bone, 43.2 mm above the pterion, and 11.5 mm anterior to the coronal suture. Another round depression lesion was visible on the saggital suture, 23.9 mm posterior to the bregma. This round lesion was 7.6 mm in diameter. Enthesophytes were present on the patellae.

Conclusion: These were the remains of a 25 - 35 year old male who had been approximately 168 cm tall. Neglected dental care, criba orbitalia, an amputation of the left leg as well as healed cranial fractures were observed.

GLD N34.4

Burial position: This individual was buried without a coffin. The remains were in an extended supine position with the head at the west end of the grave, facing to the left. The left hand was on the left femur and the right arm was extended next to the body.

Preservation: The skeletal remains were very well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were still unfused. Third molars had erupted but the roots had not closed yet. It was evident that the humeral head had only fused recently since the epiphyseal line was still clearly visible. The acromion processes as well as the vertebral epiphyseal rings were still unfused. Sternal ends of ribs three, four and five were in phase 1. This person was most likely 18 - 21 years of age at time of death.

Sex: A narrow subpubic angle, narrow sciatic notches, very large acetabulae and triangular pubic bones were indicative of a male individual. This was supported by metric analyses of the maximum diameter of the humeral head (45.4 mm), the maximum diameter of the femoral head (47.4 mm) and the proximal epicondylar breadth of the tibia (79.7 mm).

Antemortem stature: Physiological length of the femur estimated this person to have been approximately 180.7 ± 2.8 cm tall.

Dentition: All teeth were present in the maxilla and the mandible. A diastema was present between the upper central incisors. Enamel hypoplasia was observed on all the upper incisors and the lower canines. Carious lesions were present on the occlusal surfaces of both the lower right first molar and left second molar.

Pathology and trauma: Enthesophyte formations were visible on the insertion of the Achilles tendon on the left calcaneus. These spurs developed due to constant strain or trauma of the Achilles tendon. A Schmorl's node was present on the superior aspect of T12. Relatively localized subperiosteal bone growth with a lytic centre was seen on the anterior surface in the middle of the left tibia. This lesion was most likely caused by direct trauma to the anterior tibia. The right clavicle had a depressed crater like fossa with a sharp ridge like attachment site at the insertion of the costoclavicular ligament.

Conclusion: These were the remains of a 18 - 21 year old male, who had been approximately 180 cm tall. Stressmarkers such as enthesopathies and Schmorl's nodes were recorded, these were most likely associated with participation in strenuous activities. Localized trauma was also present on the anterior left tibia.

GLD N34.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The skull was slightly tilted to the right. The arms were extended next to the body and the legs were straight with feet together. The body was found on the northern side of the grave.

Preservation: All skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and the first and second sacral segments were unfused indicating an individual younger than 25 years of age. The acromion processes, vertebral epipyseal rings, epiphyses of humeral heads, wrists, knees and ankles were unfused. This indicated a person younger than 18 years of age. The sternal ends of ribs 3, 4 and 5 were in phase 0. This individual was most likely 15 - 18 years of age at time of death.

Sex: The pelvis presented with narrow sciatic notches, a narrow subpubic angle, eversion of the inferior pubic ramus, triangular pubic bones and a tall narrow sacrum. These morphological characteristics are indicative of a male. Female characteristics included sharp orbital margins and a vertical forehead. Metric analyses of the long bones supported the male morphological features (bicondylar breadth of the humerus, 58.1 mm), although others were not indicative of either a male or female individual (femoral bicondylar breadth, 74.2 mm and femoral head diameter, 41.4 mm). Based on the morphological characteristics and taking the young age into account, this person was most likely male.

Antemortem stature: The physiological length of the femur indicated an antemortem stature of approximately 162.2 ± 2.8 cm.

Dentition: The third molars had erupted but the roots had not closed yet. Extensive tooth wear was present on both first molars exposing dentin patches. Severe tartar deposits were present on the teeth. All teeth were present except all the upper incisors, which were lost antemortem. Carious lesions were present on the occlusal surface of both mandibular second molars.

Pathology and trauma: The sacrum of this individual was visibly skewed. This could have cause a slight scoliosis of the spine. A possible healed fracture of the anterior inferior ischial spine was noted on the right os coxa. This could be a tension fracture due to overexertion of the right rectus femoris muscle.

Conclusion: These were the remains of a 15 - 18 year old male who had been approximately 162 cm. Slight scoliosis and a possible tension fracture of in the anterior inferior ischial spine were recorded.

GLD N34.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position next to GLD N34.5, with the head at the west end of the grave. The right arm was extended with the hand on the right femur, the left arm was slightly bent with the hand on the pelvis.

Preservation: The skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles as well as the first and second sacral segments were in the early stages of fusion. All permanent teeth had erupted and the third molars showed minimal wear. The degree of cranial suture closure estimated this individual to be a juvenile to young adult. The sternal ends of ribs 3, 4 and 5 were in phase 2. This person was most likely 22 - 28 years old at the time of death.

Sex: A narrow subpubic angle, narrow sciatic notches, a sloping forehead, smooth orbital margins, medium to large mastoid processes and a very robust mandible were all suggestive of a male. This was supported by metric analysis of the maximum diameter of the femoral head (45.4 mm), maximum diameter of the humeral head (42.9 mm), and distal epiphyseal breadth of the tibia (45.7 mm).

Antemortem stature: The physiological length of the femur estimated this person to have been approximately 165.6 ± 2.8 cm tall.

Dentition: All permanent teeth had erupted and the first and second molars in the maxilla and mandible showed some extensive wear exposing dentin patches. No carious lesions were present. Pitted hypoplasia was seen on the lower left first molar. Brown staining of all the enamel of the maxillary and mandibular teeth were observed, this is most likely due to the smoking of tobacco.

Pathology and trauma: Schmorl's nodes were seen on the superior surface of C3, C4 and C5. Considering the age of this individual, these nodes most likely developed due to regular participation in strenuous physical activities or acute trauma. A small, healed depression fracture was observed in the right parietal bone. Its anterior-posterior diameter was 11.7 mm and it was 14.3 mm wide. Localized trauma caused a spot of subperiosteal bone growth on the lateral aspect of the left femur. This lesion is approximately 2 cm in length and 1 cm wide.

Conclusion: These were the remains of a 22 - 28 year old male, who had been approximately 165 cm tall. Pitted enamel hypoplasia was observed as well as Schmorl's nodes and a healed cranial fracture.

GLD N34.7

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the upper body slightly twisted and the head in the west, on the south side of the grave. The arms were crossed over at the wrist resting on pelvis. The calvarium was found on the abdomen between the arms. Beads were found around the left tibia.

Preservation: Skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused indicating an individual over 30 years of age. The third molars were fully erupted and relatively worn. Some first-degree osteophytes were visible on the lumbar vertebrae. The sternal ends of ribs 3, 4 and 5 fell within phase 4. This individual was most likely 30 - 40 years of age at the time of death.

Sex: Narrow sciatic notches, a narrow subpubic angle, triangular pubic bones and eversion of the inferior pubic ramus all indicated a male. Other male characteristics included large mastoid processes, rounded orbital margins and mandibular ramus flexure. These morphological characteristics were supported by metric analysis of the humeral bicondylar breadth (60.9 mm).

Antemortem stature: This person was estimated to have been approximately 157 ± 2.8 cm tall using the physiological length of the femur.

Dentition: All teeth were present in the maxilla and mandible except for the upper right first incisor, and lower right first molar, which were lost antemortem. Carious lesions were present on the occlusal surface of the right third molar and left first molar in the mandible. An abscess was observed in the root area where the lower right first molar was suppose to be. Extensive dental wear was present with dentin being exposed on all the teeth.

Pathology and trauma: This individual received an autopsy after death. Enthesophyte formations were observed on the right patella as well as on the latero-distal aspect of the tibiae. The latter is most likely a result of excessive strain on the interosseous membrane. A small exostosis were visible in the proximal third of the right femur on the antro-lateral aspect, continuous overexertion or trauma of the vastus intermedius muscle is a plausible explanation.

Conclusion: These were the remains of a 30 - 40 year old male, who had been approximately 157cm tall. He had received an autopsy after death. Stress markers suggesting participation in strenuous physical activities were noted.

GD N34.8

Burial position: This individual was buried without a coffin. The remains were in an extended position on its left side with the head at the west end of the grave, facing north. Hands were folded on the chest with the elbows to the side of the body. White and blue glass beads were found around the neck of this individual as well as copper beads around the right ankle.

Preservation: The skeleton was well preserved and complete, with only a few carpal bones and phalanges missing.

Age: Although the spheno-occipital synchondrosis and sacral segment 1 and 2 had already fused, the medial ends of the clavicles was unfused indicating an individual younger than 30 years. It was evident that the humeral head had only recently fused since the line was clearly visible. The third molars were fully erupted but no wear was present on them. The sternal ends of the ribs 3, 4 and 5 fell into phase 1. This person was most likely 20 to 28 years of age at the time of death.

Sex: A medium sized mastoid, small supraorbital tori, a slightly wide sciatic notch, a short and broad sacrum, round pelvic inlet and a vertical forehead indicated a female. On the other hand male characteristics included rounded orbital margins, a narrow subpubic angle and eversion of the inferior pubic ramus. Metric analysis of the long bones such as the femoral head (40.5 mm) and femoral bicondylar breadth (70.8 mm) indicated that this individual was most likely female.

Antemortem stature: This person was estimated to have been approximately 162 ± 2.8 cm tall by using the physiological length of the femur.

Dentition: All permanent teeth were erupted and present. Only a single carious lesion was visible on the occlusal surface of the lower left second premolar. Periodontal disease was noted.

Pathology and trauma: Spondylolysis of L4 was observed. Dorsal pittings, or parturition scars were visible on the pubic bones. A distal femoral cortical defect was noted above the medial condyle on the posterior aspect of the left femur, this developed due to repeated strain or acute trauma of the gastrocnemius muscle, hyperemia and localized bone resorption. Cortical pitting caused by strain on pectoralis major was noted on the left humerus.

Possible sharp trauma was observed on the anterior surface of the third and fourth ribs on the right. Four lesions were present, and they were approximately 8mm in length.

Conclusion: These were the remains of a 20 - 28 year old female who had been approximately 162 cm tall. Spondylolysis of L4 as well as possible sharp trauma were observed.

GLD N34.9

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were folded across the chest with the left hand touching the right elbow, and the right touching the left elbow.

Preservation: The skeletal remains were very well preserved and 100 % complete.

Age: The medial ends of the clavicles were still unfused indicating an individual younger than 30 years of age. The spheno-occipital synchondrosis as well as the first and second sacral segments was fused. The degree of cranial sutures closure estimated this person to have been a young to middle-adult. The sternal ends of ribs 3, 4 and 5 fell between phases 2 and 3. This person was most likely 22 - 30 years of age at the time of death.

Sex: A heart shaped pelvic inlet, narrow subpubic angle, eversion of the inferior pubic ramii and intermediately wide sciatic notches all suggested a male. The skeletal remains were overall very robust. Metric analyses of the long bones all supported the male morphological characteristics.

Antemortem stature: By using the physiological length of the femur an antemortem stature of approximately 165.5 ± 2.8 cm was estimated.

Dentition: All teeth were present and no carious lesion or enamel hypoplasia was noted. Only a severe tartar buildup was present.

Pathology and trauma: A partially healed fracture was present in the right frontal bone, 9 mm anterior to the coronal suture. The anterior-posterior diameter of the lesion was 14.8 mm and it was 20.5 mm wide. Another healed fracture was noted on the 5th metacarpal of the right hand. C2 and C3 were fused together (syndesmophytosis) although the rest of the spine did not show any signs of advanced osteophytic development.

Conclusion: These were the remains of a 22 - 30 year old male, who had been approximately 165 cm tall. He had one partially healed cranial fracture as well as a healed fracture of the right hand. C2 and C3 were fused together.

GLD N34.10

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The arms were extended next to the body.

Preservation: Skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles were still unfused indicating an individual younger than 30 years. All permanent teeth had erupted but no wear was visible yet. All other epiphyses were fused and obliterated. The degree of cranial suture closure indicated a juvenile to young-adult. The sternal ends of ribs 3, 4 and 5 fell between phases 2 and 3. This person was most likely 22 - 30 years of age at the time of death.

Sex: The bones were overall robust. The mastoid processes were large and mandibular ramus flexure was present. The pelvis had narrow sciatic notches and a narrow subpubic angle. These are all morphological characteristics suggestive of a male. These characteristics were supported by metric analyses of the maximum diameter of the humeral head (47.8 mm), maximum diameter of the femoral head (48 mm) and distal epiphyseal breadth of the tibia (49.4 mm).

Antemortem stature: Physiological length of the femur indicated that this person was approximately 172.5 ± 2.8 cm tall.

Dentition: All teeth were present. Carious lesions were seen on the buccal surfaces of the lower right second and third molars and the left second molar. An abscess was noted on the lower left third molar.

Pathology and trauma: Widespread subperiosteal bone growth and periostitis were visible on the right and left calcaneus and talus, most likely due to constant infection of the feet. The distal end of the left tibia and fibula was also affected by the foot infection. Schmorl's nodes were present in the thoracic and cervical regions.

Conclusion: These were the remains of a 22 - 30 year old male, who had been approximately 172 cm tall. He had widespread infection of the feet as well as Schmorl's nodes.

GLD N34.11

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The arms were extended at the sides of the body.

Preservation: The skeletal remains were well preserved and complete, except for a few ribs, which were broken, and some carpal bones, tarsal bones and phalages, which were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis and the first and second sacral segments were unfused, indicating a person younger than 25 years of age. The third molars had erupted but the roots were still open. The epiphyses of the shoulder, wrist and knee were still unfused indicating an individual younger than 18 years of age.

The distal ends of the tibiae and fibulae had recently fused since the epiphyseal line was still clearly visible. This person was most likely 14 - 18 years of age at time of death.

Sex: The supra orbital ridges were medium in size, the forehead sloped backwards and mandibular ramus flexure was present. In the pelvis the sciatic notches and the subpubic angle was narrow and the sacrum was long and very curved. All these morphological characteristics indicate a male. Metric analyses of the maximum diameter of the humeral head (46.7 mm), diameter of the femoral head (47.1 mm) and proximal epiphyseal breadth of the tibia (73 mm) supported the morphological findings.

Antemortem stature: The physiological length of the femur indicated that this person was approximately 172.5 ± 2.8 cm tall.

Dentition: In the maxilla, all teeth were present but the left first incisor, which were lost postmortem. All teeth were present in the mandible. No carious lesions or enamel hypoplasia were observed.

Pathology and trauma: No signs of trauma of pathology were noted, except for slight wedging of L5.

Conclusion: These were the remains of a 14 - 18 year old male, who had been approximately 172 cm tall. Slight wedging of L5 was observed.

GLD N34.12

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position against the north side of the grave, with the head in the west. The arms were extended with the hands resting on the pelvis.

Preservation: The skeletal remains were well preserved. All elements were present with only some carpal bones and phalanges missing. The ribs were fragmented.

Age: The medial ends of the clavicles as well as the first and second sacral segments were unfused, indicating a person younger than 30 years of age. All long bone epiphyses were fused. Third molars had erupted. The degree cranial of suture closure suggested a young adult. The sternal ends of ribs three, four and five fell within phase two. This individual was most likely 20 - 28 years of age at the time of death.

Sex: A narrow subpubic angle and medium sized sciatic notches in the pelvis, as well as rounded orbital margins, mandibular ramus flexure and a square chin indicated a possible male. This was supported by metric analyses of the long bones such as the maximum diameter of the humeral head (41.8 mm), maximum diameter of the femoral head (44 mm) and proximal epiphyseal breadth of the tibia (76 mm).

Antemortem stature: The physiological length of the femur estimated this individual to have been approximately 165.8 ± 2.8 cm tall.

Dentition: All teeth were present, except for the upper left second incisor, which were lost antemortem. A carious lesion was present on the occlusal surface of the lower left third molar. Crowding of the maxillary teeth was observed pushing the right canine into the palate.

Pathology and trauma: An exostosis was observed on the posterior aspect in the proximal half of the left femur. This bony outgrowth most likely developed due to excessive strain or trauma to the gluteus maximus muscle insertion on the femur. Slight osteoarthritic changes were visible in the acetabulum with small patches of porous bone growth. A healed nasal fracture was also recorded.

Conclusion: These were the remains of a 20 - 28 year old male, who jad been approximately 165 cm tall. An exostosis was present on the left femur as well as a healed nasal fracture.

GLD N34.13

Burial position: This individual was buried without a coffin. Remains were in an extended, supine position at an angle from northeast to southwest, with the head at the west end of the grave. The right arm was extended next to the body and the wrist of the left arm was on the pelvis.

Preservation: Skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments, were already fused, indicating a person older than 25 years of age. Third molars were completely erupted but not worn at all. No osteophytic development was visible on the lumbar vertebrae. The degree of cranial suture closure indicated that this individual was most probably a juvenile to young-adult. The sternal ends of ribs 3, 4 and 5 were in phase 3. This individual was most likely of 25 - 30 years of age at the time of death.

Sex: Narrow sciatic notches, a narrow subpubic angle, sloping forehead, rounded orbital margins, medium sized mastoids and supraorbital ridges and mandibular ramus flexure indicated a male. This was supported by metric analysis of the maximum diameter of the humeral head (44.8 mm), maximum diameter of the femoral head (44.6) and distal epiphyseal breadth of the tibia (48.2 mm).

Antemortem stature: The physiological length of the femur indicated that this individual was approximately 168.9 ± 2.8 cm tall.

Dentition: All teeth were present, and no sign of carious lesions or enamel hypoplasia were observed. The lower right third molar was impacted. Most teeth presented with a slight tartar buildup. Although the third molar had very little to no wear all first molars were extremely worn with dentin patches being exposed on the left lower first molar.

Pathology and trauma: Exostoses were present on the proximal-medial aspects of both tibiae. This most probably developed due to trauma or constant strain to the semimembranous muscle. Enthesophyte formations were also noted on the mediodistal ends of the fibulae, these occur due to strain on the interosseous membrane. Schmorl's nodes were present on T5 - T10 and on L1. Initial stages of first-degree osteophytic outgrowths were present on the vertebral bodies of some vertebrae. Subperiosteal bone growth, possibly representing an ossified haematoma, which developed due to scurvy, was observed on the right tibia.

Histological observations: A sample was taken from the anterior tibia for histological investigation. The original periosteal surface could easily be visualized macroscopically on the cross section through the lesion, and the new bone could be distinguished from the original compact bone.

Fungus infestation made the visualization of this section with polarized light very difficult, if not impossible. Nevertheless some diagnostic features could still be identified with bright light. Histological investigations revealed unaffected and clear circumferential lamellae representing the original periosteal surface. Although these lamellae were interrupted in some parts of the bone, it could still be visualized throughout the section. The original compact bone was not affected by the pathological condition and no resorption holes were observed. The newly formed bone had a radiating collagen structure. It was concluded that this section most likely came from a lesions caused by an ossified haematoma.

Conclusion: These were the remains of a 25 - 30 year old male, who had been approximately 168 cm tall. Exostoses formations and schmorl's nodes suggested regular participation in strenuous physical activities. He possibly suffered from scurvy.

GLD N34.14

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The radius, ulna and hand of both arms were crossed over the abdomen. Two strings of iron beads were found around the left writs, one string of copper beads around the right arm, two copper strings and one string of iron beads around the right proximal tibia, and two strands of iron and copper beads in the vicinity of the left tibia.

Preservation: Skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles and the first and second sacral segments were still unfused with the speno-occipital synchondrosis having fused very shortly before death, since the epiphyseal line was still clearly visible. All permanent teeth had erupted and the third molars showed little to no wear. The degree of cranial suture closure indicated that this person was a juvenile to young-adult. The sternal ends of the ribs fell within phase 2 and early phase 3. This individual was most probably 22 - 29 years of age at the time of death.

Sex: The small pelvis with narrow sciatic notches, eversion of the inferior pubic ramus and a narrow subpubic angle indicated a male. Medium sized mastoid processes, a sloping forehead, large occipital protuberance and mandibular ramus flexure was also present. All of these morphological findings indicate a male. This was supported by metric analysis of the maximum diameter of the humeral head (44.3 mm), maximum diameter of the femoral head (44.1 mm) and distal epiphyseal breadth of the tibia (43.8 mm).

Antemortem stature: The physiological length of the femur indicated that this person was approximately 173 ± 2.8 cm tall.

Dentition: All teeth were present and there were no signs of carious lesions or enamel hypoplasia.

Pathology and trauma: Schmorl's nodes were seen on T8, T9, T11 and L4. Enthesophyte formations were visible on the mediodistal aspects of the fibulae, these developed due to strain on the interosseous membrane. Increased vascularization and new bone growth was noted on the left and right calcaneus, these lesions are most probably the result of chronic infection of the feet.

Conclusion: These were the remains of a 22 - 29 year old male, who had been approximately 173 cm tall. Schmorl's nodes and possibly chronic infection of the feet were observed.

GLD N38.1

Burial position: This individual was buried in a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A single iron bead and metal fragments were found in the vicinity of the right ulna and radius.

Preservation: Skeletal remains were well preserved complete, the left ramus of the mandible was broken and parts of it were missing as well as one patella, one rib, some carpal bones and phalanges.

