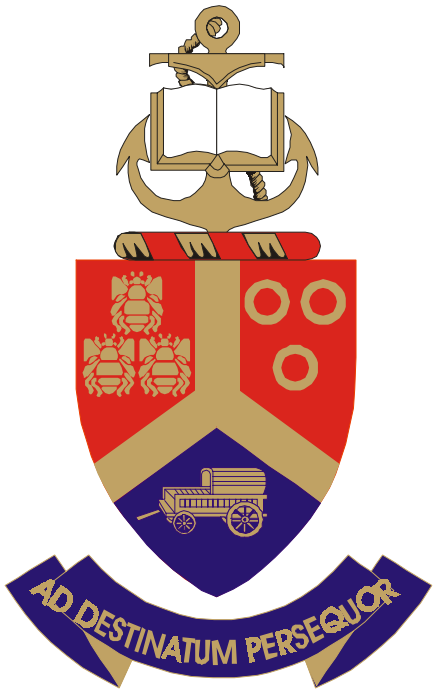
ORTHODONTIC STATUS AND TREATMENT NEED OF 12-YEAR-OLD CHILDREN IN SOUTH AFRICA: AN EPIDEMIOLOGICAL STUDY USING THE DENTAL AESTHETIC INDEX



ROBERT JOHN DRUMMOND

BChD, Dip Odont (Pret)

2003

ORTHODONTIC STATUS AND TREATMENT NEED OF 12-YEAR-OLD CHILDREN IN SOUTH AFRICA: AN EPIDEMIOLOGICAL STUDY USING THE DENTAL AESTHETIC INDEX

by

ROBERT JOHN DRUMMOND

BChD, Dip Odont (Pret)

Submitted in partial fulfilment of the
requirements for the degree of

MASTER IN DENTISTRY (ORTHODONTICS)

at the

Department of Orthodontics

in the

School of Dentistry

of the

University of Pretoria

Pretoria

Republic of South Africa

May 2003

'Sometimes when I consider what tremendous

consequences come from little things,

I am tempted to think

there are no little things'

- Bruce Barton

DEDICATION

This dissertation is dedicated to all the children of South Africa with malocclusion. I hope that this information will bring about the improvement in the orthodontic services necessary to provide all of our children with a confident smile, a functional occlusion and an improved quality of life.

ACKNOWLEDGEMENTS

My sincere thanks to the following people who contributed to this dissertation:

Prof PJ van Wyk, under whose leadership this material has been tested and refined, and for his integrity and sense of quality.

Prof ST Zietsman, for his valued advice, support and help with the establishment of training and calibration material.

The regional coordinators, the examiners and supporting staff, without whom this dissertation would not have been possible.

Ms. Rene Ehlers, for the statistical analysis.

The Principals, Staff and Pupils of the different schools, for their co-operation, time and friendliness.

Mrs Yvonne Skinner, for the typesetting of the manuscript.

My co-registrars Drs Johan Hattingh, Alfred Dippenaar and Darmesh Mistry, for their support, their interest and for "holding the fort" while I was away from the Dental School and engaged in the fieldwork.

My wife, Christa, for her constant love, interest and for caring for our little girl, while I was engrossed in undertaking and completing this dissertation.

Grete, who had to share her dad with the books and the computer for so long.

DECLARATION

I, Robert John Drummond, declare that the dissertation I am herewith submitting for the degree MChD (Orthodontics) at the University of Pretoria is my own work and has not previously been submitted for any other degree at any other University

ROBERT JOHN DRUMMOND DATE

ORTHODONTIC STATUS AND TREATMENT NEED OF 12-YEAR-OLD CHILDREN IN SOUTH AFRICA: AN EPIDEMIOLOGICAL STUDY USING THE DENTAL AESTHETIC INDEX

TABLE OF CONTENTS

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

ORTHODONTIC STATUS AND TREATMENT NEED OF 12-YEAR-OLD CHILDREN IN SOUTH AFRICA: AN EPIDEMIOLOGICAL STUDY USING THE DENTAL AESTHETIC INDEX

by

Dr Robert J Drummond

Department of Orthodontics

School of Dentistry

University of Pretoria

Republic of South Africa

LEADER: **Professor PJ van Wyk**

BSc, MChD, Dip Pub Admin, PhD (Pret)

Head of the Department of Community Dentistry

School of Dentistry

University of Pretoria

DEPARTMENT: **ORTHODONTICS**

DEGREE: **MChD (ORTHODONTICS)**

The aim of this study was to evaluate the prevalence and severity of malocclusion and orthodontic treatment needs in a sample of 12-year-old South African school children using the Dental Aesthetic Index (DAI), and to assess the relationship between malocclusion and certain socio-demographic variables.

The sample comprised 6142, 12-year-old children attending school in seven of the nine provinces of South Africa. For each subject the standard demographic

information such as gender, population group, location type and employment status of the parents were collected, after which an intra-oral examination for occlusal status using the DAI was performed.

The results showed that 47.7 per cent of the children in the sample presented with good occlusion or minor malocclusion, just over 52.1 per cent presented with identifiable malocclusion, a DAI score larger than 26. Of these, 21.2 per cent had definite malocclusion, 14.12 per cent had severe malocclusion and 16.89 per cent had very severe or handicapping malocclusion. Malocclusion as defined in this study was found to be significantly associated with the different provinces, the different population groups in South Africa, gender and dentition stage, but not with the location type or the employment status of parents.

The results of the individual variables showed that anterior maxillary and mandibular irregularity occurred in more than 50 per cent of the sample. More than 40 per cent of the children examined showed signs of crowding. Spacing in the incisal segments occurred in almost 28 per cent of the sample and maxillary midline diastema was present in 16.66 per cent of the sample. At the age of 12 years, Black children, showed a higher prevalence of maxillary midline diastema, larger than 2mm, than their White, Coloured and Asian counterparts. A maxillary midline diastema, larger than 2mm, was more prevalent in 12-year-old females than in males. Thirty one per cent of the sample had an increased overjet larger than 3mm and a severe overjet of 6mm or more occurred in only 2.18 per cent of the sample. More Black 12-year-old

children presented with an edge-to-edge anterior relationship and significantly less Black children had an increased overjet. Mandibular overjet affected only 10.43 per cent of the sample and was more prevalent in the late mixed dentition stage than in the early permanent dentition stage. Anterior openbite occurred in 7.7 per cent of the sample and ranged from 1mm to 8mm. Almost 44 per cent of the sample had a antero-posterior molar relation discrepancy.

The results of this study indicated a high prevalence of malocclusion in 12-year-old South African children. The findings provide reliable base-line data regarding the prevalence, distribution and severity of malocclusion as well as useful epidemiological data on the orthodontic treatment needs of 12-year-old children in selected rural and urban areas in South Africa. The inclusion of occlusal traits as part of the index provided an opportunity to assess several occlusal characteristics in 12-year-old South African children, separately.

OPSOMMING

ORTODONTIESE STATUS EN BEHANDELINGSBEHOEFTES VAN 12-JARIGE KINDERS IN SUID AFRIKA: 'n EPIDEMI0LOGIESE STUDIE DEUR DIE GEBRUIK VAN DIE "DENTAL AESTHETIC INDEX"

deur

Dr Robert John Drummond

Departement Ortodonsie

Skool van Tandheelkunde

Universitet van Pretoria

Republiek van Suid Afrika

LEIER: **Professor PJ van Wyk**

BSc, MChD, Dip Pub Admin, PhD (Pret)

Hoof van die Departement Gemeenskapstandheelkunde

Skool vir Tandheelkunde

Universitet van Pretoria

DEPARTEMENT: **ORTODONSIE**

GRAAD: **MChD (ORTODONSIE)**

Die doel van die studie was om die voorkoms en ernstigheidsgraad van wansluitings en die ortodontiese behandelingsbehoeftes van 'n groep 12-jarige Suid-Afrikaanse skoolkinders te bepaal, deur gebruik te maak van die 'DAI'. Die verband tussen wansluiting en sekere sosio-ekonomiese veranderlikes is ook ondersoek.

Die steekproef het bestaan uit 6142, 12-jarige skoolgaande kinders uit sewe van die nege provinsies in Suid-Afrika. Standaard demografiese inligting van elke deelnemer is ingewin, wat onder andere insluit; geslag, bevolkingsgroep, lokaliteit en die beroepstatus van die ouers. 'n Intra-orale ondersoek is daarna gedoen deur die 'DAI' te gebruik.

Die resultate het getoon dat, 47.7 persent van die kinders in die steekproef presenteer het met goeie okklusie of geringe wansluiting, net oor die 52.3 persent het presenteer met identifiseerbare wansluiting, d.i. 'n 'DAI' telling hoër as 26. Van die kinders met wansluiting het 21.2 persent presenteer met definitiewe wansluiting, 14.12 persent met ernstige wansluiting en 16.89 het baie ernstige wansluiting gehad. Die voorkoms van wansluiting soos gedefinieer in hierdie studie was positief geassosieer met die verskillende provinsies, die verskillende bevolkingsgroepe in Suid-Afrika, geslag en die ontwikkelingsstadium van die gebit, maar nie met die lokaliteit of die beroepstatus van die ouers nie.

Die resultate van die individuele veranderlikes toon aan dat anterior maksillêre en mandibulêre onreëlmatighede voorgekom het in meer as 50 persent van die steekproef. Meer as 40 persent van die kinders in die steekproef toon tekens van bondeling. Spasiering in die insisale segmente kom in ongeveer 28 persent van die steekproef voor en 'n maksillêre middellyn diasteem was teenwoordig in 16.66 persent van die groep.

Twaalf-jarige swart kinders het 'n hoër prevalensie van maksillêre middellyn diasteem, groter as 2mm, gehad. Maksillêre middellyn diasteem, groter as 2mm, kom meer voor in 12-jarige dogters as in seuns. Een-en-dertig persent van die steekproef het 'n voorbyt groter as 3mm, terwyl 'n ernstige voorbyt van 6mm en meer teenwoordig was in slegs 2.18 persent van die groep. Meer swart kinders presenteer met 'n kant-tot-kant anterior verhouding en betekenisvol minder swart kinders het 'n voorbyt groter as 3mm gehad. Mandibulêre voorbyt affekteer slegs 10.43 persent van die steekproef en was meer prevalent in die laat-gemengde-gebit-stadium as die vroeë-permanente-gebit-stadium. Anterior oopbyt was teenwoordig in 7.7 persent van die steekproef en die grootte wissel van 1 tot 8mm. Meer as 44 persent van die groep het 'n antero-posterior molaarverhouding afwyking gehad.

Die resultate van die studie toon 'n hoë voorkoms van wansluiting in 12-jarige Suid-Afrikaanse kinders. Die bevindings van die studie verskaf betroubare basislyndata aangaande die prevalensie, verspreiding en ernstigheidsgraad van wansluitings by 12-jarige skoolkinders in sekere gebiede van Suid-Afrika. Die insluiting van bepaalde okklusale einskappe as deel van die indeks, het die geleentheid gebied om hierdie okklusale veranderlikes in 12-jarige Suid-Afrikaanse kinders afsonderlik te beskryf.

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

DAI: Dental Aesthetic Index

FDI*:* Federation Dentaire Internationale

OI: Summer's Occlusal Index

HLD: Handicapping Labio-lingual Deviations Index

TPI: Treatment Priority Index

NOTI: Need for Orthodontic Treatment Index

IOTN: Index of Orthodontic Treatment Need

PAR: Peer Assessment Rating

ICON: Index of Complexity, Outcome and Need

WHO: World Health Organisation

CHAPTER 1

PROBLEM STATEMENT, GOALS AND RATIONALE

INDEX

CHAPTER 1

PROBLEM STATEMENT, GOALS AND RATIONALE

1.1 INTRODUCTION

Physical appearance may be the single variable feature having the greatest impact on self-esteem, behavioural patterns and personal interactions. Ideally, everyone should have a fair opportunity to attain his or her full potential and no one should be disadvantaged from achieving this. Orthodontics is one of the disciplines sharing the opportunity of providing children with a confident smile and a functional occlusion, thereby improving their quality of life[(1)].

Although almost all oral diseases and in particular malocclusions, may not be life-threatening, they are important noble health issues[(1)], because of their high prevalence in South African children, varying from 28 per cent in rural communities[(2)] to 78 per cent amongst members of the South African Defence Force[(3)]. Furthermore, malocclusion has a large impact on individuals and society in terms of discomfort, social and functional limitations[(1)].

Malocclusions are clinically significant variations from the normal range of growth and morphology. In contrast to disease and pathological lesions, malocclusion may be the result of a combination of minor variations from the normal; each is too mild to be classed abnormal but their combination summates to produce a clinical problem[(4)].

The oral health needs of the population could be defined, as that quantity of dental services which expert opinion believes ought to be consumed over a relevant period of time in order for its members to remain or become as "healthy" as is permitted by existing dental knowledge[5]. This is also termed normative needs[6]. The opinion of orthodontists as to treatment needs may differ considerably from that of the dentist and the general public[7].

Consumers perceived needs (wants) are based on their awareness of potential disease and on personal experience, and depend on culture, religious, educational and social status. As such, they are an important determinant of consumer behaviour, i.e. a determinant of what economists call demand[8].

Demand derives from a desire and attempt by the public to seek oral health care[9]. Striffler[10] defined desire plus the ability to obtain dental services as effective demand. In contrast, potential demand refers to the desire for care without the ability to attain it. Demand therefore reflects the ability of individuals to translate perceived needs (wants) into professional contact, and this in turn is clearly determined by organisational factors such as economy, time, ease and convenience of access, and income[11].

The extent to which these factors influence the potential demand will eventually determine the effective demand or utilisation of health services. The difference between demand and utilisation is often called unmet demand or ill-met demand[8].

Priorities should not be developed solely based on the demand for treatment. Health promotion can alter a community's perception of the problems and hence priorities. Priorities should be established through a partnership between the community and the professional advocates for oral health. The community should be involved in setting goals that are stated in terms of oral health, oral disease, oral health promotion, equity, training, personnel and health service[1].

Despite efforts in South Africa in the past decades to make health systems more equitable, access to dental health care is still far from adequate especially in the poor communities[12].

1.2 AIM

The aim of this study was to evaluate the prevalence and severity of malocclusion and orthodontic treatment needs in a sample of 12-year-old South African school children using the Dental Aesthetic Index (DAI), and to assess the relationship between malocclusion and certain socio-demographic variables.

1.3 GOALS

- To establish reliable base-line data regarding the prevalence, distribution and severity of malocclusion of 12-year-old children in selected rural and urban areas in South Africa.
- To provide useful epidemiological data on the orthodontic treatment needs of 12-year-old South African children of the selected areas.

- To determine if the malocclusion, as defined by the DAI is affected by socio-demographic variables such as gender, ethnic and socio-economic backgrounds.

1.4 PROBLEM STATEMENT

Isolated studies in South Africa have been carried out in the past[2,13,14,15]. The results of these epidemiological studies on malocclusion in South Africa are summarised in Table 2-4. However, no recent data on the prevalence, distribution and severity of malocclusion or the orthodontic treatment need of the population representative of the whole of South Africa is available. The lack of data on the distribution, prevalence and severity of malocclusion in South Africa could be affecting the effective planning for the orthodontic services, which is needed to address the ever-increasing demand for orthodontic treatment.

