5. PALAEODEMOGRAPHY

5.1 Introduction

In its broadest terms, palaeodemography encompasses the reconstruction and study of prehistoric population stabilities and dynamics (Buikstra and Konigsberg 1985). These population dynamics are studied with the aim to provide us with a better understanding of the relationship between man and his environment and the role of culture as an intermediary between man and the environment. Many authors see the development of agriculture and subsequent sedentary life as the major turning point in the evolution of human demography (Angel 1969; Ascadi and Nemeskeri 1970; Ward and Weiss 1976; Cohen and Armelagos 1984; Buikstra et al. 1986).

During the past several decades, there have been many publications based on palaeodemographic studies. Numerous publications made can be divided into broad categories that are not necessarily mutually exclusive. A set of literature dealing with the methods and techniques for primary data collection for palaeodemographic construction has been established (e.g., Angel 1969; Ascadi and Nemeskeri 1970; Henneberg 1976; Ward and Weiss 1976; Howell 1976; Coale and Demeney 1983; Gage 1988; Konigsberg and Frakenberg 1992; 2002; Paine and Harpending 1996). Problems, limitations and criticisms towards the use of skeletal data to project prehistoric population demography have been discussed (Bocquet-Appel and Masset 1982; 1996; Buikstra and Konigsberg 1985). Despite problems with materials and methods used, case studies based on archaeological populations have attracted attention from all over the world, e.g., Ubelaker (1989a), Patrick (1989), Mensforth (1990), Storey (1992) and Henneberg and Steyn (1994; 1995).

Palaeodemographers interested in the Demographic Transition theory use skeletal populations to evaluate the demographic stages that communities are experiencing. According to this theory, world societies go through three demographic stages. In the first stage, there is high fertility and high mortality rates. This pattern is usually associated with prehistoric and pre-industrialized populations (Ascadi and Nemeskeri 1970). In the second stage there is high fertility but low mortality, which is the primary factor behind accelerated modern population growths. Stage 3, often associated with modern industrialized countries, is characterized by low fertility and low mortality rates (Storey 1992).

Palaeodemographic studies usually focus on population dynamics to the exclusion of population size mainly because estimating population size requires ideal situations often not provided by both the archaeologist and the archaeological record (Ubelaker 1989a). Such ideal conditions include total site excavation and very excellent preservation to allow for maximum skeletal recovery. It is inappropriate to excavate entire sites without preservation of some of its parts. In southern Africa, complete site excavations often occur as part of mitigation procedures on sites that are earmarked for development purposes. Even then archaeologists are often under time pressure to give way to the developer and would often resort to quick but very destructive excavation procedures such as the use of heavy machinery (e.g. at Kgaswe B-55). This, in turn, compromises the chances of total recovery. Alternatively, sites with elaborate structures such the architecture of Teotihuacan (Storey 1992) may be completely excavated for research purposes. These sites often have ideal preservation conditions and can allow total skeletal 'harvest' to grant population size estimation (Storey 1992). There were no formal graveyards in southern African prehistory (Steyn 2003) and this makes it difficult to evaluate the representativeness of a sample. Individuals were buried in different areas depending on their sex, age and social status. Archaeological burials recovered in southern Africa are very often chance discoveries since no permanent grave makers were used.

5.2 Problems and limitations

Konigsberg and Frakenberg (1992) have discussed, in detail, the 'stumbling blocks' that are commonly experienced in palaeodemographic studies. The first of these is that population growth rate, i.e. the ratio of birth and death rates of skeletal populations, is never known. The second stumbling block is that it is often not clear whether or not the skeletal samples are representative of the actual populations. The representativeness of the skeletal sample is usually assumed rather than being known. The third stumbling block emanates from the fact that ages of individuals are estimated, not known (Konigsberg and Frakenberg 1992). The accuracy of age estimates is influenced by several factors such as the completeness of a skeleton, the accuracy of the method being used and biases by the assessor. The possibility of secular trends ought to be checked especially when the reference and target samples are thousands of years apart. Secular trends may influence the age at which changes in bone take place and hence blur the accuracy of aging techniques (Bocquet-Appel and Masset 1982).

In the reconstruction of a life table of ancient populations, data are derived from censuses of the dead whereas in conventional demography, the primary data source is the census of the living (Angel 1969; Ward and Weiss 1976; Buikstra and Konigsberg 1985; Ubelaker 1989a). In the absence of written records of the archaeological populations, age and sex are determined from the bones. It is therefore important that the best and most highly accurate techniques be used to determine age and sex since the results obtained will influence the palaeodemographic characteristics being studied (Bocquet-Appel and Masset 1996). Age and sex determinations are influenced, to a large extent, by the availability of relevant bones or features used in such determinations.