Age: Although the medial ends of the clavicles were still unfused, the spheno-occipital synchondrosis and first and second sacral segments had already fused indicating that this individual is most likely in his late 20's. Third molars had erupted but the roots had not closed yet. No osteophytic development was present on the vertebrae. The sternal end of ribs 3, 4 and 5 fell between phases 2 and 3. This person was most likely 23 - 30 years old at the time of death.

Sex: Morphological characteristics such as rounded orbital margins, mandibular ramus flexure, a long curved sacrum and a narrow subpubic angle indicated a male. This was supported my metric analysis of the bicondylar breadth of the humerus (61.1 mm), diameter of the femoral head (44.9 mm) and distal epiphyseal breadth of the tibia (43.6 mm).

Antemortem stature: The physiological length of the left femur estimated the antemortem stature to have been 160 ± 2.8 cm.

Dentition: All teeth were present and no signs of carious lesions or enamel hypoplasia were present.

Pathology and trauma: An abscess was present in the left mandibular ramus. A fracture of the left second rib was observed. This fracture must have occurred just before of after death since no clear signs of healing is present. Wedging of L5 was noticed as well as Schmorl's nodes on L3 and L4. Enthesophyte formations were visible between the distal ends of the left tibia and fibula, the bone growth was most likely triggered by strain on the interosseous memebrane. Widespread striations and initial stages of subperiosteal bone growth were present on the anterior surface of the left tibia. This could be an early indication of treponematosis, an ossified haematoma, which developed due to scurvy, or a traumatic lesion.

Conclusion: These were the remains of a 23 - 30 year old male, who had been approximately 160 cm tall. A huge abscess was present in the left mandibular ramus. Schmorl's nodes and enthesopathies were also noted as well as possible scurvy or treponemal disease.

GLD N38.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: The skeletal remains were very well preserved and complete except for some hand and foot phalanges.

Age: The medial ends of the clavicles were still unfused indicating an individual younger than 30 years of age. All permanent teeth had erupted with very little dental wear present on them. The degree of cranial suture closure suggested the individual to be a juvenile to young-adult. The sternal ends of ribs three, four and five were in phase three. This individual was most likely 25 - 30 years of age at the time of death.

Sex: Mandibular ramus flexure, a sloping forehead, large mastoid processes, rounded orbital margins and a narrow subpubic angle indicated that this individual was most likely male. This was supported by metric analyses of the long bones, such as the maximum diameter of the humeral head (45.2 mm), maximum diameter of the femoral head (47.3 mm) and the distal epiphyseal breadth of the tibia (47.6 mm).

Antemortem stature: The physiological length of the femur estimated the individual to have been approximately 168.7 ± 2.8 cm tall.

Dentition: All teeth were present, although the upper right second incisor and canine were only represented by roots due to postmortem damage. Pipe-smoker's wear was present on the upper left second incisor and canine.

Pathology and trauma: Enthesophye formations were present on the mediodistal aspect of both fibulae, due to strain on the interosseuos membrane. A depression fracture, which occurred near the time of death, was seen in the frontal bone right above the left orbit. This fracture was 33.9 mm wide and 32.5 mm high. A compound fracture with indications of infection was observed on the right third metacarpal. There was also an antemortem spiral fracture of the right femur 206 mm from the distal end. Severe signs of infection are present at this fracture, which evidently lead to the amputation of the femur 106 mm below the proximal end. A spiral fracture of the right tibia 117.7 mm from the distal end, as well as a fracture of the distal end of the right fibula was also observed, no signs of healing were present here. Possible cut marks were seen on C2, C4 and C6.

Conclusion: These were the remains of a 25 - 30 year old male, who had been approximately 168 cm tall. He had several fractures of the skull, right femur, tibia, fibula and third metacarpal.

GLD N38.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head to the west end of the grave. A copper bangle was found around the right wrist and two thin iron bands on the left wrist. Buttons were found in the pelvis as well as pieces of leather with metal around the neck and sternum. A cluster of shells, bones and buttons (ditaola) was also found adjacent to the body.

Preservation: Skeletal remains were very well preserved and complete, except for one left metacarpal and hand and foot phalanges. An extra carpal bone was present.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating an individual older than 25 years of age. Third molars had erupted and showed some dental wear. The degree of cranial suture closure estimated the individual to be a young adult. Sternal ends of ribs three, four and five fell between phases four and five. This person was 30 - 40 years of age at the time of death.

Sex: The person had a relatively prominent supraorbital torus, sloping forehead and medium to large mastoid processes. The pelvis showed a narrow subpubic angle, narrow sciatic notches and the pubic bones were triangular. All the morphological characteristics indicated a male. Metric analysis of the long bones such as the maximum diameter of the humeral head (41.7 mm) and the maximum diameter of the femoral head (42.5 mm) produced the same results.

Antemortem stature: The physiological length of the femur estimated this individual to have been 166 ± 2.8 cm tall.

Dentition: Most teeth were present, with only the upper molars and the lower left second premolar lost antemortem. There is a congenital deformity of the lower right second molar giving it a peg-shaped appearance. Interdental carious lesions were seen on the maxillary incisors. Carious lesions were also noted on the occlusal surface of the lower left first molar and buccal surface of the lower left third molar. A thick tartar deposit was observed on all the teeth.

Pathology and trauma: The individual had a well-healed Colle's fracture of the right radius and a Pott's fracture of the right fibula with signs of infection. Myositis ossificans acuta of the left iliac crest were noted, this most likely developed due to local trauma. A distal femoral cortical defect was also present due to strain on the medial head of the Gastrocnemius muscle.

Conclusion: These were the remains of a 30 - 40 year old male who had been approximately 166 cm tall. A well-healed Colle's and Pott's fracture of the right radius and fibula were seen as well as exostosis formation on the left iliac crest.

GLD N38.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended with hands on the pelvis.

Preservation: The skeletal remains were very well preserved and complete with only a few carpal bones and phalanges missing.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused, indicating an individual younger than 30 years of age. Although the third molars had erupted, the roots were still open and no signs of wear could be seen. It was clear that the vertebral epiphyseal rings had only recently fused since the epiphyseal lines were clearly visible. The degree of cranial suture closure suggested a young adult. Sternal ends of ribs three, four and five were in phase two. This individual was most likely 20 and 25 years old at time of death.

Sex: The person had a prominent supraorbital torus and a sloping forehead. The pelvic inlet was heart shaped and the subpubic angle and sciatic notches narrow. All these morphological characteristics indicated a male. This was supported by metric analyses of the maximum diameter of the humeral (43.3 mm) and femoral (46.2 mm) heads.

Antemortem stature: This person had an estimated antemortem stature of 173 ± 2.8 cm. (Physiological length of the femur)

Dentition: All teeth were present and a single carious lesion was visible on the occlusal surface of the lower right third molar.

Pathology and trauma: Possible shallow and repetitive cutmarks were visible on the anterior aspects of ribs two, three and four on the right and the fourth rib on the left. A localized sclerotic bone lesion was visible on the anterior aspect of the left tibia. Although this lesion is unilateral, it is suggestive of an ossified haematoma, which could develop due to trauma or scurvy. Enthesophyte formations were visible on the mediodistal aspects of the fibulae due to excessive strain on the interosseous membrane.

Histological observation: On cross section the original periosteal surface could easily be visualized macroscopically. The new bone apposition could be distinguished from the original compact bone, which did not show any lytic changes.

Histological investigation revealed that the section was infiltrated with fungus making investigation with polarized light impossible; nevertheless it was still possible to visualize diagnostic histological features. Circumferential lamellae were unaffected and clearly visible, representing the original periosteal surface under the new bone apposition. Although these lamellae were interrupted it was possible to follow it through. The original compact bone was unaffected by the pathological condition and did not show any pathological changes. The bone apposition had a radiating structure.

It was concluded that this section most likely came from a lesion caused by an ossified haematoma.

Conclusion: These were the remains of a 20-25 year old male who had been approximately 173 cm tall. Possible sharp trauma was noted on the ribs, as well as a lesion on the anterior left tibia suggestive of an ossified haematoma.

GLD N38.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The left arm was slightly bent, with the hand resting on the pelvis. The right arm was extended next to the body.

Preservation: Skeletal remains were extremely well preserved and complete except for missing carpal bones and phalanges.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused, indicating a person older than 25 years of age. All cranial sutures were open and no osteophytic outgrowths were visible on the vertebrae. Sternal ends of the third, fourth and fifth ribs were in phase three. This person was most likely 25 - 32 years of age at the time of death.

Sex: Prominent supra orbital tori, round orbital margins, a prominent chin, narrow subpubic angle and tall, narrow sacrum suggested a male. This was supported by metric analyses of the bicondylar breadth of the humerus (58.1 mm) and the maximum epiphyseal breadth of the tibia (44.1 mm).

Antemortem stature: The physiological length of the femur suggested an approximate antemortem stature of 158.1 ± 2.8 cm.

Dentition: All teeth were present except for the upper right second incisor, which were lost postmortem. Periodontal disease was observed.

Pathology and trauma: C5 and C6 were fused together. Schmorl's nodes were recorded on the lumbar vertebrae. Striations were present on both tibiae with enthesophyte formations between the distal ends of the tibiae and fibulae, due to strain on the interosseous membrane.

Conclusion: These were the remains of a 25 - 32 year old male, who had been approximately 158 cm tall. Fusion of C5 and C6 as well as Schmorl's nodes were observed.

GLD N38.7

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows, with arms and hands resting on the chest.

Preservation: All skeletal remains were well preserved and complete, except for the hand bones.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. The coronal and saggital sutures were obliterated indicating a middle to old-aged adult. Third molars were worn extensively exposing huge dentin patches. Second-degree osteophytes were present on all the lumbar vertebrae. The sternal ends of ribs three, four and five were in phase 5. This person is accordingly estimated to have been 38 - 46 years of age at the time of death.

Sex: Morphological characteristics such as prominent supra orbital tori, sloping forehead, narrow sciatic notches and a tall, narrow sacrum indicated a male. This was affirmed by metric analyses of the humeral head (44.8 mm) and the diameter of the femoral head (44.7 mm).

Antemortem stature: The physiological length of the femur estimated an antemortem stature of 164.4 ± 2.8 cm.

Dentition: All teeth were present and extremely worn with an advanced tartar deposit. Carious lesions were recorded on the occlusal surfaces of both lower third molars.

Pathology and trauma: Possible gummatous lesions, due to treponematosis, were observed on the frontal as well as the left parietal bone. The distal end of the right fibula, left tibia and femur as well as the right ulna were extremely blown up with clear osteomyelitic changes and signs of secondary bone deposition. The lateral end of the left clavicle and acromion process of the left scapula showed signs of osteoarthritis. Second-degree osteophytes were also present of the vertebrae with enthesophyte formation in the obturator foramina.

Conclusion: These were the remains of a 38 - 46 year old male who had been approximately 164 cm tall. Lesions suggestive of treponematosis infection were found throughout the remains.

GLD N38.8

Burial position: This individual was buried without a coffin. The remains were in an extended position on its right side, with the head at the west end of the grave. Both arms were bent at the elbows with the hands on the chest.

Preservation: All skeletal elements were present and very well preserved. An extra pair of hands and feet was excavated with this individual.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating an individual older than 25 years of age. The coronal and saggital cranial sutures were almost obliterated. Third molars had erupted and were worn extensively. The sternal ends of ribs three, four and five were in phase four. This individual was most likely 30 - 40 years of age at the time of death.

Sex: The skeletal remains were very robust in general. Mandibular ramus flexure, narrow sciatic notches and eversion of the ischiopubic ramus suggested a male. This was supported by metric investigations, such as the maximum diameter of the femoral head (46.3 mm) and the distal epiphyseal breadth of the tibia (46.5 mm).

Antemortem stature: Physiological length of the femur estimated this person to have been 162.7 ± 2.8 cm tall.

Dentition: All teeth were present. An interdental carious lesion was observed on the upper left first premolar. Due to either the retention of a deciduous tooth, or the presence of an extra premolar, crowding of the maxilla occurred, pushing the left second incisor into the palate. The extra tooth was lost antemortem.

Pathology and trauma: The acromion process of the right scapula was still unfused and slightly infected, suggesting tearing of the rotator cuff due to continued heaving and loading of the right arm. Schmorl's nodes were present on L5 and enthesophyte development was noted bilaterally between the distal tibiae and fibulae due to strain on the interosseous membrane.

Conclusion: The skeletal remains were those on a male, 30 - 40 years of age with an approximate antemortem stature of 162 cm. He had a single carious lesion and showed pathological lesion related to regular strenuous physical activity.

GLD N38.9

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the west end of the grave. Arms were extended next to the body. The legs were crossed at the ankle, with the right foot on top of the left.

Preservation: All skeletal remains were relatively well preserved, apart from the fragmentary condition of the skull, mandible, os coxa, and ribs. An extra foot was present.

Age: The spheno-occipital synchondrosis as well as the first and second sacral segments was fused. Third molars were erupted and worn. Osteophytes were present on all the lumbar vertebrae. The coronal and saggital sutures were almost obliterated estimating the person to be a young to middle-aged adult. The sternal ends of ribs three, four and five fell within phase four. This individual was 40 - 50 years of age at the time of death.

Sex: Large mastoid processes, rounded orbital margins and mandibular ramus flexure suggested a male. This was supported by metric analyses such as the maximum diameter of the humeral head (41.3 mm) and bicondylar breadth of the femur (78 mm).

Antemortem stature: The person was estimated to have been approximately 159.1 ± 2.8 cm tall by measuring the physiological length of the femur.

Dentition: All teeth were present, except for the lower left canine, which was lost postmortem. Carious lesions were recorded on the occlusal surfaces of the upper right canine and lower left third molar, lingual surfaces of both upper second molars and buccal surface of the lower left second molar.

Pathology and trauma: Wedging of L5 was noted. Unhealed fractures of the right 4th and 5th metatarsals were present with clear signs of infection. Strain on muscle or ligament implantations leading to enthesophytes, was seen at the implantation site of lattisimus dorsi on the humerus, at the implantation of the ilio-femoral ligament on the femur, as well as bilaterally between the distal tibiae and fibulae due to strain on the interosseous ligaments.

Conclusion: The skeletal remains were those of a 40 - 50 year old male who had been approximately 159 cm tall. He had several carious lesions and unhealed fractures of the right 4th and 5th metatarsals.

GLD N74.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The right arm was extended besides the body, with the left arms under the ribcage and pelvis. Two copper pins, forming a cross, were found on the left side of the cranium.

Preservation: All skeletal remains were well preserved and complete, except for some phalanges, which were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and were worn extensively. Advanced second-degree osteophytes were present on the lumbar vertebrae. All cranial sutures were almost obliterated. The sternal ends of ribs three, four and five fell between phases 4 and 5. This person was estimated to have been 40 - 50 years of age at the time of death.

Sex: Small mastoids, very small to no supraorbital tori, a vertical forehead and preauricular sulcus indicated a female. This was supported by metric analyses of the maximum diameter of the humeral head (39.3 mm) and maximum diameter of the femoral head (40 mm).

Antemortem stature: The physiological length of the femur estimated this person to have been approximately 155.4 ± 2.8 cm tall.

Dentition: All teeth were present and stained, most likely due to smoking. Pipesmoker's wear was recorded on the upper left second incisor and canine. Severe periodontal disease was observed.

Pathology and trauma: A healed fracture was seen on the right zygomatic arch as well as the right first metacarpal. Enthesophyte formation due to strain on the iliofemoral ligament was observed on the medial aspects of the proximal femora. Second-degree osteophytes were present on the lumbar vertebrae.

Conclusion: These were the remains of a 40 - 50 year old female who had been approximately 155 cm tall. She had severe teeth discolouration due to pipesmoking and had several healed fractures.

GLD N74.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The arms were extended next to the body. Fragments of black cloth (possibly leather) were found under the left femur. Metal buttons, a pearl button, remains of a shoe on the right foot, as well as fragments of an iron bangle around the left ankle were also found.

Preservation: Skeletal remains were very well preserved and complete except for some missing carpals, metacarpals and phalanges.

Age: The spheno-occipital synchondrosis, medial ends of the clavicles as well as the first and second sacral segments were unfused, indicating a person younger than 25 years of age. Epiphyseal lines of the humeral head and iliac crests were still clearly visible while some vertebral epiphyseal rings were still unfused. Cranial sutures were still unfused. This person was most likely 18 - 22 years of age at the time of death.

Sex: Large mastoid processes, a sloping forehead and narrow sciatic notches indicated a possible male. This was supported by metric analyses of the long bones such as the bicondylar breadth of the humerus (58.2 mm) and maximum distal epiphyseal breadth of the tibia (43 mm).

Antemortem stature: The physiological length of the femur estimated an antemortem stature of 164.6 ± 2.8 cm.

Dentition: All teeth were present except for the lower right second premolar, which had been lost antemortem. Carious lesions were present on the occlusal surface of the upper right second molar and interdentally on the upper and lower left second premolars. Marked tartar deposits and periodontal disease were noted.

Pathology and trauma: A healed depression fracture was present in the left parietal bone. This fracture was 23.7 mm from anterior to posterior and 13.3 mm in width. Slight subperiosteal bone growth was present on the left and right talus.

Conclusion: The skeletal remains were those of a 18 - 22 year old male who had been approximately 164 cm tall. He had several carious lesions and a healed cranial fracture.

GLD N74.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended with the right hand resting on the pelvis, and the left alongside the body. The calvarium was found in the abdominal cavity. Copper objects were found in the vicinity of the left femur.

Preservation: All skeletal remains were well preserved and complete except for some missing carpals, metacarpals and phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were unfused. All the cranial sutures were still open. Epiphyses of the shoulder, wrist and knee, the iliac crest and vertebral epiphyseal rings were still unfused. This person was most likely 17 - 22 years of age at the time of death.

Sex: Mandibular ramus flexure, rounded orbital margins, a slightly sloping forehead and a narrow subpubic angle indicated a possible male. These findings were supported by metric analyses of the long bones such as the maximum diameter of the humeral head (41.4 mm) and the maximum diameter of the femoral head (45.5 mm).

Antemortem stature: Physiological length of the femur estimated an antemortem stature of 161.4 ± 2.8 cm.

Dentition: All teeth were present with no signs of carious lesions.

Pathology and trauma: The left radius, ulna, tibia and fibula had a slightly blown-up appearance due to osteomyelitic changes and lesions of subperiosteal bone growth. The left tibia presented with a saber-shin appearance. These lesions most likely developed due to treponematosis. Spondylolysis of L5 was present with slight wedging of the vertebral body.

Conclusion: The remains were those of a 17 - 22 year old male who had been approximately 161.4 cm tall. His teeth were in excellent condition. He suffered from spondylolysis and wedging of L5 and presented with lesions suggestive of treponematosis.

GLD N74.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position. The right arm was extended next to the body, with the left bent at the elbow and resting on the abdomen.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating a person older than 25 years of age. Third molars had erupted and showed only slight signs of wear. Cranial suture were fused but not obliterated and suggest a young to middle - adult. The sternal ends of ribs three, four and five were in phase 4. This person was most likely 30 - 40 years old at time of death.

Sex: Prominent supra orbital tori, a sloping forehead, mandibular ramus flexure and a narrow subpubic angle suggested a male. This was supported by metric analysis such as the maximum diameter of the humeral head (44.5 mm), maximum diameter of the femoral head (46.5 mm) and distal epiphyseal breadth of the tibia (44.7 mm).

Antemortem stature: An antemortem stature of 180.3 ± 2.8cm was estimated using the physiological length of the femur.

Dentition: All teeth were present in the maxilla. In the mandible the right canine and left first molar were lost postmortem, the right first and second molars were lost antemortem and the right second premolar was only represented by a root due to postmortem damage. Carious lesions were present on the occlusal surfaces of the upper right and lower left second molars and interdentally on the lower left second molar. Large abscesses were noted on the lower left first and third molars. Marked tartar buildup and periodontal disease were observed.

Pathology and trauma: A healed parry fracture (defense fracture) was present on the distal end of the right ulna. Myositis ossificans acuta was present on the posterior aspect of the right femur due to strain or trauma of the Biceps femoris muscle. Schmorl's nodes were noted from T7 to T11. Enthesophyte formations were present between the distal tibiae and fibulae bilaterally due to strain on the interosseous membrane. Enthesophyte formation was noticed in the obturator foramen.

Histological observations: On transverse section the bone seemed extremely enlarged and very porous throughout the section. No original periosteal surface could be visualized.

Regardless of the severe fungus infestation in this section histological investigation revealed that there were a large amount of resorption holes throughout the section resulting in no clear differentiation being possible between the internal spongy bone structure and the original compact bone. No original periosteal surface could be visualized in this section. Severe tissue unrest could be seen throughout the sample.

It was concluded that this section most likely came from a lesions affected by osteomyelitic changes, as was indicated by the severe tissue unrest, large amount of resorption holes and absence of the original periosteal surface.

Conclusion: Theses were the remains of a 30 - 40 year old male who had been approximately 180 cm tall. He had several carious lesions, a healed parry fracture as well as skeletal lesions related to participation in strenuous physical activity.

GLD N74.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. Three small metal objects were found on the chest, iron bangles around the arms as well as an iron object with a piece of cloth on the distal right tibia.

Preservation: All skeletal remains were well preserved and complete except for some missing carpal bones, metacarpals and phalanges.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused, indicating a person over the age of 25 years. Third molars had erupted and were worn extensively. The sternal ends of ribs three, four and five were in phase 6. This person was most likely 40 - 55 years of age at the time of death.

