THE PREVALENCE OF OCCLUSAL TRAITS IN A SELECTED WESTERN CAPE POPULATION

BY

JOOLAM KAKA

Promoted by: Professor M.H. Moola - HEAD OF DEPARTMENT COMMUNITY DENTISTRY, UNIVERSITY OF THE WESTERN CAPE

Co-promoted by:
1. Dr. M. Ferguson - CONSULTANT ORTHODONTIST UNIVERSITY OF THE WESTERN CAPE ORAL HEALTH CENTRE, MITCHELL'S PLAIN
2. Dr. Neil Myburg - SENIOR LECTURER DEPARTMENT OF COMMUNITY DENTISTRY, UNIVERSITY OF THE WESTERN CAPE ORAL HEALTH CENTRE, MITCHELL'S PLAIN

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DECLARATION

I, ... declare that "THE PREVALENCE OF OCCLUSAL TRAITS IN A SELECTED WESTERN CAPE POPULATION" is my own work and that all the sources I have quoted have been indicated and acknowledged by means of references.

SIGNED:..........................

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DEDICATION

I dedicate this thesis to my parents who made possible my education, and the consulting orthodontists through whose commitment an orthodontic programme is possible at the University of the Western Cape:

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ABSTRACT

State funded programmes are essential to provide a treatment for the dentally handicapped. To address this need a study was undertaken under the auspices of the Orthodontic Department of the University of the Western Cape to assess the orthodontic needs of children in the Western Cape. The purpose of this study was to determine the occlusal traits of Indian children in the Western Cape and to compare them with samples internationally.

The sample consisted of 355 children, 12-14 years old, from schools administered by the House of Delegates. They were examined and recorded according to the methods set out by Baume et al. (1973), and Angle's Classification (1899) with the Dewey-Anderson (1919 and 1960) and El-Mangoury and Mustafa (1991) modifications.

The results of this study showed that bilateral molar relationships were: normal in 72.9%; mesial in 5.8% and distal in 15.5% of the children examined. The remaining had an asymmetrical molar relationship (5.8%). The upper incisal area was found to be the most crowded area in the mouth followed by the lower incisal area. Anterior crowding was present in 58.2% and spacing in 12.7% of the sample. The mean overjet was 2.7mm and the mean overbite 2.1mm. In the posterior segments, openbites accounted for approximately 6.5% and crossbites for 8.3%

On the basis of Angle's Classification it was found that 17.1% had a normal occlusion and 54.9% an Angles Class I malocclusion, 16.9% an Angle's Class II malocclusion and 5.5% an Angle's Class III malocclusion. 5.6% of the candidates had an asymmetrical molar relationship. In comparison to other population groups the results suggest that the incidence of some occlusal traits of this Western Cape sample was similar to that of other population groups while some traits were more prevalent. The pattern of the distribution of Angles Classification was also similar to that reported in studies done elsewhere.

OPSOMMING

Staatsbefondse programme is noodsaaklik vir die behandeling van tandheelkundige gestremdes. Om in hierdie behoefte te voldoen het die Universiteit van Wes-Kaapland dit onderneem om die ortodontiese behoeftes van kinders in die Wes Kaapland vas te stel.

Die doel van hierdie ondersoek was om occlusale toestande van Indiese kinders in die Wes Kaap vas te stel en dit te vergelyk met internationale monsters. Hierdie monster het bestaan uit 355 kinders, 12-14 jareges afkomstig van skole geadministreed deur die Raad van Afgevaardigdes. Hulle is ondersoek en ingedeel volgens die metodes soos bepaal deur Baume et al. (1973) en die Angles Klassifikasie (1899) met die Dewey-Anderson (1919 en 1960) en die El-Mangoury en Mustafa (1991) modifikasies.

Die resultate van hierdie ondersoek het getoon dat bilaterale molêre verwantskap as volg was normaal in 72.9%; mesiaal in 5.8% en distaal in 15.3%, van die kinders wat ondersoek was. Die oorblywendes (5.8%) het 'n asimetriese molêre verwantskap gehad. Die boonste snytand area is as die mees verdugte area in die mond gevind, gevolg deur die onderste snytand area. Verdugting in die anterior area was in 58.2% en spasiëring in 12.7% van die monster teenwoordig. Die gemidelde voorbyt was 2.6mm en die gemidelde oorbyt was 2.1mm. In die agterste segment het nagenoeg 6.5% oopbyt gevalle voorgekom en 8.3% kruisbyt gevalle. Op die basis van Angles klassifikasie is gevind dat 17.1% normale okklusies was, in 54.9% 'n Angle Klas

I wanokklusie 16.9% 'n Angles Klas II wanokklusie, en 5.5% 'n Angle Klas III wanokklusie.

In vergelyking met ander bevolkingsgroepe het die resultate getoon dat sommige okklusale toestande van hierdie Wes Kaapse toets groep dieselfde was as sommige bevolkingsroepe terwyl ander toestande meer voorgekom het. Die patroon van die verspryding van Angles Klassifikasie was ook dieselfde as dié van studies wat elders gedoen is.

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1. INTRODUCTION

People have experienced crowded, irregular and protruding teeth since antiquity and there have been attempts to correct this disorder since 1000 B.C. (Proffit, et al., 1993). Corrucini and Pacciani (1989) state that ancient Greek and Etruscan material provide evidence of the existence of well designed orthodontic appliances.

The modern-day prevalence of malocclusion, when compared with skeletal remains, is several times greater than it was 1000 years ago. Severe crowding and malalignment of teeth was unusual until relatively recently (Wolpoff, 1980).

Protruding, irregular or maloccluded teeth can produce a variety of deleterious effects on the social well-being of the individual. Studies (Bezroukar et al., 1979) have shown that psycho-social problems can arise in relation to impaired dentofacial aesthetics and that it may be associated with poor oral function. This is one argument in favour of providing an adequate orthodontic service for any community. To address this need a sound knowledge of the prevalence of malocclusion is of paramount importance. Salzman (1969) stated that the epidemiologic determination of a disease is the first step in public health endeavours. Mecklenburg (1990) emphasized the need to know about sub-population variations in oral health as the basis for devising an appropriate oral health service. Jago (1974) identified the following reasons for the accurate measurement of occlusal traits: (a) to group patients in order of orthodontic treatment priority; (b) to plan for the training of adequate human resources to meet both the actual and potential demand for such treatment and (c) to complement existing data on other facets of the craniofacial complex. It is anticipated that the information obtained in this study will be utilised in a similar way.

Industrialised Western society is characterized by highly variable dental occlusion and a high prevalence of malocclusion (Corruccini and Lee, 1984). Approximately 54% of American youths, for instance, show occlusion for which orthodontic treatment is rated necessary or desirable (Kelley and Harvey, 1977). Zietsman (1979) reported that 51% of 14-year-old Indian children needed slight or no treatment at all, whilst 49% of the children needed orthodontic treatment. The 1992 National Oral Health Survey showed that 68.1% of Indian children presented with a good occlusion or slight malocclusion and needed no orthodontic correction. However 17.5% of the children needed definitive or urgent treatment and 14.5% of the children needed minor orthodontic treatment.

Epidemiologic studies on the incidence of malocclusion in particular populations date back to the early 1900's (Garner and Butt, 1985) and the literature indicates a variation in occlusal traits in different population groups (Björk and Helm, 1969; Horowitz, 1970; Baume and Marèchaux, 1974; Pickering and Vig, 1975; Helm et al., 1975; El-Mangoury and Mustafa, 1991).

This study will examine occlusal traits in South Africans of Indian origin. Apartheid legislation has until recently classified the South African Society into different population/ethnic groups (Whites, Coloureds, Indians and Blacks). These different groups were restricted to reside in particular geographic areas. One study has examined occlusal traits in this manner (Ferguson, 1988) and since no data is comprehensively available on the Indian population group in the Western Cape, it was decided to assess the occlusal traits in this community. This will add to the data-base of information on occlusal traits for the Western Cape population. Those responsible for the provision of oral health are also awaiting the findings of this study in order to assess and address the orthodontic treatment needs of this community. The study also examined issues pertinent to the assessment of occlusal traits such as occlusion and malocclusion. It also reviewed the different methods used to determine occlusal patterns in order to identify one such method that best suited this study.