Konigsberg and Frakensberg (1992) and Bocquet-Appel and Masset (1996) outline different methods for age determination to assist in reconstruction of demographic profiles of skeletal populations. The Bayesian method and the interactive proportional fitting procedure (IPFP) reveal that individuals within the same age interval have varying chances of being at different stages of the same age indicator (Konigsberg and Frakensberg 1992; Bocquet-Appel and Masset 1996). As a result an individual being observed is divided into the number of age intervals into which the stage of the indicator has possibilities of falling within.

It is important to bear in mind the extent to which the skeletal sample is representative of the actual population (Ubelaker 1989a; Williams 1992; Storey 1992; Henneberg and Steyn 1994). The representativeness of the skeletal sample is in itself, influenced by the sampling strategies used in excavations of sites, the differential or age specific burial practices of the communities under study, and the preservation conditions prevailing on the sites (Ubelaker 1989a; Storey 1992; Henneberg and Steyn 1994).

Isolated, fragmentary and commingled remains complicate the evaluation of the representativeness of the sample. These are absolute indicators of the presence of other burials but may not yield information on sex and age of the individuals. It is therefore natural for researchers to focus on more complete skeletons and exclude incomplete and fragmentary individuals (Storey 1992). Much as this is inevitable, it does obviously compromise the representativeness of the sample.

Storey (1992) brings to the forth one of the most important conditions that must be met in order to make sound demographic inferences. This, she says, is the definition of a population. Defining an archaeological population in a demographic study calls for strict limitations on both the spatial and temporal contexts of the skeletons included in the sample. This calls for caution on the use of skeletons from sites that were occupied repeatedly over centuries e.g., Bosutswe. One needs to be careful of the stratigraphic context of each burial from such sites as to have an idea of which skeletons belong to the same period of occupation. An archaeological population can be defined by time, geographic distribution or cultural characteristics.

In order to understand the growth rate of a skeletal population, estimates of fertility (Weiss 1973; Henneberg 1976; Buikstra et al. 1986; Paine and Harpending 1996) can be made and compared to mortality rates. Population fertility can be estimated in various ways. 1) by dividing the reproductive period by the length of interval between successive children. The reproductive period (from menarche to menopause) is on average 30 years and the generally accepted birth interval is 30 months. Biologically, birth interval is influenced by the length of the lactation period, which suppresses the onset of ovulation following a successful pregnancy and delivery (Howell 1976). 2) Based on reconstructed age distribution of females and assumed age specific fertility rates. However, various cultural and socioeconomic factors governing fertility levels of females in prehistoric societies are so specific and binding that it becomes difficult to make generalizations on age specific fertility (Henneberg 1976). Despite numerous attempts to develop and perfect already existing methods for estimating fertility rates in skeletal populations (Weiss 1973; Ward and Weiss 1976; Henneberg 1976; Buikstra et al. 1986; Paine and Harpending 1996), there are still problems encountered. The most lamented problem is the accuracy of applying mathematical equations to skeletal data.

A more recently popularized method for estimating growth rate of skeletal populations is where model life tables are fitted into the skeletal data to project the fertility rates (Coale and Demeney 1983; Gage 1988; Paine 1989; Paine and Harpending 1996). The Coale and Demeney (1983) 'West' model is the one best suited for prehistoric and pre-industrial societies (Howell 1976; Paine 1989). Model life tables provide a pattern of age specific mortality to be used where the skeletal data is not workable e.g. in the case of K2/Mapungubwe (Henneberg and Steyn 1994; 1995). Mathematical models of establishing mortality patterns are a slight variation of model life tables and can be used in palaeodemography where there is insufficient primary data provided by the skeletal sample (Gage 1988).

A fundamental problem with the use of biological parameters in estimating fertility rates is that social and cultural dictates are ignored. According to some authors, e.g. Henneberg (1976), cultural and social factors responsible for limiting the number of children per female are of an insignificant magnitude and therefore can be ignored. Contrary to this, all non-Malthusian societies develop cultural mechanisms that regulate population growth rate once the critical threshold between man and his environment has been reached. For instance, among the !Kung hunter-gatherers in Botswana, South Africa and Namibia, socio-economic and cultural constraints extend the birth interval to an average of 36 months (Howell 1976) and thereby limiting the total fertility rate (TRF) to about five children per female.