Sex: Relatively prominent supra-orbital tori, medium sized mastoids, a sloping forehead, narrow subpubic angle and sciatic notches and a small pelvic inlet were all indications of a male. These morphological characteristics were supported by metric analyses such as the maximum diameter of the humeral head (42.6 mm), maximum diameter of the femoral head (48 mm) and distal epiphyseal breadth of the tibia (49.5 mm).

Antemortem stature: This person was estimated to have been 167.2 ± 2.789 cm tall using the physiological length of the femur.

Dentition: All teeth were present except for the lower right canine, which was lost antemortem. A periapical abscess was present at the root of the upper right second incisor. Marked tartar deposits were observed.

Pathology and trauma: Schmorl's nodes were recorded from T9 - T12 as well as spondylolysis of L5. Fusion of the sacrum to the left os coxa at the auricular surface was seen. Enthesophyte formations were noted at the inplantations of the achilles tendon on the calcaneus as well as on the anterior surfaces of the patellae at the implantation site of the rectus femoris tendon. The right calcaneus also had a flattened appearance with severe osteophyte formation on the medial aspect. A well-healed fracture with longstanding subluxation was noticed on the left humerus. The fracture caused shortening of the humeral shaft as well as lateral rotation of the distal end. The dislocation caused a false articulation fasset to develop between the acromion process and the posterior surface of the humeral head. This most probably caused an unstable shoulder with the humerus in a position of hyperextention and posterolateral rotation. Osteoarthritis of the left foot was indicated by severe osteophyte formation on the margins of the calcaneus.

Initial stages of ankylosing spondylitis could be indicated by the ankylosis of the left sacroiliac joint. Taking the spondylolysis and fractured humerus into consideration, these lesions can most likely be ascribed to traumatic osteoarthritis. It is also possible that this individual might have suffered from DISH.

Conclusion: It can be concluded that these were the remains of a 40 - 50 year old male who had been approximately 167 cm tall. He had several skeletal lesions indicating participation in strenuous physical activities as well as longstanding subluxation of the left humerus.

GLD N74.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows, resting on the pelvis, right hand on left.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges and carpal bones.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating an individual older than 25 years of age. Third molars had erupted and were extensively worn. The cranial sutures were partially fused and estimated the remains to be those of a young to middle - aged adult. Sternal ends of ribs number three, four and five were in phase five. This person was most likely 30 - 46 years of age at the time of death.

Sex: Morphological characteristics such as a prominent supra orbital torus, large mastoid processes, rounded orbital margins, narrow sciatic notches and subpubic angle and ischiopubic eversion indicated a male. This was supported by metric analyses such as the maximum diameter of the humeral head (45.7 mm), maximum diameter of the femoral head (46.2 mm) and distal epiphyseal breadth of the tibia (46.3 mm).

Antemortem stature: The physiological length of the femur estimated an antemortem stature of 163.1 ± 2.8 cm.

Dentition: All teeth were present and extensively worn. Interdental carious lesions were present on the lower right second premolar and first molar. A periapical abscess was also noted in the root of the lower right first molar. Marked tartar deposits and periodontal disease were observed.

Pathology and trauma: Healed fractures were present on the sternal end of the right third rib and the right fronto-maxillary junction. A depression fracture, which occurred just before, during or shortly after death, was present in the right parietal bone. Indications of possible bilateral osteoarthritic changes of the acromioclavicular joint were noted, these changes might be an indication of continues elevation of the arms. Extremely robust muscle attachments were present on the right humerus with signs of periostitis on the proximal end. Enthesophyte formations were seen bilaterally on the latero-distal ends of the tibiae due to strain on the interosseous membrane. An autopsy was performed on this individual.

Conclusion: The remains were those of a 30 - 46 year old male who had been approximately 163 cm tall. He had several healed fractures, a fresh depression fracture as well as skeletal lesion indicative of participation in strenuous physical activities.

GLD N74.7

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. A copper bangle was found around the left wrist as well as an iron and copper string under the left radius and ulna.

Preservation: All skeletal remains were well preserved and complete, except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating an individual older than 25 years of age. All cranial sutures were almost completely fused estimating the person to be a middle- to old -aged adult. The sternal ends of ribs number 3, 4 and 5 fell between phases 4 and 5. This individual was 30 - 46 years of age at the time of death.

Sex: A narrow subpubic angle, prominent supra orbital tori and medium sized mastoid processes suggested a male. This was supported by metric analyses of the long bones such as the epicondylar breadth of the humerus (60.9 mm) and the maximum diameter of the femoral head (42.7 mm).

Antemortem stature: The physiological length of the femur estimated an antemortem stature of 158.3 ± 2.8 cm.

Dentition: All teeth were present with no signs of carious lesions. Pipesmoker's wear was noted on the upper right second incisor and canine. Tartar deposits were observed.

Pathology and trauma: Both fibulae, the right humerus and left ulna had a blown up appearance with marked sabre-shin formation of both tibiae, indicating advanced stages of treponematosis. Second-degree osteophytes affected most of the vertebrae with spondylolysis of L5. Enthesophyte formations were visible on both acromion processes of the scapulae. Enthesophytes were seen between the distal ends of tibiae and fibulae bilaterally, due to strain on the interosseous membrane. Osteoarthritic changes were visible in the left and right acetabulum.

Conclusion: These were the remains of a 30 - 46 year old male who had been approximately 158 cm tall. He suffered from advanced treponematosis.

GLD N74.8

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were still unfused, indicating a person younger than 25 years of age. All cranial sutures were still open. The epiphyses of the shoulders, wrists and knees as well as the vertebral epiphyseal rings were still unfused. This individual was most likely 16 - 20 years of age at the time of death.

Sex: Prominent supra orbital tori, rounded orbital margins, narrow sciatic notches and a narrow subpubic angle were all morphological characteristics indicating a male. These were supported by metric analyses, such as the maximum diameter of the humeral head (42.6 mm), maximum diameter of the femoral head (42.5 mm) and distal epiphyseal breadth of the tibia (43.4 mm).

Antemortem stature: An antemortem stature of 171.3 ± 2.789cm was estimated using the physiological length of the femur.

Dentition: All teeth were present. Carious lesions were recorded on the buccal surfaces of the upper left second molar and lower left third molar.

Pathology and trauma: Marked striations with clear signs of subperiosteal bone growth were present on the left tibia. These most likely developed due to the presence of scurvy, trauma or initial stages of treponematosis. Spondylolysis of L4 was also recorded. Initial stages of exostoses formation were present bilaterally on the mediodistal ends of the fibulae due to strain on the interosseous memebrane. A heel spur was present on the right calcaneus with clear signs of an infection.

Conclusion: The remains were those of a 16 - 20 year old male who had been approximately 171 cm tall. He suffered from scurvy and showed skeletal lesions caused by strenuous physical activities.

GLD N74.9

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the skull at the west end of the grave. Arms were slightly bent alongside the body and the right foot crossed over the left at the ankles. A copper ring was found on a finger of the right hand.

Preservation: All skeletal remains were well preserved and complete except for some missing carpal bones and phalanges.

Age: The medial ends of the clavicles were still unfused, indicating a person younger than 30 years of age. The spheno-occipital synchondrosis as well as the vertebral epiphyseal rings was fused. All cranial sutures were still open. Third molars had erupted and the roots were closed but no signs of wear were visible. This person was estimated to have been 25 - 29 years of age at the time of death.

Sex: Rounded orbital margins, a sloping forehead, mandibular ramus flexure, narrow sciatic notches as well as a narrow subpubic angle indicated a male. These morphological traits were supported by metric investigations such as the maximum diameter of the humeral head (45.3 mm) and the maximum diameter of the femoral head (50.5 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 172.5 ± 2.8 cm.

Dentition: All teeth were present, except for the postmortem loss of the lower left first incisor. No carious lesions were recorded.

Pathology and trauma: Subperiosteal bone growth lesions were present bilaterally on the tibiae, the left being slightly more affected. Marked striations were also present on the tibiae. These are most likely ossified haematomas and evidence of scurvy or trauma to the anterior tibiae. Enthesophyte formations were present on the mediodistal ends of both fibulae due to strain on the interosseous membrane.

Conclusion: The remains were those of a 25 - 29 year old male who had been approximately 172 cm tall. He most likely suffered from scurvy.

GLD N74.10

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows with the hands resting on the thorax, right arms crossing the left.

Preservation: All skeletal remains were well preserved and complete, except for some missing phalanges.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still in the process of fusion, indicating an individual younger than 30 years of age. Partial fusion of the cranial sutures had occurred and the degree of closure suggested a juvenile to young - adult. Third molars had erupted but showed no signs of wear. The sternal ends of the third, fourth and fifth ribs were in phase 2. It was accordingly estimated that this individual was 20 - 24 years of age at the time of death.

Sex: Medium sized mastoid processes, rounded orbital margins, mandibular ramus flexure, narrow sciatic notches and a narrow subpubic angle suggested a male. This was supported by metric analyses such as the maximum diameter of the humeral head (42.6 mm), the maximum diameter of the femoral head (45.2 mm) and the distal epiphyseal breadth of the tibia (45.9 mm).

Antemortem stature: An antemortem stature of 163.1 ± 2.789cm was estimated from the physiological length of the femur.

Dentition: All teeth were present except for a possible extra upper right first molar which was lost antemortem and the original upper right first molar, which was only represented by a root due to carious activity. Other carious lesion were present on the occlusal surface of the upper left second molar and interdentally on the lower left first and second molars. Enamel hypoplasia was recorded on the lower left canine. An extra cusp was present on both upper third molars.

Pathology and trauma: Enthesophyte formations were seen between the distal tibiae and fibulae bilaterally due to strain on the interosseous membranes. Slight osteoarthritic changes were visible in both acromioclaviclur joints, these most likely developed due to continued elevation of the arms. Schmorl's nodes were recorded from T8 to L3. Enthsophytes were seen in both obturator foramina.

Conclusion: These were the remains of a 20 - 24 year old male who had been approximately 163 cm tall. He had numerous skeletal lesions suggesting regular participation in strenuous physical activities.

GLD N74.11

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. Copper bangles were found around the left forearm.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were still unfused, indicating an individual younger than 25 years of age. Third molars had erupted but the roots were still open. Epiphyses of the shoulders, wrists, iliac crests, vertebral epiphyseal rings and right knee were still unfused. This person was estimated to have been 16 - 20 years of age at the time of death.

Sex: Medium sized mastoid processes, narrow sciatic notches and a narrow subpubic angle suggested a male. The same results were obtained from metric analyses such as the bicondylar breadth of the femur (76.3 mm) and the maximum distal epiphyseal breadth of the tibia (43.6 mm).

Antemortem stature: An antemortem stature of 162 ± 2.789 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present. Enamel hypoplasia was visible on all the upper incisors and canines and on the lower teeth from the right first molar to the left canine.

Pathology and trauma: Bilateral enthesophyte formations were observed between the distal ends of the tibiae and fibulae, due to strain on the interosseous membranes. Schmorl's nodes were noted from L3 to L5. Enlarged nutrient foramina were recorded on the 3rd and 4th metatarsals of the right foot. It was also seen on the fifth metacarpal of the right hand. Premature synostosis of the saggital suture was observed. The coronal and lambdoid sutures were still open while obliteration of the saggital suture had occurred. Fusion most probably came about after growth of the brain had stopped and consequently no secondary malformation had developed.

Conclusion: These were the remains of a 16 - 20 year old male who had been approximately 162 cm tall. He had enamel hypoplasia, skeletal lesions indicative of regular participation in strenuous physical activities and premature synostosis of the saggital suture.

GLD N74.12

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended underneath the body. A copper band was found around the right proximal femur, three strings of copper beads around the left arm as well as a buckle in the vicinity of the remains.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused, indicating a person older than 25 years of age. Cranial sutures were still open suggesting the individual were a juvenile to young - adult ears). Third molars had erupted and were relatively worn. The sternal ends of the third, fourth and fifth ribs fell between phases 4 and 5. This person was estimated to have been 30 - 45 years of age at the time of death.

Sex: Large mastoid processes, rounded orbital margins, a sloping forehead, narrow sciatic notches and a narrow subpubic angle indicated a male. The same results were suggested by metric analyses such as the maximum diameter of the humeral head (44 mm) and the maximum diameter of the femoral head (45.4 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 168 ± 2.8 cm.

Dentition: All teeth were present except for the antemortem loss of the upper left first incisor. No carious lesions or enamel hypoplasia were recorded. Periodontal disease was observed.

Pathology and trauma: No signs of trauma or pathology were recorded.

Conclusion: The remains were those of a 30 - 45 year old male who had been approximately 168 cm tall. He suffered from periodontal disease, with no other signs of trauma or pathology.

GLD N 100.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: Skeletal remains were well preserved. All the bones were present except for the mandible and 3 vertebrae.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as sacral segments 1 and 2 were fused, indicating a person older than 30 years of age. Advanced second-degree osteophytes were present on the lumbar vertebrae. All permanent teeth had erupted and the third molars were very worn. The sternal ends of ribs 3, 4 and 5 fell between phases 5 and 6. This individual was most probably 40 - 55 years of age.

Sex: The relatively prominent supraorbital torii, rounded orbital margins, prominent occipital protruberance, narrow sciatic notches and narrow subpubic angle were all indicative of a male. This was supported by metric analysis of the femora, tibiae and humeri.

Antemortem stature: According to the physiological length of the femur this person was approximately 167 ± 2.8 cm tall.

Dentition: This individual had severe periodontal disease. No carious lesions were present. In the maxilla both central incisors and the right second incisor were lost postmortem. Both first molars and the left second premolar were lost antemortem. Mandibular teeth were only represented by the right second incisor and canine, the rest were lost with the mandible.

Pathology and trauma: Enthesophyte formations were present on the mediodiatal surfaces of both fibulae, they were more severe on the right side and developed due to continuous train on the interosseous membrane. Bilateral periostitis of the calcaneus bones was noted, this most likely developed due to constant infection of the feet. Advanced osteophytic outgrowths were observed on the lumbar vertebrae as well as enthesophyte formations on the patellae. Taking into consideration the estimated age of the individual, these outgrowths most likely represent normal degenerative patterns. A healed fracture of the left parietal bone was present. It was a round lesion with a diameter of about 28 mm.

Conclusion: These were the remains of a 40 - 55 year old male who had been approximately 167 cm tall. He had a healed fracture of the left parietal bone.

GLD N100.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows and resting on the chest.

Preservation: The skeletal remains were well preserved and the skeleton was complete, with only a few tarsals, carpals and phalanges missing.

Age: Third molars had erupted and were slightly worn. The medial end of the clavicles, spheno-occipital synchondrosis as well as sacral segments 1 and 2 were fused, indicating an individual older than 25 years. Only initial stages of osteophytic outgrowths were present on the lumbar vertebrae. The degree of cranial suture closure estimated the individual to be a young or middle - adult. The sternal ends of ribs 3, 4 and 5 fell between phases 3 and 4. This person was most likely 28 - 38 years of age at the time of death.

Sex: Although this person had a relatively rounded pelvic inlet and small mastoid processes, metric analysis of the femoral head (44.1 mm), proximal tibia (77.6 mm) and other bones as well as mandibular ramus flexure and rounded orbital margins suggested a male.

Antemortem stature: The physiological length of the femur estimated this individual to have been approximately 166.3 ± 2.8 cm tall.

Dentition: All teeth were present in the maxilla and no carious lesions were observed. In the mandible the right second premolar and left first incisor and first premolar were lost postmortem, the rest of the teeth were present. Carious lesions were visible on the occlusal surfaces of the right third molar and the left second molar.

Pathology and trauma: Subperiosteal bone growth lesions were present on the anterior aspect of the left femur in the proximal half, as well as on the proximal half of the right fibula on the lateral surface, giving it a slightly blown up appearance. Striations with patches of subperiosteal bone growth were present on the tibiae. A possible gummatous lesion was visible on the lateral aspect on the proximal right fibula. These may be an indication of treponematosis. A healed fracture of the right clavicle was present with severe callus formation. Second-degree osteophytes were noted on the lumbar vertebrae as well as enthesophytes in the left and right obturator foramen.

Conclusion: These were the remains of a 28 - 38 year old male who had been approximately 166 cm tall. Lesions suggestive of treponematosis were recorded as well as a healed fracture of the right clavicle.

GLD N100.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows, resting on the chest.

Preservation: The skeletal remain were well-preserved and complete.

Age: The medial end of the clavicles as well as the first and second sacral segments were fused, indicating an individual older than 25 years. Third molars were fully erupted and relatively worn. Only initial stages of first-degree osteophytes were visible on the lumbar vertebrae. Cranial suture estimated the person to be a young to middle - adult. The sternal ends of the ribs were in phase 3. This individual was most likely 25 - 30 years of age at the time of death.

Sex: The sloping forehead, rounded orbital margins, mandibular ramus flexure and medium sized mastoid processes were all indicative of a male. Metric analyses of the maximum diameter of the femoral head (48 mm), femoral circumference at mid shaft (95 mm) and the maximum diameter of the humeral head (43.9 mm) supported that this individual was male.

Antemortem stature: An antemortem stature of approximately 166 ± 2.8 cm was estimated using the physiological length of the femur.

Dentition: In the maxilla, both central incisors were lost antemortem, both lateral incisors were lost postmortem and the left canine was only represented by a root. In the mandible, all incisors as well as the left canine were lost antemortem with the left first premolar only being represented by a root.

Pathology and trauma: Enthesophytes were visible between the distal ends of the tibiae and fibulae. These most likely developed due to constant strain on the interosseous membrane. Enthesophytes were recorded on the popliteal line of the left tibia as well as on the radial tuberosity of the right radius due to stresses of the biceps muscle on the radius. All these lesions suggested possible regular participation in strenuous physical activities.

Conclusion: These were the remains of a 25 - 30 year old male who had been approximately 166 cm tall. Lesions suggesting regular participation in strenuous physical activities were noted.

GLD N100.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end, on the south side of the grave. Arms were extended alongside the body.

Preservation: The skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused, indicating an individual younger than 30 years of age. All permanent teeth had erupted. The sternal ends of ribs 3, 4 and 5 were in phase 1. This individual was most likely 18 - 23 years of age at time of death.

Sex: Morphological characteristics such as mandibular ramus flexure, a square chin, sloping forehead and narrow sacrum were indicative of a male. This was supported by metric analysis of the maximum diameter of the humeral head (43.7 mm), maximum diameter of the femoral head (45.1 mm) and femoral bicondylar breadth (77.4 mm).

Antemortem stature: This individual was approximately 160 ± 2.789cm tall. (Physiological length of the femur)

Dentition: All permanent teeth had erupted and showed very little dental wear. A slight tartar deposit was present on most of the teeth. All the teeth were present and no carious lesions were observed.

Pathology and trauma: Criba orbitalia was present in the right orbit. Craniostenosis developed due to premature closure of the saggital suture. The individual had an extra thoracic vertebrae and L5 was extremely asymmetrical with a bony mass on the right side. Burn marks were present on many of the bones.

Conclusion: These were the remains of a 18 - 23 year old male who had been approximately 160 cm tall. He had criba orbitalia as well as craniostenosis. An extra thoracic vertebra was also recorded.

GLD N100.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave, next to GLD N100.4. Arms were extended alongside the body. A copper bangle was found around the lower left arm.

Preservation: The skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were still unfused, indicating and individual younger than 25 years. All permanent teeth had erupted but the third molars were not fully erupted yet. The humeral heads as well as the iliac crests were still unfused. Sternal ends of ribs 3, 4 and 5 fell between phases 1 and 2. This person was most likely 19 - 23 years of age at the time of death.

Sex: Wide sciatic notches, a preauricular sulcus, small mastoid processes and a generally gracile skeleton suggested a possible female. This was supported by metric analyses such as the circumference of the femur at midshaft (74.7 mm) and the circumference of the tibia at the level of the nutrient foramen (83 mm). Some of the other measurements such as the maximum diameter of the femoral head (42.1 mm) could not be interpreted as either male or female. This person was most probably female.

Antemortem stature: The physiological length of the femur indicated an individual who was approximately 157.3 ± 2.789 cm tall.

Dentition: All permanent teeth had erupted and very little dental wear was visible. In the mandible, all teeth were present except for the left incisors, which were lost antemortem. An extra right second premolar was present medial to the first premolar. All teeth were present in the mandible. Enamel hypoplasia was observed on the right second premolar, and the left canine and second premolar. Abscesses leading to almost total crown destruction were seen on both lower first molars.

Pathology and trauma: Slight non-specific striations were visible on the tibiae. The fifth metacarpal on both hands were very bowed.

Conclusion: These were the remains of a 19 - 23 year old female who had been approximately 157 cm tall.

GLD NOP3/4.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The arms were extended alongside the remains.

Preservation: All skeletal remains were very well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. The first and second sacral segments were still unfused. The degree of cranial suture closure suggested a middle-age adult. The sternal ends of the ribs fell within phase 3. This person was most likely 25 - 35 years of age at the time of death.

Sex: Very narrow sciatic notches, triangular pubic bones and a narrow subpubic angle suggested a possible male. The same results were obtained from metric analyses of the long bones such as the maximum diameter of the humeral head (42.1 mm) and the maximum diameter of the femoral head (46.7 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 161.9 ± 2.8 cm.

Dentition: All teeth were present and a single carious lesion was present on the lingual surface of the upper right second premolar.