2. REVIEW OF THE LITERATURE

2.1 Introduction

A variety of terms are utilised in malocclusion prevalence studies and it is important to review some of them, to gain clarity on the different terms used and to establish a uniformity in their definition. The most important of these definitions are "occlusion" and "malocclusion".

2.2 Debates and Definitions of Occlusion

The term occlusion is important to the study of orthodontics (Tulley and Houston, 1986) and fundamental to orthodontic diagnosis (Graber, 1985). Occlusion is certainly a theme common to most branches of dentistry, but the concepts of occlusion that are held by health workers in the different dental fields of dentistry are often different (Draker, 1960; Moyers, 1988). Summers (1971) appropriately described the situation by stating that the term occlusion is an "imprecise word generally used in an imprecise way". The Shorter Oxford Dictionary (1970) defines occlusion as "the act of closure or being closed". To this list can be added many other definitions of occlusion (Draker, 1960; Summers, 1971; Cohen, 1970; Cohen and Horowitz, 1970; Baume and Marèchaux, 1974; Jago, 1974; Shaw et al., 1975). Occlusal features occur in a wide panorama from the ideal to the severest of malalignment and appear in a continuum with no demarcations separating the varying degrees (Draker, 1960; Summers, 1971; Foster and Day, 1974; McLain and Proffit, 1985). The majority of epidemiologists accept that the concept of occlusion entails a wide variety of occlusal features.

Different investigators may give different interpretations to terms like ideal occlusion, normal occlusion and malocclusion (Summers, 1971; Ramfjord and Ash, 1983) and it is important that these terms be understood for the following reasons:

The concepts of ideal and normal occlusion are important to understand because deviation from them could be interpreted as an abnormality. The concept of malocclusion implies an abnormality and suggests treatment. Therefore, ideal occlusion, normal occlusion and malocclusion must be correctly defined. It is also important to define and differentiate ideal occlusion from normal occlusion because deviations from an ideal occlusion may not necessarily constitute occlusal disability.

2.2.1 Ideal occlusion

Classic work by Angle (1899 and 1907) and the relatively recent work of Andrews (1972) established criteria for the optimal (ideal) morphologic relationship of the human dentition. What Angle defined as normal occlusion is more appropriately considered the ideal occlusion especially when the criteria are applied strictly (Massler and Frankel, 1951; Altemus, 1959; Proffit et al., 1993). Other investigators maintain that the ideal functional occlusal type has rarely, if ever, been identified and has essentially eluded the dental profession (Draker and Allaway, 1960; Jacobson, 1967; Salzman, 1974; Farawana, 1987; Tipton and Rinchuse, 1991).

2.2.2 Normal occlusion

Fundamental to orthodontic diagnosis is understanding the concept of "normal occlusion" (Graber et al., 1985).

Unfortunately, there is no clear-cut or acceptable definition of "normal occlusion" thus, much of our diagnosis in orthodontics is based on this highly arbitrary concept of the ideal (Graber, et al., 1985).

Numerous definitions of normal occlusion exist. Some emphasise arch and tooth relationships (Massler and Frankel, 1951; Ramjord and Ash, 1971; Salzman, 1974) while other definitions of normal occlusion refer to it as "one that does not require orthodontic treatment" (WHO, 1962). Normal occlusion has also been broadly categorized into attritional (Begg, 1938), static (Angle, 1899; Stoller, 1954; Ackerman and Proffit, 1969; Andrews, 1972) and biometric occlusions (Dempster, et al., 1963; Baume and Maréchaux, 1974). These concepts will be examined briefly later. Lombardi (1982) states that credible and biologically valid definitions of normal occlusion and malocclusion are elusive, because of the complexity of the factors involved and he states further that a biologically valid concept of normal occlusion includes a range of variation in the relevant occlusal variables that is compatible with health and unimpaired function.

This understanding of occlusion is widely accepted and the concept of normal occlusion which will be adopted in this study.

The concepts of attritional, static and biometric occlusion are important to understand as they are often interpreted as synonymous with normal occlusion.

2.2.3 Attritional occlusion

Steadman (1937), Lombardi and Bailit (1972) and Evans et al. (1984) found that technologically primitive people have a better aligned dentition than do civilized populations. Begg (1938, 1954) together with several other authors (Campbell and Gray, 1936; Cran, 1960; Murphy, 1963; Begg and Kesling, 1977) after observing the extensive occlusal and interproximal wear of pre-literate man stated that it represented the true occlusion of man. Modern Australian Aboriginals (no longer exhibiting marked attrition) do not develop crowding (Corrucini, 1990) so that the concept of the normality of attritional occlusion therefore becomes questionable.

2.2.4 Static occlusion

In 1900 Angle stated that "the key to occlusion is the relative position of the first molars. In normal occlusion the mesio-buccal cusp of the upper first molar is received in the buccal groove of the lower first molars", thus laying down the first principle of static occlusion. Stoller (1954) and Andrews (1972) also established principles for static occlusion.

Cryer (1904) and Akapata and Jackson (1979) disagreed with the concepts of a static occlusion, emphasizing rather the dynamic nature of occlusion.

2.2.5 Biometric occlusion

Hellman (1921) and Simon (1926) first stressed the existence of a wide variation in occlusions in function and the non-existence of an ideal occlusion and thereby established the first principles of a biometric occlusion. The concept of biometric occlusion therefore implies a range of variation in tooth alignment and jaw relationships which are compatible with normal function and in the absence of disease (Hellman, 1921; Lombardi and Bailit, 1972; Lombardi, 1982, Katz, et al., 1990; Tipton and Rinchuse, 1991). Biometric occlusion refers specifically to occlusion during function and therefore differs from the concepts of normal occlusion accepted by epidemiologists (WHO, 1972).

The word "normal occlusion" implies variations around an average or mean value, whereas "ideal occlusion" connotes a hypothetical concept or goal. There is therefore a particular clinical difference between a "normal occlusion" and an "ideal occlusion" (Moyers, 1988). However, the word normal occlusion has been used for many years in orthodontics as a synonym for ideal. This has resulted in semantic and treatment difficulties.

2.3 Malocclusion

2.3.1 History of malocclusion

The first appearance of dental crowding in man was described by the anthropologist Tobias (1967), (Quoted by Dickson 1969) in the skull of the pre-historic man, "Zinjanthropus". Robinson (1956) (in Dickson 1969) examined the lower jaw of another of man's ancestors, Australopithicus robustus, and remarked on the lack of spaces in their dentition. Weidenresich (1945) (in Dickson, 1969) described the discovery of the remains of a group of Hominids in China and North and East Africa. The dental examination of these skulls have shown a wide variability in tooth size especially in the molar area. Anthropologic studies on malocclusion support the theory that disto-occlusion is a relatively recent feature. It was first shown in an Alemanic skull from the sixth century. Baume and Marèchaux (1974) stated that the latter skull showed features of racial intermixture. Until then, mesio-occlusion was the type most commonly observed (Tobias 1967). (Quoted in Dickson, 1969).

2.3.2 Debates and definition of malocclusion

Malocclusion has been reported in many different ways. The lack of an adequate definition of malocclusion is probably a major factor in the wide variation of its reported distribution. There is a wide divergence in the definition of malocclusion (Mills, 1966), which makes comparison with other studies difficult. It is important, therefore, to obtain some consensus on the definition of malocclusion not only to make comparisons with other studies manageable but also because it is central to this study.

Some definitions emphasise the importance of morphology and function (WHO, 1962; Salzman, 1968; Summers, 1971) while others maintain that other factors should also be taken into consideration such as the cultural norms of the individual and the body image and aesthetic values of individuals and groups (Jago, 1974; Prahl-Andersen, 1978). The definition of malocclusion is not one to be made by orthodontic clinicians or dental scientists alone. Explicitly or implicitly the person with the malocclusion has a role to play in its definition (Jago, 1974). This has important implications for epidemiological studies.

An appropriate definition of what constitutes a malocclusion is also constrained by the different reasons people give for their perception of the need for orthodontic treatment (Secord and Backman, 1959; Cohen, 1970; Moorrees, et al., 1971; Jago, 1974; Baume and Maréchaux, 1974; Shaw et al., 1975; Isaacson, 1983; Tulley and Houston, 1986; Downer, 1987).
It is clear that malocclusion is not a disease entity but a morphological variation which may or may not be associated with pathological conditions (Solow, 1970).

There are a wide variation of factors that have to be taken into consideration which therefore makes the definition of malocclusion vague (Draker, 1960; Summers, 1971; Lombardi, 1982).