The potential interest (priorities) in orthodontic treatment for an increasing proportion of children undoubtedly will affect the type of services provided, as well as organisation and delivery systems[16]. The priorities set by the Oral Health Management for handling malocclusion lack the vision to cope with the changed priorities of the community due to oral health promotion. Service statistics of the Gauteng Oral Health Services[17] indicated that of the total attendance (265524), less than one per cent (2220) of the patients attended for orthodontic related problems. Orthodontic treatment rendered was 125 removable appliances for minor occlusal disturbances, 28 single arch fixed

appliance therapies and 21 full fixed appliance therapies for more complex orthodontic problems.

1.5 RATIONALE

Provincial oral health management require accurate data on the prevalence, distribution and severity of malocclusion and the orthodontic treatment need of its child population. Such data is essential for the effective planning of the education, training and deployment of dental manpower and resources as well as the distribution thereof[18,19].

As public interest in oral health increases, the demand for orthodontic treatment will increase; it is important to have epidemiological data to estimate the total need for orthodontic care services[16]. The epidemiological data on orthodontic treatment need is of interest for dental public health programs, clinical treatment, screening for treatment priority, resource planning, and third party funding[20].

CHAPTER 2

REVIEW OF THE LITERATURE

INDEX

CHAPTER 2

REVIEW OF THE LITERATURE

2.1 EPIDEMIOLOGY OF MALOCCLUSION

Epidemiology could be defined as: "The study of the distribution and determinants of health related conditions and events in populations and the application of this information to the control of health problems"[21]. There are two important features in this definition: The inclusion of "health related conditions" indicates that epidemiology is not just a study of diseases, but of any condition, that affects a large segment of the population. It is the epidemiologist's task to help ensure that people do not turn into patients.

The aim of epidemiologic studies of malocclusion is to describe and analyse the prevalence and distribution of malocclusion in various populations, the ultimate goal being to identify etiologic factors[22]. Abundant epidemiologic data relating to malocclusion have been compiled over this century, but the epidemiology of malocclusion has been lingering at the descriptive stage. The present knowledge of the epidemiology for occlusal anomalies includes the following:

- General agreement exists that malocclusions have a multifactorial aetiology and that the two basic categories are genetic and environmental.

- The effective organisation and planning of orthodontic services within the public health service require accurate data on the orthodontic treatment need of the child population[19].

The complexity of malocclusion necessitates that epidemiologic studies be based on some kind of classification. The number of combinations of single traits of malocclusion is practically infinite; a comprehensive classification of malocclusion for epidemiologic purposes cannot be made into a limited number of types[23]. Helm[22] suggests that the logical approach is to base such classification on the single traits of malocclusion. A given malocclusion trait represents a certain variation of the morphological variables concerned.

The assessment of orthodontic needs is difficult, controversial and varies, partly due to the lack of uniformity in diagnosis and partly due to variety of social factors in each community[24]. Thus in some countries missing or irregular teeth are a social embarrassment and stigma, whereas in another community they are hardly noticed.

The results of many of the earlier epidemiological investigations are not comparable owing to subjective evaluation of the features registered and because only the most general conclusions were drawn from the mass of data obtained in the investigation of large population groups[25]. For this reason, and because of the desire to statistically analyse and compare epidemiological data, there has been a search for an occlusal index to record traits of

malocclusion in numerical and categorical format and to enlist a degree of objectivity into their assessment[26].

International studies report a remarkable variation in orthodontic need. Baseline data published by the World Health Organisation[27] for 13- and-14 year-olds in 10 industrialised countries (not including the United Kingdom), reveals orthodontic treatment need ranging between 21 per cent and 64 per cent.

In the United Kingdom orthodontic treatment need increased from 5 per cent in 1942[28], to 15 per cent in 1954[29] and 70 per cent as reported by Haynes[30].

Whilst some regional and national differences are to be expected, such large variations in the reported need for orthodontic treatment are difficult to explain. The differences more likely reflect the inherent objectivity of the assessment system used[31] and their questionable validity and reliability[32].

This lack of accurate base line data has excluded orthodontics from the recommendations of the *Federation Dentaire Internationale*[33] for a stepwise progression towards "Health for all by the year 2000". As a result, there have been urgent calls to remedy this problem by developing an internationally acceptable Index of Orthodontic Treatment Need[34].

2.2 EPIDEMIOLOGICAL ORTHODONTIC SURVEY METHODS

In the orthodontic context, an index is used to describe a rating or categorizing system that assigns a numeric score or alphanumeric label to a person's

occlusion. There are five types of indices, each for a distinct purpose. Indeed, it is the purpose rather than content or conventions of an index that distinguishes it.

2.2.1 DIAGNOSTIC CLASSIFICATION

Angle's classification[35] is the best known of this type, its subclasses often being used to describe incisor and buccal segment relationships separately. These classifications serve their purpose reasonably well, allowing ease of communication between orthodontists.

2.2.2 EPIDEMIOLOGICAL INDICES

These indices record every trait in a malocclusion to allow estimation of the prevalence of malocclusion in a given population; for example, the epidemiologic registration of malocclusion described by Björk, Krebs, and Solow[36], the *Federation Dentaire Internationale* (FDI) method[37], or Summer's Occlusal Index (OI)[38]. Other indices of this type score tooth alignment in a way that allows study of tooth irregularity and periodontal diseases[39], or treatment stability[40].

2.2.3 TREATMENT NEED (TREATMENT PRIORITY) INDICES

Several indices have been developed to allow categorisation of malocclusion according to the level of treatment need. Examples of these are Draker's Handicapping Labio-lingual Deviations (HLD) Index[41], Grainger's Treatment Priority Index (TPI)[42], and Salzman's Handicapping Malocclusion

Assessment[43], the Dental Aesthetic Index (DAI)[44], Summer's Occlusal Index (OI)[38]. These indices have been primarily designed for epidemiological purposes, but have also been used to determine treatment priority. These indices yield a score for each trait or component that is then weighted to calculate an overall score.

Another method of assigning treatment priority is to establish a list of conditions or traits in categories that denote the extent to which treatment is considered necessary. An example of these is the Swedish National Board for Welfare Index[45], which determines whether or not a patient's malocclusion falls within the scope of treatment in the Swedish public dental services. Similar indices in Norway, the NOTI[46] are used to determine the level of public health co-payment that the patient may be entitled to, i.e. there may be total reimbursement for severe malocclusion such as associated with cleft lip and palate and partial or nil reimbursement for malocclusions considered minor. The Index of Orthodontic Treatment Need (IOTN)[47] is used primarily in Great Britain.

2.2.4 TREATMENT OUTCOME INDICES

Assessment of the outcome of treatment or the changes resulting from treatment is a further potential use of occlusal indices. Several indices have been developed to evaluate treatment success[48,49,50]. Summer's Occlusal Index (OI)[38] has also been used to assess the outcome of treatment. The Peer

Assessment Rating (PAR)[51] Index has been developed specifically for this purpose.

2.2.5 TREATMENT COMPLEXITY INDEX

The recently developed Index of Complexity, Outcome and Need (ICON)[52] measures treatment complexity, the outcome of the orthodontic treatment and orthodontic treatment need.

2.3 THE DENTAL AESTHETIC INDEX (DAI)

Although a number of classifications and indices have been suggested for characterisation of dento-facial anomalies, only a few have been adopted for general use outside the country of origin. This is partly due to considerable variation in socio-culturally-determined perceptions and the reactions to dento-facial appearance[53,54,55,56].

Although numerous indices have been developed, none as yet has been accepted universally[51]. In the meantime, one of the indices available must necessarily be chosen. The selection of an index for measuring any condition is dependent upon two main factors:

- The objective of the investigation i.e. the nature of the information required.
- The ability of the examiner to consistently reproduce the diagnosis on which the index is based[18].

2.3.1 ESTABLISHING MALOCCLUSION SEVERITY LEVELS ON THE DENTAL AESTHETIC INDEX (DAI) SCALE

During the 1970s, the importance of psychosocial factors in the assessment of malocclusion was acknowledged in the USA and internationally[57,58]. It was said that the definition of malocclusion was not one to be made by orthodontic clinicians alone. There was believed to be a salient need for the development of an orthodontic index containing psychosocial as well as clinical criteria[59,60]. The relationship between dental aesthetics and psychological and social well-being has been noted by many investigators. Helm[61] for instance, noted that 'Concern for dental appearance is an essential factor in determining psychosocial need for orthodontic treatment'. Brook and Shaw[62] stated that the assessment of a patients treatment need must include aesthetic impairment and by inference psychosocial need for orthodontic treatment. Stricker *et al*[63] concluded that the psychosocial consequences of malocclusion due to unacceptable aesthetics may be as serious or even more serious than the biological problems.

In response to the demand for an orthodontic index that includes psychosocial criteria in assessing need for orthodontic care and for use in epidemiological surveys, Cons *et al*[44] developed the Dental Aesthetic Index (DAI) that integrated the psychosocial and physical elements of malocclusion. The Dental Aesthetic Index (DAI) is an orthodontic index based on socially defined aesthetic norms. Which is a regression equation that links mathematically the

public's perceptions of dental aesthetics with the objective physical measurements of the occlusal traits associated with malocclusion. The DAI is particularly sensitive to occlusal conditions that have the potential for causing psychological or social dysfunction.

The DAI includes the hypotheses that socially derived norms for acceptable dental appearance set the standard for evaluation of acceptable levels of dental aesthetics and that the conditions of malocclusion is socially defined by the deviation of occlusal configurations from social norms. Extreme deviations from acceptable dental appearance should have a negative impact on social, psychological and physical function.

The components of the DAI regression equation and their actual and rounded regression coefficients (weights) are shown in Table 2-1. The Standard DAI regression equation calls for the measured components of the DAI to be multiplied by their rounded regression coefficients (weights); the summation of their products and the addition of a constant number to the total. The resulting sum is the DAI score. The regression equation for obtaining a DAI score is:

DAI score = 6(missing incisors, canines and premolars) + (crowding) + (spacing) + 3(diastema) + (largest maxillary irregularity) + (largest mandibular irregularity) + 2(anterior maxillary overjet) + 4(anterior mandibular overjet) + 4(anterior open bite) + 3(antero-posterior molar relationship) + 13[64]

Table 2-1: The components of the standard DAI regression equation and their actual and rounded regression coefficients (weights)[64]

DAI components	Regression coefficient	
	Actual weights	**Rounded weights**
1. Number of visible missing teeth (incisors, canines and premolars in the maxillary and mandibular arches)	5.76	6
2. Crowding in the incisal segment	1.15	1
3. Spacing in the incisal segment	1.31	1
4. Midline diastema	3.13	3
5. Largest maxillary irregularity	1.34	1
6. Largest mandibular irregularity	0.75	1
7. Anterior maxillary overjet	1.62	2
8. Anterior mandibular overjet	3.68	4
9. Vertical anterior openbite	3.69	4
10. Antero-posterior molar relation	2.69	3
11. Constant	13.36	13

The standard DAI loses relatively little precision when regression weights are rounded[44]. After an individuals score has been calculated it can be placed on a scale to determine the point at which the score falls between most and least aesthetic dental appearances. The further a DAI score falls from the norm of most acceptable dental appearance the more likely the occlusal condition, if left untreated, may be either socially or physically handicapping or both.

The DAI, an orthodontic index that provides a single score linking the publics perceptions for dental aesthetics with objective measurements associated with malocclusion, has decision points along the DAI scale defining specified case

severity levels. DAI scores of 25 and below represent normal or minor malocclusion with no treatment needed or slight treatment need. DAI scores of 26 to 30 represent definite malocclusion with a treatment option considered elective. DAI scores of 31 to 35 represent severe malocclusion with treatment indicated as highly desirable. DAI scores of 36 and higher represent very severe or handicapping malocclusion with treatment considered mandatory[64].

Table 2-2: The DAI groups of severity of malocclusion and treatment need[64]

GROUP	SEVERITY LEVEL AND TREATMENT NEED
≤ 25	Normal or minor malocclusion No treatment need or slight need
26 – 30	Definite malocclusion Treatment elective
31 – 35	Severe malocclusion Treatment highly desirable
≥ 36	Very severe (handicapping) malocclusion Treatment mandatory

In their latest edition, Oral Health Surveys, Basic Methods[65], the World Health Organization (WHO) incorporated the Dental Aesthetic Index (DAI) criteria for assessing dento-facial anomalies.

In view of the recent endorsement of the DAI by the World Health Organization, this index was chosen as the instrument to conduct this survey. For a detailed explanation of the Dental Aesthetic Index, see annexure 1.

2.4 EPIDEMIOLOGY OF MALOCCLUSION IN OTHER COUNTRIES - DEFINED BY THE DENTAL AESTHETIC INDEX

Since it's introduction in 1986 the DAI[44] had been used in many studies to describe the prevalence of malocclusion in different countries. A comparison of various international studies in which the DAI was used is summarised in Table 2-3. A further discussion of each of these studies follows the table.

Table 2-3: Comparison of various international studies in which the DAI was used

Study	Country	Age	n	13 -25	26-30	31-35	36-
Johnson Harkness 2000[66]	Australia	10	309	20.1	24.5	22.4	33
Current study	**South Africa**	**12**	**5744**	**47.7**	**21.2**	**14.1**	**16.8**
Abdullah and Rock 2001[67]	Malaysia	12-13	5112	51.2	24.7	14.2	9.9
Esa, Razak and Allister 2001[68]	Malaysia	12-13	1519	62.6	19.6	10.6	7.2
Chi, Johnson and Harkness 2000[69]	New Zeeland	13	150	20	33	20	27
Estioko, Wright and Morgan 1994[70]	Australia	12-16	268	63.4	18.7	11.9	6
Otuyemi *et al*, 1999[71]	Nigeria	12-18	703	77.4	13.4	5.5	3.7
Red indicate a prevalence higher than the current study Blue indicate a prevalence lower than the current study							

Johnson and Harkness[66] studied the need for orthodontic treatment in a random sample of 10-year-old, New Zealand school children in Dunedin using the Dental Aesthetic Index (DAI). When absent or unerupted teeth were

disregarded, orthodontic treatment was considered to be 'mandatory' for one-third of the children. The remaining children were almost equally divided among the three other treatment-need groups: 'highly desirable', 'elective', and 'not necessary'. The majority of the children had crowding and spacing in at least one incisor segment, and a molar occlusion other than Angle Class I. In this predominately mixed-dentition sample, more children were considered to need orthodontic treatment than older children in studies using the DAI.

Abdullah and Rock[67] assessed the prevalence and severity of malocclusion in a large sample of 12-13-year-old Malaysian children. A random sample of 5112 Malaysian children was drawn according to a multi-stage technique, which accounted for the ethnic composition of the population. Subjects were examined using both components of the Index of Orthodontic Treatment Need (IOTN) and the Dental Aesthetic Index (DAI). They found that the proportion of children in need of orthodontic treatment was 47.9 per cent according to grades 4 and 5 of the dental health component (DHC) of IOTN and 22.8 per cent according to grades 8-10 of the aesthetic component (AC). Using 31 points as the cut-off point for treatment acceptance, the DAI index indicated that 24.1 per cent needed treatment.