Pathology and Trauma: Spondylolysis with spondylolythesis of L5 was recorded with the neural arch not fitting on the vertebral body, denoting longstanding subluxation. Vertebral osteophytes were present on L4 and L5 and wedging of L4 was also observed. L5 does not seem to have a neural arch, with its supposed neural arch fitting perfectly onto S1. Articulation of the sacrum with the os coxa is slightly lower on the left than on the right. This may be and indication of early kyphosescoliosis. Three lesions found on the frontal bone were suggestive of gummatous lesions caused by treponematosis infection, with the one above the right orbit having a stellate appearance.

Conclusion: These were the remains of a 25 - 35 year old male who had been approximately 161 cm tall. Several vertebral abnormalities as well as possible treponemal infection were recorded.

GLD NOP3/4.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. A single button was found in the vicinity of the remains.

Preservation: All skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed only a slight indication of dental wear. No vertebral osteophytes were observed. The degree of cranial suture closure suggested a young to middle-adult. The sternal ends of the third, fourth and fifth ribs were in phase 3. This person was most likely 25 - 35 years of age at the time of death.

Sex: Narrow sciatic notches, a narrow subpubic angle, triangular pubic bones as well as a long narrow sacrum suggested a male. Metric analyses of the long bones such as the maximum diameter of the humeral head (45.4 mm) and the maximum diameter of the femoral head (46.6 mm) supported this.

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 165.3 ± 2.8 cm.

Dentition: All teeth were present except for all the lower first molars, second molars and right third molar, which were lost antemortem. Carious lesions were present on the lingual surface of the upper right lateral incisor, occlusal surface of the upper right third molar, buccal surface of the lower left third molars as well as interdentally on the lower right first premolar. Abscesses causing total crown destruction were present on the upper right second molar, left lateral incisor, left first premolar as well as the left second molar. Enamel hypoplasia was noted on the lower canines.

Pathology and trauma: Widespread striations with osteomyelitic changes and subperiosteal bone deposition were noted on both tibiae. The left tibia was more affected and it had a saberchin appearance. The left fibula was also affected and had a blown up appearance. These are most likely an indication of treponematosis infection. Softening of the nasal bones making them thin and atropic was also noted.

Histological observations: On transverse section it could be seen that the bone was extremely thickened and comparable to N74.7 although it was not as porous. Only slight porosity was visible macroscopically on transverse section.

Histological investigations a relatively intact periosteal surface, represented by the original circumferential lamellae, interrupted in several instances across the section. Appositional bone was observed on top of the original periosteal surface and it appeared to have a radiating structure. The cortical bone presented with more resorption holes than would be expected for in normal bone.

It was concluded that this section was most likely taken from a lesion caused by an ossified haematoma as was supported by the intact periosteal surface and radiating new bone structure. Resorption holes across the section giving the sample a slightly porous appearance suggest that an infections disease was also active in this individual.

Conclusion: These were the remains of a 25 - 35 year old male who had been approximately 165 cm tall. Lesions suggesting possible treponematosis and scurvy were observed.

GLD S.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: Only the skull, right scapula, six cervical and one thoracic vertebra were present and well preserved.

Age: Third molars were fully erupted and worn. The spheno-occipital synchondrosis as well as the vertebral epiphyseal rings were fused, indicating an individual older than 25 years of age. Signs of first-degree osteophytes were present on the vertebrae. The degree of cranial suture closure estimated this individual to be a young to middle-aged adult. This person was estimated to have been 30 - 50 years of age at the time of death.

Sex: A slight supraorbital torus, rounded orbital margins and large mastoid processes suggested a male.

Antemortem stature: An estimation of antemortem stature was impossible due to the fragmentary condition of the remains.

Dentition: All teeth were present in the maxilla with signs of enamel hypoplasia on both canines. Advanced tartar deposits were visible. An enamel pearl could be seen on the left third molar.

Pathology and trauma: No trauma of pathology was observed.

Conclusion: These were the remains of a 30 - 50 year old male. No trauma or pathology was observed.

GLD S1.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: All the elements, which included a skull, mandible, six complete ribs and rib fragments, four lumbar and one cervical vertebra, were well preserved.

Age: The spheno-occipital synchondrosis was fused, third molars had erupted and showed signs of dental wear. The degree of cranial suture closure estimated this person to have been a young- to middle-aged adult. The sternal ends of the ribs estimated were in phase 3. This person was most likely 30 - 45 years at the time of death.

Sex: A prominent supraorbital torus, sloping forehead, large mastoid processes, rounded orbital margins and mandibular ramus flexure suggested a male.

Antemortem stature: Antemortem stature could not be determined due to the fragmentary conditions of the remains.

Dentition: All teeth were present with no indication of carious lesions. A tartar deposit was present on most teeth with slight periodontal disease.

Pathology and trauma: A healed nasal fracture was recorded.

Conclusion: These were the remains of a 30 - 45 year old male. He had slight periodontal disease as well as a healed fracture of the nasal bone.

GLD S1.3

Burial position: This individual was buried without a coffin. Remains were in an extended, supine position with the head at the west end of the grave.

Preservation: All skeletal elements were relatively well preserved and complete except for the right humerus and left os coxa, which were fragmented. Ulnae and radii, five cervical and all lumbar vertebrae, phalanges as well as a few carpal bones were missing. Two extra metacarpals were present.

Age: The medial ends of the clavicles were still unfused. Third molars had erupted, but showed no signs of wear. The vertebral margins of the scaplae were still unfused. This person was most likely 20 - 24 years of age at the time of death.

Sex: A sloping forehead, relatively prominent supraorbital tori and large mastoid processes suggested a male. This was supported by metric analysis of the long bones such as the maximum diameter of the humeral head (43.7 mm), maximum diameter of the femoral head (45.6 mm) and the distal epiphyseal breadth of the tibia (49.4 mm).

Antemortem stature: The physiological length of the femur suggested an antemortem stature of 170.4 ± 2.8 cm.

Dentition: All teeth were present except for the lower right first molar, which was lost antemortem. Carious lesions were present on the occlusal surfaces of the upper left third and lower right second molars.

Pathology and trauma: Slight periostitis was observed on both feet, predominantly affecting the tali. Enthesophytes were seen on the mediodistal aspect of the right fibula. This most likely developed due to constant strain on the interosseous membrane. Clear striations were present on both tibiae with a prominent sclerotic lesion, giving the bone a saber-shin appearance, in the middle and the anterior right tibia. Gummatous lesions were also present on the right tibia. These lesions most likely developed due to treponemal disease. Periostitic changes were also present on the medial maleoli of the left and right tibiae.

Histological observations: A clear original periosteal line could be visualized macroscopically on cross section. The very thick new bone apposition could be easily distinguished from the original compact bone. The bone had a slightly porous appearance on cross section.

Histological investigations revealed that the original periosteal surface, represented by the external circumferential lamellae, could easily be visualized throughout the section. Although the appositional bone was not comprised of radiating trabeculae, it still had a radiating architecture. The original compact bone was generally unaffected by the pathological condition.

It was concluded that this section was most likely taken from a lesions caused by an ossified haematoma, as indicated by the intact periosteal surface and radiating stricture of the newly formed bone. The presence of resorption holes in the appositional bone do however suggest that and infectious disease might have been active in this individual as well.

Conclusion: These were the remains of a 20 - 24 year old male who had been approximately 170 cm tall. He most likely suffered from treponemal disease and scurvy.

GLD S1.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A metal plate, which might be part of the grave in-fill, was found under the thorax.

Preservation: All skeletal elements were relatively well preserved. The right ulna and radius were damaged. One thoracic vertebra, several ribs, six carpal bones, four metacarpals and hand and foot phalanges were missing.

Age: The medial ends of the clavicles as well as the first and second sacral segments were unfused. Third molars had erupted and all vertebral epiphyseal rings were fused. The sternal ends of the third, fourth and fifth ribs were in phase 2. This person was most likely 20 - 25 years of age at the time of death.

Sex: Rounded orbital margins, slight supraorbital tori and large mastoid processes suggested a male. These morphological characteristics were supported by metric analyses such as the maximum diameter of the humeral head (41.3 mm) and the maximum diameter of the femoral head (42.7 mm).

Antemortem stature: Using the physiological length of the femur, stature was estimated at 164.8 ± 2.8 cm.

Dentition: All teeth were present except for the upper left first molar, which was lost antemortem. Signs of enamel hypoplasia were present on the upper second incisor and canine as well as all the lower incisors and canines. Carious lesions were present on the lingual surface of the upper right second incisor, occlusal surfaces of the upper second molars, as well as interdentally on the lower right second premolar and first molar. The upper right second incisors were shovel shaped.

Pathology and trauma: Enthesophytes were present on the mediodistal aspects of both fibulae, due to strain exerted on the interossious membrane. Schmorl's nodes were present on L3 and L4. Pitting on the articular surfaces of some phalanges and ankylosis of other phalanges were observed and can most likely be ascribed to osteoarthritic changes. Cortical pitting of the humerus at the implantation sight of Latissimus dorsi was also present on the left side.

Conclusion: These were the remains of a 20 - 25 year old male who had been approximately 164 cm tall. He had several carious lesions and evidence of enamel hypoplasia.

GLD S1.5

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A copper bangle was found around the left radius and ulna.

Preservation: Skeletal elements were relatively well preserved, except for the vertebrae, ribs, scapulae and pelvis, which were damaged and broken. Hand and foot bones were fragmented and incomplete.

Age: The medial ends of the clavicles as well as the first and second sacral segments were fused. Third molars had erupted and only showed a slight indication of dental wear. Second and third degree osteophytes were present on the lumbar vertebrae. The sternal ends of the ribs fell between phases 4 and 5. This person was most likely 35 - 45 years of age at the time of death.

Sex: Large mastoid processes, a prominent nuchal crest, curved sacrum and extremely narrow sciatic notches suggested a male. This was supported by metric analyses of the maximum diameter of the humeral head (44.3 mm), as well as the maximum diameter of the femoral head (45.3 mm).

Antemortem stature: Using the physiological length of the femur stature was estimated at 162.9 ± 2.8 cm.

Dentition: All teeth were present except for the upper right canine, which was only represented by a root due to antemortem trauma. The lower left canine was laterally rotated. Pitted enamel hypoplasia was observed on the buccal surface of the lower left second premolar. Severe periodontal disease was present as well as a thick tartar deposit.

Pathology and trauma: Heel spurs and periostitis were present on the left and right calcaneus. Enthesophytes were present on the distal ends of the tibiae and fibulae with clear periostitic changes, these most likely developed due to continuous strain on the interosseous membrane. Cortical pitting and subperiosteal bone growth were noted on the neck of the left femur, this most likely developed due to strain on the iliofemoral ligament. Bone changes, most likely due to chronic inflamation were present on the ishial tuberosities and the lateral condyle of the left humerus. Bilateral osteoarthritic changes of the lateral ends of the clavicles were also noted, this probably developed due to frequent elevation of the arms.

Conclusion: These were the remains of a 35 - 45 year old male who had been approximately 162 cm tall. Several stress makers indicative of constant strenuous physical activity were observed on the remains.

GLD S1.6

Burial position: This individual was buried without a coffin.

Preservation: All remains were relatively well preserved but fragmented, the skull, clavicles and scapulae were not measurable. All elements were present except for some missing phalanges.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused. Third molars had erupted, but no dental wear were present on them and the roots were still open. The iliac crests and ischial tuberosities were only partly fused and vertebral epiphyseal rings in the thoracic region were still unfused. This person was most likely 18 - 23 years of age at the time of death.

Sex: Mandibular ramus flexure, prominent gonial eversion, narrow sciatic notches and a long narrow sacrum suggested a male. This was supported by metric analyses of the maximum diameter of the humeral head (46.3 mm) as well as the maximum diameter of the femoral head (48 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 172.8 ± 2.8 cm.

Dentition: No maxillary teeth were recorded. All teeth were present in the mandible. No carious lesions or enamel hypoplasio were observed.

Pathology and trauma: Osteoarthritic changes causing pitting of the articular surfaces on the talus and calcaneus of both feet as well as the distal left fibulae were noted. Marginal osteophytes were also present on the tali and calcanei.

Conclusion: These were the remains of a 18 - 23 year old male who had been approximately 172 cm tall. He presented with arthritic changes of the feet.

GLD S2.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: The remains were relatively well preserved but fragmented and incomplete. The skull, mandible, clavicles, distal end of left radius, distal end of left femur, right humeral head, tibiae, fibulae and feet, missing only a few phalanges, were recovered. The scapulae, vertebrae and ribs were present but damaged. An additional, tarsal, three metatarsals and 10 phalanges of a foot were recovered that did not belong to this person.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. Third molars had erupted and were well worn. Cranial sutures were more than 50% closed, indicating a young- to middle-aged adult. This person was most likely 35 - 45 years of age at the time of death.

Sex: Rounded orbital margins, large mastoid processes and a generally robust skull and mandible suggested a male. This was supported by metric analyses such as the maximum diameter of the humeral head (43.7 mm) and the maximum proximal epiphyseal breadth of the tibia (75.4 mm).

Antemortem stature: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: All teeth were present except for the postmortem loss of the lower left first incisor. A single carious lesion was present on the buccal surface of the upper left second molar. This individual suffered from severe periodontal disease and had a thick tartar deposit on most teeth.

Pathology and trauma: Clear striations with a slight indication of new subperiosteal bone deposition were seen on the left tibia. These could be due to localized trauma to the anterior left tibiae or haematoma formation as a result of scurvy. Enthesophytes were observed on the mediodistal aspect of the right fibula, this most likely developed due to strain on the interosseous membrane.

Conclusion: These were the remains of a male, 35 - 45 years of age. He had lesions on the anterior surface of his left tibia suggesting either trauma or scurvy.

GLD S2.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: The remains were fragmented and damaged. The skull, mandible and pelvis were missing. Skeletal elements present in this box represent at least two or three individual. An extra left femur, left distal radius and ulna as well as a left patella, which might belong to the femur, were found. For the purpose of the report the almost complete postcranial remains were labeled individual **A,** the left femur and patella, individual **B**, and the distal left radius and ulna, individual **C**.

Age: Due to the fragmentary condition of the remains all three individuals can only be described as adult.

Sex: Individual A and B: No skulls or os coxae were present. But the remains were generally robust and metric analyses such as the maximum diameter of the femoral head (A, 44.4 mm. B, 43.7 mm) suggested that both individuals were male.

Individual C: Sex could not be determined due to the fragmentary condition of the remains.

Antemortem stature: Due to the fragmentary condition of the remains antemortem stature could not be determined for any of these individuals.

Dentition: No teeth were found.

Pathology and trauma: Individual A: Severe subperiosteal bone growth was present on the distal ends of both tibiae. The right calcaneus showed clear signs of infection. The distal end of the right fibula was also severely infected with new bone growth. Heel spurs and enthesophyte formation at the implantation site of the achilles tendon were present on both calcanei. Enthesophytes were also present on the distal fibulae due to strain on the interosseuos membrane.

Conclusion: These were the remains of at least two adult males; individual A had suffered from a chronic infection of the feet.

GLD S2.3

Burial position: This individual was buried without a coffin. Remains were in an extended, prone position with the head at the west end of the grave.

Preservation: All remains were relatively well preserved but extremely fragmented. Scapulae, clavicles, pelvis, some metatarsals and phalanges of the foot were missing.

Age: The first and second sacral segments were still unfused. Third molars had erupted but were not worn. All vertebral epiphyseal rings were unfused. The degree of cranial suture closure indicated a juvenile to young-age adult, most likely 20 - 25 years of age at the time of death.

Sex: Medium sized supraorbital tori and a sloping forehead suggested a male. Metric analyses of the bicondylar breadth of the humerus (64.3 mm) and bicondylar breadth of the femur (76.1 mm) supported this.

Antemortem stature: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: All teeth were present except for the upper left first incisor and canine, which were lost postmortem. No carious lesions were observed.

Pathology and trauma: The left tibiotalar-joint was fused together, with only a slight indication of infection on the two bones. Fusion most likely occurred due to trauma of the affected joint. A healed transverse fracture at approximately mid-shaft were present on the right radius. An antemortem oblique fracture with radiating fracture lines and no sign of healing were noted 65 mm below the lesser trochanter of the right femur.

Conclusion: These were the remains of a male, who had been betweenm 20 - 25 years of age. He had ankylosis of the tibiotalar-joint, a healed fracture of the radius, and an unhealed antemortem fracture of the right femur.

GLD S2.4

Burial position: This individual was buried without a coffin. The remains were in an extended position on its left side with the head at the west end of the grave. A copper ring was found on the right hand as well as pieces of woven material near the left heel.

Preservation: Remains were well preserved and complete with only some phalanges missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed some dental wear. First-degree osteophytes were present on the lumbar vertebrae. The sternal ends of ribs 3, 4 and 5 were in phase 5. This person was most likely 33 - 43 years of age at the time of death.

Sex: Medium sized supreorbital tori, wide sciatic notches, a wide subpubic angle, preauricular sulci and a round pelvic inlet suggested a female. This was supported by metric analyses such as the maximum diameter of the humeral head (55.9 mm) and the bicondylar breadth of the femur (72.8 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 159.8 ± 2.8 cm.

Dentition: All teeth were present except for the lower second molar, which was lost antemortem. Carious lesions were present on the occlusal surface of the upper left second molar and interdentally on the lower right second premolar. Periapical abscesses were present on the lower right third and left first molars. Severe periodontal disease was present with a thick tartar deposit.

Pathology and trauma: A well-healed fracture was noted on the lateral right clavicle with subsequent osteophytic development on the acromial end, leading to pseudoarthrosis with the acromion process. A healed fracture of the nasal bone was also present. Osteophytic outgrowths and slight periostitis were also recorded on the right acromion. Enthesophytes were present on the mediodistal and laterodistal ends of the tibiae and fibulae, these most likely developed due to strain exerted on the interosseuos membrane. Exostosis formation was also present on the posterior aspect of the left femur in the distal third. This most likely developed due to strain and/or trauma to vastus medialis. Striations and subperiosteal bone growth were present on the anterior surfaces of both tibiae. The lesions were localized and well developed. These lesions can be either due to treponematosis infection, although no other lesions indicating such were present, haematoma formation related to scurvy or trauma. Enthesophytes were present at the inplantation sight of achilles tendon on the left and right calcaneus.

Histological observations: Macroscopic investigation of the transverse section through the lesions did not show any diagnostic feature and seemed relatively normal except for a very uneven periosteal surface.

Microscopic inspection revealed severe fungus infestation making examination with polarized light impossible. Nevertheless some diagnostic features could be identified. Clear and unaffected external circumferential lamellae underneath newly formed bone could be visualized. The lamellae could be followed throughout the section although it was interrupted in some places. The original compact bone seemed unaffected and normal. The newly formed bone had a radiating bone structure.

It was concluded that this section most likely came from a lesions caused by an ossified haematoma.

Conclusion: These were the remains of a 33 - 43 year old female who had been approximately 159 cm tall. She had healed fractures of the nasal bone and clavicle as well as several indication of participation in strenuous physical activity. She also suffered from either treponemal disease or scurvy, which had caused subperiosteal lesions on the anterior surfaces of both tibiae.

GLD S2.5

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the west end of the grave. Pieces of metal were found above the right femur.

Preservation: The skeletal remains were poorly preserved; the bones were brittle and fragmented. A damaged skull and mandible, right clavicle and scapula, both humerii, fragments of vertebrae, proximal ends of left ulna and radius, fragmented pelvis, femora, tibiae, fibulae and only a few hand and foot bones were present.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted with little to no sign of dental wear. The sternal ends of ribs 3, 4 and 5 were in phase 3. This individual was most likely 25 - 30 years of age at the time of death.

Sex: Slight mandibular ramus flexure, large mastoid processes, a long narrow curving sacrum and narrow sciatic notches suggested a male. This was supported by metric analyses of the long bones such as the maximum diameter of the humeral head (42.2 mm) and the maximum diameter of the femoral head (43 mm).

Antemortem stature: The physiological length of the femur yielded an estimated stature of 162.9 ± 2.8 cm.

Dentition: All teeth were present. This person suffered from severe periodontal disease.

Pathology and trauma: Bilateral periostitis of the acromion processes were observed, and had most likely developed due to constant elevation of the arms. Enthesophytes were present below the neck of the left femur on the anterior aspect, these developed due to strain on the iliofemoral ligament. A heelspur was present on the right calcaneus, with enthesophyte formation on the implantation site of the achilles tendon on both calcanei.

Conclusion: These were the remains of a 25 - 30 year old male who had been approximately 162 cm tall. There were several lesions suggesting regular participation in strenuous physical activity.

GLD S2.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: All skeletal remains were well preserved and complete except for a missing left foot and fragmented ribs.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and were slightly worn. The degree of cranial suture closure suggested a young- to middle-aged adult. The sternal ends of the third, fourth and fifth ribs fell in phase 5. This person was most likely 35 - 46 years of age at the time of death.

Sex: Rounded orbital margins, large supraorbital tori, medium sized mastoid processes, narrow sciatic notches, a narrow subpubic angle and a heart-shaped pelvic inlet suggested a possible male. Metric analyses of the long bones such as the maximum diameter of the humeral head (42.7 mm) and the maximum diameter of the femoral head (43.6 mm) supported this finding.

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 165.8 ± 2.8 cm.

Dentition: All teeth were present except for the upper left third molar, which was lost antemortem. There were no carious lesions, only slight tartar deposits.