It can be concluded that malocclusion encompasses all deviations of the teeth and jaws from normal alignment (Lombardi, 1982; Harris, 1975) and can involve soft tissue trauma, adverse personal appearance and interference with normal speech (Farawana, 1987). Furthermore social and psychological factors must also be taken into consideration (FDI, 1973).

Baume et al. (1973) have suggested that the term occlusal disorder be used as it indicates a variation in occlusion rather than malocclusion.

2.3.3 The epidemiology of malocclusion

Malocclusion is globally endemic although its prevalence varies widely in different communities (Akapata and Jackson, 1979; Lombardi, 1982). Many studies of the prevalence of various aspects of malocclusion have been published where different investigators have estimated different features of occlusal disharmony (Jago, 1974).

Some investigators have used different definitions and methods of measurements making comparisons between the studies difficult. (Salzman, 1968; Lombardi and Bailit, 1972; Jago, 1974; Infante, 1975; Lavelle, 1976; Zietsman, 1979; Steigman et al., 1983; Farawana, 1987). Others have used small samples and different age groups for reporting. However, Freer (1970) maintains that in spite of the many limitations, previous studies on the prevalence of malocclusion are important, because they collectively provide valuable information.

There are many factors which influence the variation of occlusal patterns both between different populations and within the same population (Dockerell, 1958; Jago, 1974; El-Mangoury and Mustafa, 1991). Jago (1974) developed a framework which categorized these factors under the headings of ethnicity, genetics and heredity, age, sex, geographical location, social stratum, diet and individual development history. This study will be describing the prevalence of different occlusal traits in a group of adolescents living under a certain set of political, social and particular geographical circumstances in South Africa. Richardson (1980) has said that a population group is viewed as an ethnic group if it came from the same community (social stratum) and lived in the same geographical area. The existence of a distinct community on a genetic basis cannot be justified. For this reason this literature review will specifically focus on the impact of ethnicity, age and sex upon occlusal patterns. Since caries is also considered to be an important determinant of malocclusion (Proffit et al., 1993), its role in influencing occlusal patterns will also be considered.

***(a) Ethnicity, race and population groups*:**

Racial classification for statistical data is a constant feature of publications in South Africa. The question of the necessity for racial classification of health statistics received considerable attention in the American literature (Nelson, 1970). However, the United Nations Demographic Yearbook does not provide separate data for different racial groups. Montagu (1974) has stated that the human "race" cannot be neatly divided into racial groups. In South Africa the population has been assigned at birth to a "population" group. Section (1) of The population Registration Act of 1950 as amended, lays down four basic definitions of these groups: Blacks, Coloureds, Asians and Whites. The Act also allows for people classified as Coloured/Black to be further sub-divided by proclamation into ethnic or other groups. This is a political classification and has no scientific bases in culture, ethnicity or genetics. As a result of the Group Areas Act each of these population groups (as defined by the government) were confined to live in specific residential areas each with their own infrastructure (including schools). This study will determine the occlusal traits of children from schools administered by the House of Delegates and its inhabitants classified as Indian. This classification is based only on a decree of Parliament and not on any genetic or cultural basis. The FDI has emphasized the need to establish a database of information on the occlusal conditions of all people worldwide (Baume et al., 1973). Such information is important, firstly, to ascertain the need and demand for orthodontic treatment in a given community so that appropriate arrangements could be made for the allocation of staff and financial resources (Stephens et al., 1985) and secondly, to help identify possible etiological factors which, if identified, could be used in a possible preventative programme. This study will provide information on occlusal traits in this part of the world.

Table 1 - OCCLUSAL VARIATION AMONG DIFFERENT ETHNIC GROUPS

Author	Date	Nationality	Sample Size	Sample Age	% Prevalences Malocclusion	% Prevalences Class I	% Prevalences Class II	% Prevalences Class III
Baume	1974	Polynesian	9854	3-60	a	a	10.0	5.5
El-Mangoury and Mustafa	1991	Egyptian	501	18-24	65.7b	33.3	21	10.6
Garner and Butt	1985	Black American	445	13-15	73b	44	16	8.7
Garner and Butt	1985	Kikuyu Kenyan	505	13-15	83.2b	51.7	7.9	16.8
Goose *et al*.	1957	British	2956	7-15	32.7	13.7	16.1	2.9
Grewe *et al*.	1968	Indian	651	9-15	65.5	53	9.6	2.9
Helm	1970	Danish	3842	6-18	78.5	49.7	24.5	4.3
Horowitz	1970	American	718	10-12	93.2	65.2	22.5	5.5
Ingervall	1974	Swedish	301c	18d	90	83	3	4
Laine and Hausen	1983	Finnish	451	17-51	a	a	15	5
Salzmann	1969	American	7514	12-17	100e	54	32	14
Siriwat and Jarabak	1985	American	500	8-12	100e	47.2	46.4	6.4
Solow and Helm	1969	Danish	275	f	72.8	37.4	34	1.4
Sputh	1980	American	455	14d	84.5	39.3	36.5	8.7
Wood	1971	Eskimo	100	11-20	82	64	8	10
Zietsman	1979	South African Black	119	12-14	45.4	33.6	7.6	4.2
Zietsman	1979	South African Coloured	51	14	60.8	52.9	3.9	3.9
Zietsman	1979	South African Indian	51	14	76.5	58.8	13.7	3.9
Zietsman	1979	South African White	490	14	76.7	47	24.5	1
Evans *et al*	1984	Lengua Indians	202	15-60	99.4	79.8	20.2	0

a No figures reported
b Malocclusion prevalence including Class IV
c Male sample only
d Only mean age reported (age range not reported
e Malocclusion sample only
f Children but age range not reported

ASSESSMENT OF ORTHODONTIC TREATMENT NEED

AUTHOR	YEAR	TREATMENT NEED	AGE RANGE	SAMPLE SIZE	NATIONALITY
SCLARE	1945	>40%	NOT GIVEN	NOT GIVEN	BRITISH
JACKSON	1952	>40%	NOT GIVEN	NOT GIVEN	BRITISH
GARDNER	1955	>40%	NOT GIVEN	NOT GIVEN	BRITISH
GOOSE ET AL.	1957	>40%	NOT GIVEN	NOT GIVEN	BRITISH
WALTER (cited by FOSTER and DAY)	1963	>40%	NOT GIVEN	NOT GIVEN	BRITISH
FOSTER and DAY	1973	>40%	NOT GIVEN	NOT GIVEN	BRITISH
INGERVALL SEEMAN and THILANDER (citing HEIKENHEIMO)	1978	75%	10 YR OLD	NOT GIVEN	SWEDISH
HAYNES	1972	70%	11-12 YRS	566	ENGLISH
ZIETSMAN	1979	25%	12-14 YRS	119	BLACK SOUTH AFRICANS (URBAN)
ZIETSMAN	1979	47%	14 YRS	51	COLOURED SOUTH AFRICANS
ZIETSMAN	1979	49%	14 YRS	51	INDIAN SOUTH AFRICANS
ZIETSMAN	1979	63%	14 YRS	63	WHITE SOUTH AFRICANS
KOTZE, MIZRAHI & ZIETSMAN	1982	78%	11-12 YRS	NOT GIVEN	WHITE SOUTH AFRICANS
HILL	1992	>60%	09-15 YRS	NOT GIVEN	BRITISH
SWANEPOEL	1984	30%	NOT GIVEN	NOT GIVEN	BLACK SOUTH AFRICANS
VAN WYK ET AL.	1984	44%	NOT GIVEN	NOT GIVEN	COLOURED SOUTH AFRICANS
DE MUELENARE and VILJOEN	1987	17%	NOT GIVEN	171	RURAL BLACK SOUTH AFRICANS
DE MUELENARE ET AL.	1992	28%	NOT GIVEN	171	RURAL BLACK SOUTH AFRICANS

Table 2

Kerouso <u>et al</u>. (1992) emphasized the variation in occlusal characteristics and occlusal anomalies in different population groups. The determination of occlusal patterns in different communities is a major focus of research and health care planning and plays a critical role in the search for etiologic factors (Corrucini, 1984).