Esa, Razak and Allister[68] evaluated malocclusion and orthodontic treatment need in a sample of 12-13-year-old Malaysian school children using the Dental Aesthetic Index (DAI), they also assessed the relationship between malocclusion and socio-demographic variables, perceptions of need for

orthodontic treatment, aesthetic perception and social functioning. The sampling procedure involved a multistage, clustered and stratified random sampling technique. The sample comprised of 1519 school children attending 20 secondary government and government-aided schools in urban and rural areas of the Klang District in Peninsular Malaysia. There were 772 males and 747 females in the sample. For each subject a questionnaire eliciting standard demographic information such as gender, parents' income and ethnic origin and questions on perception of need for orthodontic treatment and satisfaction with dental appearance and function was completed. They found that most subjects (62.6 per cent) require no orthodontic treatment. Only about 7 per cent had handicapping malocclusion that needed mandatory treatment. Malocclusion, as defined in this study, was found to be significantly associated with gender and subjects' area of residence. There were no significant differences in mean DAI scores for Malays, Chinese and Indian children. Significant associations were found between DAI scores and perception of need for orthodontic treatment, satisfaction with dental appearance and social functioning ($P<0.01$).

Chi, Johnson and Harkness[69] used the Dental Aesthetic Index (DAI) to assess the prevalence of unmet orthodontic treatment need in 150, 13-year-old school children in Dunedin, New Zealand. They also compared the findings with those obtained in the same children at 10 years of age. Fewer 13-year-olds (27 per cent) had a 'mandatory' need of orthodontic treatment, than when they were 10 years old (33 per cent), 20 per cent had 'no/little' need for orthodontic

treatment, 33 per cent had an 'elective' need for treatment and 20 per cent had a 'desirable' need for treatment. The decrease in DAI scores is attributed to over-sensitivity of the index to mixed dentition traits. When the individual scores were analysed, only 7 per cent of the 10-year-olds were given the same scores as when they were 13 years old, 52 per cent were given higher scores and 41 per cent were given lower scores. This disagreement between scores was masked to a limited extent by the DAI categories: 49 per cent of the 10-year-olds were assigned to the same DAI category at 13 years of age, 20 per cent to a greater treatment-need category and approximately 30 per cent to a lower treatment-need category. The DAI, in common with other malocclusion indices, is unreliable over time because it is affected by developmental changes in the occlusal traits measured.

Estioko, Wright and Morgan[80] using the Dental Aesthetic Index (DAI), measured the distribution, prevalence and severity of malocclusion and orthodontic treatment need in a selected population of adolescents, to determine if the malocclusion so defined was affected by socio-demographic variables such as age, gender, ethnic and socio-economic background. Two hundred and sixty-eight secondary school children, aged 12- to 16-years from Heidelberg, Australia participated in the study. For each subject a questionnaire eliciting standard demographic information such as age, gender, parent's occupation, and ethnic origin was completed. The findings demonstrated that most subjects (63.4 per cent) had a dental appearance requiring no treatment. Only six per cent of the subjects had malocclusions that needed mandatory

treatment. Malocclusion, as defined in the study, was found to be significantly associated with age.

Otuyemi *et al*[71] investigated the distribution, prevalence and severity of malocclusion and treatment need amongst randomly selected (n = 703) rural and urban Nigerian children, aged 12-18 years (mean 14.0 ± 1.84) using the Dental Aesthetic Index (DAI). They also assessed whether malocclusion was affected by age, gender and socio-economic background. Most of the children (77.4 per cent) had a dental appearance that required no orthodontic treatment. Over 13 per cent fell into the group where treatment for malocclusion is considered to be 'elective'. A substantial proportion (9.2 per cent) of the population had severe to handicapping malocclusion where treatment was 'highly desirable' or 'mandatory'. There were no statistically significant differences in DAI scores between age groups, gender and socio-economic background.

Ansai *et al*[72] used the Dental Aesthetic Index (DAI) to evaluate malocclusion in 15- to 18-year-old Japanese high school students (n = 409). This study used a sample of students from randomly selected urban and rural high schools in Japan's Kyushu district. The DAI scores for urban and rural high school students, as well as the total DAI scores from these two areas were significantly higher than that of American high school students. These results showed that the number of students with an acceptable dental appearance among Japanese high school students is significantly lower than among

American high school students. This indicates a higher need for orthodontic treatment among Japanese high school students.

2.5 FINDINGS OF PREVIOUS ORTHODONTIC EPIDEMIOLOGICAL STUDIES IN SOUTHERN AFRICA

Jacobson[73] studied 460 crania and mandibles of South African Blacks in the Department of Anatomy at the University of the Witwatersrand, Johannesburg. The study material originated from adults, ranging in age between 16 and 108 years. The results of this study showed that the percentage of well-aligned teeth was 76.2 and 67.1 respectively in a total of 63 maxillae and 70 mandibles. In 96.4 per cent of males and 97.4 per cent of females a Class I type occlusion (neutroclusion) was recorded, while a Class II type was recorded in less than three per cent of the sample in both sexes. Since, criteria for assessing malocclusion had not been standardised yet, no comparative tables could be compiled for other population groups.

The first extensive epidemiological study of the occlusion and treatment needs of 14-year-old children living in Pretoria were done in 1979 by Zietsman[14]. The sample consisted of 490 white children. The Angle system[35] for classifying the antero-posterior dental relationship was used. Other features recorded on a specially designed form were; the absence, rotations or displacements of individual teeth, crowding or spacing of 3mm or more in each of the posterior segments of both arches, the presence of crossbite or open bites and an upper central diastema of 1mm or more. Based on the presence and severity of the

above features each case was examined and classified subjectively as having either a normal occlusion or a malocclusion. Roughly, one in four (23.3 per cent) children were found to have a normal occlusion, but 76.7 per cent needed orthodontic treatment.

Zietsman[74] undertook three further pilot studies. A sample of 119 Black subjects was drawn from the Tswana ethnic group of Bophuthatswana and two samples, each of 51, 14-year-olds were drawn from a school for Asians and a school for Coloured children. The results showed that 54.6 per cent of Black, 39.2 per cent of Coloured and 23.3 per cent of Asian children had a normal occlusion according to Angle's[35] standards. Treatment was essential or necessary for 25 per cent of Blacks, 47 per cent of Coloureds and 49 per cent of Asians.

Hirschowitz, Rashid and Cleaton-Jones[75] undertook a study to determine the dental status of a sample of 402, 12-year-old urban Black school children from a lower socio-economic group living in Soweto. Malocclusion was scored as present or absent, only gross anomalies were scored and cases were subdivided into Class I, II and III. Malocclusion was present in only 11 per cent of children, of which 79.5 per cent had Class I; 12.4 per cent had Class II and 9 per cent had Class III malocclusions. The authors concluded that the low prevalence of malocclusion might be due to the well-developed jaws and a tendency to bimaxillary protrusion, which was regarded as normal for the population studied.

Kotze, Mizrahi and Zietsman[3] in a study using the Occlusal Index of Summers[38], investigated the need for orthodontic treatment of White children aged 11-12 years in families of members of the South African Defence Force. They found that 22 per cent of the subjects had good occlusions or slight malocclusions which needed no treatment and that 78 per cent presented with occlusal problems which required minor or definite treatment.

Swanepoel[14] examined a group of Black children from Ga-Rankuwa, north of Pretoria. He used the modified *Federation Dentaire Internationale*[59] measurements of occlusal traits, for the classification of occlusal problems. His results showed that 70 per cent needed no treatment, whereas 30 per cent presented with major deviation in occlusion, involving definite treatment needs.

Van Wyk, du Plessis and Snyman[76], using the Occlusal Index of Summers[38], showed that 56 per cent of urban Coloured children from the Eersterust township of Pretoria had good occlusions or slight malocclusions and that 44 per cent required minor to definite orthodontic treatment.

In 1987, de Mûelenaere and Viljoen[77] published the results obtained from a survey done amongst the Black rural community of Tshikundamalema in Venda. A total of 171 children were examined and an occlusal index calculated for each, using the Index described by Summers[38]. It was found that 83 per cent of the children examined had a good occlusion or only a slight malocclusion and that 17 per cent needed minor to urgent treatment.

In a follow-up study, de Mûelenaere, Wiltshire and Viljoen[2] determined the occlusal status of 342 Venda school children of the town of Thoyoandou, to evaluate whether urbanisation had a significant influence on the development of malocclusion. Twenty-eight per cent of these children required orthodontic treatment and 12 per cent treatment of a specialised nature with fixed appliances. It was concluded that, although even basic dental services were not readily available in the more rural areas, factors such as the degree of westernisation, consumption of processed foods, pollution and ethnic impurity in the urban areas had led to a higher prevalence of malocclusion.

In 1989, a comprehensive national epidemiological survey was undertaken on 4863, 12-year-old South African children, representing the Black, Coloured, Asian and White communities[15]. The Occlusal Index of Summers[38] was used to study the incidence of the various features of malocclusion and to compare data with those of previous surveys done in South Africa and in the United States of America. According to the results of this study, 70 per cent of the children in the group do not need any orthodontic treatment at all, while a mere 1.8 per cent were in need of urgent treatment.

In 1988, the Swaziland health authorities requested the Department of Community Dentistry of the Medical University of Southern Africa, to assess the quality of the dental services in the country. The first phase of the project entailed an assessment of the oral health status of 12-year-old school children[78]. The Occlusal Index of Summers[38] was used to determine the

prevalence of occlusal disorders, various features of malocclusion and to estimate the orthodontic treatment needs of children[79]. Their results indicated that the occlusal status of Swazi school children should be maintained and if possible, improved, but that the delivery of highly specialised orthodontic treatment procedures was not required.

Ackerman and Wiltshire[80] conducted a study among five hundred and eleven disabled children in the greater Pretoria area. The Occlusal Index[38] was used and a questionnaire filled out regarding the children's treatment needs, habits, as well as swallowing and breathing patterns. Of the original sample, 16.4 per cent had previously received orthodontic treatment and were excluded from the study. About 26 per cent of the remaining group of 381 children needed orthodontic treatment, but only 0.5 per cent indicated that they were planning to seek orthodontic treatment. The results of this study indicated that the frequency of malocclusion in disabled children was not much higher than in normal caucasoid children. It was concluded that the need for orthodontic treatment was as great for disabled children as for normal children and that their malocclusion plight should be taken into account in future oral health care planning in South Africa.

Table 2-4: Summary of the findings of previous orthodontic epidemiological studies in Southern Africa

Researcher	Population group	Age	Good occlusion or slight malocclusion %	Minor or comprehensive orthodontic need %	Index
Zietsman 1979[13]	Whites	14	37	63	Angle classification[35] and various other occlusal traits
Zietsman 1979[74]	Blacks	14	54.6	45.4	Angle classifications[35]
	Coloureds		39.2	60.8	
	Asians		23.3	76.7	
Hirschowitz, Rashid and Cleaton-Jones 1981[75]	Urban Blacks	12	89	11	Malocclusion was scored as present or absent
Kotze, Mizrahi and Zietsman 1982[3]	Whites	11-12	22	78	Occlusal index of Summers[38]
Swanepoel 1985[14]	Blacks	14	70	30	Modified FDI Method[59]
Van Wyk, du Plessis and Snyman 1985[76]	Urban Coloureds	12-13	56	44	Occlusal index of Summers[38]
de Mûelenaere and Viljoen 1987[77]	Rural Blacks		83	17	Occlusal index of Summers[38]
de Mûelenaere, Wiltshire and Viljoen 1992[2]	Blacks	14	72	28	Occlusal index of Summers[38]

Table 2-4: Summary of the findings of previous orthodontic epidemiological studies in Southern Africa (Continued)

Researcher	Population group	Age	Good occlusion or slight malocclusion %	Minor or comprehensive orthodontic need %	Index
Briedenhann *et al* 1991[15]	Asians Blacks Coloureds Whites	12	75.1	24.9	Occlusal index of Summers[38]
Volsckenk *et al* 1993[79]	Blacks	12	82.37	17	Occlusal index of Summers[38]
Ackerman and Wiltshire 1994[80]	White disabled children		25.5	74.5	Occlusal index of Summers[38]

Despite the considerable differences in the reported findings, it is clear that a large percentage of South African children presents with malocclusion and needs orthodontic treatment.

CHAPTER 3

RESEARCH METHODOLOGY

INDEX

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In the previous chapter, various studies to determine the orthodontic status and treatment needs of children in South Africa were discussed; most of these studies were restricted to particular geographical areas or specific groups of children. In 1997, the national Department of Health took the initiative to conduct a national oral heath survey amongst 4-5-, 6-, 12- and 15-year-old children in South Africa to determine the oral health status and treatment needs.

3.2 NATURE AND SCOPE OF THE SURVEY

3.2.1 INTRODUCTION (OVERVIEW)

The survey was conducted in the nine provinces of South Africa and this part of the survey consisted of malocclusion status and treatment need assessments using the Dental Aesthetic Index (DAI)[44]. The survey was conducted amongst 12-year-old school children and took place at public schools. The sample size with regard to the survey was determined by Statomet (Bureau for Statistical and Survey Methodology) and was calculated to be accurate to the level of

regions in the provinces. The survey was executed between July 1999 and June 2002.

3.2.2 PERSONNEL

A provincial supervisor was appointed in each of the provinces to supervise the execution of the project. In addition to the supervisor, the following personnel were also employed during the survey; examiners, record clerks, dental assistants and drivers.

3.3 SAMPLE

3.3.1 SAMPLING

A two-staged cluster sample was used to draw the sample. In stage 1, the name, type (higher primary or secondary), size and address of each school in the region was obtained and the names of the schools to be included in the sample was randomly selected. Separate samples were drawn for each of the two types of schools mentioned above. In stage 2, the required number of school children per region per population group* was drawn by roughly calculating the percentage representation of the twelve-year-old group to the total school population. By using this figure, the sizes of the different schools and the required sample sizes, the number of children per school, to be included in the sample, was calculated.

* The population groupings[81] referred to in this document comprise the following:

- **Asians** – mainly people of Indian descent.
- **Blacks** – descendants of African people who migrated in a southerly direction from Central Africa. They comprise ten different ethnic groupings: Xhosa, Zulu, Swazi, South Ndebele, North Ndebele, Northern Sotho, Southern Sotho, Venda and Shangaan.
- **Coloureds** – people of mixed parentage. Mainly descendants of the indigenous Khoikhoin people, the Malayan slaves (introduced to the Cape by the Dutch East Indian Company) and the White settlers.
- **Whites** – descendants of the European settlers, mainly Dutch, British, German, French, Portuguese, Greek, Italian and Jewish.

3.3.2 SAMPLE SIZE AND REPRESENTATION

The size of the realized sample per province is shown in Table 3-1.

In terms of section 104 of the Constitution of South Africa (1996)[82], schedule 4, provinces are responsible for the rendering of heath services and are therefore autonomous in the execution of certain health functions. Two of the provinces Gauteng and the Limpopo Province (formerly known as the Northern Province) made use of this section in the Constitution to conduct their own surveys using their own protocols, independent from the nationally planned survey.

Table 3-1: The size of the realized sample for the 12-year-old group

Province	Sample Size
Northern Cape	386
Western Cape	900
Eastern Cape	209
KwaZulu-Natal	1922
North West	1114
Mpumalanga	698
Free State	913
Limpopo	776
Total	**6918**

For orthodontic status and treatment need assessment the Gauteng Province opted for the Index of Orthodontic Treatment Need (IOTN)[47] and no comparable data regarding the malocclusion status and treatment need of the children in this province are therefore available. The Limpopo Province used the DAI[44] for their assessment of malocclusion but the computing system they used to capture and analyse the data is not compatible with the nationally used system. Results for malocclusion status and treatment need for children of the Limpopo Province are available but could not be used in further analysis of the data. Due to financial and human resource constraints, the survey was only executed in one of the regions of the Eastern Cape Province and in three of the five regions of the Northern Cape Province.