Pathology and trauma: This individual had an amputation of the left foot, which had caused ankylosis of the left distal tibia and fibula with some osteophytic outgrowths on the distal end. Enthesophytes were seen between the distal ends of the right tibia and fibula due to strain exerted on the interosseous membrane. Osteoarthritic changes were present in the left sacroiliac joint giving the auricular surface a pitted appearance. These change are most likely due to traumatic arthritis associated with the amputation. A healed fracture of the right fifth metacarpal present. Longstanding subluxation of the sternal end of the right clavicle was also observed and caused an alteration to the sternoclavicular joint.

Conclusion: This was the remains of a 35 - 46 year old male who had been approximately 165 cm tall. He had a well-healed amputation of the left foot, slight arthritis of the left sacroiliac joint, a healed fracture of the right fifth metacarpal and longstanding subluxation of the right clavicle.

GLD S2.7

Burial position: This individual was buried without a coffin. The remains were in an extended position, on its right side, with the head at the west end of the grave.

Preservation: Skeletal remains were well preserved and complete. A humeral shaft wrapped in cloth was found with this individual as well as a left radius and ulna and left hand bones wrapped separately. There seem to be no association between these remains, and it is assumed that they belong to 3 separate individuals. For the purpose of this report the complete skeleton will be named individual **A**, the humeral shaft, individual **B**, and the forearm, individual **C**.

Age: Individual A: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed signs of slight dental wear. First-degree osteophytes were present on the lumbar vertebrae. The degree of cranial suture closure suggested a middle- to old-aged adult. The sternal ends of the ribs were in phase 5. This person was most likely 38 - 50 years of age at the time of death.

Individual B: Age could not be determined, due to the amputation of both epiphyseal ends.

Individual C: The distal epiphyses of the radius and ulna were fused, suggesting that it belonged to an adult.

Sex: Individual A: Rounded orbital margins, very narrow sciatic notches, a narrow subpubic angle, heart-shaped pelvic inlet and mandibular ramus flexure indicated a male.

These characteristics were supported by the metric analyses such as the maximum diameter of the humeral head (43.5 mm) and the maximum diameter of the femoral head (42.9 mm).

Individual B and C: Sex could not be determined due to the fragmentary condition of the remains.

Antemortem stature: Individual A: The physiological length of the femur estimated stature at 163.1 ± 2.8 cm.

Individual B and C: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: Individual A: All teeth were present. A carious lesion was present on the occlusal surface of the lower right third molar. A huge abscess, causing total crown destruction of the upper right third molar, was recorded. The individual suffered from slight periodontal disease and had a moderate tartar deposit especially on the front teeth.

Pathology and trauma: Individual A: Bilateral osteoarthritis of the acromioclaviclular joint were recorded, this most likely developed due to repeated elevation of the arms. Enthesophytes between the distal tibiae and fibulae were present due to continuous strain on the interosseous membrane. Schmorl's nodes were observed from T7 to T9. Enthesophyte formations were present on both calcanei at the implantation site of the achilles tendon.

Individual B: This 137 mm long humeral shaft was amputated at the proximal and distal ends, with widespread infection and new bone formation. The distal amputation was, perhaps, not successful and lead to a second amputation, in which the entire arm was removed.

Individual C: The left radius and ulna were amputated just below the elbow. Clear signs of infection were present at the site of amputation, as well as in the hand leading to ankylosis between the hamatum and capitate.

Conclusion: These were the remains of three individuals

Individual A: A 38 -50 year old male who had been approximately 163 cm tall. He presented with several lesions indicative of frequent participation in strenuous physical activities.

Individual B: The age and sex of this individual could not be determined. He was represented by a humeral shaft, amputated at both ends with signs of severe infection.

Individual C: This amputated lower arm and hand belonged to an adult. Widespread signs of infection were recorded.

GLD S2.8

Burial position: This individual was buried without a coffin. The remains were in an extended position, on its left side, with the head at the west end of the grave.

Preservation: Remains were relatively well preserved but extremely damaged and fragmented. All skeletal elements were represented by the fragments except for the hands and right patella, which were missing.

Age: The first and second sacral segments were still unfused. Third molars had erupted and showed signs of slight wear. Vertebral epiphyseal rings were fused. This person was most likely 22 - 30 years of age at the time of death.

Sex: Large mastoid processes, rounded orbital margins, a narrow curved sacrum and very narrow sciatic notches suggested a male. The morphological findings were supported by metric analyses, such as the epicondylar breadth of the humerus (59.5 mm) and the maximum diameter of the femoral head (42.7 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 163.1 ± 2.8 cm.

Dentition: All teeth were present, except for the upper right second incisor, upper left first molar and lower central incisors, which were lost postmortem. The upper left second molar, lower right first and second molars, both lower left premolars as well as the second molar were lost antemortem. Dental care was evidently neglected, and the individual suffered from severe periodontal disease. Periapical abscesses were noted at the upper right central incisor, and second molar as well as the upper left first molar. Carious lesions were present on the occlusal surfaces of the upper right first premolar, upper left first premolar and third molar and the lower left first and third molars. A retained deciduous canine were present next to the permanent left canine in the mandible.

Pathology and trauma: An extra lumbar vertebra was recorded. Enthesophytes were present on the mediodistal aspect of the right fibula, these most likely developed due to prolonged strain on the interosseous membrane.

Conclusion: These were the remains of a 22 - 30 year old male who had been approximately 163 cm tall. Neglected dental care caused several carious lesions and periapical abscesses. He had retention of a lower left deciduous canine into adulthood as well as an extra lumbar vertebra.

GLD S2.9

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the west end of the grave.

Preservation: The skeletal remains were very well preserved and complete, except for a few carpal bones, which were missing.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. The first and second sacral segments were still unfused. Third molars had erupted and were relatively worn. Second-degree osteophytes were present on the lumbar vertebrae. The sternal ends of ribs 3, 4 and 5 were in phase 5. This person was most likely 35 - 48 years of age at the time of death.

Sex: Rounded orbital margins, prominent supra orbital tori, a sloping forehead, large mastoid processes, a curved sacrum and a narrow subpubic angle suggested a male. The same results were obtained from metric analyses of the long bones, such as the maximum diameter of the humeral head (45 mm) and the maximum diameter of the femoral head (46 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 167.5 ± 2.8 cm.

Dentition: All teeth were present. Carious lesions were observed on the buccal surfaces of the lower right second molar and left first and second molar. Slight periodontal disease were present around the upper and lower central teeth.

Pathology and trauma: Enthesophytes between the distal ends of both tibiae and fibulae were present due to prolonged strain of the interosseous membrane. Straitions were present on the anterior surface of both tibiae with a slight indication of subperiosteal bone growth. These could have developed due to the presence of scurvy, trauma to the anterior tibiae, or it may be early signs of a treponemal infection. A single possible gummatous lesion on the frontal bone might support treponemal disease. A healed fracture was present on the right eighth rib as well as a well healed spiral fracture of the left femur. Bilateral osteoarthritic changes of the acriomioclavicular joints were recorded, these most likely developed due to continuous elevation of the arms. Enthesophyte formations were noted in the obturator foramen, on the anterior patellae, as well as at the implantation site of the achilles tendon on the calcanei. These bony outgrowths as well as the osteoarthritic changes in the acromioclavicular joints suggested frequent participation in strenuous physical activities. Schmorl's nodes were present from L1 to L3.

Histological observation: Macroscopic investigations of the transverse section through the lesion did not show any evidence of pathological changes except for a slightly uneven periosteal surface.

Histological inspection of the periosteal surface indicated that the striations observed macroscopically did not develop due to pathological changes and was merely normal morphological variation. The circumferential lamellae were normal and continues throughout the wavelike striations on the periosteal surface and no evidence of newly formed bone were visible.

It was accordingly concluded that the striations visible on macroscopic level was not pathological and that it can be ascribed to normal variation.

Conclusion: These were the remains of a 35 - 48 year old male who had been approximately 167cm tall. There were several stress makers visible on the remains suggesting regular participation in strenuous physical activities as well as two healed fractures.

GLD S2.10

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: The skeletal remains were not well preserved. All elements were present except for a single carpal bone and some phalanges, which were missing. The mandible, scapula and ribs were fragmented.

Age: The medial ends of the clavicles were still unfused. Third molars had erupted but showed no signs of wear. Vertebral epiphyseal rings had only recently fused. Sternal ends of the third, fourth and fifth ribs fell in phase 4. This person was most likely 25 - 32 years of age at the time of death.

Sex: Small supraorbital tori, medium sized mastoid processes, a round pelvic inlet, a wide short sacrum and wide sciatic notches suggested a female. The same results were obtained from metric analyses of the long bones, such as the maximum diameter of the humeral head (38.4 mm), and the maximum diameter of the femoral head (40 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 149.6 ± 2.8 cm.

Dentition: All teeth were present and showed signs of extreme dental wear, tartar deposits and discolouration. A single carious lesion was observed interdentally on the upper right third molar.

Pathology and trauma: No pathology or trauma was recorded.

Conclusion: These were the remains of a 25 - 32 year old female who had been approximately 149 cm tall. No pathology or trauma was present except for a single carious lesion.

GLD S3.1

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position, with the head at the west end of the grave.

Preservation: The skeletal elements, which were present, were relatively well preserved. These included a skull, mandible, the distal half of the right humerus, right ulna and radius, os coxae, sacrum, both femora, eleven vertebrae, some hand and foot bones and rib fragments. An extra right maxilla was also found with this individual. For the purpose of this report the complete skeleton will be referred to as individual **A** and the maxilla will represent individual **B**.

Age: Individual A*:* The first and second sacral segments were fused. Third molars had erupted and were very worn. Advanced second-degree osteophytes were present on the lumbar vertebrae. The degree of cranial suture closure suggested a middle- to old-adult. The sternal ends of the ribs fell between phases 5 and 6. This individual was most likely 40 - 50 years of age at the time of death.

Individual B: All permanent teeth were present. It can therefore be concluded that this person was an adult.

Sex: Individual A: Prominent supra orbital tori, round orbital margins, a sloping forehead, large mastoid processes, prominent occipital muscle attachments, very narrow sciatic notches and a narrow subpubic angle indicated a male. These morphological findings were supported by metric results such as the bicondylar breadth of the humerus (62 mm) and the maximum diameter of the femoral head (48.8 mm).

Individual B: Sex could not be determined due to fragmentary condition of the remains.

Antemortem stature: Individual A: The physiological length of the femur yielded an approximate antemortem stature of 165.8 ± 2.8 cm.

Individual B: Due to the fragmentary condition of the remains stature could not be estimated.

Dentition: Individual A: All teeth were present except for the upper first molars and lower left second premolar, which were lost antemortem. Carious lesions were present interdentally on the upper left second premolar and lower right second premolar as well as on the occlusal surface of the lower right second molar. Enamel hypoplasia were observed on all the upper incisors as well as the lower second incisors and canines. Periodontal disease was also recorded.

Individual B: All teeth were present in the right maxilla with a single carious lesion interdentally on the second molar.

Pathology and trauma: Individual A: Enthesophyte formations were present in the obturator foramen as well as on the implantation of the right achilles tendon. This individual had a healed fracture of the right third metacarpal as well as sacralization of L5.

Individual B: No trauma or pathology was observed.

Conclusion: This was the remains of a 50 - 60 year old male who had been approximately 165 cm tall, as well as the maxilla of a second adult. Stress markers, such as enthesophyte formations, were observed in individual A.

GLD S3.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position, with the head at the west end of the grave, next to GLD S3.3.

Preservation: The remains were well preserved and complete, except for some missing phalanges, carpal and tarsal bones.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. Third molars had erupted and showed little dental wear. No osteophytes were present. The sternal ends of the ribs fell within phase 4. This person was most likely 30 - 40 years of age at the time of death.

Sex: Morphological characteristics such as rounded orbital margins, large mastoid processes, prominent supra orbital tori, narrow sciatic notches, and a narrow subpubic angle indicated a male. This was supported by metric analyses of the maximum diameter of the humeral head (41.7 mm) and the maximum diameter of the femoral head (42.6 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 162.7 ± 2.8 cm.

Dentition: All teeth were present, except for the lower right second incisor, which were lost antemortem. Enamel hypoplasia was observed on all upper incisors and canines as well as the lower canines and first premolars. Periapical abscesses were present at both lower first molars. A thick tartar deposit was recorded on most of the teeth. The person had suffered from severe periodontal disease.

Pathology and trauma: A healed fracture of the sixth right rib was noted as well as a partially healed fracture of the right fifth metacarpal, which also showed a slight infection. Enthesophyte formations were present on the posterior inferio-lateral surfaces of the patellae. The posterior arch of the atlas was unfused.

Conclusion: These were the remains of a 30 - 40 year old male who had been approximately 162 cm tall. He had a few healed fractures as well as a congenitally unfused vertebral arch of C1.

GLD S3.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the east end of the grave. A double layer of finely woven black textile was found in the vicinity of the pelvis as well as copper bangles on the left and right tibiae.

Preservation: All skeletal elements were well preserved and complete, except for a few missing phalanges and carpal bones.

Age: The medial ends of the clavicles s well as the spheno-occipital synchondrosis were fused, the first and second sacral segment were in the process of fusion. Third molars had erupted and showed no evidence of dental wear. The degree of cranial suture closure suggested a juvenile to young-aged adult. The sternal ends of the ribs were in phase 3. This person was most likely 25 - 30 years of age at the time of death.

Sex: Prominent occipital muscle attachments, narrow sciatic notches, a narrow subpubic angle and eversion of the ischiopubic ramus indicated a possible male. The same results were obtained during metric analyses of the maximum diameter of the humeral head (42.1 mm) as well as maximum diameter of the femoral head (43.4 mm).

Antemortem stature: An antemortem stature of 165.6 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present with no carious lesions.

Pathology and trauma: Enthesophytes were present between the distal ends of the tibiae and fibulae. These developed due to continuous strain exerted on the interosseous membranes. Enthesophyte formations were also present on the infero-lateral surface of the right patella as well as in the obturator foramen. Osteoarthritic changes of the acromioclaviclur joints were also noted bilaterally, this most likely came about due to constant and repetitive elevation of the arms.

Conclusion: These were the remains of a 25 - 30 year old male who had been approximately 165 cm tall. He had several stress markers, such as enthesophyte formations and arthritic changes of the acromioclavicular joints, suggesting regular participation in strenuous physical activities.

GLD S3.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west, against the north wall of the grave. Iron bracelets were found on the right and left arms. Copper beads with some preserved fabric were found below the knees.

Preservation: The skeleton was well-preserved and complete, except for some missing phalanges and carpal bones.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed clear signs of dental wear. Cranial sutures were almost totally obliterated and suggested a middle- to old-aged adult. The sternal ends of the ribs were in phase 5. This person was most likely 38 - 50 years of age at the time of death.

Sex: A slight supra torus, mandibular ramus flexure, large mastoid processes, narrow sciatic notches and a narrow subpubic angle suggested a male. This was supported by metric analyses such as the maximum diameter of the humeral head (43.9 mm) and the maximum diameter of the femoral head (44.3 mm).

Antemortem stature: Antemortem stature was estimated at 166.8 ± 2.8 cm from the physiological length of the femur.

Dentition: All teeth were present, except for the lower first molars, which were lost antemortem as well as the lower left second incisor, lost postmortem. The individual had suffered from severe periodontal disease. Carious lesions were present interdentally on the upper right first premolar and third molar, lower right second premolar as well as on the lower left first and second premolars. Another carious lesion was recorded on the occlusal surface on the lower left second molar.

Pathology and trauma: This individual received an autopsy after death. Enthesophytes were present on the latero-distal aspect of the tibiae due to continuous strain exerted on the interosseous membrane. An enlarged nutrient foramen was present on the third metatarsal of the right foot. The etiology of enlarged formina in the foot is unknown. Enthesophyte formations were also present on the implantation sight of the achilles tendon on both calcanei as well as in the obturator foramina, indicating frequent participation in strenuous physical activities.

Conclusion: These were the remains of a 38 - 50 year old male who had been approximately 166 cm tall. He received an autopsy after death and several stress makers were noted on his remains.

GLD S3.5

Burial position: This individual was buried in a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A copper bracelet was found around the left wrist as well as some coffin wood and nails.

Preservation: The remains were well preserved and complete, except for the skull, which were damaged and missing phalanges and carpal bones. Two extra tarsal bones, which did not belong to this individual, were also excavated.

Age: The medial ends of the clavicles were fused, and the first and second sacral segments were partly fused. Third molars had erupted, but did not show any dental wear. The sternal ends of the third, fourth and fifth ribs fell within phase 3. This individual was most likely 25 - 30 years of age at the time of death.

Sex: Mandibular ramus flexure, rounded orbital margins, a narrow curved sacrum and narrow sciatic notches suggested a male. These morphological findings were supported by metric analyses, such as the maximum diameter of the humeral head (42 mm) and the maximum diameter of the femoral head (42.5 mm).

Antemortem stature: An antemortem stature of 162.7 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present and complete, except for the upper right second premolar and lower left first molar, which were only represented by a root. The individual suffered from severe periodontal disease. Carious lesions were present on the occlusal surfaces of both lower second molars. Total crown destruction and periapical abscesses were seen on the upper right second premolar as well as the lower left first molar.

Pathology and trauma: This individual had received an autopsy. Enthesophytes were present on the latero-distal ends of both tibiae as well as the medio-distal aspect of the right fibula, these developed due to continuous strain exerted on the interosseous membrane. A complete transverse perimotem fracture of the left femur was observed, and it occurred around the time, or soon after death, since no healing could be detected. Schmorl's nodes were present on the lumbar vertebrae.

Conclusion: These were the remains of a 25 - 30 year old male who had been approximately 162 cm tall. Several stress makers were visible on his remains, and he had a complete transverse perimortemfracture of the left femur.

GLD S3.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Beads were found around the neck of the individual.

Preservation: All skeletal elements were well preserved and complete, except for a few phalanges, carpal bones and right metacarpals, which were missing.

Age: The medial ends of the clavicles, first and second sacral segments, the vertebral epiphyseal rings, iliac crests, as well as the vertebral border of the scapulae were unfused. The humeral heads have only recently fused and the epiphyseal lines were clearly visible. This individual was most likely 16 - 20 years of age at the time of death.

Sex: Medium sized supraorbital tori, large mastoid processes, prominent occipital muscle attachments, mandibular ramus flexure, narrow sciatic notches and a long narrow sacrum indicated a male. The same results were obtained from metric analyses of the long bones such as the maximum diameter of the humeral head (44.2 mm) and the maximum diameter of the femoral head (47.9 mm).

Antemortem stature: An antemortem stature of 163.4 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present, with a single carious lesion interdentally on the lower left second premolar. The upper left second incisor was pegshaped.

Pathology and trauma: Exostoses were present at the implantation sites of the pectoralis major muscles on the anterior humeri. A single Schmorl's node was observed on L4.

Conclusion: These were the remains of a 16 - 20 year old male who had been approximately 163 cm tall. He presented with exostoses and a singlr Schmorl's node on L4.

GLD S4.1

Burial position: This individual was buried in a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A heavy iron disc with a 'hanger' was found under the pelvis.

Preservation: The bones were relatively well preserved. All long bones were present although some were badly damaged and fragmented. Some phalanges and two carpal bones were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed signs of dental wear. The sternal ends of the third, fourth and fifth ribs were in phase 4. This individual was most likely 28 - 32 years of age at the time of death.

Sex: The skeletal remains were extremely gracile with a straight forehead, rectangular shaped pubic bones, wide sciatic notches, a wide subpubic angle and a short broad sacrum. These morphological characteristics suggested a female. The same results were obtained from metric analyses, such as the maximum diameter of the humeral head (37.3 mm) and the maximum diameter of the femoral head (38.8 mm).

Antemortem stature: An antemortem stature of 146.5 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present, except for the upper right first incisor, the upper lateral incisors, the upper left first and second molars as well as the lower left first molar, which were only represented by a root. All these tooth crowns were destructed by abscess formations. A periapical abscess as well as partial destruction of the crown was present in the upper right first premolar. Further carious lesions were observed interdentally on the upper right first molar as well as the left central incisor, the lower left second incisor and the left first premolar. Carious lesions on the occlusal surfaces were seen on the upper right second molar, lower right first premolar and second molar as well as the lower left second molar. The maxillary third molars were congenitally absent. This individual suffered from severe periodontal disease.

Pathology and trauma: Dorsal pitting was present on the pubic bone, also known as parturition scars. Enthesophytes were also noted in the obturator foramen.

Conclusion: These were the remains of a 28 - 32 year old female who had been approximately 146 cm tall. Neglected dental care was evident and scarring due to parturition was present on the pubic bones.

GLD S5.1

Burial position: This individual was buried in a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A piece of metal was found on top of the right femur.

Preservation: The skeletal elements were relatively well preserved and complete although some were damaged. Some phalanges were missing.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed dental wear. First-degree osteophytes were present on the lumbar vertebrae. The sternal ends of the third, fourth and fifth ribs fell between phases 3 and 4. This person had most likely been between 28 - 34 years of age at the time of death.

Sex: A very narrow curved sacrum, rounded orbital margins, large mastoid processes, mandibular ramus flexure and a sloping forehead suggested a male. The same results were obtained from metric analyses of the long bones such as the maximum diameter of the humeral head (42.1 mm) and the maximum diameter of the femoral head (45.2 mm).

Antemortem stature: An antemortem stature of 163.4 ± 2.8 cm was calculated from the physiological length of the femur.