Controversies, concerns and critiques raised about palaeodemography around the mid 1980s to the early 1990s (Buikstra and Konigsberg 1985; Konigsberg and Frakenberg 1992) appear to have now been partially answered and corrected. One of the main concerns at the time was the use of poor aging techniques especially on adults (Buikstra and Konigsberg 1985; Bocquet-Appel and Masset 1996). At the time, the pubic symphysis and cranial sutures were the most highly relied upon methods despite the fact that they had low accuracy and could only provide broad age ranges (Angel 1969; Bocquet-Appel and Masset 1982; Buikstra and Konigsberg 1985; Ubelaker 1989a; Konigsberg and Frakenberg 1992; Loth and İşcan 1994). At this point in the evolution of anthropological aging techniques, it is tempting to argue that this concern is being dealt with by developing more reliable and more accurate methods such as the rib phase analysis (e.g., Loth and İşcan 1994; 2000a; Oettlé and Steyn 2000). This method has produced satisfactory results for different purposes. Other age estimation techniques such as the Bayesian method and the IPFP are being reviewed to assist in aging adult skeletons more accurately (Konigsberg and Frakenberg 1992; Bocquet-Appel and Masset 1996). Although sex and population specificity are still a concern in skeletal aging, more and more reference collections are being established in order to bridge the spatial differences between reference samples and study samples. Archaeological as well forensic skeletons are now aged using reference samples closer to them than was the case in the past. For instance, the Department of Anatomy, University of Pretoria has developed a rib phase model for South African blacks (Oettlé and Steyn 2000) and this was used to age the Toutswe skeletons in the current study.

5.3 Other similar studies

In sub-Saharan Africa, palaeodemographic studies are not common due to the fact that it is difficult to obtain skeletal samples from the same site or sites of the same period that are large enough to warrant such studies. In southern Africa, one of the best case studies of palaeodemography has been done on skeletons from Mapungubwe and K2 sites (Henneberg and Steyn 1994; 1995).

From these sites, 109 skeletons were excavated, 97 from K2 and 12 from Mapungubwe, a sample large enough to allow for reconstruction of the life table. Two life tables were calculated, one for K2 only and another one for the K2/Mapungubwe combination (Henneberg and Steyn 1994; 1995). The stable population results showed a very low life expectancy of about 12 years at birth, which could not be compared with any prehistoric or modern Malthusian populations (Henneberg and Steyn 1994; 1995). An annual increase in population of 2.5% was then used to adjust the demographic situation and the life expectancy at birth rose to at least 18 years, providing a more workable life table (Henneberg and Steyn 1994; 1995). The K2/Mapungubwe results are used in this study for comparison with the Toutswe results.

Another case study of the reconstruction of palaeodemography in southern Africa was done on skeletal remains from Oakhurst, a rock shelter situated along the southern coast of South Africa (Patrick 1989). The Oakhurst study is important in that it is one of the first paleodemographic studies done in southern Africa, however some problems exist. The main problem is that the Oakhurst sample spans a period of approximately 10 000 years, but there are not enough skeletons to indicate demographic transition throughout the centuries. The sample of 42 individual skeletons is too small to argue that it is representative of the population of a 10 000 year period. Therefore, a comparison between Oakhurst demography and that of any other skeletal population has to be done with caution.

In North America and other parts of the world, numerous case studies have been published, e.g., Ubelaker (1989a), Mensforth (1990), Storey (1992). Teotihuacan is an ancient Mesoamerican city located on the northeastern side of the Valley of Mexico, not far from Mexico City, dated between 150 BC and AD 750 (Storey 1992). A life table for this population was calculated from a sample of 206 individuals. The results are that nearly 30% of infants died before the end of their first year. The area had high infant mortality and life expectancy at the end of the first year was about 20 years.

Another example comes from Kentucky in the northeastern side of the United States of America. Here different authors (e.g., Mensforth 1990) have reported a late archaic skeletal population of 430 individuals from Carlson Annis (Bt-5). The demographic study of this population included 354 individuals. The resulting life table shows a life expectancy of 22.4 years at birth, which raised by five years once an infant, completed the first year of its life (Mensforth 1990). Like other archaeological examples, this community was characterized by high infant mortality. Of the 354 individuals, 98 are between seven lunar months and four years. Only 70.3% of the babies born survived to reach five years. At least 19.5% of the original population survived to 40 years (Mensforth 1990).