Although the controversy concerning the influence that heredity and environment have on occlusion and malocclusion has not been fully resolved, it is an accepted principle that different communities express different occlusal traits (Smith and Bailitt, 1977; Harris, 1975; Harris and Smith, 1980; Corrucini and Potter, 1980; Corrucini, 1984; Lundstrom, 1984; Proffit, 1986; Björk and Helm, 1969; Horowitz, 1970; Baume and Marèchaux, 1974; Ingervall and Hedegaard, 1975; Akapata and Jackson, 1979; El-Mangoury and Mustafa, 1991). That these differences are an indication of the different genetic background is now largely discredited (Foster, 1942; Dockerell, 1958; Altemus, 1959; Emrich <u>et al</u>., 1965; Wood, 1971; Jago, 1974; Smith and Bailitt, 1977; Corrucini and Potter, 1980; Corrucini, 1984).

Table 1 summarises the prevalence of malocclusion among different population groups, based on Angle's classification. Table 2 indicates the orthodontic treatment needs in different population groups. The wide distribution of these two variables amongst the various population groups is clearly demonstrated.

Some studies have shown a difference in occlusal patterns between children of Indian descent and other population groups (Kapila, 1983).

This study will assess the occlusal traits of Indian children. (see Appendix 1B). This will contribute to the database of occlusal traits in the Western Cape.

***(b) Age*:**

Most of the studies reviewed on occlusal traits consider subjects in the age group 12-14 years. The reason is that it is normally the age at which people seek orthodontic treatment and when all the permanent teeth from first molar to first molar are present. The full extent of the malocclusion or occlusal trait can be easily assessed and it is the period just before the adolescent growth spurt. This study examines 12-14 year old subjects for similar reasons. Some investigators have shown an increase in the prevalence of malocclusion with age (Helm, 1970; Myllarniemi, 1970; Richardson and Ana, 1973; Ingervall, 1974; Helm et al., 1975; Smith and Bailit, 1977; Jarvinen, 1981), while others have not reported such findings. Moore (1940), Gardiner (1956), Knutson (1965), Goose, Thomson and Winter (1957).

In 1974 Baume and Marèchaux did an extensive study on the Filipinos and found a decreased frequency with age, while Akapata and Jackson (1979) in their study in Lagos found no difference in the overjet values of their sample at the age intervals of 15, 19, 20 and 21 years. These reports are contradictory and it is therefore, concluded that age is not a reliable factor in determining malocclusion (Helm, 1968).

***(c) Sex differences*:**

Some investigators have shown a difference between boys and girls in the prevalence of malocclusion (Seipel, 1946; Altemus, 1959; Emrich et al., 1965; Helm, 1968; Richardson, et al., 1973; Magnusson, 1976). Recently El-Mangoury and Mustafa (1991) and Holmes (1992) showed a significant sex difference in their prevalence studies.

However, other investigators report little or no difference between boys and girls in the prevalence of malocclusion (Humphreys and Leighton, 1950; Goose, Thompson and Winter, 1957; Miller and Hobson, 1961; Akapata and Jackson, 1979; Smith and Bailit, 1977; Laine and Hausen, 1983; De Muñiz, 1986; Keruso et al., 1988).

The relationship between gender and malocclusion is therefore controversial and inconclusive.

This study will examine the statistical significance of differences in occlusal traits between the males and females in the present sample to determine whether or not there is a gender difference. If no gender difference is statistically found the data will be pooled.

***(d) Caries*:**

The recent National Oral Health Survey (1991) shows that the mean caries experience of 12 year old South African Indians was 1.33 and that of 15 year olds of the same population group was almost double (2.54). The missing component of the DMFD was 0.11, the decayed component 0.88 and the filled component 0.34. As the missing component was low, caries may therefore not be an important factor influencing occlusal patterns in the Indian community. The DMFT of 6 year old Indian children was found to be 0.10, of which 0.06 was the decayed, 0.03 the missing and the 0.01 the filled components of the DMFT. When we compare the mean caries experience of the South African Indians to the WHO goals of DMFT by the year 2000, it will be found to be well within those objectives. In relation to the geographical location of the sample, it is recognized that this study was confined to the metropolitan areas and may be a true indication of caries prevalence as 90% of the Indians live in the four major metropolitan areas.

The most important cause of localised malocclusion is undoubtedly dental caries (Moyers, 1988). Northway (1977) (in Moyers 1988) has shown that the space occupied by the primary molars closes when primary teeth are lost due to dental caries. Many studies have found a close relationship between the early loss of deciduous teeth and malocclusion (Clinch and Healy, 1959; Salzman, 1938, Lundstrom, 1955; Breakspear, 1951; Fanning, 1962; Owen, 1971; Ronnerman and Thilander, 1977; Magnússon, 1979). The premature loss of deciduous teeth has more serious consequences in children in whom crowding already exists (Clinch and Healy, 1959; Linder Aranson, 1960).

Some authors maintain that there is no agreement in the literature establishing the amount of dental malocclusion stemming from the early loss of tooth material (Hill, Blayney and Wolf, 1959; Davies, 1991).

However, most of the evidence indicates that the early loss of deciduous teeth is an important contributor to the etiology of malocclusion. Dental caries may therefore be a significant factor to consider in assessing occlusal patterns.

(i) **Factors important in the desire for orthodontic treatment**: Professional counselling in orthodontic treatment is usually based on consideration of both psychologic (Bezroukor et al., 1979) and aesthetic implications of malocclusion. Among the lay public, appearance seems to be the primary motivation for treatment. The need for orthodontic treatment as perceived by the public depends on current socio-cultural norms for appearance and on a variety of complex psychosocial factors (Stricker, 1970). The importance of dental appearance in society's perceptions of facial attractiveness has been demonstrated in children as well as adults (Secord and Backman, 1959; Linn, 1966; Cohen and Horowitz, 1970; Shaw, 1981).
In addition to social pressures (Lewit and Virolainen, 1968) self-perception of dental appearance may be an important psychological factor in the individual's desire for

orthodontic treatment (Albino, 1981). Helm et al. (1977) did a longitudinal study from childhood to adulthood on the long term psychosocial effects of malocclusion in Danish subjects and they concluded that certain malocclusions, especially conspicuous occlusal and space anomalies, may adversely affect body image and self-concept, not only during adolescence, but also in adulthood. The psychosocial aspect of malocclusion may therefore be an important factor in stimulating desire for orthodontic treatment.

2.3.4 Measurements of malocclusion or occlusal traits

The epidemiologic determination of a disease is the first step in public health endeavour (Salzmann, 1969) and it should form the research arm of public health providing the scientific basis upon which public health policy decisions are made (Katzenellenbogen et al., 1991). Epidemiologic studies continue to be the first public health actions required in pursuing emerging diseases, disorders and epidemics as well as in monitoring trends for the nation and subpopulation. Most importantly, the study of the distribution of diseases in the population and their associated risk factors provides the basis for the development and implementation of public health initiatives.

The fundamental task in epidemiologic research is therefore to quantify the occurrence of illness. The goal is to evaluate hypotheses about the causation of illness and its sequelae and more importantly to establish treatment needs for a population group.

The importance of the epidemiological determination of occlusal patterns among different population groups therefore becomes apparent.

Dental epidemiologist have since Angle (1899) attempted to measure malocclusion in individuals and express the prevalence rates in populations. Epidemiologists have had difficulty in arriving at a common basis for the measurement of malocclusion, hence the very wide and disparate collection of information. The FDI (1973) and the WHO attempted to look at various occlusal traits and to measure these variations (Jago, 1974).

(a) Basic principles for the epidemiological determination of occlusion:

Foster and Menezes (1976) and Jago (1974) stated that the assessment of occlusion for public health purposes has two main objectives. The first is to screen the population for individual treatment need and priority. The second is to obtain information for the planning of resources and facilities for orthodontic treatment.

Numerous epidemiological studies on occlusion and malocclusion exist where different methods of assessment were utilised. For these studies to be valid certain principles must be identified. The method used must define the extent of the problem (Summers, 1971). To achieve this it should be simple, accurate, reliable, reproducible and should be objective in nature. An "index of malocclusion" or an "index of the need for treatment" could be subjective because it is difficult to establish meaningful cut-off points to distinguish those who require care from those who do not. The FDI in 1973 emphasised the need to adopt a uniform method of occlusal assessment that will be easy to apply and one not based on treatment need. The Federation has recommended the measurement of occlusal traits.