Dentition: All teeth were present and complete except for the upper right first molar, which were only represented by a root. A huge carious lesion caused total crown destruction of the upper right first molar, and a periapical abscess was present in its root. Another carious lesion was observed interdentally on the upper right second molar. Severe periodontal disease affected especially the front teeth and a thick tartar deposit was also present.

Pathology and trauma: Healed fractures of the nasal bone as well as the left supra-orbital margin were observed. Enthesophytes were present between the distal ends of the tibiae and fibulae due to prolonged strain exerted on the interosseous membrane. An enlarged nutrient foramen was present on the first metatarsal of the left foot. The aetiology of the phenomenon is unknown.

Conclusion: These were the remains of a 28 - 34 year old male who had been approximately 163 cm tall. Neglected dental care was evident. Healed facial fractures were observed.

GLD SE7.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A small ring was found under the left foot of this individual.

Preservation: The skeletal remains were relatively well preserved. Only postcranial elements were present, some of which were fragmented. Of the postcranial elements a right arm, 1 thoracic and 5 cervical vertebrae, 14 carpal bones, 6 metacarpals and 18 phalanges were missing.

Age: The medial ends of the clavicles were fused. Advanced stages of second and third degree osteophytes were present on the lumbar vertebrae. The sternal ends of the third, fourth and fifth ribs were in phase 6. This individual had most likely been between 44 - 60 years of age at the time of death.

Sex: Wide sciatic notches, a wide subpubic angle and laterally places ischial tuberosities indicated a possible female. This was confirmed by metric analyses of the long bones such as the maximum diameter of the femoral head (41 mm) and the distal epiphyseal breadth of the tibia (42 mm).

Antemortem stature: An antemortem stature of 148.7 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: No teeth were available.

Pathology and trauma: Osteoarthritic changes were visible in both acetabulae as well as in the right acromioclavicular joint. Second-degree osteophytes were present on almost all the vertebrae.

Conclusion: These were the remains of a 44 - 60 year old female who had been approximately 148 cm tall. Osteoarthritic changes of both hips as well as the right shoulder were observed.

GLD SE7.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head tat the west end of the grave. The arms were extended alongside the body.

Preservation: Although the skeleton was complete, some bones were fragmented.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. Third molars had erupted and were slightly worn. The degree of cranial suture closure indicated that this person might be a juvenile to young-adult. The sternal ends of the third, fourth and fifth ribs fell in phase 4. This individual was most likely 28 - 32 years of age at the time of death.

Sex: A prominent supraorbital torus, rounded orbital margins, medium sized mastoid processes, mandibular ramus flexure and narrow sciatic notches suggested a male. This was supported by metric analyses of the long bones such as the maximum diameter of the humeral head (43 mm) and the maximum diameter of the femoral head (42.4 mm).

Antemortem stature: An antemortem stature of 153.3 ± 2.8 cm was estimated from the physiological length of the femur.

Dentition: All teeth were present with no carious lesions.

Pathology and trauma: A moderate amount of subperiosteal bone growth were present on the anterior surface of both tibiae giving them a slightly blown up and striated appearance. They might have developed due to the ossification of haematomas caused by scurvy, or they might be an early sabre-shin formation due to treponematosis. No other lesions to confirm any of the above-mentioned conditions were observed.

Histological observations: The original compact bone, periosteal surface and new bone apposition could easily be distinguished on macroscopic examination of a transverse section of the lesion.

Microscopic investigation revealed that the original periosteal surface, represented by the circumferential lamellae, were unaffected by the pathological condition and could be followed throughout the section. The original cortical bone did not show any pathological changes and was not affected by the condition. The newly formed bone on the outside of the original periosteal surface had a radiating collagen structure.

It was concluded that this section was most likely taken from a lesions caused by an ossified haematoma.

Conclusion: These were the remains of a 28 - 34 year old male who had been approximately 153 cm tall. He had possibly suffered from scurvy.

GLD SE7.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. The skull and mandible of this individual was covered in a Hessian type tunic or cloth with buttons. A pair of boots was also found next to this individual.

Preservation: Skeletal remains were relatively well preserved. The skull, mandible, ribs and right scapula were damaged and fragmented. The left pisiform and some phalanges were missing.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused with the first and second sacral segments partially fused. Third molars had erupted but displayed no dental wear. The sternal ends of the third, fourth and fifth ribs fell within phase 4. This person was most likely 30 - 40 years of age at the time of death.

Sex: Very narrow sciatic notches, a curved sacrum and medium sized mastoid processes suggested a possible male. The same results were obtained from metric analyses of the maximum diameter of the humeral epicondylar breadth (62.1 mm) as well as the maximum diameter of the femoral circumference at midshaft (85 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 159.5 ± 2.8 cm.

Dentition: All teeth were present, except for the upper left central and lower left second incisors, which were lost postmortem. The upper right first premolar was lost antemortem due to a periapical abscess. A retained upper deciduous left central incisor was lost postmortem.

Pathology and trauma: Schmorl's nodes were present on T1, T8 to T12 as well as on L3 and L4. Subperiosteal bone growth possibly indicating chronic inflammation was present on the right calcaneus. Early signs of subperiosteal bone growth were present on the right tibia with striations visible allover both tibiae. These can develop due to treponematosis, scurvy or trauma to the tibiae. No other evidence existed to suggest treponemal disease. Enthesophytes were present on the mediodistal ends of both fibulae, these most likely developed due to strain on the interosseous membrane. Clear secondary bone deposition was present on the medial proximal third of the left femur giving it a blown up appearance.

Histological observations: Macroscopic investigation of a transverse section through the tibia did not reveal any pathological changes.

On microscopic level no pathological bone changes could be detected. The cortical bone as well as the external circumferential lamellae was normal and no resorption hole bone remodeling indicative of an underlying pathological condition could be observed.

It was concluded that the striation observed in the tibiae did not develop due to a pathological condition as can merely be ascribed to normal morphological variation.

Conclusion: These were the remains of a 30 - 40 year old male who had been approximately 159 cm tall. He might have suffered from scurvy and had several Schmorl's nodes suggesting participation in regular strenuous physical activities.

GLD SE7.5

Burial position: This individual was buried without a coffin. The remains were in an extended position, on its right side, with the head to the west end of the grave. Arms were bent at the elbows and both hands were resting against the chest. A Hessian bag was found covering the left side of the cranium.

Preservation: Skeletal remains were extremely well preserved and complete except for some missing ribs, phalanges and a carpal bone.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. The degree of cranial suture closure suggested a juvenile to young-adult. Third molars had erupted and showed only a slight indication of dental wear. The sternal ends of the third, fourth and fifth ribs were in phase 5. This person was most likely 33 - 43 years of age at the time of death.

Sex: Sharp orbital margins, a vertical forehead, small mastoid processes, a short wide sacrum, preauricular sulci and wide subpubic angle indicated a possible female. This finding was supported by metric analyses of the maximum diameter of the femoral head (40.8 mm) and the maximum proximal epiphyseal breadth of the tibia (65.6 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 154.7 ± 2.8 cm.

Dentition: All teeth were present with no carious lesions. Periodontal disease and some tartar deposits were present.

Pathology and trauma: A healed fracture was present on the left zygomatic arch. An inferior calcaneal spur or heel spur were present on the right calcaneus. This developed due to chronic of acute trauma to the abductor hallucis and flexor digitorum brevis tendon attachments. Enthesophytes were present between the distal ends of the tibiae and fibulae, this developed due to strain on the interosseous membrane. Possible ossified haematomas and striations were present bilaterally in the tibiae. These most likely developed due to the individual suffering from scurvy. An exostosis was present on the lateral aspect of the distal left humerus. This may have developed due to chronic strain or acute trauma to the medial head of ticeps brachii. Enthesophyte formations were present on the ischial tuberosities as well as in the obturator foramen of the inominate. Dorsal pitting, or parturition scars were observed on the pubic bones. A Schmorl's node was recorded on L4.

Conclusion: This was the remains of a 33 - 43 year old female who had been approximately 154 cm tall. Striations on the tibiae in relation with periodontal disease suggest that this person suffered from scurvy. She had a healed fracture of the left zygomatic arch. Several stress markers were observed, such as enthesophytes and Schmorl's nodes, suggesting participation in strenuous physical activities.

GLD SE7.6

Burial position: This individual was buried without a coffin. The remains were in an extended position, on its right side, directly behind GLD SE7.5, with the head at the west end of the grave. The hands had been positioned above the pelvis.

Preservation: All skeletal elements were present, except for slight damage on the distal and proximal ends of some long bones and missing phalanges.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused, and the epiphyseal lines were still clearly visible on the clavicles. Third molars had erupted and were slightly worn. The degree of cranial suture closure indicated a juvenile to young-adult. The sternal ends of the ribs fell within phase 3. This person was most likely 25 - 30 years of age at the time of death.

Sex: Large mastoid processes, prominent supra orbital tori, rounded orbital margins and narrow sciatic notches indicated a possible male. The same results were obtained from metric analyses of the maximum diameter of the humeral head (41.5 mm) and maximum diameter of the femoral head (46.2 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 165.6 ± 2.8 cm.

Dentition: All teeth were present, except for the upper left canine and lower left molar, which were lost antemortem. The lower right third molar was only represented by a root due to an abscess. Carious lesions were visible on the occlusal surfaces of the upper left first molar as well as the lower left third molar. A thick tartar deposit was present on the teeth; this person had also suffered from severe periodontal disease. An extra deciduous tooth was found with the skull, but did nog belong to this individual.

Pathology and trauma: Healed fractures were present on the 4th left metacarpal as well as a left foot phalange. Enthesophytes were observed between the distal ends of the tibiae and fibulae, these most likely developed due to chronic strain on the interosseous membrane. The right fibula had a blown up appearance, the right tibia had clear signs of subperiosteal bone growth, with a lateral infectios lesion. Initial stages of subperiosteal bone growth were also visible along the whole length of the left tibia. These lesions probably developed due to severe periostitis. The large lesion on the anterior tibia was most likely an ossified haematoma. Myositis ossificans traumatica was present on the anterior left femur, and most likely developed due to trauma of the Vastus intermedius muscle. The above-mentioned lesion may be due to scurvy. The nose had am eaten away appearance ,and a lesion, very suggestive of a healed gummata, was present on the frontal bone. It is possible that this individual suffered from treponematosis. These features indicate the individual may have also suffered from treponemal disease.

Conclusion: These were the remains of a 25 - 30 year old male who had been approximately 165 cm tall. Pathological lesions suggest that this individual suffered from scurvy as well as treponematosis. Healed fractures of the left hand and foot were also recorded.

GLD SE7.7

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position, with the skull squashed into the south wall of the grave. The right arm was bent under the thorax and the left arm was raised against the south wall of the grave. A Hessian bag was found between the remains and the south wall of the grave for the whole length of the body. A copper earring was also found.

Preservation: Skeletal remains were well preserved and complete except for some missing phalanges.

Age: The medial ends of the clavicles as well as the first and second sacral segments were still unfused. Third molars had erupted, but showed no evidence of dental wear. The degree of cranial suture closure suggested a juvenile to young-adult. The sternal ends of the ribs were in phase 2. This individual was most likely 20 - 25 years old at the time of death.

Sex: A very robust mandible with mandibular ramus flexure, sloping forehead, narrow sciatic notches as well as a narrow subpubic angle suggested a male. The same results were obtained from metric analyses of the long bones, such as the maximum diameter of the humeral head (43 mm) and the maximum diameter of the femoral head (47.3 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 172.5 ± 2.8 cm.

Dentition: All teeth were present. Slight periodontal disease was observed with a carious lesion on the buccal surface of the lower right second molar. Three extra, rudimentary developed teeth were present behind the third molar in the maxilla. Crowding of the mandibular teeth was also present causing the second right incisor to move backwards.

Pathology and trauma: Subperiosteal bone growth, probably due to chronic inflammation, was present on the inferior and lateral calcaneus of both feet. Both tibiae had a slightly blown up appearance with osteomyelitic changes, secondary bone deposition and striations. Striations and bone deposition were also present on the anterior aspect of the proximal left fibula. Lesions very suggestive of gummatous lesions were observed on the skull, this individual had most likely suffered from treponemal disease. Slight osteoarthritic changes were also noted in the acetabulae.

Histological observations: On cross section the bone was extremely thickened and no original periosteal surface could be distinguished. The cortex seemed slightly porous.

Histological investigations revealed severe fungus infestation. Nevertheless some diagnostic features could still be identified. A clear unaffected periosteal surface represented by the original external circumferential lamellae was observed although it was interrupted. The cortical bone was not destroyed but more resorption holes than normal were present. The appositional bone had a radiating architecture.

It was thus concluded that this section most likely came from a lesion caused by an ossified haematoma. The presence of resorption holes in the cortex does however suggest that an infectious disease was also present.

Conclusion: These were the remains of a 20 - 25 year old male who had been approximately 172 cm tall. He had suffered from treponematosis and possible scurvy.

GLD SE7.8

Burial position: This individual was buried without a coffin. Remains were in an extended, supine position, with the head at the west end of the grave. Arms were slightly bent and resting on the pelvis.

Preservation: All remains were well preserved and complete except for the ribs, which were fragmented and some missing phalanges.

Age: The medial ends of the clavicles as well as the spheno-occipital synchondrosis were fused. Some well-developed first-degree osteophytes were present on the lumbar vertebrae. Third molars had erupted and showed dental wear. The degree of cranial suture closure suggested a young- to middle-aged adult. The sternal ends of the ribs fell between phases 4 and 5. This person was most likely 35 - 45 years of age at the time of death.

Sex: A very robust mandible with mandibular ramus flexure, large mastoid processes, a sloping forehead, rounded orbital margins, a long narrow sacrum, narrow sciatic notches and a narrow subpubic angle suggested a male. The same results were obtained from metric analyses of the long bones, such as the maximum diameter of the humeral head (45.4 mm) and the maximum diameter of the femoral head (43.8 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 160.1 ± 2.8 cm.

Dentition: All teeth were present, except for the upper left central incisor, which were lost postmortem. This individual suffered from periodontal disease. Carious lesions were present on the occlusal surface of the upper left first molar as well as interdentally between the upper left second premolar and first molar. An extra irregularly shaped tooth was present behind the upper right third molar.

Pathology and trauma: Criba orbitalia was present in the left orbit. Enthesophyte formations were present on the implantation sight of the achilles tendon the calcanei, on the olecranon processes, both patellae as well as in the obturator foramina. Second-degree osteophytes were present on the lumbar vertebrae. Enthesophytes were also present between the distal ends of the tibiae and fibulae due to chronic strain on the interosseous membrane. All of the above-mentioned lesions indicate longstanding participation in strenuous physical activities. Localized trauma to the lateral aspect of the left humerus caused secondary bone deposition with a spongy appearance. Widespread striations were present on the tibiae and fibulae. The right fibula had a slight blown up appearance. These might be due to the presence of treponemal disease.

Conclusion: This was the remains of a 35 - 45 year old male who had been approximately 160 cm tall. He had an extra tooth. Widespread signs of participation in strenuous physical activities were observed as well as lesions indicative of treponemal infection.

GLD SE7.9

Burial position: This individual was buried without a coffin. Remains were in an extended, supine position with the head at the west end of the grave. Arms were bent at the elbows and resting on the chest. A copper ring was found on the right hand of this individual as well as a coin below the right side of the sacrum (possibly where the back pocket of trousers would be).

Preservation: The skeletal remains were well preserved and complete.

Age: The medial ends of the clavicles as well as the first and second sacral segments were fused. Third molars had erupted and showed dental wear. First-degree osteophytes were present on the lumbar vertebrae. The degree of cranial suture closure suggested a middle- to old-aged adult. Sternal ends of the third, fourth and fifth ribs were in phase 5. This individual was most likely 38 - 48 years of age at the time of death.

Sex: A narrow and curved sacrum, narrow sciatic notches, narrow subpubic angle, eversion of the inferior pubic ramus and rounded orbital margins suggested a possible male. Metric analyses of the long bones, such as the maximum diameter of the humeral head (45.2 mm) and the maximum diameter of the femoral head (46.7 mm) confirmed the morphological findings.

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 168.7 ± 2.8 cm.

Dentition: All teeth were present except for the upper left lateral incisor, lower right first molar and lower left third molar, which were lost antemortem. Severe periodontal disease was present as well as a thick tartar deposit. Carious lesions were present on the lingual surface of the upper right lateral incisor, occlusal surfaces of the upper left second molar and lower left second molar, and interdentally on the upper left and lower left first molars. Abscesses causing severe crown destruction were present on the lower right second molar as well as the lower left first molar. The antemortem loss of the lower left third molar was due to a periapical abscess.

Pathology and trauma: A 6th lumbar vertebrae and wedging of L5 were observed in this individual. Widespread striations were visible on the tibiae with advanced stages of osteomyelitic changes and secondary bone deposition on the anterior surfaces. These could be sabre-shin formations due to treponematosis. A spot of localized secondary infection, most likely due to trauma were present on the distal end of the right tibia. An exostosis were present on the lateral aspect of the left humerus, this most likely developed due to chronic infection or trauma to the deltoid muscle. Enthesophyte formations were present on the olecranon process of the right ulna, as well as on the mediodistal aspects of both fibulae due to constant strain on the interosseous membrane. Schmorl's nodes were present from C3 to C6. These stress indicators suggest regular participation in strenuous physical activities. A healed parry fracture (defense fracture) of the right ulna was observed. Another healed fracture of the 5th metacarpal on the left was noticed, this fracture cause bony ankylosis between the proximal end of the 4th and 5th metacarpals.

Histological observations: On cross section the newly formed bone, original periosteal surface as well as the original cortical bone can easily be distinguished from each other macroscopically. The newly formed bone seemed extremely porous.

Despite severe fungus infestation histological investigations revealed a well define uninterrupted original periosteal surface represented by the original circumferential lamellae. Trabeculae radiating from the original periosteal surface to the new outer surface of the bone were present. Although the section seemed slightly porous and resorption holes were present this can be expected during the early stages of ossification of a haematoma.

It was concluded that this is a section taken from a recently ossified haematoma.

Conclusion: These were the remains of a 38 - 48 year old male who had been approximately 168 cm tall. Neglected dental care, possible treponemal infection or scurvy as well as two healed fractures were observed.

GLD SE7.10

Burial position: This individual was buried without a coffin. The remains were in an extended position, against the north wall af the grave, with the head to the west.

Preservation: The skeletal remains were relatively well preserved although several pieces were missing and fragmented beyond recognition.

Age: The squama of the temporal bone, tympanic bone and pertous bone fell within phase 8. The length of the clavicles was 45 mm. The scapulae were 38.8 mm in length and 30.1 mm in width and the humerus was 80 mm in length. This baby had most likely been 1 - 3 month old at the time of death.

Sex: Sex could not be determined due to the young age of the individual.

Antemortem stature: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: No teeth were present.

Pathology and trauma: No pathology or trauma was observed.

Conclusion: These were the remains of a 2-month-old baby of unknown sex.

GLD SE7.11

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the east end of the grave. Arms were bent at the elbows and resting on the chest. A safety pin was found on the left side of the neck. in situ.

Preservation: The skeletal remains were very well preserved and complete except for some missing phalanges. The skull, scapulae and ribs were fragmented.

Age: The medial ends of the clavicles as well as the first and second sacral segments were fused. First-degree osteophytes were present on the lumbar vertebrae. Cranial sutures were still open and indicated that this individual might be a juvenile to young-adult. The sternal ends of the ribs were in phase 5. This person was most likely 30 - 40 years of age at the time of death.

Sex: Small mastoid processes, wide sciatic notches, a short flat sacrum and preauricular sulci suggested a female. The same results were obtained from metric analyses of the long bones, such as the maximum diameter of the humeral head (36.7 mm) and the maximum diameter of the femoral head (40.5 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 148.5 ± 2.8 cm.

Dentition: All teeth were present, except for the third molars, which seem to have been congenitally absent. Severe periodontal disease and a thick tartar deposit were observed.

Pathology and trauma: Enthesophytes were present in the obturator foramen of both os coxae. Schmorl's nodes were noted on L3 and L4. Enthesophytes were also observed between the distal ends of the tibiae and fibulae (this developed due to continuous strain on the interosseous membrane). The above-mentioned stress makers are a result of old age as well as regular participation in strenuous physical activities. Slight osteoarthritic changes were present in the acetabulae as well as dorsal pitting, or parturition scars, on the pubic bones.

Conclusion: These were the remains of a 30 - 40 year old female who had been approximately 148 cm tall. Several stress makers were observed on her remains as well as scars due to parturition.

GLD SE11.1

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A lot of damage was done to the remains by the ground moving machinery, causing displacement of bones.

Preservation: The remains found at GLD SE11.1 represented 2 individuals. Each individual will be discussed separately and will be referred to as individual **A** and individual **B**.

Individual A: Remains were relatively well preserved and complete except for a very fragmented skull, ribs, clavicles, scapulae and vertebrae. The left femur, distal end of the right femur, sacrum, os coxae and some phalanges were missing.

Individual B: This individual was represented by two complete arms and hands, which were well preserved.

Age: Individual A: All epiphyses were fused and obliterated. Second-degree osteophytes were present on the lumbar vertebrae. Third molars had erupted and were extremely worn. The sternal ends of the ribs were in phase 6. This person was most likely older than 50 years of age at the time of death.

Individual B: All epiphyses were fused. Due to the fragmentary condition of the remains. it could only be concluded that this person was an adult at the time of death.

Sex*:* IndividualA: Mandibular ramus flexure, a robust mandible and rounded orbital margins suggested a male. The same results were obtained from metric analyses of the long bones, such as the epicondylar breadth of the humerus (60.5 mm) and the bicondylar breadth of the femur (79.6 mm).