The skeletons from Ossuary II in Maryland were used to construct a life table of the community (Ubelaker 1989a). The life table showed that at birth life expectancy was 23 years but once an individual survived the first five years of life, then that individual could expect to live an additional 27 years to reach the age of 42. Despite the relatively high life expectancy at birth by comparison to other cases, the sample indicated a relatively high infant mortality rate and low adolescence mortality (Ubelaker 1989a).

5.4 Analysis of survival times

The main aim of palaeodemography is the analysis of survival times. Survival time refers to the time from a fixed starting point to the death of an individual (Altman 1991; Hosmer and Lemeshow 1999). In clinical trials, the starting point can be the time of when treatment was applied to the subject. In palaeodemography the starting point is the time of birth so that the survival time is between birth and death. The statistical analysis of survival time is referred to as survival analysis (Altman 1991; Hosmer and Lemeshow 1999). Survival analysis can be carried out in different ways such as; (1) a life table, (2) a survivorship curve and (3) a Kaplan-Meier curve. There are different kinds of life tables designed for different kinds of data (Angel 1969; Ubelaker 1989a; Altman 1991; Williams 1992; Hosmer and Lemeshow 1999). In palaeodemography, a life table encompasses an estimation of life expectancy. A life table presents tabulated data while the survivorship curve and the Kaplan-Meier curve present data graphically (Altman 1991; Hosmer and Lemeshow 1999).

A total of 84 skeletons were used to for survival analysis of the Toutswe population. Of these, 52 are infants and juveniles younger than 15 years while the remaining 32 are adults aged between 15 and 75 years.

5.4.1 Life table

A life table is, in essence, a brief summary of mortality rates and demographic characteristics of a population, or an indication of varying chances of death due to age or a mortality schedule (Weiss 1973; Coale and Demeney 1983; Ubelaker 1989a; Storey 1992). An advantage of using a life table is that it allows for the estimation of life expectancy, which can not be estimated from either a survivorship or a Kaplan-Meier curve.

The birth and death rates of the Toutswe population are unknown and hence a stationary population assumption was used to reconstruct a life table by means of Halley's method (Acsadi and Nemeskeri 1970). A stationary population is defined by equal birth and death rates, zero migration and a relatively constant age distribution (Ascadi and Nemeskeri 1970; Weiss 1973;Coale and Demeney 1983; Williams 1992; Storey 1992). The stable population theory assumes that unchanging birth and death rates for a hundred years would yield unchanging age structures of that population within that one hundred-year period.

The Toutswe skeletons come from several sites, but none of the sites produced a sufficient sample size to warrant isolated life table construction. All skeletons were therefore combined to construct a single life table with the assumption that the entire sample was representative of the actual population. An adult sex distribution was also evaluated.

Methods

Five-year age intervals were used to establish the age distribution. The age interval is based on an idealized concept of a cohort in which a group of people born within the same age interval experience similar probabilities of death as a function of age during their lives (Williams 1992). An age interval has two qualities, an entry age and the width of the interval. Deciding on these qualities is influenced by the age resolution obtained from the skeletons. Estimation of age from skeletons cannot provide resolutions for one-year intervals, especially after the first year of life (Williams 1992). Ubelaker (1989a) advises that five-year intervals be used because they are broad enough to encompass possible errors incurred in estimating age, but at the same time short enough to depict mortality patterns more easily and clearly. The last interval can be left open ended to include all individuals much older than its entry age (Williams 1992).

For skeletons whose ages fell across two or more age intervals, such skeletons were distributed by fractioning them into equal values which were then placed into relevant age intervals (Henneberg and Steyn 1994; 1995). For instance, a skeleton aged between 30 and 50 years was divided into four parts, each being 0.25 and each five -year interval between 30 and 50 was allocated a 0.25 value. The life table was calculated using the Halley's method as follows:

The number of all skeletons whose ages fell within an age interval (x) was summed to determine the number of deaths (Dx) per age interval. The percentage of deaths for each interval (dx) was calculated by expressing the number of deaths (Dx) as a percentage of the total sample. The percentage of survivors of each interval (lx) is the percentage of the original sample that survived into the beginning of that interval. It is calculated by subtracting the percentage of deaths (dx) of a previous interval from the percentage of survivors (lx) in the same interval. The probability of death (qx) was calculated by dividing the percentage of deaths (dx) by the number of survivors present at the beginning of the interval for which the probability of death (qx) is calculated. The total number of years lived by all individuals within the same interval (Lx) was calculated by adding the number of survivors in an interval (lx) to the number of survivors entering the next interval (lo). The sum was then multiplied by 5 (length of age interval) and the result divided by 2 to get the answer i.e. Lx = 5 (lx +lo) / 2. The total number of years remaining in the lifetimes of all individuals entering each age interval (Tx) is the sum of

Lx values of that interval and all those after it. Life expectancy (ex) at each interval was obtained by dividing the Tx value by the lx value in that age interval (x). It represents the number of years an individual within a particular age interval (x) can be expected to live (Ubelaker 1989a). The life table was computed using a spreadsheet developed in Excel.