Although the survey was planned to be a national oral health survey, the weighted national figures cannot be regarded as national figures in the true sense of the word because of the reasons mentioned above. The figures

obtained in this survey are however in terms of geographical representation (Western Cape, KwaZulu-Natal, North West Province, Mpumalanga, Free State and parts of the Eastern Cape and Northern Cape Provinces) representative of a large section of the twelve-year-olds in South Africa. It is expected that the real figures for South Africa would not differ much from the figures obtained for this survey.

3.4 INDEX FOR ORTHODONTIC STATUS AND TREATMENT NEED ASSESSMENTS

In the 1997 version of the World Health Organisation's publication "Oral Health Surveys, Basic Methods"[65], this body recommends the use of the Dental Aesthetic Index for malocclusion status and treatment need assessments.

3.4.1 HEALTH QUESTIONNAIRE

For each child taking part in the survey, the parent or legal guardian completed a health questionnaire before the examination. Explanatory notes on the reasons for the use of the health questionnaire, during the epidemiological survey is contained in annexure 2.

3.4.2 SURVEY FORMS

A compounded version of various WHO forms had been devised for the collection of the demographic data and the assessment of malocclusion status and treatment need (annexure 3).

3.4.3 INSTRUMENTS, EQUIPMENT AND CONSUMABLES

Provinces were responsible for the purchasing of all instruments, equipment and consumables used during the survey. The following instruments, equipment and material were used in the survey:

- Periodontal probe - The WHO periodontal probe was used.
- Mouth mirror - An ordinary mouth mirror (No 4) was used.
- Stationery - A clipboard, pencil, sharpener and an eraser were recommended.
- Consumables – Disinfecting agents, paper-towels, rubber gloves, facemasks.
- Equipment - Portable dental chairs and lights, autoclaves and suitable receptacles for the return of used instruments.

3.4.4 INFECTION CONTROL

The only method recommended for the sterilisation of the periodontal probes and mouth mirrors was by autoclaving. A large number of CPI-type probes were made available to each province to enable proper sterilisation. For the protection of examiners and patients, the use of disposable gloves and surgical masks was recommended throughout the survey.

3.5 CALIBRATION AND TRAINING

Thirty-five dental casts, study models of patients that underwent a full orthodontic examination at the University of Pretoria, Dental School and that represent the types of malocclusion that were expected in the population, were selected before the training of the examination teams. These models were used in the training and calibration of the provincial examiners. Three staff members, who were familiar with the criteria for the different variables of the DAI, evaluated each of these study models. The scores obtained in this way were used as the gold standard during the training and calibration of the examiners. Two of the people were also used as trainers for the provincial examiners. Training per province was conducted over a period of three days.

Training and calibration consisted of the following: On day one, a detailed lecture on the use of the DAI, including all conventions and international guidelines was presented. The lecture elucidated by visual aids and practical training was done using ten of the previously selected models. Immediately thereafter the next set of ten models was assessed by the trainees and the scores obtained by each trainee was compared with that of the gold standard. During day two, the differences that occurred between the score of the trainees and the golden standard were discussed and the reasons for these differences were clarified. Training and calibration on children at a suitable school were also performed during day two. On day three, participants were

instructed to assess the next set of 15 previously selected dental casts, using the DAI.

Inter-examiner agreement was tested using the percentage agreement. Only examiners with an agreement score greater than or equal to 80 per cent were included in the final study.

3.6 ETHICAL MATTERS

The following ethical matters were adhered to:

Consent to be examined:

Consent for the examination of school children was obtained from the various educational authorities as well as the parent or legal guardian of the child.

Ethical committee:

The Ethical Committee of the University of Pretoria approved the protocol for the National Oral Health Survey as well as the relevant annexures.

3.7 STATISTICAL ANALYSIS

A standard DAI score was calculated for each child in the twelve-year-old age group by using the formula as explained in Chapter 2. The children were classified into four groups according to the severity of malocclusion and treatment need as measured by the standard DAI score.

Two-way frequency tables for DAI groups by province, gender, population group, location type and occupation of the parents were compiled. A log linear

analysis was performed to investigate the interactions in these two-way tables. A p-value of less than 0.05 indicates that the variables in that particular interaction term differ significantly. If an interaction term was found to be significant, the nature of the interaction was further investigated by considering the parameter estimates and associated p-values for each interaction.

CHAPTER 4

RESULTS AND DISCUSSION

INDEX

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

In the previous chapter, the methodology to collect the date was explained. The results and possible reasons for some of the findings will be discussed in this chapter.

4.2 REPRODUCIBILITY

The combined intra- and inter-examiner reproducibility was higher than 83 per cent.

4.3 COMPOSITION OF THE SAMPLE IN TERMS OF DENTITION STAGE

Proffit[83] suggested that the morphological variation with age may not be related to chronological age but to the stage of dental development.

The DAI, in common with other malocclusion indices, is unreliable over time because it is affected by developmental changes in the occlusal traits measured[69]. Most 12-year-old children will present with a dentition in the early permanent dentition stage, and the remainder will still be in the late mixed dentition stage[4].

Division of the sample in the late mixed dentition stage and early dentition stage indicated that 25 per cent of the study population were still in the late mixed dentition stage and 75 per cent presented with a dentition in the early permanent stage. These findings may be important in the interpretation of the results of the study. The DAI was developed to assess the prevalence of malocclusion in the permanent dentition stage[84]. Some of the occlusal traits measured will improve with the transition from the mixed dentition stage to the permanent dentition stage, resulting in an improvement of the DAI score[70,72,85,86,87].

The interaction between the dentition stage, population groups and gender were further investigated.

4.3.1 THE PREVALENCE OF DENTITION STAGE BY POPULATION GROUPS IN SOUTH AFRICA

The prevalence of the late mixed dentition stage and early permanent dentition stage in the different population groups of South Africa is shown in Table 4-1. The results show that 25.14 per cent of the Coloured, 26.15 per cent of the Black, and 28.57 per cent of the Asian and 33.69 per cent white twelve-year-old South African school children were in the late mixed dentition stage. The difference between the White and the other groups was statistically significant ($p<0.05$).

Table 4-1: The percentage distribution of the late mixed dentition stage and early permanent dentition stage for the population groups in South Africa

Population group	Late mixed dentition	Early permanent dentition
Asian	28.57%	71.43%
Black	26.15%	73.85%
Coloured	25.14%	74.86%
White	33.69%	66.31%
p=0.001		

4.3.2 THE PREVALENCE OF DENTITION STAGE BY GENDER

Gender differences for the prevalence of the late mixed dentition or the early permanent dentition stage in 12-year-old South African school children are shown in Table 4-2. The results indicate that there are a larger number of 12-year-old girls presenting with a dentition in the early permanent stage than boys, 77.61 per cent and 68.11 per cent respectively. The distribution of the number of males and females in the two stages of dental development was significantly different ($p<0.05$). Johnson and Harkness[66] studied the prevalence of malocclusion and orthodontic treatment need in 10-year-old New Zealand children using the DAI. They found statistically significant gender differences in the study sample. These differences were attributed to the differences in the dental development of boys and girls.

Table 4-2: The percentage distribution of late mixed dentition stage and the early permanent dentition stage by gender

Gender	Late mixed dentition	Early permanent dentition
Male	31.89%	68.11%
Female	22.39%	77.61%
p<0.0001		

4.4 PREVALENCE AND TREATMENT NEED OF MALOCCLUSION IN SOUTH AFRICA

The prevalence and severity of malocclusion and the recommended orthodontic treatment need for each of the categories of the DAI is summarised in Table 4.3. The results show that 47.7 per cent of the children in the sample presented with good occlusion or minor malocclusion. Just over 52.3 per cent presented with identifiable malocclusion, a DAI score larger than 26. Of these 21.29 per cent had definite malocclusion, 14.12 per cent had severe malocclusion and 16.89 per cent had very severe or handicapping malocclusion.

Almost forty-eight per cent of the children had a dental appearance where orthodontic treatment need is 'slight' or 'not indicated'. Just over twenty one per cent of the 12-year-old children fell into the malocclusion group where orthodontic treatment is considered 'elective'. The rest of the sample presented with malocclusion varying from severe to very severe where orthodontic treatment is 'highly desirable' (14.12 per cent) and 'mandatory ' (16.89 per cent).

Table 4-3: Orthodontic treatment need of 12-year-old South African children according to the DAI

DAI score	Severity levels	Frequency	%
≤ **25**	Normal or minor malocclusion No treatment need or slight need	2740	47.70
26 – 30	Definite malocclusion Treatment elective	1223	21.29
31 - 35	Severe malocclusion Treatment highly desirable	811	14.12
≥ **36**	Very severe (handicapping) malocclusion Treatment mandatory	970	16.89

McLain and Proffit[86], reported that 11.0 per cent of 12- to 17-year-old children in America had normal occlusion, 35 per cent had minor manifestations of malocclusion, 25 per cent had a definite malocclusion for which orthodontic treatment was 'elective', 13 per cent were judged to have conditions for which orthodontic treatment was 'highly desirable', and 16 per cent were judged as having a condition for which orthodontic treatment was 'mandatory'.

According to Briedenhann *et al*[15], using the Occlusal Index of Summers[38], the majority of the South African 12-year-olds (53.6 per cent) presented with a good occlusion, 17.5 per cent had slight malocclusion but needed no treatment and 15.7 per cent needed minor treatment for small deviations in occlusion. Definite treatment was needed in 11,5 per cent of the subjects studied, while 1.8 per cent fell into the category where urgent treatment was necessary to correct the occlusal problems. The results from the current study indicate a higher prevalence of malocclusion in 12-year-old South African school children.

Compared to the reported prevalence of malocclusion from other studies[66-71] the percentage of subjects needing orthodontic treatment at the various severity levels are consistently higher for this study as depicted in Table 2-3. The results of these studies indicate that malocclusion is more severe in 12-year-old South African children. The difference between the present study and the studies shown in Table 2-3 could be due to the inclusion of older children in the other studies. It would appear that the high proportion of subjects with handicapping malocclusion in the present study is due to the large number of subjects in the mixed dentition stage who have temporary occlusal conditions.

These conclusions are supported by the study of Johnson and Harkness[66] on 10-year-old New Zealand children using the DAI, where much higher percentages of malocclusion were recorded. It has been shown that for children with a dentition in the mixed dentition stage the DAI score was higher than for children with a dentition in the permanent dentition stage[44,64,70,88].

These differences could also be attributed to inter-examiner variability or a higher incidence of malocclusion in 12-year-old South African children or a combination of these factors.

The prevalence of malocclusion was further investigated using variables such as geographical location, population groups and gender.

4.5 PREVALENCE OF MALOCCLUSION IN THE DIFFERENT PROVINCES OF SOUTH AFRICA

The frequency and percentage distribution of the DAI categories in the different provinces are summarised in Table 4.4. The *p*-value indicates that the variables in the interaction term, province and DAI group, are dependent. That is, the distribution of the number of children in the groups is significantly different for the different provinces. Large variations occur in the prevalence of malocclusion in the different provinces of South Africa.

For the provinces Eastern Cape, Free State, North West and Western Cape the tendency is that there are fewer children in the groups with lower DAI scores and more children in the groups with higher scores, indicating a higher prevalence of malocclusion.

For the provinces KwaZulu-Natal, Mpumalanga and Northern Cape, the pattern is the opposite, with more children in the groups with a lower DAI score and less children in the groups with higher DAI scores. The prevalence of malocclusion for these provinces is therefore much lower.

Table 4-4: The frequency and percentage distribution of the DAI groups for the sample by province

Province		13 - 25	26 - 30	31- 35	≥ 36
Eastern Cape	Frequency	48	50	43	59
	%	24	25	21.5	29.5
Free State	Frequency	319	238	158	182
	%	35.56	26.53	17.61	20.29
KwaZulu-Natal	Frequency	991	390	243	257
	%	52.68	20.73	12.92	13.66
Mpumalanga	Frequency	354	102	52	49
	%	63.55	18.31	9.34	8.80
North West	Frequency	553	191	126	175
	%	52	18.63	12.29	17.07
Northern Cape	Frequency	181	82	29	22
	%	57.64	26.11	9.24	7.01
Western Cape	Frequency	317	170	160	226
	%	36.09	19.54	18.39	25.98
Total	Frequency	2740	1223	811	970
	%	47.7	21.29	14.12	16.89
p<0.0001					

4.6 PREVALENCE OF MALOCCLUSION BY GENDER

The frequency and percentage distribution of the DAI categories for the different gender groups is shown in Table 4-5. According to a log linear analysis, the differences between the two groups were statistically significant ($p<0.05$).

Table 4-5: The frequency and percentage distribution of the DAI groups by gender

		13 - 25	26 - 30	31- 35	≥ 36	Total
Male	Frequency	1178	552	405	495	2630
	%	44.79	20.99	15.40	18.82	
Female	Frequency	1550	664	405	474	3093
	%	50.11	21.47	13.09	15.32	
p = 0.0015						

Table 4-6 presents the interaction between the DAI groups and gender. These results indicate that there are significantly more girls in the group with a DAI score '13 – 25' than would be expected if the variables DAI group and gender were independent, implying that there are more girls than boys with a normal occlusion. Evaluating the data on the 10 per cent level it was found that there are significantly more boys in the group with a DAI score '36+'. In other words, the prevalence of malocclusion as expressed by the DAI categories is higher in boys than in girls. This is in accordance with the findings of other studies that girls tend to have lower DAI scores than boys[65,68,69].

This gender difference in the DAI scores should be interpreted with caution. As observed earlier (section 4.3.2) significant differences occur in the proportional distribution of DAI categories in the mixed dentition stage and the permanent dentition stage. The results of the current study also indicate that there are more boys in the mixed dentition stage than girls (Table 4-2). The differences in dental development could therefore contribute to the difference in the DAI representation for boys and girls.

Table 4-6: The interaction of DAI groups with gender

Gender	DAI score	Estimate	P-value
Male	13-25	-0.0758	0.0002
	26-30	-0.0153	0.5513
	31-35	0.0419	0.1537
	>36	0.0492	0.0738
Female	13-25	0.0758	0.0002
	26-30	0.0153	0.5513
	31-35	-0.0419	0.1537
	>36	-0.0492	0.0738

4.7 PREVALENCE OF MALOCCLUSION BY POPULATION GROUP IN SOUTH AFRICA

Table 4-7 presents the frequency and percentage distribution of the DAI categories for the different population groups in South Africa. At the cut-off point of 36 to demarcate the priority of orthodontic treatment, 21.01 per cent of the Asian, 14.81 per cent of the Black, 23.04 per cent of the Coloured and 19.54 per cent of the White 12-year-old South African children presented with a handicapping malocclusion, requiring 'mandatory' orthodontic treatment. The distribution of the number of children in the different DAI groups differs significantly for the different population groups ($p<0.05$).

Table 4-7: The frequency and percentage distribution of the DAI groups by population group in South Africa

		13 - 25	26 - 30	31- 35	≥ 36
Asian	Frequency	108	53	27	50
	%	45.38	22.27	11.34	21.01
Black	Frequency	1996	825	522	581
	%	50.87	21.02	13.30	14.81
Coloured	Frequency	387	229	169	235
	%	37.94	22.45	16.57	23.04
White	Frequency	223	106	87	101
	%	43.13	20.50	16.83	19.54
p<0.0001					

The nature of the interaction between the DAI group and the population groups were therefore further explored (Table 4-8). The interaction between DAI group and the population groups can be summarised as follow:

- For Blacks there are significantly more pupils in the group with a DAI score '13 – 25' and significantly less in the group with a DAI score of '36+'. Indicating the occurrence of more normal occlusion and less severe malocclusion in Black 12-year-old South African school children.
- The opposite pattern is observed for Coloureds with all the parameters being significant, indicating the occurrence of less normal occlusion and more severe malocclusion in Coloured 12-year-old South African school children.
- For Asians and Whites, the cell frequencies do not differ significantly.