The literature shows that the combination of occlusion and the position of the teeth is the observable end result of all the aetiological factors which produce these relationships. Therefore it is possible to divide occlusion into its component parts which could be measured accurately (Foster and Day, 1976; Gravely and Johnson, 1974). To do this the occlusal features measured are usually divided into intra-arch, interarch and the more unusual individual features. The intra-arch features measured are deviations of individual teeth from the ideal arch form, the interarch features include assessment of overjet, overbite, openbite and the antero-posterior relationship of the arches. Other miscellaneous features that must also be considered are hypodontia (all the indices except those of Van Kirk and Pennel (1959) and Draker (1960) assess the occurrence of hypodontia) and the number of missing teeth. However, for hypodontia to be measured accurately in the developing dentition radiographs are necessary, which is impractical in community studies. The assessment of occlusal features is the most satisfactory aspect of the indices which have been developed for community studies and a wide variety of occlusal indices have been established to meet various needs. Some of these indices will be briefly reviewed in order to identify one that will meet the needs of this study.

***(b) Occlusal indices*:**

These different indices can be broadly classified according to specific attributes that describe their application (Haeger et al., 1992), (Table 3).

METHODS OF OCCLUSAL ASSESSMENT

TYPE OF INDEX	AUTHORS
Simple methods for assessment of "normal" and "abnormal" occlusion	Angle's classification (1907) Angle's (1907) and Dewey-Anderson modification (1919) & (1960) Angle's classification with Dewey-Anderson and El-Mangoury and Mustafa modifications (1991)
Assessment of malocclusion prevalence	Massler and Frankel (1951) Van Kirk and Pennel (1959)
Assessment of malocclusion in terms of severity	Draker (1960) Grainger (1961) Summers index (1971) Salzman (Malocclusion Severity Assessment 1967)
Treatment priority index	Salzman (Handicapping Malocclusion Assessment to establish treatment priority 1967) Brooke and Shaw (Index of Orthodontic Treatment Need 1989)
Assessment of occlusal traits	Baume et al. (1973) (FDI method of measuring occlusal traits)
Index for the evaluation of completed orthodontic cases	Berg and Fredlund (1981) Durbin and Sadowsky (1986) Haeger et al. (1992)

Table 3

Most of the methods of occlusal assessment were based on Angles designation of "normal" and "abnormal" occlusion. Some methods of occlusal assessment (Hellman, 1921) also include a designation of the relationships of the anterior segments. There are various modifications to this classification, e.g. the Dewey-Anderson modification (1919-1960) and the more recent method explained by El-Mangoury and Mustafa (1991). Angle's system is widely used and the principles will therefore be applied in this study to make comparisons with other studies easier. However, a modification of the Angle classification will be used instead. Sclare (1945) and Moore (1940) both felt that from the public health point of view the problem resolved itself into a question of how much orthodontic treatment was needed in a given group of individuals. Massler and Frankel (1951) and Van Kirk and Pennel (1959) developed an index which looked at individual teeth and not at interarch relationships. This index examines the position of individual teeth in an arch, i.e. rotations, inclinations and its relationship to the teeth next to it, but does not consider the relationship of the teeth in one arch to that of teeth in another arch. The Angle classification, therefore, is superior to the Massler and Frankel (1951) method as it assesses the interarch relationships of teeth in occlusion. The modifications by El-Mangoury and Mustafa (1991) further categorises each of the Angle classes of malocclusion. This makes it possible:

1. To place each type of malocclusion into a more descriptive category.

2. To identify the component of the dentition that may be at fault.

This modification of Angle classification has been found to be the most refined and descriptive of the Angle classification to date and it was thus decided to use it in this study.

In 1960, Draker proposed the Handicapping Labio-lingual Deviation Index (HLD). This was the first orthodontic index designed to meet the administrative needs of programme plans. This represented an advance from existing indices, because it took into consideration the total dental arch as well as the individual tooth. He believed that the index measured physical factors associated with dental disfigurement which could affect the social acceptance of an individual in school or on the job.

In 1961 a new index, The Treatment Priority Index (TPI) by Grainger introduced a new level of sophistication. The TPI was designed to eliminate the arbitrary nature of earlier indices. It utilized a weighted scale based on data established on a trial population to assign numerical values to the various occlusal features. The TPI used a method of weighting certain features and was therefore not very favourable, because of its subjective nature.

In 1966 Summers recommended the use of his Occlusal Index (OI) for scoring occlusal abnormalities in epidemiological studies. The Summers index is widely used. Reasons for this usage include greater reproducibility, more objectivity and less intra- and inter-examiner variability (De Muelenaere et al., 1992). In the Summers system, the observed occlusal problems are grouped together, given values and calculated to give the degree of malocclusion. Recently, Summers index has also been used to evaluate completed orthodontic cases to determine the quality of treatment received by the patient (Pickering and Vig, 1975; Elderton and Clark, 1983).

The first popular index to attempt to measure the aesthetic factor objectively was the Eastman Aesthetic Index (EEI) by Howitt, Stricker and Henderson (1967). This index was a milestone, to determine the need for, or priority of, orthodontic treatment.

The Handicapping Malocclusion assessment record of Salzman (HMAR) (1967) incorporated most of the measurements of the earlier indices and organised the data in a compact form. Gray and Dermijin (1977) found that the HMAR did not perform as well as the TPI and occlusal index of Summers (1966). The HMAR is also more complicated and not easy to apply.

To circumvent subjectivity, the Fédération Dentaire Internationale (FDI) introduced in 1970 their method of measuring occlusal traits (MOT) (Baume et al., 1973). This MOT was recommended by the FDI Commission on Classification and Statistics for Oral Conditions (COCSTOC). The index recognises amongst other features the presence of supernumerary teeth and palatal impingement caused by excessive overbite of the lower incisors which other indices do not. It also allows for comparison to be made of individual traits between populations. According to McLain and Proffit (1985) the easiest way to investigate the prevalence of malocclusion is to divide the orthodontic problem into its morphological components. The FDI method examines different occlusal components. It assesses occlusal traits and not malocclusions or treatment needs. As malocclusion and treatment need are subjective the determination of occlusal trait will avoid such problems. The prevalence of different traits can be identified. For a public health programme this is advantageous as specific traits could be prioritised for treatment especially where funds and human resources are limited. Different occlusal patterns could also be more easily compared with those of other population groups, e.g. the prevalence of anterior crowding. The possible disadvantage of the FDI method is that it does not report on treatment need. It also does not consider aesthetics and lacks a method to determine the psychosocial impact of a particular trait on an individual.

In 1989, Brook and Shaw developed an Index of Orthodontic Treatment Needs (IOTN). This index was comprised of a dental health component and an aesthetic component.

In addition indices for the evaluation of completed orthodontic cases have also been designed (see Table 3, pp.26). To this list can be added various modifications and combinations of the existing indices.

i) Functions of indices:

One of the most important functions of the occlusal indices is to provide data which could be utilized to indicate treatment need and then establish programmes to meet these needs. The data is analyzed in different ways to fulfil this objective.

Assessment of need for treatment:

In most indices the summation of the scores is used to indicate need. Weighting of the occlusal features is done on the assumption that some deviations are more important than others in determining treatment needs. The HMAR (1967) doubles the score in the upper incisor segment. Grainger (1961) and Summers (1971) have complex systems of differential weighting for all the parameters involved. Draker (1960) also uses differential weighting by giving a numerical score to features assessed on a yes/no basis, and gives a different weighting to measurements recordable in millimetres.

It is apparent that these methods of determining need for treatment, while appearing objective by involving measurement and mathematics, are based on the subjective concept that deviations from ideals or norms require corrective treatment, and the greater the deviation the greater the need or treatment. The addition of weighting adds to the subjectivity. Compounding the problem, different indices give different weightings to the same features. This weighting is determined by the originator of the particular index and is therefore subjective as some indices give a greater weighting to features important to function while other add additional weight to features important for aesthetics. The added value of these weightings are summed up and the total obtained will categorize the patient into different levels of either those that need no treatment, that require minor treatment and those urgently in need of treatment (e.g. Summer's Index, 1971) Therefore it is evident that objective measures have not been devised and are not likely to be (Jago, 1974; Katz, 1978; Zietsman, 1979).

<u>Planning of resources for an orthodontic programme</u>:

With regard to the type of treatment required, the assessment methods of Grainger (1961) and Summers (1971) go some way toward providing this information by allocating the subjects into various syndromes of malocclusion according to the main deviation from the ideal. The aetiological factors, which are difficult to assess, need to be recorded as they have a bearing on the treatment. None of the available methods cater for recording the possible aetiology.