Results

The results indicate a high infant mortality rate (Table 5.1). The zero to four-year age interval has the highest representation, with about 30% of the individuals belonging in this group. The life expectancy at birth was about 17 years, but once a child survived the first five years of its life it could expect to live another 18.45 years to become approximately 24 years. Fifty-three of the 84 individuals (nearly two-thirds) died before reaching the age of 15 years. Thus, only one-third of the original sample survived beyond 15 years. A sharp decline in the number of deaths is seen between the ages of 10 and 19 years, where 12 individuals had died at the end of 14 years but only five dying at the end of 19 years. Only five individuals lived to be between 50 and 75 years old. One of the features of this population is that many of individuals died prematurely but those who did survive adolescence lived for a relatively long period. The large number of infants and juveniles could be a result of high rate of reproduction as has been implicated in the K2/Mapugubwe study (Henneberg and Steyn 1994), or may be a function of differential disposal of the dead.

5.4.2 Survivorship curve

A survivorship curve is a graph used to depict the percentage of the original sample alive at the end of each age category (Ubelaker 1989a; Altman 1991; Hosmer and Lemeshow 1999). The total sample is theoretically taken as 100 percent of the actual population.

The survivorship curve (Figure 5.1) shows four distinct features reflected by changes in the steepness of the slope at roughly four phases. First it shows a steep slope in survivorship between the ages of five and 15 years. The 50% mark of the curve is at approximately 15 years. This phase is a result of high mortality rates during the early years of life. The second phase is approximately between the ages of 15 and 35 years where the slope is fairly gentle. The gentleness of the slope is due to the relatively low mortality. The percentage of individuals alive from one age category to the other drops by small amounts from 15-35 years and hence a gentle slope in the survivorship curve. Between the ages of 35–55 the curve becomes fairly steep marking the third phase of the survivorship curve. This indicates a fairly rapid decline in the percentage of survivors during early adulthood. In the last phase starting at 60 years, there are very small chances of survival and after the age of 75 there are no survivors.

Table 5.1 Life table of the Toutswe population.

Age	Dx	dx	lx	qx	Lx	Tx	ex
0- 4	26	30.95	100.00	0.31	422.62	1723.214	17.23
5 - 9	16.5	19.64	69.05	0.28	296.13	1300.595	18.84
10 - 14	10.5	12.50	49.40	0.25	215.77	1004.464	20.33
15 - 19	5.5	6.55	36.90	0.18	168.15	788.690	21.37
20 - 24	1.5	1.79	30.36	0.06	147.32	620.536	20.44
25 - 29	2	2.38	28.57	0.08	136.90	473.214	16.56
30 - 34	5	5.95	26.19	0.23	116.07	336.310	12.84
35 - 39	5	5.95	20.24	0.29	86.31	220.238	10.88
40 - 44	4.2	5.00	14.29	0.35	58.93	133.929	9.38
45 - 49	3.7	4.40	9.29	0.47	35.42	75.000	8.08
50 - 54	1.65	1.96	4.88	0.40	19.49	39.583	8.11
55 - 59	1.15	1.37	2.92	0.47	11.16	20.089	6.89
60 - 64	0.65	0.77	1.55	0.50	5.80	8.929	5.77
65 - 69	0.45	0.54	0.77	0.69	2.53	3.125	4.04
70 -74	0.2	0.24	0.24	1.00	0.60	0.595	2.50
Total	**84**						