Table 4-8: The interaction of the DAI groups with the population group in South Africa

Population group	DAI Score	Estimate	p-value
Asian	13-25	0.01930	0.816
	26-30	0.0572	0.5608
	31-35	-0.1367	0.2833
	>36	0.0602	0.5572
Black	13-25	0.26	<0.0001
	26-30	0.0642	0.1775
	31-35	-0.0876	0.131
	>36	-0.2365	<0.0001
Coloured	13-25	-0.2749	<0.0001
	26-30	-0.1451	0.0169
	31-35	0.1473	0.0387
	>36	0.2727	<0.0001
White	13-25	-0.0044	0.9405
	26-30	0.0238	0.744
	31-35	0.0771	0.344
	>36	-0.0964	0.195

4.7.1 ASIANS

In a study in by Zietsman[74] in 1979 using the Angle[35] classification it was found that 51 per cent of 14-year-old Indian children needed slight or no treatment at all and for 49.0 per cent of the children, orthodontic treatment was either essential or necessary. The survey conducted by Briedenhann *et al*[15], using the OI[38], showed that 68.1 per cent of Asian children presented with a good occlusion or slight malocclusion that needed no orthodontic correction. Definite or urgent treatment to correct occlusal deviations was

needed in the case of 17.5 per cent of the Asian children and minor orthodontic removable appliance therapy was needed in the case of 14.5 per cent.

In the present study 45.38 per cent of the 12-year-old Asian school children presented with good occlusion, 22.27 per cent had slight malocclusion with 'elective' treatment indicated, while 11.34 per cent exhibited severe occlusal deviations that need comprehensive orthodontic treatment. 'Mandatory' treatment to correct handicapping malocclusions was indicated in 21.01 per cent of the children (Table 4-7).

4.7.2 BLACKS

The results of the current study support previous findings that the need for orthodontic treatment based upon objective assessment of dental relationships is less serious amongst Black 12-year-old children than amongst the children belonging to other population groups in South Africa[15,77].

The results of the present study show that 50.87 per cent of black South African 12-year-olds presented with normal or minor malocclusion implying no treatment need or slight need. Over 21 per cent had definite malocclusion where treatment is considered 'elective'. A substantial proportion presented with a malocclusion that needed urgent orthodontic treatment; 13.3 per cent had severe malocclusion for which treatment is 'highly desirable', while 14.81 per cent of the Black children presented with a very severe malocclusion requiring 'mandatory' orthodontic treatment (Table 4-7).

Otuyemi *et al*[71] investigated the prevalence and the severity of malocclusion and treatment need amongst a randomly selected group of Nigerian children, aged 12-18 years, using the Dental Aesthetic Index (DAI). These authors found that most of the children (77.4 per cent) had a dental appearance that required no orthodontic treatment. Over 13 per cent fell into the group where treatment for malocclusion is considered to be 'elective' and 9.2 per cent of the population had severe to handicapping malocclusion where treatment is 'highly desirable' or 'mandatory'.

4.7.3 COLOUREDS

The results of the present study indicate that only 37.94 per cent of the Coloured children examined had good occlusion or slight malocclusion that needed no orthodontic treatment (Table 4-7). Briedenhann *et al*[15] reported that 70.9 per cent of the Coloured 12-year-old children required no orthodontic treatment. Van Wyk, Du Plessis and Snyman[76] studied the prevalence of malocclusion in Coloured children in Eersterust, Pretoria. They found that 56.5 per cent of the children did not require any orthodontic treatment. Zietsman[74] used the modified *Federation Dentaire Internationale* measurements of Occlusal Traits and reported that 53 per cent of a Coloured community in the Pretoria region needed slight or no orthodontic treatment.

The results of the current study indicate that malocclusion of various degrees is significantly more prevalent in the Coloured 12-year-old South Africa school children (Table 4.7). Just over twenty-two per cent had definite malocclusion

but required only 'elective' treatment, 16.57 per cent needed 'definite' orthodontic treatment for severe malocclusion and 23.04 per cent presented with handicapping malocclusion that needed 'mandatory' orthodontic treatment (Table 4-7).

Van Wyk, Du Plessis and Snyman[76] showed that only 7 per cent of the Coloured children in their study needed comprehensive orthodontic treatment to correct major occlusal problems. In the study by Briedenhann *et al*[15] only 14.3 per cent of the Coloured children were in need of urgent orthodontic treatment.

4.7.4 WHITES

Zietsman[13] reported that 37.0 per cent of 14-year-old White children living in Pretoria needed minor or no treatment at all. The study by Kotze, Mizrahi and Zietsman[3] revealed that 22 per cent of 11 and 12 year old South African Defence Force children presented with occlusions that needed no orthodontic treatment. Seventy-eight per cent of the children exhibited severe occlusal problems that needed definite or urgent orthodontic treatment. Briedenhann *et al*[15] found that 46.4 per cent of White South African 12-year-olds presented with good occlusion, 22 per cent had slight malocclusion but no treatment was needed while 18.2 per cent exhibited minor occlusal deviations. Definite treatment was needed in the case of 11.4 per cent to correct major occlusal deviations and 2.1 per cent required urgent orthodontic attention.

The results of the current study showed that 43.13 per cent of White South African school children had a normal occlusion, 20.50 per cent presented with definite malocclusion where selective orthodontic treatment is indicated. Severe and handicapping malocclusion were present in 16.83 per cent and 19.54 per cent of the White South African school children respectively (Table 4-7).

Kelly and Harvey[89] reported that 10.5 per cent of white American children between 12 and 17 years of age presented with normal occlusion, 34.6 per cent had minor deviations but no treatment was indicated, while 25.7 per cent exhibited definite occlusal deviations that needed elective orthodontic treatment. A further 29.2 per cent presented with either handicapping or severely handicapping malocclusion, in which case orthodontic treatment was either desirable or necessary.

4.8 PREVALENCE OF MALOCCLUSION BY LOCATION TYPE

The demographic section of the epidemiological form used in the survey makes provision for schools to be situated in thee location types. These locations are as follow:

- Urban schools – These are schools situated in cities, towns, townships and informal settlements.
- Farm schools – Schools on commercial farms.

- Non-urban schools – These are schools situated in all areas not included under "urban" or "farm schools". These schools will usually be found in the more rural parts of the country.

The prevalence of malocclusion in the different location types is presented in Tables 4-9.

Table 4-9: The frequency and percentage distribution of the DAI groups by location type

		13 - 25	26 - 30	31- 35	≥ 36
Urban schools	Frequency	1284	637	470	587
	%	43.12	21.39	15.78	19.71
Farm schools	Frequency	274	142	70	60
	%	50.18	26.01	12.82	10.99
Non-urban schools	Frequency	1107	407	250	300
	%	53.63	19.72	12.11	14.53
Total	Frequency	2665	1186	790	947
	%	47.69	21.22	14.14	16.95
p=0.7773					

No differences were observed in the prevalence of malocclusion in the different location types i.e. urban, farm schools and non-urban schools ($p>0.05$). In other words, the prevalence of malocclusion in the three location types does not differ significantly. The results of the current study therefore suggest that the provision of orthodontic services for the rural and urban areas should not be different.

4.9 PREVALENCE OF MALOCCLUSION BY EMPLOYMENT STATUS OF PARENTS

The percentage and frequency distribution of malocclusion by employment status of the parents are presented in Tables 4-10. The prevalence of malocclusion by employment status of the parent does not differ significantly ($p>0.05$). If employment status of the parents is used as an indicator of the socio-economic background, the results suggest that these factors do not influence the prevalence of malocclusion.

Table 4-10: The percentage and frequency distribution of the DAI groups by employment status of parents

		13 - 25	26 - 30	31- 35	≥ 36
Employed	Frequency	2060	947	641	765
	%	46.68	21.46	14.53	17.34
Unemployed	Frequency	680	276	170	205
	%	51.09	20.74	12.77	15.40
Total	Frequency	2740	1223	811	970
	%	47.70	21.29	14.12	16.89
p= 0.4973					

4.10 ANALYSIS OF THE DIFFERENT VARIABLES OF THE DAI

According to Proffit, Field and Moray[90] two major types of malocclusion occur, intra-arch irregularities and malalignment, and discrepancies in occlusal contact relationship. The Dental Aesthetic Index[44] makes provision for the analysis of data into these two categories as well as the individual variables (Table 4-11).

Table 4-11: Classification of the variables of the Dental Aesthetic Index

Intra-arch irregularities and malalignment
1. Missing incisor, canine and premolar teeth-maxillary and mandibular teeth
2. Crowding in the incisal segments
3. Spacing in the incisal segments
4. Midline diastema
5. Largest anterior maxillary irregularity
6. Largest anterior mandibular irregularity
Discrepancies in occlusal contact relationship
7. Anterior maxillary overjet
8. Anterior mandibular overjet
9. Vertical anterior openbite
10. Antero-posterior molar relation

4.10.1 INTRA-ARCH IRREGULARITIES AND MALALIGNMENT

4.10.1.1 Missing maxillary and mandibular incisors, canines and premolars

The number of missing permanent incisor, canine and premolar teeth in the upper and lower arches was recorded. A history of all missing anterior teeth was obtained to determine whether extractions were performed for aesthetic reasons. Teeth were not recorded as missing if spaces were closed, if a primary tooth was still in position and its successor has not yet erupted, or if a missing incisor, canine or premolar tooth has been replaced by a fixed prosthesis[65].

Table 4-12 summarises the prevalence of missing maxillary and mandibular incisors, canines and premolars. The results of the study show that missing

incisors, canines and premolars are more common in the maxilla, 9.72 per cent, than in the mandibula, 8.57 per cent, (Table 4-12). These differences were statistically significant ($p<0.05$). For the maxilla 6.18 per cent of the children presented with only one tooth missing and 3.54 per cent presented with two to six teeth missing. For the mandible 4.88 per cent presented with one tooth missing and 3.69 per cent presented with two to six teeth missing.

Table 4-12: Percentage and frequency distribution of missing maxillary and mandibular incisors, canines and premolars

Number of missing teeth	Maxilla		Mandible	
	Frequency	%	Frequency	%
No missing teeth present	5182	90.28	5245	91.44
Missing teeth present	558	9.72	491	8.57
p=0.0068				
1 tooth missing	355	6.18	280	4.88
2 teeth missing	177	3.08	141	2.46
3 teeth missing	16	0.28	39	0.68
4 teeth missing	8	0.14	25	0.44
5 teeth missing	1	0.02	5	0.09
6 teeth missing	1	0.02	1	0.02

4.10.1.2 Crowding in the incisal segments

Crowding in the incisal segment is the condition in which the available space between the right and left canine teeth is insufficient to accommodate all four incisors in normal alignment. Teeth may be rotated or displaced out of alignment in the arch[65].

Crowding of the incisors are the most common form of Angle Class I malocclusion and is by far the most prevalent form of malocclusion[83].

The results of the current study indicate that 40 per cent of the children, that is 2298 presented with crowding in the incisal segments, 24.03 per cent presented with crowding in one segment and 15.98 per cent presented with crowding in two segments.

Table 4-13: Prevalence of crowding in the incisal segments

Crowding in the incisal segments		
	Frequency	**%**
No crowding present	3445	59.98
Crowding present	2298	40.01
One segment crowded	1380	24.03
Two segments crowded	918	15.98

The slight increase in the anterior arch dimension during normal development is not sufficient to overcome moderate to severe discrepancies. Crowding is therefore likely to persist into the permanent dentition, particularly if it was severe initially[83]. Proffit, Field and Moray[90] reported that crowding of incisors affects nearly half of all children in the mixed dentition years, it worsens in the adolescent years as the permanent teeth erupt and continues to increase, especially in the mandibular arch, in adults.

4.10.1.3 Spacing in the incisal segments

Spacing is the condition in which the amount of space available between the right and left canine teeth exceeds that required to accommodate all four incisors in normal alignment. If one or more incisor teeth have proximal surfaces without any interdental contact, the segment was recorded as having space. Both the upper and lower incisal segments were examined for spacing. The space from a recently exfoliated primary tooth was not recorded if it appears that the permanent replacement will soon erupt[65].

One of the characteristic features of normal occlusion is arch continuity as expressed by proximal contact between all teeth in each dental arch. Factors such as mesial drift, transeptal fibres, the slope of the occluding cusp and the direction of occlusal forces contribute to the maintenance of this continuity[91,92,93]. The loss of contact as through loss of proximal tooth material is viewed as detrimental to arch integrity and normal function[94]. Hemley[95], on the other hand, claimed that spacing is an acceptable variation in the normal occlusion pattern and not a malocclusion.

A considerable number of individuals show spaces between some, or even all, of their teeth. These are known as "spaced dentition"[94]. Spacing in the incisal segment is indicative of space excess in these segments. Spacing can be a symptom of missing or undersized lateral incisors, para-function habits such as thumb sucking, mouth-breathing and tongue-thrusting, flared or rotated central

incisors, anodontia, macroglossia, dento-alveolar disproportions and true tooth size/jaw size discrepancies[96].

Table 4-14 shows the prevalence of incisor spacing, of the 5744 children examined, more than 27 per cent of the children presented with spacing. Almost nineteen per cent of the children presented with excess space in only one segment and 9.09 per cent with excess space in the two incisor segments.

Table 4-14: The prevalence of spacing in the incisal segments

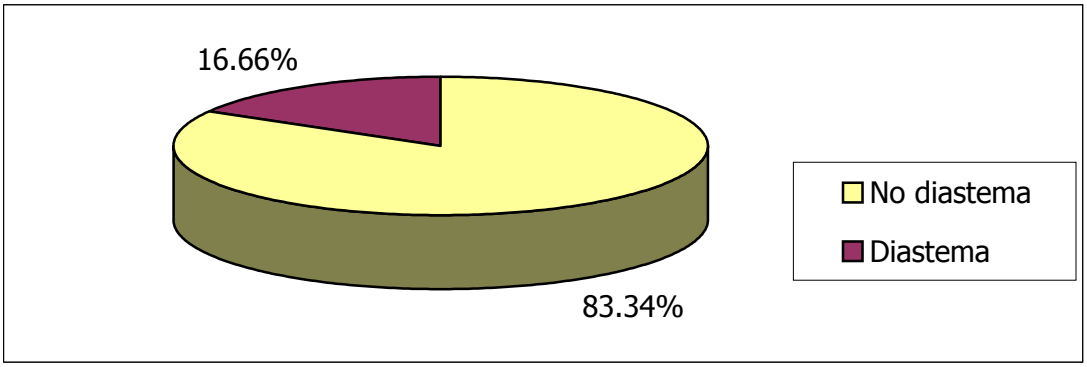
Spacing in the incisal segment		
	Frequency	**%**
No spacing present	4156	72.35
Spacing present	1588	27.65
One segment spaced	1066	18.56
Two segments spaced	522	9.09

4.10.1.4 Maxillary midline diastema

4.10.1.4.1 Prevalence and severity of maxillary midline diastema

A diastema is defined as a space greater than 0.5 millimetres between the proximal surfaces of adjacent teeth[97], a midline diastema indicates a space between the central incisors[4]. Of the 5744 children examined, 950 or 16.66 per cent presented with maxillary midline diastema (Figure 4-1).