The determination of occlusal traits should therefore remain the prime objective. The combination of certain traits could determine treatment needs for specific situations, i.e. depending on what the community regards as important treatment indicators and the availability of resources.

ii) <u>A critical analysis of the indices</u>:

Ast, Carlos and Cons (1965) report that estimates of malocclusion among school age children warranting treatment range from 20% to 80%. The disagreement among the findings of reported surveys can be ascribed, they say, to the lack of precise measurement. The Angle classification has often been used but its subjectivity and the inability of others to convert the classification to numerical values for statistical manipulation have led to a search for a classification system having more objectivity and one which is readily reproducible by investigators interested in applying epidemiologic techniques to the malocclusion problem. Because of the confusion concerning the interpretation of Angle's writings, its use particularly in epidemiological studies will also remain in doubt (Rinchuse and Rinchuse, 1991). Unless epidemiological studies using the Angle's classification are carried out by the same examiner, different communities cannot easily be compared with each other (Gravely and Johnson 1974). However, Angles classification has been widely used in epidemiological studies and is important in comparing studies.

The inherent problem of the methods of Massler and Frankel (1951) and Van Kirk and Pennel (1959) was limited by their concept that the unit of occlusion was a single tooth. As stated before this index only looked at the position of a single tooth, i.e. its alignment and relationship to neigbouring teeth and not to teeth in another arch. Many indices of malocclusion have been proposed for the qualitative or numerical assessment of the occlusal status of individuals (Draker, 1960; Grainger, 1961; Howitt, Stricker and Henderson, 1967; Salzman, 1967; Summers, 1966). However, Freer (1972) states that no index can measure the overall effects of a particular malocclusion on a particular individual. This is so, because the indices are based on the clinician's concepts of the effects of malocclusion on oral health and facial appearance. Since indices measure the clinician's concepts of the magnitude of any departure from normality, Freer (1972) concludes that none of the present indices are capable of measuring the degree of "handicap", either physiological or socio-psychological, caused by a malocclusion.

The Eastman Aesthetic Index, developed by Howitt, Stricker and Henderson (1967), was designed to measure occlusal factors associated with dental aesthetics. Neither these indices nor any of the indices developed by others have been found to be completely satisfactory for the assessment of a particular occlusion as a malocclusion based on functional and aesthetic considerations. Lack of reliable and valid indices, and the standardization of reporting have, in the past, prevented any meaningful comparisons between various surveys (Holmes, 1992). Jago (1974), in a critical appraisal of the epidemiology of dental occlusion, writes that "although general agreement exists that socio-psychological factors must be considered, no objective way of measuring these factors has yet been established". The COCSTOC working group (Commission on Classification and Statistics for Oral Conditions) of the Fédération Dentaire Internationale agrees that no objective way of measuring either the social or the psychological factors related to "disharmonies" of occlusal traits exists. That goal, the group believes, will not be achievable until methods for determining meaningful cut-off points have been established for combinations of traits and individual traits which separate individuals who require treatment in public programs from those who do not (Baume et al., 1973). The index that examines these features and one that will fulfil the requirements of this study, i.e. be simple, accurate, reliable and objective is the FDI COCSTOC-MOT method (Baume et al., 1973).

iii) The FDI method for the measurement of occlusal traits:
This is a method for the measurement of occlusal traits, rather than an index of malocclusion or an index of treatment (Jago, 1974; Proshek et al., 1979). The FDI suggests that with current knowledge, it is overwhelmingly difficult to establish meaningful cut-off points which distinguish those subjects who require care from those who do not.

Numerous indices exist to determine treatment needs. The methods of Van Kirk and Pennel (1959); Grainger (1961); Salzman (1967) and Summers (1971) summate the scores to assess the presence of a handicapping condition. In contrast, the methods of Björk et al., (1964) and the FDI (Baume et al., 1973) do not determine treatment need, but measure and record occlusal features and establish occlusal traits. Whilst examining the same features as the others, both the FDI and Björk method take into account the presence of supernumerary teeth. The FDI method is also the only method that considers gingival trauma through recording whether or not there is soft tissue impingement. In addition assessing occlusal traits by way of MOT (measurement of occlusal traits) facilitates comparisons amongst different populations (Baume and Maréchaux, 1974).

It seems therefore, that the concept of occlusal variation rather than malocclusion is a superior method for the development of a reliable, valid, qualitative method of assessing occlusal traits. A review of the different indices of malocclusion has shown that there is no totally objective method (Freer, 1970) and perhaps the search for an index based on absolute objectively will be found to be futile (Jago, 1974).

Though the FDI method is not without fault, it is presently the most suitable method for measuring occlusal traits making comparisons to other findings relatively easy and as such will be used in this study.

iv) <u>Angle's classification</u>:

Edward H. Angle, in 1899, contributed much to the understanding of malocclusion. Several methods of classifying malocclusion have been developed since, to describe normal occlusion and malocclusion (Dewey, 1919; Ackerman and Proffit, 1969), but the Angle system has survived the test of time (Rinchuse and Rinchuse, 1991) and is still the primary system employed.

In addition to its clinical use, Angle's classification has frequently been used to measure the prevalence of malocclusion in communities. Epidemiological studies published prior to 1956 were reviewed by Brash et al., (1956). More recent studies include those of Goose et al., (1957), Miller and Hobson (1961); Ast et al. (1962); Ast et al. (1965). Considerable variations in the prevalence of malocclusion have been reported in different communities (Brash et al., 1956; Ast et al., 1962; Gravelly and Johnson, 1974; Steigman et al., 1983), and these authors pointed out that such contrasting results probably reflect differences in diagnostic standards rather than differences between communities.

However, to date many epidemiological studies have used Angles classification for the following reasons:

(1) it is easy to use;

(2) it is the most widely used method of occlusal assessment;

(3) Angle's is the system of communication most often utilised in dentistry and therefore easily understood, (Graber, 1985), Rinchuse and Rinchuse (1991);

(4) it is also the language accepted by the legal profession and;

(5) is the language found in our literature to describe case reports, epidemiological studies and empirical work.

It was, therefore decided to use Angle's classification in this study so that the present findings could be compared to a wide range of malocclusions. The method described by El-Mangoury and Mustafa (1991) was chosen - a further modification of the Dewey-Anderson modification of Angle's classification (Appendix IIB). This modification has as its basis the Angle's classification. This makes comparison to other studies possible as many studies report on the prevalence of malocclusion using Angle's classification. Dewey (1919) and Anderson (1960) further divided each class into different types to make Angles class more descriptive and the advantage of the El-Mangoury and Mustafa (1991) modification has already been discussed.

3. AIMS AND OBJECTIVES

3.1 Aims

The aim of this study is to determine the occlusal traits of school children between the ages of 12-14 years attending Indian schools in the Western Cape and who are classified Indian in accordance with the Population Registration Act of 1950.

3.2 Objectives

The objectives of the study are:

(a) To determine the prevalence of occlusal traits in this group using the FDI COCSTOC-MOT method.

(b) To determine the prevalence of malocclusion in terms of the Angles classification with the El-Mangoury and Mustafa (1991) modification.

(c) To compare these findings with other population groups both in the Cape and elsewhere.

4. MATERIALS AND METHODS

This study was conducted to examine the occlusal traits in a selected Western Cape population sample. The materials and methods for this study shall be discussed under the following headings:

4.1 The Population

4.2 The Sample

4.3 Materials

4.4 Experimental Procedure

4.5 Measurements

4.6 Statistical Analysis

4.1 The Population

The South African government promulgated the Group Areas Act in 1950 by which the four major racial groups lived in separate and clearly defined areas. On the basis of this policy primary, secondary and to a large extent tertiary education is controlled by "Own Affairs" Educational Department (Government Gazette, Vol. 219 (8914) 28 September 1983, pages 12, 70). Although the Group Areas Act has been repealed and the introduction of Models C, (racially mixed schools) B and D schools has introduced some racial integration in both residential areas and schools, the schools and residential areas that were initially established remain largely intact and relatively homogenous.