Dx- number of deaths

dx- percentage of deaths

lx- percentage of survivors at the beginning of an age category

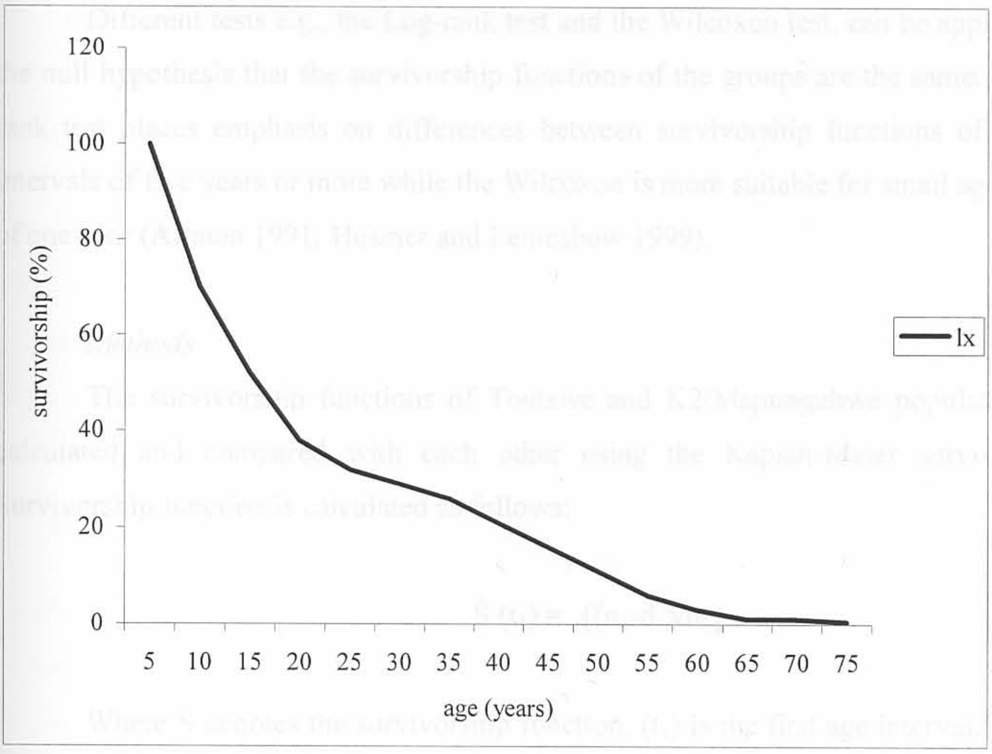
qx- probability of death

Lx- total number of years lived by all individuals

Tx- total number of years remaining in the life times of all individuals

ex- life expenctancy

Figure 5.1 Survivorship curve of the Toutswe people



5.4.3 Kaplan-Meier survival estimates

Kaplan-Meier survival curve is a graphic presentation of survivorship functions. The survivorship function is defined as the probability of observing a survival time exceeding, that which has been stipulated. For example, in a palaeodemographic analysis with age intervals of five years, the survivorship function of the first age category is the possibility of survival after the first five years (Altman 1991; Hosmer and Lemeshow 1999). Kaplan-Meier survival estimate is one of the most commonly used survival analysis.

The Kaplan-Meier survival estimate is an effective means of comparing survivorship functions at each age category in two or more groups of data. The groups being compared are usually defined by some key factors that they both possess. For instance, the Toutswe and K2/Mapungubwe populations are both Iron Age inhabitants of the Shashe-Limpopo basin. The main reason for comparing groups of data using the

Kaplan-Meier survival estimate is to quantify the differences between the groups at different points in time.

Different tests e.g., the Log-rank test and the Wilcoxon test, can be applied to test the null hypothesis that the survivorship functions of the groups are the same. The Log–rank test places emphasis on differences between survivorship functions of large age intervals of five years or more while the Wilcoxon is more suitable for small age intervals of one year (Altman 1991; Hosmer and Lemeshow 1999).

Methods

The survivorship functions of Toutswe and K2/Mapungubwe populations were calculated and compared with each other using the Kaplan-Meier survival curve. Survivorship function is calculated as follows:

$$\hat{S}\,(t_1) = \{(n_1\text{-}d_1)/n_1\}$$

Where $\hat{S}$ denotes the survivorship function, (t_1) is the first age interval, (n_1) is the number individuals alive at the beginning of the first age category and (d_1) is the number of deaths that occurred during the first age category (Altman 1991; Hosmer and Lemeshow 1999). For the second age category the formula is the same and the result is multiplied by the survivorship function of the first age category i.e.,

$$\hat{S}\,(t_2) = \{(n_1\text{-}d_1)/n_1\} \times \{(n_2\text{-}d_2)/n_2\}$$

Where (t_2) is the second age category (n_2), is the number of people alive at beginning of the second age category and (d_2) is the number of individuals who died during the second age category. The third age category is multiplied by the first and the second age category (Altman 1991; Hosmer and Lemeshow 1999):

$$\hat{S}\,(t_3) = \{(n_1\text{-}d_1)/n_1\} \times \{(n_2\text{-}d_2)/n_2\} \times \{(n_3\text{-}d_3)/n_3\}$$

The Log-rank test was then calculated to test the null hypothesis that the survivorship functions of the two groups are the same.