Figure 4-1: Prevalence of maxillary midline diastema in 12-year-old South African school children



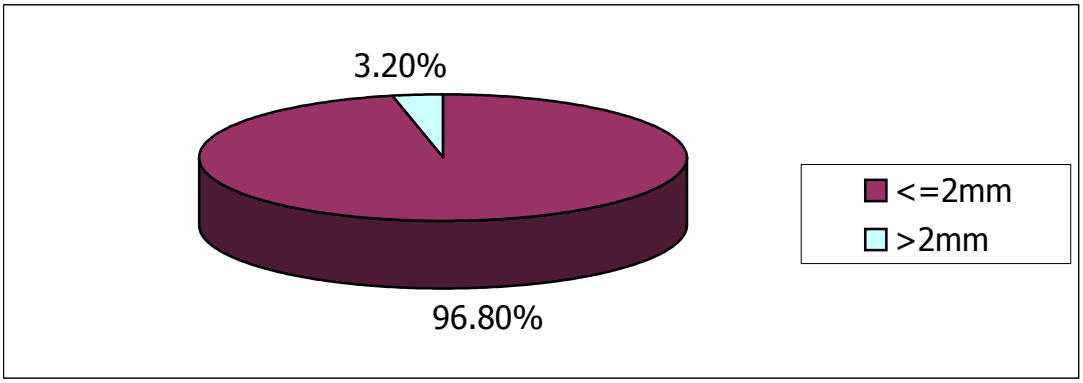
The size of the diastema ranges from 1 to 8mm, the distribution of the severity of diastema in the affected groups is shown in Table 4-15.

Table 4-15: Percentage distribution of the severity of maxillary midline diastema in the affected group

Size	Percentage distribution (%)
1mm	7.96
2mm	5.50
3mm	1.92
4mm	0.85
5mm	0.26
6mm	0.16
8mm	0.02

In the developing dentition at the age of 12 years, the presence of a diastema is regarded as a normal phenomenon. In the absence of a deep overbite these spaces normally close spontaneously[4]. If the space between the maxillary central incisors is greater than 2mm, spontaneous closure is unlikely[83,98]. If spaces greater than 2mm are taken into account, 3.2 per cent of the children presented with diastema (Figure 4-2).

Figure 4-2: Prevalence of diastema (>2mm) in 12-year-old South African school children



4.10.1.4.2 The distribution of maxillary midline diastema by population group in South Africa

The percentage distribution of midline diastema by population group in South Africa is shown in Table 4-16. The results show that 18.86 per cent of the White, 17.66 per cent of the Black, 12.81 per cent and 12.3 per cent of the Coloured and Asian 12-year-old South African school children presented with maxillary midline diastema. The differences between the four groups were statistically significant (p<0,05).

Table 4-16: Prevalence of maxillary midline diastema in the different population groups in South Africa

Population group	Percentage distribution (%)
Asian	12.30
Black	17.66
Coloured	12.81
White	18.86
p=0.0029	

Because the interaction between population group and diastema was statistically significant (p=0.0029), the nature of the interaction was further investigated by considering the parameter estimates and the associated p-values. The results of the interaction between population group and midline diastema is summarised in Table 4-17. The results show that for Whites and Blacks there are significantly more children with a midline diastema, for Coloureds there are statistically less children with a midline diastema. Asians tend to have less midline diastemas, this difference was however statistically not significant (Table 4-17).

Table 4-17: Interaction between population group and the presence of anterior maxillary midline diastema

Race	Diastema	Estimate	P-value
Asians	Present	-0.1235	0.1020
Blacks	Present	0.0923	0.0069
Coloureds	Present	-0.0966	0.0317
Whites	Present	0.1278	0.0107

Horowitz[99] studied comparable populations of 10-to-12-year-old Black and White children in the United States and found that 19 per cent of the Black children exhibited a midline diastema compared with only 8 per cent of the White children. Richardson *et al*[100] recorded maxillary midline diastema in 18.65 per cent and 24.6 per cent of 12-year-old White and Black children in the United States respectively.

If the cut-off point of 2mm, which is regarded, by Proffit[83] and Edwards[98] as "acceptable" at the age of 12 is applied, 3.83 per cent of the Black group 2.48

per cent of the White group, 1.72 per cent of the Coloured group and 0.82 per cent of the Asian group presented with diastema (Table 4-18). The differences between the four groups were statistically significant (p<0,05).

Table 4-18: Prevalence of diastema (>2mm) in the different population groups in South Africa

Population group	Midline diastema	%	P-value	Estimate	P-value
Asian	>2mm	0.82	0.0029	-0.02387	0.3775
Black	>2mm	3.83		0.2920	0.0053
Coloured	>2mm	1.72		-0.1195	0.3616
White	>2mm	2.48		0.0663	0.639

Because the interaction between midline diastema >2mm and population group was statistically significant (p=0.0029), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values. The results for the interaction of population group and midline diastema larger than 2mm is summarised in Table 4-18. The results indicate that there are significantly more black 12-year-old children with a midline diastema larger than 2mm.

In a study in the United States, Brunelle, Bhat and Lipton[101] found that maxillary midline diastema larger than 2mm was prevalent in 5.5 per cent of Non-hispanic Whites, 12.5 per cent in Non-hispanic Blacks and only 4.1 per cent in Mexican-Americans in a 12- to 17-year-old sample.

Richardson *et al*[100], in a biracial study of maxillary midline diastema in the United States, reported that at the age of 10- to 14-years the mean widths of the diastemas were larger in black children than in white children.

4.10.1.4.3 The distribution of maxillary midline diastema by gender

The gender distribution of diastema is shown in Table 4-19. The results show that diastema is distributed almost equally between male and female.

Table 4-19: The prevalence of midline diastema by gender

Gender	Diastema	%
Male	Present	17.26
Female	Present	16.16
p=0.3718		

If diastema larger than 2mm is taken into account, the results show that about twice as many females (3.77 per cent) than males (2.53 per cent) presented with diastema (Table 4-20). The differences between the two groups were statistically significantly (p<0,05). The results indicate that there are more girls than boys with a midline diastema larger than 2mm.

Table 4-20: Gender distribution of diastema (>2mm) in 12-year-old South African school children

Gender	Midline diastema	%	Estimate	P-value
Male	>2mm	2.53%	-0.1131	0.0039
Female	>2mm	3.77%	0.1131	0.0039

These differences should be interpreted with caution. Various authors, Kaimenyi[102] in Kenya, Richardson *et al*[100] in the United States (6- to 14 -year-olds) and Steigman and Weissberg[94] (12- to 14-year-olds) have shown that diastema is more prevalent in girls than in boys. These differences reversed to boys between the ages of 14 – 16 years[95,100]. Thereafter, no differences between male and female were evident[95,96,103]. The difference between boys and girls in the current study could therefore be attributed to the earlier maturation of the female group.

4.10.1.4.4 The distribution of maxillary midline diastema by dentition stage

The distribution of midline diastema and midline diastema larger than 2mm in the late mixed and early permanent dentition is shown in Table 4-21.

Table 4-21: Percentage distribution of midline diastema and midline diastema >2mm in the affected group

Dentition stage	Midline diastema	Midline diastema >2mm
Late mixed dentition	18.77%	4.23%
Early permanent dentition	15.98%	2.87%
	p=0.02	p=0.004

Because the interaction between midline diastema and midline diastema >2mm and dentition stage was statistically significant (p=0.02 and p=0.004), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values. The results for the interaction of

dentition stage and midline diastema and midline diastema larger than 2mm are summarised in Table 4-22. The results indicate that midline diastema is more prevalent in the late mixed dentition than in the early permanent dentition. This was also true for a midline diastema larger than 2mm.

The results of the current study supports the finding by Richardson *et al*[100] and Lindsey[104] that indicated that midline diastema reduce with the transition from the mixed dentition to the permanent dentition.

Table 4-22: The interaction between midline diastema and dentition stage

Midline diastema	Dentition stage	Estimate	P-value
Present	Late mixed dentition	0.0483	0.0155
	Early permanent dentition	-0.0483	0.0155
>2mm	Late mixed dentition	0.1159	0.0041
	Early permanent dentition	-0.1159	0.0041

4.10.1.5 Maxillary and mandibular irregularity

Irregularities may be either rotations out of, or displacements from, normal alignment. The four incisors in the upper (maxillary) and lower (mandibular) arch were examined to locate the greatest irregularity. Irregularities may occur with or without crowding. If there is sufficient space for all four incisors in normal alignment but some are rotated or displaced, the largest irregularity was recorded[65].

The results of the study show that irregularities were more common in the maxilla, 59.52 per cent, than in the mandibula, 53.06 per cent, (Table 4-23).

These differences were statistically significant ($p<0.05$). This is in contrast to the findings of Brunelle, Bhat and Lipton[101] who studied 12- to 17-year-old American children, they reported that mandibular incisors appeared to have more alignment irregularities than maxillary incisors. In the current study the size of the irregularities ranged from 1 to 8mm (Table 4.23). Irregularities 1mm and smaller were more prevalent in the mandibula. Irregularities, 2mm to 4mm, however were more prevalent in the maxilla.

Table 4-23: The prevalence of maxillary and mandibular anterior irregularity

Anterior irregularity	Maxilla	Mandibula
No irregularity	40.48%	46.94%
Largest irregularity	59.52%	53.06%
p<0.0001		
1mm	19.79	28.15
2mm	19.62	16.30
3mm	10.83	5.48
4mm	5.15	2.18
5mm	2.39	2.39
6mm	1.20	1.20
7mm	0.35	0.35
8mm	0.19	0.19

4.10.2 DISCREPANCIES IN OCCLUSAL CONTACT RELATIONSHIP

4.10.2.1 Anterior maxillary overjet

4.10.2.1.1 The prevalence and severity of maxillary overjet

Anterior maxillary overjet is the measurement of the horizontal relation of the incisors with the teeth in centric occlusion. The distance from the labial-incisal edge of the most prominent upper incisor to the labial surface of the corresponding lower incisor was measured. Maxillary overjet was not recorded where all the upper incisors were missing or in lingual crossbite. If the incisors occlude edge to edge, the overjet was scored as zero[65].

Anterior maxillary overjet indicates an antero-posterior deviation in Class II direction[83]. The percentage of children that presented with a maxillary overjet is shown in Figure 4-24.

According to Moyers[4] an overjet between 1mm and 3mm are considered normal. The results of the current study indicated that 57.18 per cent of the subjects presented with a normal maxillary overjet, 11.10 per cent presented with a 0mm overjet (edge-to-edge) and 31.73 per cent presented with an overjet larger than 3mm.

The increased overjet ranged from 4mm to 8mm. An overjet of 4mm to 6mm, suggesting a moderate problem[62] occurred in 29.55 per cent of the children, and an overjet of more than 6mm, indicating a severe problem[62] occurred in only 2.18 per cent of the children (Table 4-24).

Table 4-24: Percentage and frequency distribution of maxillary overjet

Maxillary overjet	Frequency	%
0mm	638	11.10
1-3mm	3287	57.18
>3-6mm	1699	29.55
>6mm	125	2.18

4.10.2.1.2 The distribution of maxillary overjet by population group in South Africa

The percentage distribution of maxillary overjet for the different population groups of South Africa is presented in Table 4-25. The distribution of maxillary overjet differs significantly for the different population groups ($p<0.05$).

Table 4-25: The percentage distribution of maxillary overjet for the different population groups in South Africa

Race	0mm	1 to 3mm	>3mm
Asian	8.26	60.74	30.99
Black	11.52	58.83	29.65
Coloured	10.21	52.41	37.38
White	10.96	52.50	36.54
p<0.0001			

Because the interaction between maxillary overjet and population groups was significant ($p<0.001$), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values. The results for the interaction of maxillary overjet and population groups is summarised in Table 4-26.

Table 4-26: The interaction between maxillary overjet and the different population groups in South Africa

Population group	Maxillary overjet	Estimate	P-value
Asian	0 mm	-0.1392	0.2505
	1-3mm	0.1488	0.0565
	>3mm	0.0096	0.9111
Black	0mm	0.1078	0.0492
	1-3mm	0.0313	0.3888
	>3mm	-0.1391	0.0005
Coloured	0mm	-0.0114	0.8691
	1-3mm	-0.0826	0.0736
	>3mm	0.0940	0.0575
White	0mm	0.0428	0.6044
	1-3mm	-0.0975	0.0818
	>3mm	0.0547	0.3622

The results indicate that significantly more Black 12-year-old children presented with an edge-to-edge anterior relationship and significantly less Black children with an increased overjet. This suggests that Black 12-year-old South African school children have a greater Class III tendency than a Class II tendency. This finding is supported by Garner and Butt[105], in an epidemiologic study on the prevalence of malocclusion in Black American and Kenyans age 13- to-15-years, they reported a higher prevalence of Class III malocclusion in the Kenyan population.

4.10.2.1.3 The distribution of maxillary overjet by gender

The percentage distribution of maxillary overjet for male and female is presented in Table 4-27. The interaction between maxillary overjet and gender

showed statistical significance ($p<0.05$), indicating that the distribution of maxillary overjet is significantly different for the gender groups.

Table 4-27: The percentage distribution of maxillary overjet by gender

Gender	0mm	1 to 3mm	>3mm
Male	10.14	55.53	34.33
Females	11.91	58.57	29.53
p<0.0004			

The interaction between maxillary overjet and gender group was further investigated by considering the parameter estimates and the associated p-values (Table 4-28).

Table 4-28: The interaction between maxillary overjet and gender

Gender	Maxillary overjet	Estimate	P-value
Male	0mm	-0.0740	0.0098
	1-3mm	-0.0104	0.5948
	>3mm	0.0844	<0.0001
Female	0mm	0.0740	0.0098
	1-3mm	0.0104	0.5948
	>3mm	-0.0844	<0.0001

The results indicate that significantly more boys than girls had an increased overjet, i.e. overjet more than 3mm and significantly more girls than boys had an edge-to-edge overjet (0mm overjet). This implies that 12-year-old boys have larger overjets and a higher prevalence of Class II malocclusions. Furthermore, 12-year–old South African girls tend to have fewer overjets larger than 3mm and a higher prevalence of edge–to–edge overjet indicating a

tendency towards Class III malocclusion. Brunelle, Bhat and Lipton[101] studied 12- to 17-year-old American children, and found that the average overjet (3.3mm) for boys was larger than the average overjet (2.8mm) for girls. This gender difference in the prevalence of maxillary overjet could be attributed to earlier maturation of the female group.

4.10.2.1.4 The distribution of maxillary overjet by dentition stage

The percentage distribution of maxillary overjet for the two dentition stages is presented in Table 4-29. The distribution between these stages of dental development differed significantly ($p<0.05$).

Table 4-29: The percentage distribution of maxillary overjet for the late mixed dentition stage and the early permanent dentition stage

Gender	0mm	1 to 3mm	>3mm
Late mixed dentition	12.15	53.59	34.26
Early permanent dentition	10.76	58.34	30.91
p=0.0127			

Because the interaction between maxillary overjet and the dentition stage differed significantly (p=0.0127), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values. The results indicate that significantly more 12-year-old children presented with a normal overjet in the early permanent dentition stage than 12-year-old children in the late mixed dentition stage (p 0.0127). In other words, there is a higher prevalence of normal (1 to 3mm) overjet in 12-year-old children in the permanent dentition stage than in the mixed dentition stage. Certain occlusal

traits including overjet, naturally improves with age[101]. These improvements are due to normal developmental changes and growth that occur during the transition from the mixed dentition stage to the permanent dentition stage.