This study was confined to the Indian population group. The origin and definition of this group has been reviewed (see Appendix 1B). As stated in the review of the literature, as a result of the Group Areas Act those individuals classified as Indian were not allowed to live in any other area besides those designated as Indian areas. In the Western Cape those areas were as follows: (1) Rylands, a suburb of Athlone; (2) Cravenby Estate under the municipality of Parow and; (3) Pelican Park which falls under the jurisdiction of the magisterial district of Muizenberg. According to the 1992 population census the total population of "Indians" in the Western Cape was 16500, of whom 9510 are based in the Athlone area, 2686 in the Muizenberg Magisterial district and 4304 in the Goodwood Municipal area. The population from which the sample was selected is described by school, age and gender in Tables 4 and 5.

DISTRIBUTION OF SCHOOLS

Area	High School	Primary School	Total	% Distribution of Population
PELICAN PARK	1	1	2	15
CRAVENBY	1	1	2	25
RYLANDS	1	2	3	60

Table 4

AGE AND GENDER DISTRIBUTION OF POPULATION SAMPLE

Age	% Male	% Female	% Sample
12	20	20	20
13	50	50	45
14	30	30	35

Table 5

This study examined children aged 12 to 14 years only. The 1985 census indicated that five to nine year old's constituted 10.5% of the Western Cape population. For the purpose of this study the assumption is made that this group (i.e. 5-9 year olds) now represents the ten to fourteen year old group in 1992. This study examined 355 children in this age group which comprised 37% of the total population of Indians of this age group in the Western Cape.

4.2 The Sample

Criteria for selection:

The sample was drawn from a school going population of 12-14 year old children. This age range was chosen because (1) it corresponds with the age range in other studies of occlusal assessment; (2) a full complement of permanent teeth is usually present and most malocclusions are established or becoming established and; (3) it corresponds to the time that orthodontic treatment is generally commenced.

Inclusion criteria

(1) All children aged 12-14 years.

(2) They had to be school-going.

(3) Those who had turned twelve on the day of the examination, but had not yet turned fifteen on the day of the examination were included.

(4) Only those subjects present in the school on the day of the examination were considered.

Exclusion criteria

(1) Those who were absent on the day of the examination were not considered.

(2) Those not classified "Indian" according to the Population Registration Act. However all children (in the age group under consideration) were examined but the results of those not fulfilling the criteria were not included in the study.

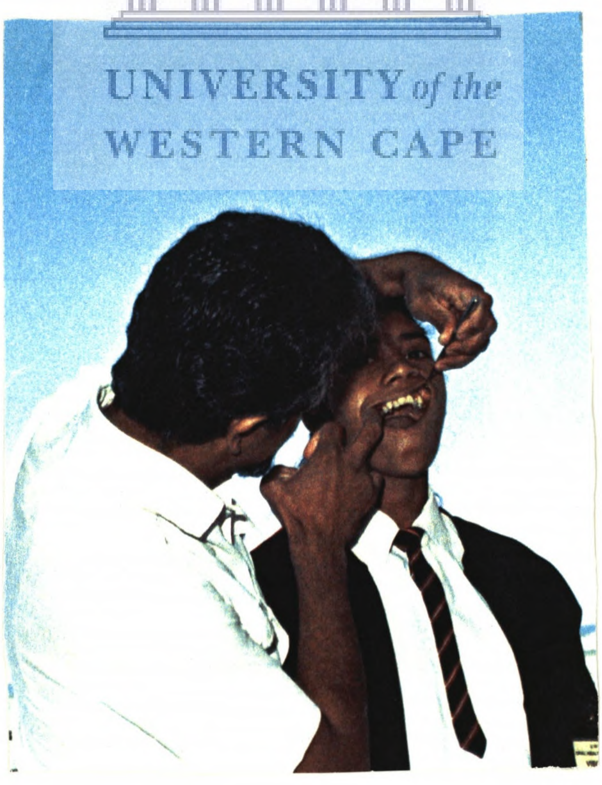
(3) Those candidates who had received or were receiving orthodontic treatment were excluded.

A survey of the schools showed that the standard 5 and 6 classes contained the majority of school children in the specified age range of 12-14 years.

(a) Sample size

As the total number of children in this age group comprised of only 389 candidates it was decided to examine only those who conformed to our criteria for selection. The final sample size was 355.

EXAMINATION INSTRUMENTS
(Figure 1)



EXAMINATION OF PATIENT
(Figure 2)

Criteria for examination

Two indices of examination were selected:

(1) The measurement of occlusal traits as recommended by the FDI (1973) and;

(2) A modification of the Dewey-Anderson (1919 and 1960) method of assessing Angle's classification as used by El-Mangoury and Mustafa (1991). (see Appendix IIB for criteria).

Permission was obtained from parents or guardians for the examination of the subjects. A letter requesting this acquiescence was addressed to them (Appendix IC).

4.3 Materials

The instruments used:

(a) a plane mouth mirror (No.2)

(b) a periodontal probe (a Michigan probe with Williams markings)

(c) a sharp HB pencil

(d) a modified Meyerson plastic dental ruler

(e) the FDI-COCSTOC-MOT examination form (Baume et al., 1973) (see Appendix IIB)

(f) examination form to record Angle's classification.
A modification to Dewey-Anderson method of assessing Angle's classification was used (El-Mangoury and Mustafa, 1991) (see Appendix IIA).

METHOD USED TO MEASURE EXTENT OF OVERJET
(Figure 3)

METHOD USED TO MARK EXTENT OF OVERBITE
(Figure 4a)

MEASUREMENT OF OVERBITE
(Figure 4b)

4.4 Experimental Procedure

A clinical examination was carried out in a classroom with natural light. The subjects were stood against a window facing the examiner. All examinations were performed by the author in a standing position. All the relevant data for each subject were recorded by an assistant onto the form designed by the FDI (Baume et al., 1973) (See Appendix IIA).

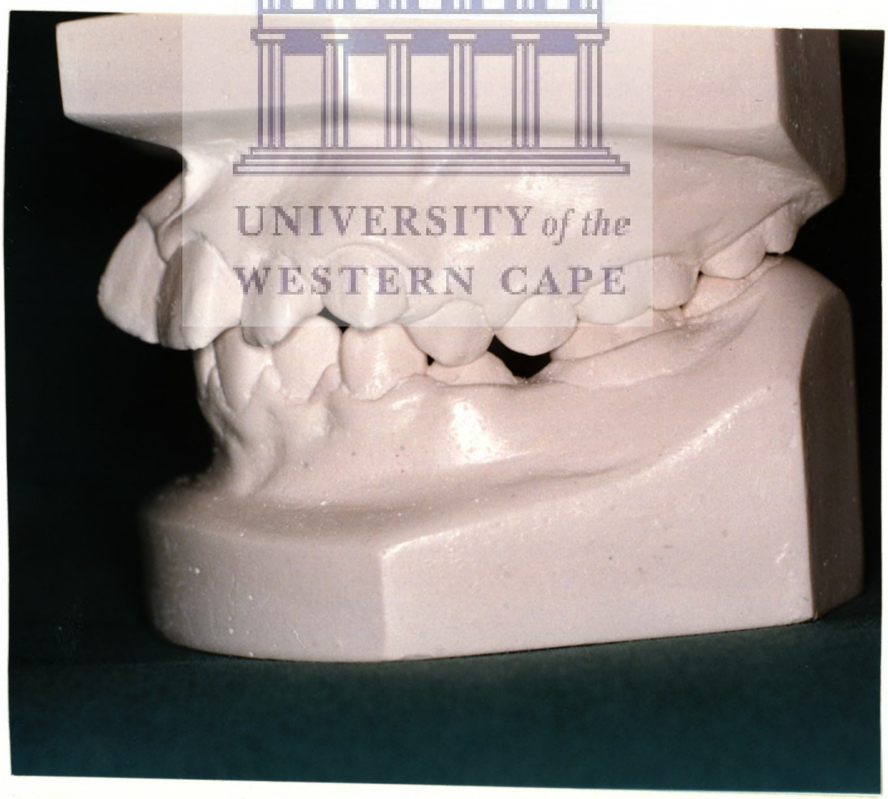
4.5 Measurements

The criteria for registration of occlusal features were those used by the World Health Organisation (1962). The following characteristics were examined and recorded.

1. Dentition status: missing permanent teeth, supernumerary teeth, malformation of incisors, ectopic eruption, retained primary teeth.
2. Space conditions: diastema, crowding, spacing.
3. Occlusion: maxillary overjet, mandibular overjet, anterior crossbite, overbite, anterior openbite, midline shift, antero-posterior relations of the first permanent molars (or premolars if aforementioned were absent), posterior openbite, lingual/buccal crossbite. (See Appendix IIB).