Individual B: Metric analyses of the humerus such as the epicondylar breadth (59 mm) indicated a possible male.

Antemortem stature: Individual A: Stature could not be determined due to the fragmentary condition of the remains.

Individual B: Stature could not be determined due to the fragmentary condition of the remains.

Dentition: Individual A: All teeth were present, except for the central incisors and left lateral incisor, which were lost postmortem. The upper and lower left third molars were lost antemortem. A single carious lesion was present interdentally on the lower right third molar. All teeth presented with extreme dental wear. Periodontal disease was noted with a thick tartar deposit and brownish teeth discolouration.

Individual B: No teeth were found.

Pathology and trauma: Individual A: No pathology or trauma was observed.

Individual B: No pathology or trauma was observed.

Conclusion: These were the remains of two individuals. Individual A was a male older than 50 years of age. Individual B was an adult male. No pathology or trauma was noted in either individual A or B.

GLD SE11.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: Skeletal elements were relatively well preserved. Femora, tibiae, fibulae, feet (with some missing phalanges) as well as a fragmented os coxae were present.

Age: All epiphyses were fused and obliterated. This person was most probably adult at the time of death.

Sex: In general the skeletal remains were very robust and suggested a male. Metric analyses of the long bones, such as the maximum diameter of the femoral head (49.2 mm) and the maximum distal epiphyseal breadth of the tibiae (46.5 mm) yielded the same results.

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 168.4 ± 2.8 cm.

Dentition: No teeth were available for analyses.

Pathology and trauma: Severe periostitis and secondary bone deposition causing a slight exostosis was observed on the length of the linea aspera of the right femur. This most likely developed due to constant strain or trauma of the adductor muscles of the thigh. Subperiosteal bone growth was also present on the posterior surface of the left tibia in the proximal half. Severe non-specific osteomyelitis was present at the distal end of the right tibia with a huge cloaca and abundant new bone formation on the affected tibia and fibula. Severe infection and bone regeneration were also seen on the right talus and calcaneus. This infection most likely came from the tibia.

Conclusion: This was the remains of an adult male who had been approximately 168 cm tall. He had severe non-specific osteomyelitis.

GLD SE11.3

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. A metal bangle was found in the vicinity of the remains.

Preservation: All remains present were well preserved. This included nine vertebrae, femora, 2 carpal bones, fragmented ribs, sacrum, os coxa, tibiae, fibulae and feet with some missing phalanges.

Age: All epiphyses were fused and obliterated. Second-degree osteophytes were present on the lumbar vertebrae. The sternal ends of the ribs were in phase 6. This person was most likely 45 - 60 years of age at the time of death.

Sex: Morphological features such as wide sciatic notches, a wide subpubic angle, broad flat sacrum and preauricular sulci suggested a female. The same results were obtained from metric analysis of the maximum diameter of the humeral head (41 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 164.2 ± 2.8 cm.

Dentition: No teeth were available for analyses.

Pathology and trauma: Osteoarthiritic changes were present in the right and left acetabulum. Second-degree osteophytes were present on the lumbar vertebrae. The before mentioned are most likely a normal occurrence of degeneration associated with old age. Enthesophytes were present on the posterolateral surface of the left tibia just proximal to the middle. This most likely developed due to constant strain of trauma to the tibialis posterior muscle. Dorsal pitting or parturition scars were present on the pubic bones.

Conclusion: This was the remains of a 45 - 60 year old female who had been approximately 164 cm tall. The normal degeneration of bone, due to old age, were visible.

GLD SE11.4

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave. Arms were extended alongside the body. Buttons with red fabric were found on the shoulders and below the chest of this individual. It was suggested that the body had been laid on a tunic, possibly military.

Preservation: Skeletal remains were very well preserved and complete except for some missing carpal bones, the fifth metatarsal of the left foot and phalanges. An extra patella was found with this individual.

Age: The medial ends of the clavicles as well as the first and second sacral segments were unfused. Cranial sutures were still open and suggested a juvenile to young-adult. Third molars had erupted but the roots were open, no dental wear was observed. Some vertebral epiphyseal rings as well as the vertebral borders of the scapulae were unfused. The sternal ends of the ribs were in phase 2. This individual was most likely 19 - 25 years of age at the time of death.

Sex: Morphological features such as medium sized mastoid processes, no mandibular ramal flexure, a vertical forehead, relatively wide sciatic notches, preauricular sulci and a wide subpubic angle proposed a possible female. The same results were obtained from metric analyses of the long bones such as the maximum diameter of the humeral head (38.7 mm) and the maximum diameter of the femoral head (40.8 mm).

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 154.3 ± 2.789cm.

Dentition: All teeth were present and there were no carious lesions.

Pathology and trauma: Enthesophytes were present between the distal ends of the tibiae and fibulae due to continuous strain on the interosseous membrane.

Conclusion: These were the remains of a 19 - 25 year old femalse who had been approximately 154 cm tall. No important signs of pathology or trauma were noted.

GLD SE11.5

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the east end of the grave. Beads were found in association with the left wrist as well as an earring and a ring.

Preservation: The remains were well preserved and complete, except for some missing carpal bones and phalanges. The scapulae, os coxae and sacrum were damaged.

Age: The medial ends of the clavicles as well as the first and second sacral segments were unfused. The spheno-occipital synchondrosis had fused and the epiphyseal line was clearly visible. The third molars had erupted, but the roots were open. All the long bone epiphyses had fused. This individual was most likely 20 - 25 years of age at the time of death.

Sex: Large mastoid processes, a prominent nuchael region, mandibular ramus flexure and a narrow subpubic angle indicated a possible male. Metric analyses of the long bones such as the maximum diameter of the humeral head (45.3 mm) and the maximum diameter of the femoral head (43.7 mm) yielded the same results.

Antemortem stature: The physiological length of the femur yielded an estimated antemortem stature of 164.5 ± 2.8 cm.

Dentition: All teeth were present, except for the postmortem loss of the right central incisor. Carious lesions were present on the occlusal surfaces of the lower right second and third molars as well as the third molar on the left. At least three impacted teeth were visible within the anterior body of the mandible just beneath the right canine and second incisor.

Pathology and trauma: No pathology or trauma was observed.

Conclusion: These were the remains of a 20 - 25 year old male who had been approximately 164 cm tall. Three impacted teeth were noted.

GLD SE11.6

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the east end of the grave. The hands had been placed on the pelvis.

Preservation: All the remains were well preserved and complete except for some missing carpal bones and phalanges. The ribs were fragmented.

Age: The medial ends of the clavicles, spheno-occipital synchondrosis as well as the first and second sacral segments were fused. Third molars had erupted and showed dental wear. First-degree osteophytes were present on the lumbar vertebrae. The sternal ends of the third, fourth and fifth ribs were in phase 4. This individual hadn most likely been between 30 - 37 years of age at the time of death.

Sex: A vertical forehead, sharp orbital margins, pointy menton and wide sciatic notches suggested a female. The same results were obtained from metric analyses of the long bones such as the maximum diameter of the humeral head (38.1 mm) and the maximum diameter of the femoral head (41.5 mm).

Antemortem stature: The physiological length of the femur yielded and estimated antemortem stature of 152.6 ± 2.8 cm

Dentition: All teeth were present and there were carious lesions. Severe periodontal disease was observed with a moderate tartar deposit.

Pathology and trauma: A healed spiral undisplaced fracture in the distal third of the right femur had caused severe callus formation as well as patches of new bone growth due to infection. Enthesophyte formations were present on the calcaneus of the right and left foot at the implantation site of the Achilles tendon.

Conclusion: These were the remains of a 30 - 37 year old female who had been approximately 152 cm tall. She had a healed fracture of the right femur.

GLD SE12.1

Burial position: This individual was buried without a coffin. No clear description of the burial was given.

Preservation: Skeletal remains were relatively well preserved and consisted of a mandible, maxilla, fragmented skull, humerii, seven fragmented vertebrae and damaged ribs.

Age: All epiphyses were fused. Third molars had erupted and were slightly worn. No osteophytes were present on the vertebrae. This individual had most likely been between 20 - 40 years of age at the time of death.

Sex: A very robust mandible with ramal flexure and large mastoid processes suggested a male. Metric analyses of the maximum diameter of the humeral head (45.6 mm) and the epicondylar breadth of the humerus (60.4 mm) yielded the same results.

Antemortem stature: Stature could not be determined due to the fragmentary condition of the remains.

Dentition: All teeth were present, except for the upper right first and third molars, the lower central incisors as well as the lower left lateral incisor, which were lost postmortem. Crowding of the lower teeth whad been caused by and right extra premolar. Severe discolouration of the teeth was present, most likely due to pipe smoking. A thick tartar deposit was also observed. Carious lesions were present on the occlusal surfaces of the upper left second molar, the lower right second molar, and interdentally on the lower right first molar and left second premolar. A periapical abscess was noted at the lower right first molar.

Pathology and trauma: Schmorl's nodes were present on L1 and L2.

Conclusion: These were the remains of a male, 20 - 40 years of age. Neglected dental care was observed as well as an extra lower premolar.

GLD SE15.1

Burial position: This individual was buried without a coffin. The remains were in an extended, prone position with the head at the west end of the grave. The skull was jammed into the northwest corner of the grave. Arms were found underneath the individual with the right and left hand placed together at the region of the pelvis. Three pieces of rusted iron were found on top of the skull, a string of green and white beads around the left wrist, blue and white beads around the right wrist, a copper ring, viscous material as well as a leather band with a buckle were found with this individual.

Preservation: All the skeletal remains recovered were well preserved., and it included: a skull, mandible, fragmented scapulae and ribs, fragmented vertebrae, humerii, a damaged right ulna, fragmented radii, femora, a damaged os coxa and a few hand bones.

Age: The spheno-occipital synchondrosis and the first and second sacral segments, the humeral heads, distal epiphyses of the femura as well as the distal epiphyses of the radii and ulnae were unfused. Both proximal femoral epiphyses were fused. This individual had most likely been between 15 - 18 years of age at the time of death.

Sex: A vertical forehead, sharp orbital margins, wide sciatic notches and very small mastoid processes indicated a possible female. Metric analyses of the long bones such as the maximum diameter of the humeral head (38.1 mm) and the maximum diameter of the femoral head (38.5 mm) yielded the same results.

Antemortem stature: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: All teeth were present. A single carious lesion was visible on the occlusal surface of the lower right second molar.

Pathology and trauma: Criba oribitaliae were visible in both orbits.

Conclusion: These were the remains of a female, 15 - 18 years of age. She had criba orbitalia.

GLD SE15.2

Burial position: This individual was buried without a coffin. The remains were in an extended, supine position with the head at the west end of the grave.

Preservation: All the remains recovered were relatively well preserved and consisted of a left radius and ulna, femora, fragmented os coxae, scapulae, vertebrae and ribs and hand bones.

Age: The first and second sacral segments were fused. All long bone epiphyses were fused. Second-degree osteophytes were present on the lower thoracic vertebrae. The sternal ends of the third, fourth and fifth ribs were in phase 6. This person had most likely been between 45 - 55 years of age at the time of death.

Sex: A very robust skeleton with large acetabulae, a long narrow sacrum, narrow subpubic angle and eversion of the inferior pubic ramus indicated a possible male. Metric analyses of the femoral heads (52.5 mm) yielded the same results.

Antemortem stature: Stature could not be estimated due to the fragmentary condition of the remains.

Dentition: No teeth were available for analyses.

Pathology and trauma: Second-degree osteophytes were present on the lower thoracic vertebrae.

Conclusion: These were the remains of a male, who had been between 45 - 55 years of age.

GLD SE16

Burial position: No information on the burial position was available.

Preservation: The remains recovered were relatively well preserved and consisted of a fragmented skull and mandible.

Age: Third molars had erupted and showed dental wear. The spheno-occipital synchondrosis was fused. Due to the fragmentary condition of the remains, this individual can be described as being a middle- to old-aged adult over 30 years of age.

Sex: Mandibular ramus flexure, a very robust mandible with a short broad ramus and large elongated mandibular condyles suggested a possible male.

Antemortem stature: Antemortem stature could not be determined due to the fragmentary condition of the remains.

Dentition: All teeth were present except for the upper right third molar and the lower left canine, which were lost postmortem.

Pathology and trauma: No trauma or pathology was present.

Conclusion: These were the remains of an adult male.

GLD S16.1

Burial position: No information regarding the burial position was available.

Preservation: Remains were relatively well preserved although a lot of the bones were damaged and broken. The skull, mandible, tibiae, fibulae hands and feet were missing.

Age: The medial ends of the clavicles were fused. Second-degree osteophytes were present on some of the vertebrae. The sternal ends of the ribs were in phase 6. This person was most likely 45 - 60 years of age at the time of death.

Sex: An overall very robust skeleton with narrow sciatic notches suggested a male. Metric analyses of the femurs such as the maximum diameter of the femoral head (49.6 mm) confirmed this.

Antemortem stature: Stature could not be estimated due to the fragmentary condition of the remains.

Dentition: No teeth were available for analyses.

Pathology and trauma: No pathology or trauma was noted.

Conclusion: These were the remains of a male, aho had been 45 - 60 years of age.

Appendix 2

Table A2.1 List of grave goods excavated in association with each individual (1/2)

Individual	Associated grave goods
GLD N8.3	Coffin
GLD N8.2	Iron beads
GLD N8.4	Leather band and iron disc
GLD N8.5	Iron beads
GLD N8.6	Iron beads
GLD N8.8	Iron bracelet, copper bangle, glass bead
GLD N8.9	Iron fragments
GLD N8.10	Copper earring, iron bracelet
GLD N34.2	Iron bangle, white bead, green bead
GLD N34.3	Ring, iron and copper bangles
GLD N34.7	Beads
GLD N34.8	Copper beads, blue and white beads around neck
GLD N34.14	9 strands of copper and iron beads
GLD N38.1	Coffin, metal fragments, iron bead
GLD N74.1	Copper pins
GLD N74.2	Metal buttons, leather, shoe, copper bangle
GLD N74.3	Copper fragments
GLD N74.5	Metal objects, iron bangles, cloth
GLD N74.7	Iron and copper bangle
GLD N74.9	Copper ring
GLD N 74.11	Copper bangle
GLD N74.12	Copper band and beads, buckle
GLD N100.5	Copper bangle
GLD NOP3/4.2	Button
GLD S1.4	Metal plate
GLD S1.5	Copper bangle
GLD S2.4	Copper ring, woven material
GLD S2.5	Metal pieces
GLD S3.3	Copper bangles, black woven textile
GLD S3.4	Copper beads, iron bracelets and textile
GLD S3.5	Coffin, copper bracelet
GLD S3.6	Beads
GLD S4.1	Coffin, iron disc, hanger
GLD S5.1	Coffin, iron pieces
GLD SE7.2	Small ring
GLD SE7.4	Tunic, buttons, Boots
GLD SE7.5	Sacking
GLD SE7.7	Sacking, copper earring
GLD SE7.9	Copper ring, coin
GLD SE7.11	Safety pin

Table A2.1 List of grave goods excavated in association with each individual (2/2)

Individual	Associated grave goods
GLD SE11.3	Metal bangle
GLD SE11.4	Button and textile, possibly military
GLD SE11.5	Beads, earring, ring
GLD SE15.1	Beads, ring, leather band, buckle, textile
GLD N31.E.3	Iron bangle
GLD N31.E.5	Copper string, cloth

Appendix 3

Table A3.1 Total number of individuals represented by the different elements from the dump

Element	Males	Females	Unknown	Total
Skull and mandible	20		17	37
Clavicle	1	1	18	20
Scapula			15	15
Sternum			11	11
Vertebra			18	18
Sacrum	6	3	2	11
Humerus	16	4	6	26
Radias	1		24	25
Ulna			24	24
Os coxa	12	3	5	20
Femur	17	5		22
Tibia	13	4	1	18
Fibula	1		18	19
Estimated total	20	5	12	37

Legend for Tables A3.2 - A 3.14

n - number of individuals represented by the bone fragments recovered from the dump

Association - bone fragment which can be associated with another bone from the dump (number given)

U - unknown

Table A3.2 List of skulls and mandibles recovered from the dump (Table 1 of 3)

Number	Description	Age(years)	Sex	Trauma and pathology	Association	n
GLD D.1	Maxilla,upper teeth,inferior orbits,nasal bones	Adult>40	unknown	None		1
GLD D.2	Right mandibular ramus and condyle				D.4	
GLD D.3	Mandible with teeth from right M1 to left M1				D.4	
GLD D.4	Right part of maxilla from first molar to canine	Adult	male	None		1
GLD D.5	Right mandibular ramus without condyle	Adult<40	unknown	None		1
GLD D.6	Right gonion with M3 and M2				D.5	
GLD D.7	Coronoid process	unknown	unknown	None		1
GLD D.8	Lower M1 and PM2 with piece of mandible	unknown	unknown	None		1
GLD D.9	Right parietal and fragment of left parietal	unknown	unknown	None		1
GLD D.10	Fragment of occipital bone and forament magnum				D.9	
GLD D.11	Skull cap	Adult	unknown	None		1
GLD D.12	Right mastoid and temporal bone	Adult	unknown	None		1
GLD D.13	Lateral part of left orbit	unknown	unknown	None		1
GLD D14	Right mastoid and temporal bone	unknown	male	None		1
GLD D.15	Left mastoid and temporal bone	unknown	male	None		1
GLD D16-53	Skull fragments that could not be associated	unknown	unknown	None		1
GLD D54 -55	Madibular fragments that could not be associated	unknown	unknown	None		1
GLD '1'2'3'.56	Cranium	Adult	male	None		1
GLD '1'2'3'.57	Complete mandible	40<	male	periodontal disease		1
GLD '1'2'3'.58	Complete skull and hyoid bone	Adult	male	antemortem tooth loss		1
GLD '1'2'3.59	Mandible with broken left gonion				1'2'3'.58	
GLD 4.60	Complete mandible	Adult<40	male	None		1
GLD 4.61	Left half of maxilla, lower orbit and teeth	Aduly<35	male	None		1
GLD 4.62	Left temporal bone and mastoid				4.61	
GLD 4.63	Right half of mandible and teeth				4.61	
GLD 4.64	Frontal bone and left parietal bone	young adult	male	lesions of frontal bone		1
GLD 4.65	Occipital bone				4.64	
GLD 4.66	Right parietal bone				4.64	
GLD 4.67	Right half of maxilla and teeth				4.64	

Table A3.2 List of skulls and mandibles recovered from the dump (Table 2 of 3)

Number	Description	Age (years)	Sex	Trauma and pathology	Association	n
GLD 4.69	Frontal, both parietal and right side of occipital	unknown	unknown	None		1
GLD 4.70	Both parietal, right temporal and occipital	Adult	male	None		1
GLD 4.71	Frontal and right nasal bones				4.7	
GLD 4.72	Cranium	18-25	male	None		1
GLD 4.73	Maxilla with teeth				4.72	
GLD H.74	Complete skull and mandible	30-50	male	fracture		1
GLD H.75	Maxilla, teeth and 7 associated pieces	Adult	male	periodontal disease		1
GLD H.76	Almost complete mandible with damaged ramus				H.75	
GLD H.77	Chin with 4 teeth				H.79	
GLD H.78	Part of mandible with 2 molars				H.79	
GLD H.79	Occipital bone	Adult	male	None		1
GLD H.80	Right parietal, temporal and piece of frontal bone				H.79	
GLD H.81	Left parietal, temporal and piece of frontal bone				H.79	
GLD H.82-85	4 pieces of skull roof				H.79	
GLD H.86	Face	Adult	male	None		1
GLD H.87	Part of left temporal bone and mastoid				H.88	
GLD H.88	Maxilla	Adult	male	periodontal disease		1
GLD H.89	Mandible with both ramii missing				H.88	
GLD H.90	Right temporal bone and mastoid	unknown	unknown	None		1
GLD H.91	Left temporal, parietal and piece ofoccipital bone	Adult	male	None		1
GLD H.92	Right half of mandible and teeth missing ramus				H.91	
GLD H.93	Left mastoid and temporal bone	unknown	unknown	None		1
GLD H.94	Right temporal bone and mastoid	unknown	unknown	None		1
GLD H.95	Left half of complete skull	Adult	male	None		1
GLD H.96	Right temporal bone and mastoid				H.95	
GLD H.97	Right half of mandible and teeth				H.95	
GLD I.98	Skull cap	unknown	unknown	None		1
GLD I.99	Part of left parietal				I.98	
GLD I.100	Occipital bone				I.98	

Table A3.2 List of skulls and mandibles recovered from the dump (3/3)						
Number	Description	Age (years)	Sex	Trauma and pathology	Association	n
GLD I.102	Right maxilla with teeth				I.101	
GLD C.103	Complete mandible right ramus missing	Adult<40	male	None		1
GLD C.104	Left half of mandible	Adult	unknown	None		1
GLD C.105	Left temporal bone and mastoid					1
GLD I.100	Occipital bone	unknown	male	None	I.98	
GLD 4.67	Right half of maxilla and teeth				4.64	
					TOTAL INDIVIDUALS	37