4.10.2.2 Anterior mandibular overjet

4.10.2.2.1 The prevalence and severity of mandibular overjet

Mandibular overjet was recorded when any lower incisor protrudes anteriorly or labially to the opposing upper incisor, i.e. in crossbite. Mandibular overjet was not recorded if a lower incisor was rotated so that one part of the incisal edge is in crossbite (i.e. is labial to the upper incisor) but another part of the incisal edge was not[65].

Anterior mandibular overjet, indicative of Class III malocclusion or anterior crossbite, is much less frequent with an occurrence of only 10.43 per cent in the sample (Table 4-30).

Table 4-30: Percentage and frequency distribution of anterior mandibular overjet

Anterior mandibular overjet	Frequency	%
Absent	5175	89.58
Present	602	10.43
1 - 3mm: great treatment need	493	8.54
4 - 8mm: very great treatment need	109	1.89

The mandibular overjet ranged from 1mm to 8mm (Table 4-30). According to Proffit, Fields and Moray[90] a reverse overjet of 1mm to 3mm, suggesting a great treatment need occurs in 8.54 per cent of the children. A reverse overjet

of more than 3.5 mm, suggesting a very great treatment need occurs in almost two percent of the children (Table 4-30).

4.10.2.2.2 The distribution of mandibular overjet by population group in South Africa

The prevalence of mandibular overjet is shown in Table 4-31. The results indicate that 11.89 per cent of the Asian, 11.20 per cent of the Black, 8.99 per cent, and 6.68 per cent of the Coloured and White 12-year-old South African school children presented with anterior mandibular overjet. The differences between the four groups were statistically significantly (p<0,05).

Table 4-31: The percentage distribution of mandibular overjet for the different population groups in South Africa

Race	Percentage distribution
Asian	11.89
Black	11.20
Coloured	8.99
White	6.68
p=0.0044	

Because the interaction between mandibular overjet and the population group differed significantly (p=0.0044), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values. The results show that there are significantly more Black children with a mandibular overjet and statistically less White children with mandibular overjet (Table 4-32). These results indicate that a Class III malocclusion or anterior crossbite is

more prevalent in 12-year-old black South African school children and less prevalent in 12-year-old white South African children.

Table 4-32: The interaction between population groups and the presence of mandibular overjet

Race	Mandibular overjet	Estimate	P-value
Asians	Present	0.1265	0.1081
Blacks	Present	0.0932	0.0210
Coloureds	Present	-0.0294	0.5764
Whites	Present	-0.1930	0.0079

4.10.2.2.3 The distribution of mandibular overjet by dentition stage

The distribution of anterior mandibular overjet in the late mixed and early permanent dentition is shown in Table 4-33. The distribution of mandibular overjet between the late mixed dentition stage and the early permanent dentition stage was significantly different ($p<0.05$).

Table 4-33: The percentage distribution of mandibular overjet by dentition stage

Dentition stage	Percentage distribution (%)
Late mixed dentition	12.43
Early permanent dentition	9.77
p=0.0045	

Because the interaction between mandibular overjet and the dentition stage was significant (p=0.0045), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values (Table 4-34).

The results indicate that anterior mandibular overjet i.e. Class III malocclusion or anterior crossbite, is more prevalent in the late mixed dentition stage than in the early permanent dentition stage.

Table 4-34: The interaction between mandibular overjet and dentition stage

Dentition Stage	Mandibular overjet	Estimate	P-value
Late mixed dentition	Present	0.0677	0.0045
Early permanent dentition	Present	-0.0677	0.0045

4.10.2.3 Vertical anterior openbite

4.10.2.3.1 The prevalence and severity of vertical anterior openbite

Anterior openbite is a lack of vertical overlap between any of the opposing pairs of incisors (openbite)[65]. Anterior open bite reflects discrepancies in the vertical plane of space[83]. As a child becomes older, it is increasingly likely that malocclusion in the vertical plane of space, is related to skeletal jaw proportions and not just to displacement of the teeth[83].

In the present study 7.7 per cent of the children presented with anterior openbite. The size of the anterior openbite ranged from 1 to 8mm (Table 4-35).

Table 4-35: The prevalence of vertical anterior openbite

Vertical anterior openbite	Percentage distribution (%)
Absent	92.30
Present	7.70
1mm	2.01
2mm	2.63
3mm	1.51
4mm	0.64
5mm	0.57
6mm	0.22
7mm	0.09
8mm	0.03

In a malocclusion study in Nigeria, on 12- to 13-year-old children, Otuyemi *et al*[71] reported that anterior open bite is a common malocclusion trait, and that it occurs in 10.2 per cent of the rural and urban Nigerian communities.

Proffit, Fields and Moray[90] classified an open bite of 0 to 2mm as a moderate problem, an openbite of 3 to 4mm as a severe problem and an openbite larger than 4mm as extreme. Brunelle, Bhat and Lipton[101] in a study in the United States found that a moderate anterior open bite according to the classification by Proffit, Fields and Moray[90] occurred in 2.8 per cent, a severe open bite occurred in 0.5 per cent and extreme open bite occurred in 0.2 per cent of the 12- to 17-year-old American population. The results of the current study show that a moderate anterior open bite occurred in 4.64 per cent of the sample, a severe open bite in 2.15 per cent and an extreme open bite occurred in 0.91 per cent (Table 4-36).

Table 4-36: The percentage distribution of vertical anterior openbite of the affected group

Vertical anterior openbite	Percentage distribution (%)
Moderate: 0 to 2mm	4.64
Severe: 3 to 4mm	2.15
Extreme: > 4mm	0.91

4.10.2.3.2 The distribution of vertical anterior openbite by population group in South Africa

The percentage distribution of anterior openbite for the different population groups of South Africa is presented in Table 4-37. The results show that 7.97 per cent of the Black, 7.76 per cent of the Coloured and 7.07 per cent and 4.49 per cent of the White and Asian twelve-year-old South African school children presented with vertical anterior openbite. The differences between the different population groups were not statistically significant (p>0,05).

Table 4-37: The prevalence of vertical anterior openbite by population group in South Africa

Population group	Percentage distribution (%)
Asian	4.49
Black	7.97
Coloured	7.76
White	7.07
p=0.2470	

4.10.2.3.3 The distribution of vertical anterior openbite by gender

The gender distribution of anterior open bite is shown in Table 4-38. There is a significant difference in the distribution of anterior openbite between males and females in this age group in South Africa ($p<0.05$).

Table 4-38: Gender distribution of anterior open bite in 12-year-old South African school children

Gender	Percentage distribution (%)
Males	6.50
Females	8.72
p=0.007	

Because the interaction between vertical anterior openbite and gender was significant (p=0.007), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values (Table 4-39). The results show anterior open occur significantly less in boys than in girls. Brunelle, Bhat and Lipton[101] found for 12- to 17-year-old American children that the average openbite (1.5mm) for boys was less than the average openbite (2.1mm) for girls.

Table 4-39: The interaction between vertical anterior openbite by gender

Gender	Vertical anterior openbite	Estimate	P-value
Male	Present	-0.0793	0.0017
Female	Present	0.0793	0.0017

4.10.2.3.4 The distribution of vertical anterior openbite by dentition stage

The percentage distribution of vertical anterior open bite in the late mixed dentition stage and the early permanent dentition stage is shown in Table 4-40. Anterior openbite is almost equally distributed between the late mixed dentition stage and the early permanent dentition stage. The differences between the two groups were not statistically significant (p>0,05).

Table 4-40: The percentage distribution of vertical anterior openbite and dentition stage

Dentition stage	Percentage distribution (%)
Late mixed dentition	7.56
Early permanent den	7.75
p=0.91	

4.10.2.4 Antero-posterior molar relation

4.10.2.4.1 The prevalence of discrepancies in antero-posterior molar relationship

This assessment was based on the relationship of the permanent upper and lower first molars. The right and the left side were assessed with the teeth in occlusion and only the largest deviation from the normal relation, Angle Class I was recorded[65].

The prevalence of discrepancies in the antero-posterior molar relationship is presented in Table 4-41. The results indicate that 55.48 per cent of the sample

presented with a normal molar relationship and 44.52 per cent presented with an antero-posterior molar relationship discrepancy. Of the affected group 30.21 per cent presented with a half a cusp displacement and 14.31 per cent presented with a full cusp displacement.

Table 4-41: Prevalence of the antero-posterior molar relationship

Antero-posterior molar relationship		
	Frequency	**%**
Normal relationship	3199	55.48
Abnormal relationship	2567	44.52
Half a cusp displacement	1742	30.21
Full cusp displacement	825	14.31

4.10.2.4.2 The distribution of antero-posterior molar relation by population group in South Africa

The percentage distribution of antero-posterior molar relation for the different population groups of South Africa is presented in Table 4-42. The distribution of antero-posterior molar relation is significantly different for the different population groups ($p<0.05$).

Table 4-42: The percentage distribution of antero-posterior molar relation by population group in South Africa

Race	Normal	Half a cusp displacement	Full cusp displacement
Asian	48.57	35.10	16.33
Black	58.59	28.14	13.26
Coloured	47.66	34.35	17.99
White	50.86	35.24	13.90
p<0.0001			

Because the interaction between population group and molar relation was statistically different ($p<0.0001$), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values (Table 4-43). The results indicate that there are significantly more Black 12-year-old children with a normal molar relationship ($p<0.001$), while significantly more 12-year-old Coloured children presented with a full cusp molar displacement ($p=0.0258$).

Table 4-43: The interaction between of antero-posterior molar relation by population group in South Africa

Population group	Antero-posterior molar relation	Estimate	P-value
Asian	Normal (Class I)	-0.0782	0.2572
	Half a cusp displacement	0.0350	0.647
	Full cusp displacement>3mm	0.043	0.6329
Black	Normal (Class I)	0.1897	<0.0001
	Half a cusp displacement	-0.1055	0.0038
	Full cusp displacement>3mm	-0.0842	0.0608
Coloured	Normal (Class I)	-0.1161	0.0057
	Half a cusp displacement	-0.0053	0.9055
	Full cusp displacement>3mm	0.1214	0.0258
White	Normal (Class I)	0.0046	0.9297
	Half a cusp displacement	0.0758	0.1780
	Full cusp displacement>3mm	-0.804	0.2588

4.10.2.4.3 The distribution of antero-posterior molar relation by gender

The percentage distribution of antero-posterior molar relation for males and females are presented in Table 4-44. The differences in the distribution of antero-posterior molar relation for male and females are statistically significant ($p<0.05$).

Table 4-44: The percentage distribution of antero-posterior molar relation for males and females

Gender	Normal	Half a cusp displacement	Full cusp displacement
Male	53.08	31.67	15.25
Female	57.51	28.98	13.51
p=0.0032			

Because the interaction between gender group and antero-posterior molar relation was statistically different ($p<0.0001$), the nature of the interaction was investigated by considering the parameter estimates and the associated p-values (Table 4-45). There are significantly more girls than boys with a normal molar relationship.

Table 4-45: The interaction between antero-posterior molar relation by gender

Population group	Antero-posterior molar relation	Estimate	P-value
Male	Normal (Class I)	-0.0616	0.0008
	Half a cusp displacement	0.0228	0.2691
	Full cusp displacement>3mm	0.0388	0.1244
Female	Normal (Class I)	0.0616	0.0008
	Half a cusp displacement	-0.0228	0.2691
	Full cusp displacement>3mm	-0.0388	0.1244

4.10.2.4.4 The distribution of antero-posterior molar relation by dentition stage

The percentage distribution of antero-posterior molar relation for the late mixed dentition stage and the early permanent dentition stage is presented in Table 4-46. The differences in the distribution of antero-posterior molar relation for the late mixed dentition stage and the early permanent dentition stage is not statistically significant (p>0.05).

Table 4-46: The percentage distribution of antero-posterior molar relation by dentition stage

Dentition stage	Normal	Half a cusp displacement	Full cusp displacement
Late mixed dentition	56.89	29.19	13.92
Early permanent dentition	55.02	30.54	14.43
p=0.28			

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Most children, 52.3 per cent in this study were found to have a dental appearance that did require orthodontic treatment, ranging from 'selective' to 'mandatory'. At the cut-off point of 32 to demarcate priority of orthodontic treatment, 31.01 per cent presented with severe and handicapping malocclusion, requiring 'definite' and 'mandatory' treatment. Compared to the dental appearance of Australian, New Zeeland and Malaysian subjects, South African children were found to have worse dental aesthetics and consequently a higher need for orthodontic treatment.

Malocclusion as defined in this study was found to be significantly associated with the different provinces of South Africa, gender, the different population groups of South Africa and dentition stage, but not with location type or employment status of parents.

The results of this study indicate a high prevalence of malocclusion in 12-year-old South African children. These findings established reliable base-line data regarding the prevalence, distribution and severity of malocclusion as well as useful epidemiological data on the orthodontic treatment needs of 12-year-old children in selected rural and urban areas in South Africa.

At present, there is no doubt that many children with severe and handicapping malocclusion are not receiving adequate orthodontic treatment. As both the general dental health and socio-economic status of the population of South Africa improve, it is likely that the number of children seeking orthodontic treatment will increase. This possible increase in patients seeking orthodontic care and the already high prevalence of malocclusion necessitate the careful planning of adequate orthodontic services in South Africa. For orthodontic problems, prevention is unlikely to be effective because malocclusion changes only a little with lower caries rates and tooth loss as general dental health improves and specific prevention measures for alignment or occlusal problems do not exist at present[89]. ' Prevention ' of malocclusion is possible in only a few special circumstances. 'Interceptive' treatment can be very helpful in reducing the severity of the problems but rarely is so successful that later treatment becomes unnecessary[83]. Orthodontic services should therefore be comprehensive, delivering appropriate treatment in response to specific situations, resulting in the efficient treatment of non-skeletal and skeletal problems. Because no differences were found in the prevalence of malocclusion between the different location types, it would appear that the type of orthodontic services needed at the different location types in South Africa should not be different.

From the results of this study and other studies conducted elsewhere using the DAI it appears that the prevalence and treatment need are slightly higher for younger children than for older groups. This inverse relationship between

chronological and DAI findings needs to be taken in consideration when using the DAI to plan orthodontic services. The use of dentition stage rather than chronological age as inclusion criteria for surveys using the DAI also needs to be explored.

LITERATURE REFERENCES

1 Sheiham A. Guest Editorial: The Berlin Declaration on Oral Health and Oral Health Services. Quintessence Int 1993; 24: 829-831.

2 De Mûelenaere JJGG, Wiltshire WA, Viljoen WP. The occlusal status of an urban and rural Venda group. J Dent Assoc S Afr 1992; 47: 517-520.

3 Kotze JH, Mizrahi E, Zietsman ST. The need for orthodontics in the SADF. J Dent Res 1982; 62: 503.

4 Moyers RE. Handbook of orthodontics, Fourth edition. Chicago: Year Book Medical Pub; 1988.

5 Jeffers JR, Bognanno MF, Barlett JC. On demand versus need for medical services and the concept of "shortage". Am J Public Health 1971; 61: 47-63.