Results

The survivorship functions of Toutswe and K2/ Mapungubwe are given in Table 5.2. The Table indicates that at the beginning, the sample from Toutswe was 84 individuals and K2/Mapungubwe was 109 individuals. At the end on the first five years of life, Toutswe had lost 26 individuals resulting in a survivorship function of 0.6905 while K2/Mapungubwe had lost 50 of its members and hence a survivorship function of 0.5413. The total number of individuals alive at the end of five years is 58 and 59 for Toutswe and K2/Mapungubwe respectively. Between zero and 50 years, the survivorship function of Toutswe exceeds that of K2/Mapungubwe and the two almost equal each other at the end of 55 years. This means that during the first 50-year period, Toutswe lost a smaller percentage of its original size every five years than K2/Mapungubwe. The two groups had lost nearly the same percentages of their original sizes at the end of 55 years.

A Log-rank test was used to test for statistical differences between the survivorship functions of K2/Mapungubwe and Toutswe at various age categories. The survivorship functions of the two groups do not differ significantly as indicated by the Log-rank test. The chi square test of 0.4155 also indicates that these populations were not statistically different. From the Kaplan-Meier survival estimate by group (Figure 5.2), the two groups started at a survival probability of 100% each and declined every five years. The rate of decline was highest at K2/Mapungubwe. Between the end of the first five years and 60 years, the Toutswe curve is higher that the K2/Mapungubwe curve indicating that Toutswe had a higher percentage of survivors during this period.

5.5 Adult sex distribution

The adult sample is made of 30 individuals aged between 17 and 75 years (Table 5.3). Of these, 17 were males (57%), seven were females (23%) and the remaining 6 (20%) are indeterminate. Most of the adults died between the ages of twenty and sixty years (80%) and only a percentage (7%) of them are old aged. The adult sample found in this study is too small to make more statistical inferences from.

Table 5.2 Survivorship functions of Toutswe and K2/Mapungubwe samples

Age **(Years)**	**Toutswe Beginning Total (n)**	**Fail (Dx)**	**Survivor Function**	**K2 and Mapungubwe Beginning total (n)**	**Fail (Dx)**	**Survivor Function**
< 5	84	26	0.6905	109	50	0.5413
<10	58	16.5	0.4940	59	18	0.3761
< 15	41.5	10.5	0.3690	41	13	0.2569
< 20	31	5.5	0.3036	28	4	0.2202
< 25	25.5	1.5	0.2857	24	5.50	0.1697
< 30	24	2	0.2619	18.50	7.75	0.0986
< 35	22	5	0.2024	10.75	2	0.0803
< 40	17	5	0.1429	8.75	2.50	0.0573
< 45	12	4.2	0.0929	6.25	1.70	0.0417
< 50	7.8	3.7	0.0488	4.55	0.95	0.0330
< 55	4.1	1.65	0.0292	3.60	0.70	0.0266
< 60	2.45	1.15	0.0155	2.90	0.70	0.0202
< 65	1.3	0.65	0.0077	2.20	1.20	0.0092
< 70	0.65	0.45	0.0024	1	1	0.0000
< 75	0.2	0.2	0.0000			