Table A3.3 List of sternums recovered from the dump

Number	Description	Age(years)	Sex	Trauma and pathology	Association	n
GLD H.1	Manubrium	U	U	None		1
GLD C.2	Manubrium	U	U	None		1
GLD C.3	Manubrium	U	U	None		1
GLD C.4	Manubrium and piece of body	U	U	None		1
GLD H.5	Manubrium	U	U	None		1
GLD D.6	Manubrium	U	U	None		1
GLD D.7	Body				D.6	
GLD C.8	Body with perforation	U	U	None		1
GLD C.9	Body with perforation	U	U	None		1
GLD H.10	Body fragment	U	U	None		1
GLD H.11	Body fragment	U	U	None		1
GLD D.12	Body fragment	U	U	None		1
					TOTAL INDIVIDUALS	11

Table A3.4 List of sacra recovered from the dump

Number	Description	Age (years)	Sex	Trauma and pathology	Association	n
GLD C.1	Complete sacrum	U	Male	None		1
GLD D.2	Right 1/2of sacrum	U	Male	None		1
GLD C.3	Complete sacrum	30>	Male	None		1
GLD D.4	Complete sacrum	30>	Male	None		1
GLD D.5	Complete sacrum	30<	Female	None		1
GLD D.6	Sacrum damaged on both alae	30>	Female	None		1
GLD D.7	Sacrum, right auricular surface damaged	30<	Male	None		1
GLD C.8	Sacral fragments	U	U	None		1
GLD D.9	Sacral fragments	U	U	None		1
GLD I.10	Left auricular surface and S1	U	U	None		1
					TOTAL INDIVIDUALS	10

Table A3.5 List of humeri recovered from the dump (Table 1 of 2)							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD D.1	Humeral shaft	Left	U	U	None		1
GLD I.2	Distal humeral shaft	Left	U	U	None		1
GLD D.3	Distal humeral shaft	Left	U	U	None		1
GLD D.4	Distal epichondyles	Left	Adult	Male	None		1
GLD D.5	Distal 1/3 of humerus	Left	Adult	Male	None		1
GLD D.6	Complete humerus,distal and proximal ends damaged	Left	Adult	U	None		1
GLD C.7	Proximal 1/3 of humerus	Left	Adult	Male	None		1
GLD D.8	Humeral head and 1cm of shaft	Left	Adult	Male	None		1
GLD D.9	Humerus with distal 1/3 missing	Left	Adult	Male	None		1
GLD D.10	Proximal 1/3 of humerus	Left	Adult	Male	None		1
GLD D.11	Humerus with proximal end missing	Right	Adult	Male	Pitting at deltoid		1
GLD D.12	Complete humerus	Right	Adult	Male	None		1
GLD D.13	Complete humerus,distal and proximal ends damaged	Right	U	U	None		1
GLD I.14	Complete humerus with proximal end missing	Right	Adult	Male	None		1
GLD D.15	Proximal 1/2 of humeral shaft no humeral head	Right	U	U	None		1
GLD D.16	Complete humerus with head missing	Right	Adult	Male	None		1
GLD D.17	Complete humerus with head missing	Right	14-19	Male	None		1
GLD D.18	Distal 1/3 of humerus	Right	Adult	Male	None		1
GLD D.19	Distal 2/3 of humerus	Right	Adult	Male	None		1
GLD D.20	Distal 1/2 of humerus	Right	Adult	Male	None		1
GLD D.21	Humeral head	Right				D.17	
GLD H.22	Humeral head fragments	Unknown	U	Male	None		1
GLD D.23	Humeral head	Left	19>	Female	None		1
GLD D.24	Humeral head	Right				D.15	
GLD C.25	Humeral head and 3cm of anterior shaft	Left	Adult	Female	None		1
GLD C.26	2 matching humeri	Left + Right	Adult	Female	None		1
GLD H.27	2 matching humeri	Left + Right	Adult	Female	None		1
GLD C.28	Shaft without distal and proximal epiphysis	Right	Adult	Male	None		1

Table A3.5 List of humeri recovered from the dump (Table 2 of 2)							
Number	Description	Side	Age(years)	Sex	Trauma and pathology	Association	n
GLD D.30	Distal 1/2 of humerus	Left				D.10	
						TOTAL INDIVIDUALS	26

Table A3.6 List of radii recovered from the dump							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD +-D.1	2/3of proximal radius	Left	Adult	U	None		1
GLD D.2	Distal 1/3 of radius	Left				D.1	
GLD C.3	Complete radius	Left	Adult	U	None		1
GLD +-D.4	Complete radius	Left	12-18	U	None		1
GLD C.5	Complete radius	Left	Adult	U	None		1
GLD H.6	Complete radius	Left	Adult	U	None		1
GLD C.7	Complete radius	Left	Adult	U	None		1
GLD D.8	Distal 2/3 of radius	Left	Adult	U	None		1
GLD D.9	Proximal 2/3 of radius	Left	Adult	U	None		1
GLD C.10	Complete radius	Left	Adult	Male	None		1
GLD C.11	Distal 2/3 or radius	Left	Adult	U	None		1
GLD+-D.12	Proximal 1/4 of radius	Left	Adult	U	None		1
GLD C.13	Distal 1/2 of radius	Left	Adult	U	None		1
GLD C.14	Proximal 1/4 of radius	Left	Adult	U	None		1
GLD C.16	Distal 1/4 of radius	Left	Adult	U	None		1
GLD +-D.17	Complete radius	Right	Adult	U	None		1
GLD H.18	Complete radius	Right				H.6	
GLD D.19	Complete radius	Right	Adult	U	None		1
GLD H.20	Proximal 1/2 of radius	Right	Adult	U	None		1
GLD C.21	Radius with distal end missing	Right	Adult	U	None		1
GLD C.22	Proximal 1/3 of radius	Right	Adult	U	None		1
GLD C.23	Distal end of radius	Right	Adult	U	None		1
GLD +-D.24	Radius with distal end missing	Right	12-18	U	None		1
GLD D.25	Distal end of radius	Left				D.24	
GLD C.26	Proximal 1/2 of radius without head	U	U	U	None		1
GLD C.27	Proximal 1/4 of radius	Right	Adult	U	None		1
GLD C.28	Radial head	U	U	U	None		1
GLD D.29	Proximal 1/4 of radius	Right	Adult	U	None		1
						TOTAL INDIVIDUALS	25

Table A3.7 List of ulnae recovered from the dump (Table 1 of 2)							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD C.1	Proximal 2/3 of ulna	Left	Adult	U	Enthesophyte		1
GLD +-D.2	Complete ulna	Left	Adult	U	Enthesophyte		1
GLD +-D.3	Complete ulna	Left	Adult	U	None		1
GLD C.4	Proximal 2/3 of ulna	Left	Adult	U	None		1
GLD D.5	Complete ulna	Left	Adult	U	Enthesophyte		1
GLD D.6	Distal 1/3 of ulna	Left	Adult	U	Fracture		1
GLD D.7	Proximal 2/3 of ulna	Left				D.6	
GLD D.8	Distal 1/2 of ulna	Left	Adult	U	None		1
GLD D.9	Proximal 1/2of ulna	Left				D.8	
GLD D.10	Proximal 1/4of ulna	Right	Adult	U	None		1
GLD D.11	Proximal 1/2of ulna	Right	Adult	U	Enthesophyte		1
GLD D.12	Proximal 1/2of ulna	Right	Adult	U	None		1
GLD D.13	Distal 1/2 of ulna	Right				D.12	
GLD C.14	Proximal 2/3 of ulna	Right	Adult	U	None		1
GLD C.15	Distal 1/3 of ulna	Right				C.14	
GLD D.16	Complete ulna	Right	Adult	U	None		1
GLD+-D.17	Ulna with distal 1/4 missing	Right	Adult	U	Enthesophyte		1
GLD C.18	Ulna with distal 1/4 missing	Right	Adult	U	None		1
GLD H.19	Proximal 2/3 of ulna	Left	Adult	U	None		1
GLD D.20	Complete ulna	Right	Adult	U	None		1
GLD C.21	Olecranon process	U	U	U	None		1
GLD C.22	Distal 1/2 of ulna	Right	Adult	U	None		1
GLD C.23	Distal 2/3 of ulna	Left	Adult	U	None		1
GLD D.24	Distal 1/2 of ulna	Left	Adult	U	None		1
GLD C.25	Distal 1/4 of ulna	Right	Adult	U	None		1
GLD D.26	Complete ulna with distal end missing	Right	14-17	U	None		1
GLD D.27	Ulna with no proximal or distal ends	Left	14-17	U	None		1
GLD C.28	Distal 1/3 of ulna	Left	14-17	U	None		1

Table A3.7 List of ulnae recovered from the dump (Table 2 of 2)							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD H.29	Complete Ulna	Right				C.28	
						TOTAL INDIVIDUALS	24

Table A3.8 List of femora recovered from the dump

Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD 4.1	Femur with distal and proximal ends missing	Left	14-16	Male	None		1
GLD C.2	Complete femur	Left	Adult	Male	None		1
GLD H.3	Femoral head, neck and trochanters	Left	Adult	Male	None		1
GLD 4.4	Femur with proximal end missing	Left	Adult	Male	None		1
GLD D.5	Complete femur	Left	Adult	Male	Cutmarks		1
GLD H.6	Complete femur	Left	Adult	Male	None		1
GLD D.7	Complete femur	Left	Adult	Male	None		1
GLD H.8	Distal end of femur	Left	Adult	Male	None		1
GLD D.9	Femur with distal end missing	Left	Adult	Male	None		1
GLD +-D.10	Complete femur	Left	Adult	Male	None		1
GLD 4.11	Complete femur	Right				4.1	
GLD H.12	Unfused epiphysis	Right	14-16	Male	None		1
GLD C.13	Complete femur	Right				C.13	
GLD H.14	Femoral head, neck and trochanters	Right				H.3	
GLD C.15	Distal 1/2 of femur	Right	Adult	Male	None		1
GLD +-D.16	Complete femur	Right	Adult	Male	Exostosis		1
GLD H.17	Proximal 1/2 of femur	Right	Adult	Male	None		1
GLD D.18	Complete femur	Right				D.7	
GLD'1'2'3.19	Complete femur	Right				D.9	
GLD D.20	Femur with proximal end missing	Right	Adult	Female	None		1
GLD 4.21	Two complete femurs	Left + Riight	Adult	Female	None		1
GLD D.22	Piece of femoral head	U	Adult	Female	None		1
GLD H.23	2 femurs, righ missing distal half	Left + Right	Adult	Male	None		1
GLD +-D.24	Two complete femurs	Left + Right	Adult	Female	None		1
GLD C.25	Two complete femurs, only proximal halves	Left + Right	Adult	Female	None		1
GLD C.26	Two complete femurs	Left + Right	Adult	Male	None		1
GLD D.27	Complete femur	Right	Adult	Male	None		1
						TOTAL INDIVIDUALS	22

Table A3.9 List of tibiae recovered from the dump (Table 1 of 2)

Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD +-D.1	Distal 1/3 of tibia	Left	Adult	Male	None		1
GLD D.2	Lateral proximal 1/2 of tibia	Left				D.1	
GLD D.3	Medial proximal 1/2 of tibia	Left				D.1	
GLD C.4	Proximal 1/2 of tibia	Left	Adult	Female	None		1
GLD C.5	Distal 2/3 of tibia	Left				C.4	
GLD C.6	Proximal 1/3 of tibia	Left	Adult	Male	None		1
GLD D.7	Proximal end of tibia	Left	Adult	Male	None		1
GLD +-D.8	Complete tibia with proximal epiphysis missing	Left	13-17	Male	None		1
GLD D.9	Complete tibia	Left	Adult	Female	Striations		1
GLD +-D.10	Complete tibia	Left	Adult	Male	None		1
GLD +-D.11	Complete tibia with distal end missing	Left	Adult	Male	None		1
GLD D.12	Distal 1/2 of tibia	Left	Adult	Female	None		1
GLD D.13	Distal 1/3 of tibia	Left	Adult	Male	None		1
GLD D.14	Complete tibia with medial malleolus damaged	Left	Adult	Female	None		1
GLD D.15	Distal 4/5 of tibia	Right	Adult	Male	Exostosis		1
GLD D.16	Proximal 1/5 of tibia	Right				D.15	
GLD D.17	Complete tibia with medial malleolus damaged	Right				D.11	
GLD D.18	Complete tibia with lateral condyle damaged	Right				D.14	
GLD 4.19	Complete tibia	Right	Adult	Male	Striations		1
GLD D.20	Complete tibia	Right				D.10	
GLD +-D.21	Complete tibia	Right				D.8	
GLD D.22	Complete tibia	Right	Adult	Male	Periostitis		1
GLD C.23	Distal 3/4 of tibia	Right				C.5	
GLD C.24	Unfused distal epiphysis	Right	14-16	Male	None		1
GLD C.25	Complete tibia	Right	Adult	Male	None		1
GLD C.26	Proximal 1/3 of tibia	Left				C.25	
GLD C.27	Distal 1/2 of tibia	Left				C.26	
GLD D.28	Piece of tibial shaft	U	Adult	U	None		1

Table A3.9 List of tibiae recovered from the dump (Table 2 of 2)							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD D.30	Complete tibia with medial malleolus damaged	Right	Adult	Male	None		1
						TOTAL INDIVIDUALS	18

Table A3.10 List of fibulae recovered from the dump

Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD C.1	Fibula with proximal end missing	Left	Adult	U	Periostitis		1
GLD D.2	Complete fibula	Left	Adult	U	None		1
GLD D.3	Complete fibula	Left	Adult	U	None		1
GLD D.4	Fibula with proximal end missing	Left	Adult	U	None		1
GLD D.5	Fibula with proximal end missing	Left	Adult	U	None		1
GLD +-D.6	Fibula with proximal epiphysis missing	Left	14-16	U	None		1
GLD C.7	Distal 1/2 of fibula	Left	Adult	U	None		1
GLD D.8	Fibula with distal end missing	Left	Adult	U	None		1
GLD D.9	Piece of fibula shaft	U	U	U	None		1
GLD D.10	Distal end of fibula	Left	Adult	Male	None		1
GLD D.11	Proximal end of fibula	Left	Adult	U	None		1
GLD D.12	Proximal end of fibula	Right	Adult	U	None		1
GLD D.13	Distal end of fibula	Right	U	U	None		1
GLD D.14	Proximal end of fibula	Right	U	U	None		1
GLD D.15	Complete fibula with distal end damaged	Right	Adult	U	None		1
GLD D.16	Complete fibula with distal end damaged	Right	Adult	U	None		1
GLD D.17	Distal 1/4 of fibula	Right	Adult	U	None		1
GLD D.18	Fibula with distal and proximal ends missing	Right	U	U	None		1
GLD'1'2'3.20	Fibula with distal and proximal ends missing	Right	U	U	None		1
						TOTAL INDIVIDUALS	19

Table A3.11 List of scapulae recovered from the dump							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD'1'2'3.1	Superior and lateral portion of scapula	Left	U	U	None		1
GLD C.2	Inferior 1/2 of glenoid fossa, spinous process	Left	Adult	U	None		1
GLD C.3	Fragment of medial border	Left				C.2	
GLD C.4	Inferior angle, fragments of medial and lateral border	Left				C.2	
GLD D.5	Inferior angle, fragments of medial and lateral border	Left	Adult	U	None		1
GLD H.6	Complete Scapula	Left	Adult	U	None		1
GLD H.7	Glenoid fossa and acromion	Right	U	U	None		1
GLD D.8	Korakoid, glenoid fossa, medial border, inferior angle	Right	U	U	None		1
GLD+-D.9	Almost complete scapula, medial border damaged	Right	21<	U	None		1
GLD C.10	Spinous process,glenoid fossa, korakoid,acromion	Right	U	U	None		1
GLD H.11	Spinous process,glenoid fossa,acromion, lat border	Right	U	U	None		1
GLD D.12	Glenoid fossa,korakoid,superior and lateral border	Right	U	U	None		1
GLD D.13	Spinous process and acromion	Right				D.12	
GLD D.14	Tip of acromion	Right	U	U	None		1
GLD H.15	Korakoid process	U	U	U	None		1
GLD H.16	Acromion	Right	U	U	None		1
GLD H.17	Glenoid fossa and fragment of korakoid process	Right				H.16	
GLD H.18	Piece of body	Right				H.16	
GLD H.19	Piece of body	Right				H.16	
GLD H.20	Spinous process,glenoid fossa, korakoid,acromion	Left	U	U	None		1
GLD D.21	Acromion	Left	U	U	None		1
GLD D.22	Acromion	Right				D.21	
						TOTAL INDIVIDUALS	15

Table A3.12 List of clavicles recovered from the dumo

Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD H.1	Midportion of clavicle	Right	U	U	None		1
GLD D.2	Meidal 1/3 of clavicle	Right	30<	U	None		1
GLD I.3	Complete clavicle	Right	25>	U	None		1
GLD H.4	Lateral 2/3 of clavicle	Right	U	U	None		1
GLD+-D.5	Medial part of shaft	Right	U	U	None		1
GLD H.6	Complete clavicle	Right	30<	U	None		1
GLD +-D.7	Lateral part of shaft	Right	U	U	None		1
GLD C.8	Lateral part of shaft	Right	U	U	None		1
GLD I.9	Medial 4/5 of clavicle	Right	30<	U	None		1
GLD C.10	Complete clavicle	Right	30<	U	None		1
GLD C.11	Complete clavicle	Left				C.10	
GLD C.12	Lateral 1/2 of clavicle	Left	U	U	None		1
GLD C.13	Lateral 1/2 of clavicle	Left	U	U	None		1
GLD C.14	Complete clavicle,medial end damaged	Left	25<	U	None		1
GLD C.15	Complete clavicle	Left	25<	U	None		1
GLD 4.16	Complete clavicle	Left	30>	female	None		1
GLD D.17	Complete clavicle	Left	25<	male	None		1
GLD D.18	Complete clavicle, lateral end damaged	Left	30>	U	None		1
GLD D.19	Lateral 2/3 of clavicle	Left	U	U	None		1
GLD D.20	Lateral 1/2 of clavicle	Left	U	U	None		1
GLD D.21	2cm of midshaft	U	U	U	None		1
						TOTAL INDIVIDUALS	20

Table A3.13 List of os coxae recovered from the dump							
Number	Description	Side	Age (years)	Sex	Trauma and pathology	Association	n
GLD C.1	Part of iliac bone	Left	20>	female	None		1
GLD C.2	Complete os coxa	Left	Adult	female	None		1
GLD C.3	Complete os coxa	Left	20>	male	None		1
GLD H.4	Iliac	Left	20>	male	None		1
GLD +-D.5	Piece of pubic bone	Left				H.4	
GLD+-D.6	Complete with auricular surface damaged	Left	Adult	male	None		1
GLD D.7	Complete os coxa	Left	Adult	male	None		1
GLD D.8	Iliac and part of acetabulum	Left	Young Adult	male	None		1
GLD D.9	Pubic bone	Left				D.8	
GLD C.10	Part of iliac bone	Right	Adult	U	None		1
GLD +-D.11	Complete with damaged iliac	Right	Adult	female	Enthesophytes		1
GLD D.12	Oscoxa missing pubic bone	Right	Adult	male	None		1
GLD 4.13	Complete os coxa	Right	Adult	male	None		1
GLD D.14	Part of iliac bone	Right	Adult	male	None		1
GLD D.15	Part of iliac bone	Left	Adult	male	None		1
GLD D.16	part of acetabulum and pubic bone	Left				D.15	
GLD D.17	Ischial tuberosity	Left	Adult	U	None		1
GLD H.18	Ischial tuberosity	Left	Adult	U	None		1
GLD H.19	Part of iliac bone	Left				H.18	
GLD H.20	Part of pubic bone	Left				H.18	
GLD H.21	Ischial tuberosity	Right	Adult	U	None		1
GLD D.22	Ischial tuberosity	Right	18-19	U	None		1
GLD'1'2'3.23	Pubic bone	Light	Young Adult	male	None		1
GLD C.24	Pubic bone	Light	Adult	male	None		1
GLD C.25	Os coxa with damaged iliac and missing pubis	Right	Adult	male	None		1
GLD C.26	Complete os coxa	Left				C.25	
	Fragments					H.18	
						TOTAL INDIVIDUALS	20

Table A3.14 List of vertebrae recovered from the dump					
Number	Description	Age (years)	Sex	Trauma and pathology	n
GLD C	Axis	Adult	U	None	1
GLD D	Axis	Adult	U	None	1
GLD 4	Atlas	Adult	U	None	1
GLD H	Atlas	Adult	U	None	1
GLD H	Atlas, Axis and 2xcervical vertebrae	Adult	U	None	1
GLD C	Atlas, Axis, 4xcervical,10xthoracic and 5xlumbar vertebrae	Adult	U	None	1
GLD 4	One cervical and one thoracic vertebra	Adult	U	None	1
GLD D,E	2xcervical, 8xthoracic and 2xlumbar vertebrae	young adult	U	None	1
GLD H	Matched atlas and axis	Adult	U	None	1
GLD H	Atlas, axis and 2xcervical vertebrae	Adult	U	None	1
GLD H	Matched atlas and axis	Adult	U	None	1
GLD H	1xlumbar and 4xthoracic vertebrae	Adult	U	None	1
GLD C	8xthoracic and 5xlumbar vertebrae	Adult	U	None	1
GLD H	2xthoracic and 5xlumbar vertebrae	Adult	U	None	1
GLD D	4xlumbar vertebrae	Adult	U	None	1
GLD D	14x thoracic vertebrae unmatched	Adult	U	None	2
	3xlumbar vertebrae unmatched	Adult	U	None	1
	84xunmatched fragments				
				TOTAL INDIVIDUALS	18