6 Goodman HS, Weyant RJ. Dental Health Personnel Planning: A review of the literature. J Public Health Dent 1990; 50: 48-63.

7 Shaw WC, Lewis HG, Robertson NRE. Perception of malocclusion. Br Dent J 1975; 138: 211-216.

8 Van Wyk PJ, van Rooy HK, Rudolph MJ, van der Merwe CA. Unmet and Ill-met Demand for Oral Health Services in the RSA. In: Van Wyk PJ, editor. Results of the National Oral Health Survey: South Africa 1988/89; 1994. p. 147-152.

9 Spencer AJ. The estimation of need for dental care. J Public Health Dent 1980; 40: 311-327.

10 Striffler DF. Dental treatment, need demand and utilization In: Striffler DF, Young WO & Burt BA Dentistry, Dental Practice and the Community, 3 rd. ed. Philadelphia: WD Saunders. 1983. p. 293-339.

11 Cooper MH. The demand and need for dental care. Social Policy Administration 1979; 13: 19.

12 De Mûelenaere KR. Possibilities for Prevention of Malocclusions in South African Children. J Dent Assoc S Afr 1997; 52: 9-14.

13 Zietsman ST. Characteristics of Malocclusion in 14-year-old Pretoria Caucasoids. J Dent Res 1976; 55: 548.

14 Swanepoel F. The need for orthodontic treatment amongst the Negroid population in Ga-Rankuwa. J Dent Res 1985; 64: 779.

15 Briedenhann SJ, Van Wyk PJ, Rossouw LM, Wolmarans L. Prevalence of malocclusion in 12-year-old South African children 1991. In: Van Wyk PJ, editor. National oral Health Survey: South Africa 1988/89. Pretoria: Department of Heath; 1994. p. 109-118.

16 Jenny J. A social perspective on need and demand for orthodontic treatment. Int Dent J 1975; 25: 248-53.

17 Holtshousen WSJ. Personal communication, Holtshousen WSJ, Deputy Director Oral Health Services. Gauteng Health Department. 1997.

18 So LL, Tang LK. A comparative study using the Occlusal Index and the Index of Orthodontic Treatment Need. Angle Orthod 1993; 63: 57-64.

19 Burden D, Holmes A. The need for orthodontic treatment in the child population of the United Kingdom. Eur J Orthod 1994; 16: 395-399.

20 Foster TD. The public health interest in assessment for orthodontic treatment. J Public Health Dent 1979; 39: 137-42.

21 Last JM. A Dictionary of Epidemiology 2nd ed. New York: Oxford University Press; 1988.

22 Helm S. Epidemiology and Public Health Aspects of Malocclusion. J Dent Res, Special Issue 1977; 56: 27-31.

23 Helm S. Prevalence of Malocclusion in Relation to Development of the Dentition. Acta Odont Scand 1970; 28 (Suppl): 58.

24 Moss JP. Public Health Orthodontics for the Developing Nations. J Indian Dent Assoc 1983; 55: 405-408.

25 Björk A, Krebs A, Solow, B. A Method for Epidemiological Registration of Malocclusion. Acta Odontol Scand 1964; 22: 27-41.

26 Buchanan IB, Shaw WC, Richmond S, O'Brien KD, Andrews M. A comparison of the reliability and validity of the PAR Index and Summer's Occlusal Index. Eur J Orthod 1993; 15: 27-31.

27 World Health Organization. Oral health care systems. An international collaborative study. London. Quintessence Publishing Company Ltd; 1985.

28 British Society for the Study of Orthodontics. Report of the special committee on orthodontic treatment of elementary school children and postgraduate orthodontic teaching. Transactions of the British Society for the Study of Orthodontics 1942. p. 114-120.

29 British Dental Association. Report of the Committee on Orthodontic Services. London. British Dental Association; 1954.

30 Haynes S, Orthodontic treatment need in English children aged 11-12 years. Br J Orthod 1973; 1: 9-12.

31 Downer MC. Craniofacial Anomalies - are they a public health problem? Int Dent J 1987; 37: 193-196.

32 Foster TD. Orthodontic surveys - A critical appraisal. Br J Orthod 1980; 7: 59-63.

33 Federation Dentaire Internationale. Global Goals for Oral Health in the year 2000. Int Dent J 1982; 32: 74.

34 Linge L. The role of the general practitioner and the orthodontist in the provision of orthodontic care. Int Dent J 1987; 37: 86-90.

35 Angle EH. Classification of malocclusion. Dent Cosmos 1899; 41: 248-64.

36 Björk A, Krebs A, Solow B. A method for the epidemiological registration of malocclusion. Acta Odont Scand 1964; 22: 27-41.

37 Baume LJ, Horowitz HS, Summers CJ, Backer Dirks O, Brown WA, Carlos JP, *et al*. A method of examining occlusal traits developed by the FDI commission on classification and statistics for oral conditions (COCSTOC). Int Dent J 1973; 23: 530-7.

38 Summers CJ. A system for identifying and scoring occlusal disorders. Am J Orthod 1971; 59: 552-67.

39 Lau D, Griffiths G, Shaw WC. Reproducibility of an index for recording the alignment of individual teeth. Br J Orthod 1984; 11: 80-4.

40 Little RM. The irregularity index. Am J Orthod 1975; 69: 554-63.

41 Draker HL. Handicapping labio-lingual deviations: a proposed index for public health purposes. Am J Orthod 1960; 46: 295-305.

42 Grainger RM. Orthodontic treatment priority index. PHS publication no 1000, Series 2, No 25. Washington: US Government Printing Office, 1967.

43 Salzmann JA. Handicapping malocclusion assessment to establish treatment priority. Am J Orthod 1968; 54: 749-65.

44 Cons NC, Jenny K, Kohout FJ. DAI: the Dental Aesthetic Index. Iowa: College of Dentistry, University of Iowa, 1986.

45 Linder-Aronson S. Orthodontics in the Swedish Public Dental Health system. Trans Eur Orthod Soc 1974; 233-40.

46 Espeland LV, Ivarssoon K, Stenvik A. A new Norwegian index of orthodontic treatment need related to orthodontic concern among 11-year-olds and their parents. Community Dent Oral Epidemiol 1992; 20: 274-279.

47 Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod 1989; 309-20.

48 Berg R, Fredlund A. Evaluation of orthodontic treatment results. Eur J Orthod 1981; 1: 55-68.

49 Eismann D. Reliable assessment of morphological changes results of orthodontic treatment. Eur J Orthod 1980; 2: 19-25.

50 Gottlieb EL. Grading your orthodontic treatment results. J Clin Orthod 1975; 9: 156-61.

51 Richmond S, Shaw WC, O'Brein KD, Buchanan IB, Jones R, Stephens CD, *et al*. The development of the PAR Index (Peer Assessment Rating): reliability and validity. Eur J Orthod 1992; 14: 125-140.

52 Daniels C, Richmond S. The development of the Index of Complexity, Outcome and Need (ICON). J of Orthod 2000; 27: 149-162.

53 Sticker G. Psychological issues pertaining to malocclusion. Am J Orthod 1970; 58: 276-83.

54 Jenny J. A social perspective on need and demand for orthodontic treatment. Int Dent J 1975; 25: 248-56.

55 Adams GR. Physical attractiveness, personality and social reactions to peer pressure. J Psycho 1977; 96: 287-96.

56 Baldwin DC. Appearance and aesthetics in oral health. Community Dent Oral Epidemiol 1980; 8: 244-56.

57 Greene JC. Summary of the conference. International Conference on the Epidemiologic Assessment of Dentofacial Anomalies. Int Dent J 1970; 20: 654-6.

58 Federation Dentaire Internationale, Commission on Classification and Statistics for Oral Conditions. Who needs and who wants orthodontic treatment? London: Federation Dentaire Internationale; 1975.

59 Cohen LK, Jago OJD. Toward the formulation of socio-dental indicators. Int J Health Serv 1976; 6: 681-98.

60 Burt BA. Methods for assessing the distribution of oral diseases. In: Striffler DF, Young WO, Burt BA, eds. Dentistry, dental practice and the community. 3rd Ed. Philadelphia: WB Saunders; 1983. p. 75-114.

61 Helm S. Epidemiology and public health aspects of malocclusion. J Dent Res Spec 1977; 56: 27-31.

62 Brook PH, Shaw WC. The development of an index of orthodontic treatment priority. Eur J Orthod 1989; 11: 309-20.

63 Stricker G, Clifford E, Cohen LK, Giddon DB, Meskin LH, Evans CA. Psychosocial aspects of craniofacial disfigurement. Am J Orthod 1979; 76: 410-22.

64 Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. Aust Dent J 1996; 41(1): 43-6.

65 World Health Organisation. Oral Health Surveys, Basic Methods. 4th ed. Geneva: World Health Organisation; 1997. p. 47.

66 Johnson M, Harkness M, Prevalence of malocclusion and orthodontic treatment need in 10-year-old New Zealand children. Aust Orthod J 2000; 16 (1): 1-8.

67 Abdullah MS, Rock WP, Assessment of orthodontic treatment need in 5,112 Malaysian children using the IOTN and DAI indices. Community Dent Health 2001 Dec; 18(4): 242-8.

68 Esa R, Razak IA, Allister JH, Epidemiology of malocclusion and orthodontic treatment need of 12-13-year-old Malaysian school children. Community Dent Health 2001; 18(1): 31-6.

69 Chi J, Johnson M, Harkness M. Age changes in orthodontic treatment need: a longitudinal study of 10- and 13-year-old children, using the Dental Aesthetic Index. Aust Orthod J 2000; 16(3): 150-6

70 Estioko LJ, Wright FA, Morgan MV. Orthodontic treatment need of secondary school children in Heidelberg, Victoria: an epidemiologic study using the Dental Aesthetic Index. Community Dent Health 1994; 11(3): 147-51.

71 Otuyemi OD, Ogunyinka A, Dosumu O, Cons NC, Jenny J, Malocclusion and orthodontic treatment need of secondary school students in Nigeria according to the dental aesthetic index (DAI). Int Dent J 1999; 49(4): 203-10.

72 Ansai T, Miyazaki H, Katoh Y, Yamashita Y, Takehara T, Jenny J, *et al.* Prevalence of malocclusion in high school students in Japan according to the Dental Aesthetic Index. Community Dent Oral Epidemiol 1993; 21(5): 303-5.

73 Jacobson A. Occlusion and malocclusion in the South African Bantu. J Dent Assoc S Afr 1967; 22: 300-307.

74 Zietsman ST. Orthodontic treatment needs in Southern Africa. J Dent Assoc S Afr (Special Health Year Issue) 1979; 34: 689-690.

75 Hirschowitz AS, Rashid SAA, Cleaton-Jones PE. Dental caries, gingival health and malocclusion in 12-year-old urban Black school children from Soweto, Johannesburg. Community Dent Oral Epidemiol 1981; 9: 87-90.

76 Van Wyk PJ, du Plessis LS, Snyman WD. The need for orthodontic treatment in the Coloured community in Pretoria. J of Dent Res 1985; 64: 781 (Abstract).

77 De Mûelenaere JJGG, Viljoen WP. The occlusal status of a non-westernised rural community in the Tshikundamalema area of Venda. J Dent Assoc S Afr 1987; 42: 143-146.

78 Rossouw LM, Hodge M, de Vries J, du Plessis JB, Gugushe TS, Giles D. Project Swaziland (Part 1): Development of oral health services – Study methodology and summary of results. J Dent Assoc S Afr 1993; 48: 501-515.

79 Volschenk H, Briedenhann SJ, Cumber E. Rossouw LM. The occlusal status of 12-year-old Swazi children. J Dent Assoc S Afr 1993; 48: 512-515

80 Ackerman and Wiltshire (1994) The occlusal status of disabled children. J Dent Assoc S Afr 1994; 49(9): 447-51.

81 Department of National Health and Population Development. Health trends in South Africa. Pretoria: Government Printer; 1992.

82 Republic of South Africa. The Constitution of the Republic of South Africa 1996 (Act 108 of 1996). Available from: http//www.gov.za/constitution.

83 Proffit WR. Contemporary orthodontics. Third edition. St Louis: Mosby; 2000.

84 Otuyemi OD, Jones SP. Methods of assessing and grading malocclusion: A review. Aust Orthod J 1995; 14: 21-27.

85 Summers CJ. Some effects of developmental changes on the indices of malocclusion. J Public Health Dent 1966: 26: 212-220.

86 McLain JB, Proffit WR. Oral health status in the United States: Prevalence of Malocclusion. J Dent Educ 1985; 49: 386-396.

87 Tarvit DJ, Freer TJ. Assessing malocclusion: The time factor. Br J Orthod 1998; 25: 31-34.

88 Jenny J, Cons NC, Kohout FJ, Jakobsen J. Predicting handicapping malocclusion using the Dental Aesthetic Index. Int Dent J 1993; 43: 128-132.

89 Kelley JS, Harvey CR. Kelley JS, Harvey CR. An assessment of the occlusion of the teeth of youths 12-17 years. United States Public Health Service. Vital Health Stat 1 1977; Series 11(162): 1-65.

90. Proffit WR, Fields HW, Moray LJ. Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES-III survey, Int J Adult Orthod Orthogn Surg 1998; 13: 97-106.

91 Lundstrom A. Changes in crowding and spacing of the teeth with age. Dent Pract (Bristol) 1969; 19: 218-224.

92 Moyers RE. Handbook of Orthodontics. Third edition. Chicago: Yearbook Medical Publishers; 1972. p. 188-192.

93 Van Beek H, Fidler VJ. An experimental study of the effect of functional occlusion on mesial tooth migration in macaque monkeys. Arch Oral Biol 1977; 22: 269-271.

94 Steigman S, Weissberg Y. Spaced Dentition: An Epidemiologic Study. Angle Orthod 1985; 55(2): 167-176.

95 Hemley S. A Text on Orthodontics. Washington DC: Corner Publications Ltd; 1971. p. 20-30, 38, 121, 142, 169, 176, 388-390.

96 Hashim Nainar SM, Gnanasundaram N. Incidence and etiology of midline diastema in a population in South India (Madras). Angle Orthod 1988; 59(4): 277-282.

97 Keene HJ. Distribution of diastemas in the dentition of man. Am J Phys Anthropol 1963; 21: 427-441.

98 Edwards JG. The diastema, the frenum, the frenectomy: a clinical study. Am J Orthod. 1977; 71(5): 489-508.

99 Horowitz HS. A study of occlusal relations in 10 to 12 year old Caucasian and Negro children. Int Dent J 1970; 20: 593.

100 Richardson ER, Malhotra SK, Henry M, Little RG, Coleman HT. Biracial study of the maxillary midline diastema. Angle Orthod 1973; 43: 438.

101 Brunelle JA, Bhat M, Lipton JA. Prevalence and distribution of selected occlusal characteristics in the US population, 1988-91. Dent Res 1996; 75: 706-713.

102 Kaimenyi JT. Occurrence of midline diastema and frenum attachments amounts school children in Nairobi, Kenya. Indian J Dent Res 1998; 9(2): 67-71.

103 McVay TJ, Latta GH. Incidence of the maxillary midline diastema in adults. J Prosthet Dent 1984; 52(6): 809-811.

104 Lindsey D. The upper midline space and its relation to the labial frenum in children and adults. Br Dent J 1977; 143: 327.

105 Garner LD, Butt MH. Malocclusion in Black Americans and Nyeri Kenyans: An Epidemiologic Study. Angle Orthod 1985; 55(2): 139-146.