Beginning total- number of individuals alive at the beginning of an age category

Fail- number of individuals who failed to succeed to the next age interval

Figure 5.2 Comparisons of survival curves using Kaplan-Meier survival estimates

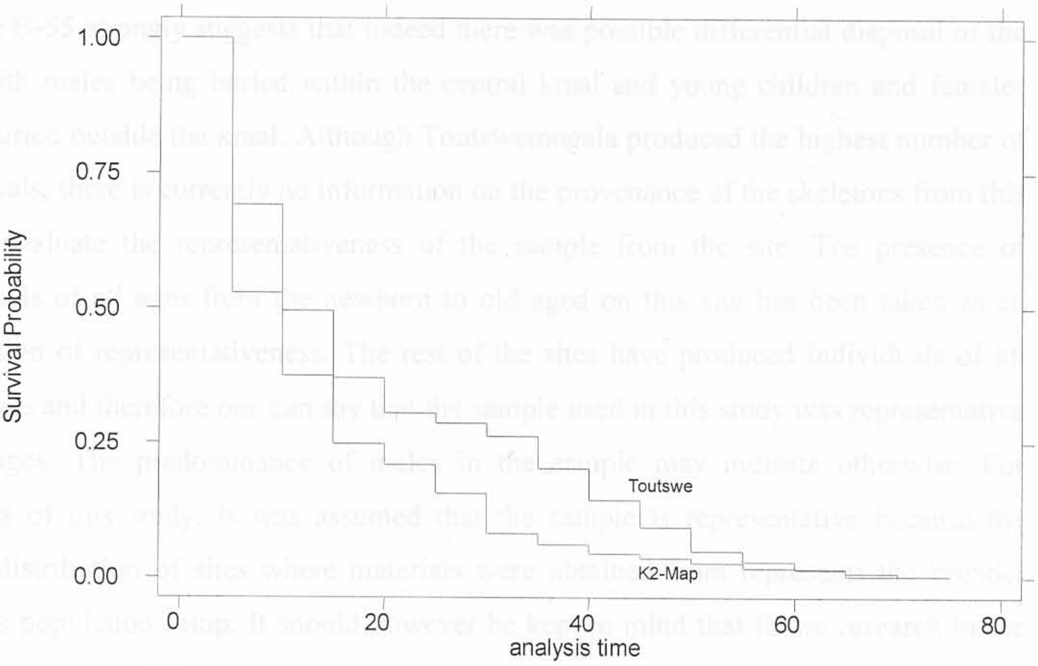


Table 5.3 Adult sex and age distribution

Age (years)	Male	Female	Indeterminate	Total
17-25	3	0	1	4
20-50	5	4	3	12
30-60	7	3	2	12
50-75	2	0	0	2
Total	**17**	**7**	**6**	**30**

5.6 Discussion

The presence of fetal and old aged individuals in the sample was taken on a superficial level to imply non-differential disposal of the dead from all sites. However, Kgaswe B-55 strongly suggests that indeed there was possible differential disposal of the dead with males being buried within the central kraal and young children and females being buried outside the kraal. Although Toutswemogala produced the highest number of individuals, there is currently no information on the provenance of the skeletons from this site to evaluate the representativeness of the sample from the site. The presence of individuals of all ages from the newborn to old aged on this site has been taken as an assumption of representativeness. The rest of the sites have produced individuals of all age ranges and therefore one can say that the sample used in this study was representative of all ages. The predominance of males in the sample may indicate otherwise. For purposes of this study, is was assumed that the sample is representative because the spatial distribution of sites where materials were obtained from represents the broader Toutswe population setup. It should however be kept in mind that future research in the Toutswe area may differ.

Although splitting the total sample into individual sites distorts the broader picture, it is worth mentioning separately the Toutswemogala and Kgaswe B-55 skeletons. Only four of the 31 Toutswemogala skeletons are adults aged between 20 and 50 years. These include two males, one female and one indeterminate individual. This site demonstrates a very distinct pattern of very little representation of adults. This may raise questions regarding the representativeness of individuals from this site but answers to such questions would not be attempted in this report. Contrary to Toutswemogala, Kgaswe B-55 has 16 adults out of a total of 27 skeletons. Thus nearly 56% of the Kgaswe B-55 skeletons are adults aged between 15 and 75 years old. Of these, eight are males, three are females and the remaining five are indeterminates.

The Toutswe and K2/Mapungubwe palaeodemographic results show some similarities. In these samples, infants and juveniles younger than 15 years are the most highly represented, 63.1% for Toutswe and 74.3% for K2/Mapungubwe. The figures for K2/Mapungubwe were corrected for growth (Henneberg and Steyn 1994). High infant mortality rates, little representation of adolescents and few adults characterize these two prehistoric population groups.

At Kgaswe B-55 graders stripped the entire site during a developmental project. Although the entire site has been excavated, the skeletal sample obtained is not sufficient to allow for sound population size estimation. Only 27 individuals were found and some have been badly destroyed during excavation. All other sites included in this study have only been partially excavated and consequently no attempts were made to estimate the population size of the Toutswe people.

The Oakhurst sample is similar to the Toutswe sample in that they are both characterised by high infant mortality. From the Oakhurst sample it was found that only 27% of newborn babies had chances of fully participating in reproduction (Patrick 1989). Although the Oakhurst sample is small, it indicates a slightly lower life expectancy at birth. An individual at 20 years could expect to live an additional 13 years to be 33 years old at Oakhurst. At the age of 20 years, an individual at Toutswe could expect to live an additional 20 years. It is possible that differences resources of subsistence and diseases may be the reason for a lower life expectancy at Oakhurst than at Toutswe and K2/Mapungubwe but sample size differences can not be ruled out as being responsible for the mortality patterns seen between these three groups.