Standardisation of examiner:

The examiner was standardised by classifying 20 study models of patients who had presented themselves to the U.W.C. Dental Faculty for dental treatment. The models were re-examined 14 days later by the same examiner. Data was recorded on the FDI



EXAMPLE OF MODEL EXAMINED
(Figure 5)

COCSTOC-MOT examination form (Baume et al., 1973) and the form designed to accumulate information on Angle's classification with the Dewey-Anderson (1919 and 1960) and El-Mangoury and Mustafa (1991) modifications. The Kappa test was utilised to assess the intra-examiner variability. In Appendix III the formula used for the Kappa test can be found as well as an example. Only one variable is assessed in the example.

When applied to the entire sample the variability in classification was found to be above 85%. A summary of the result appears in Appendix III.

Pilot Study

A pilot study was carried out to assess intra-examiner variability and the general logistics of the study. The sample comprised 20 children from a single school who had fulfilled the criteria for eligibility to this study. They were examined in school using the same method as was described under Methodology. These children were re-examined 14 days later. The results of the pilot study were recorded according to the FDI COCSTOC-MOT method for the determination of occlusal traits and Angle's classification with the Dewey-Anderson (1919 and 1960) and El-Mangoury and Mustafa (1991) methods. No problems were encountered. The intra-examiner variability was measured using the Kappa test. A summary of the results of the pilot study is on page 126 in Appendix III. The consistency was found to be above 80%.

4.6 Statistical Analysis

Data analysis:

All data were captured using the Dbase-IV (Ashton-Tate) programme and were analyzed using the Epi-Info (WHO) statistical programme. Frequencies were computed for all data. Mean results and standard deviations were calculated for all the traits that could be measured quantitatively. The frequencies of certain variables were evaluated using the chi-squared and Kappa tests (See Appendix III).

Intra examiner variation

During the survey a random sample of approximately 10% of the children were re-examined to check for intra-examiner variability. The variability was determined by comparing the values obtained for the following variables:

(a) crowding

(b) spacing

(c) midline deviation

(d) overjet

(e) overbite

(f) midline diastema

(g) midline deviation; and

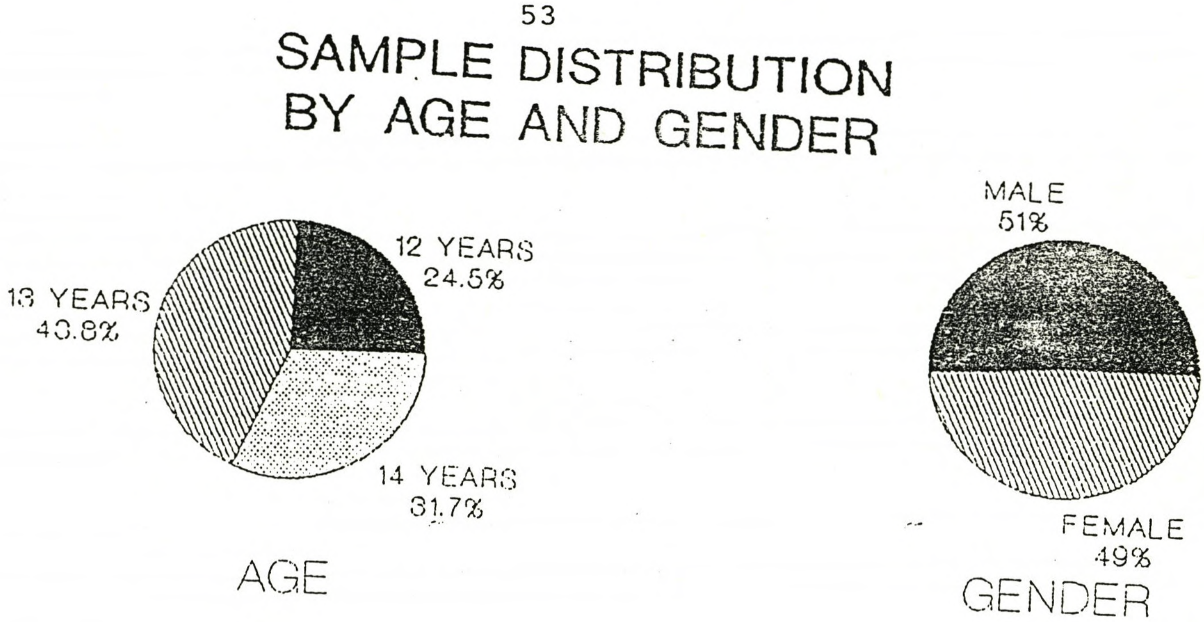
(h) molar relationship.

The results of the intra-examiner evaluations are summarised in Appendix IV. The Kappa test was used to determine the variability for the re-examinations and it was found to be below 15%.

5. RESULTS

5.1 Introduction

The results of the recordings of the different occlusal traits of this study group are presented. The report tabulates all occlusal traits as required by the WHO and in accordance with the COCSTOC-MOT (Commission on classification of oral conditions-measurements of occlusal traits (Baume et al., 1973). Only some aspects of the traits will be emphasised.



A B

Figure 6

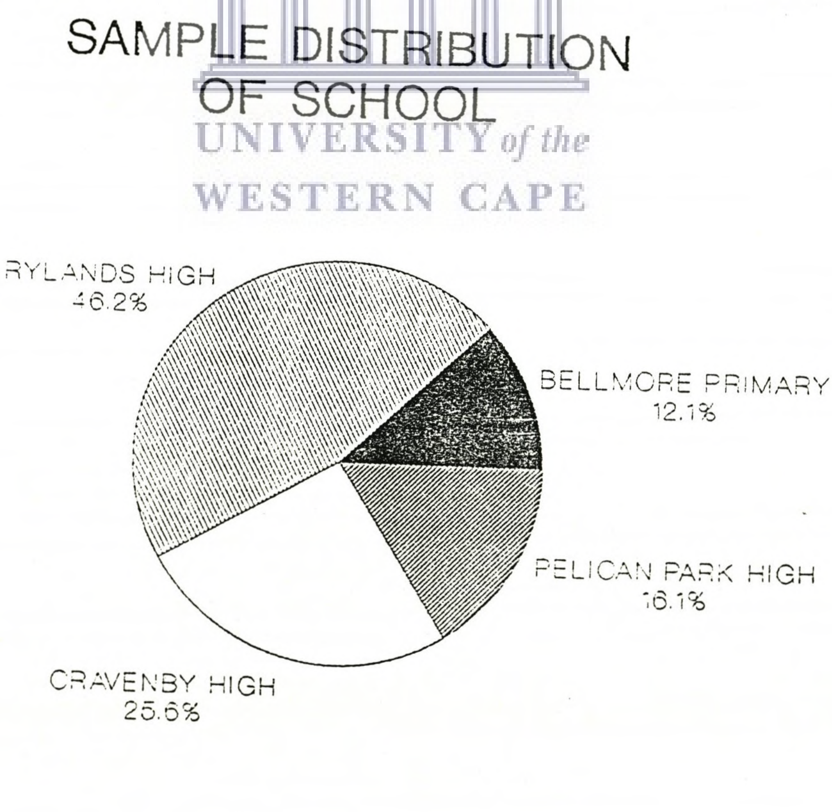


Figure 7

5.2 Sample Distribution by Age, Sex and School

Figures 6 and 7 and Table 4 show the distribution of the sample by age, sex and school.

(a) Age

The age distribution of the sample shows that the 13 year old subjects were the most commonly represented age group (Fig.6A) (43.8%). This represented the median age of the sample. The mean age was found to be 12.93.

(b) Sex

The sex distribution of the sample (as shown in Fig.6B) reflects the gender distribution of the population, which is in a ratio of 1:1.

(c) School

The major percentage of the sample was drawn from the suburb of Rylands (Rylands High School and Bellmore Primary School), as indicated in Fig.7.

DISTRIBUTION OF SAMPLE BY GENDER, AGE AND SCHOOL

SCHOOL	GENDER	AGE IN YEARS 12	13	14	
BELLMORE	M F	5 7	10 11	11 4	26 22
RYLANDS HIGH	M F	22 22	39 39	39 17	100 78
CRAVENBY	M F	7 11	16 15	14 9	37 35
PELICAN PARK	M F	9 5	13 12	7 11	29 28
	TOTAL	88	155	112	355

Table 6

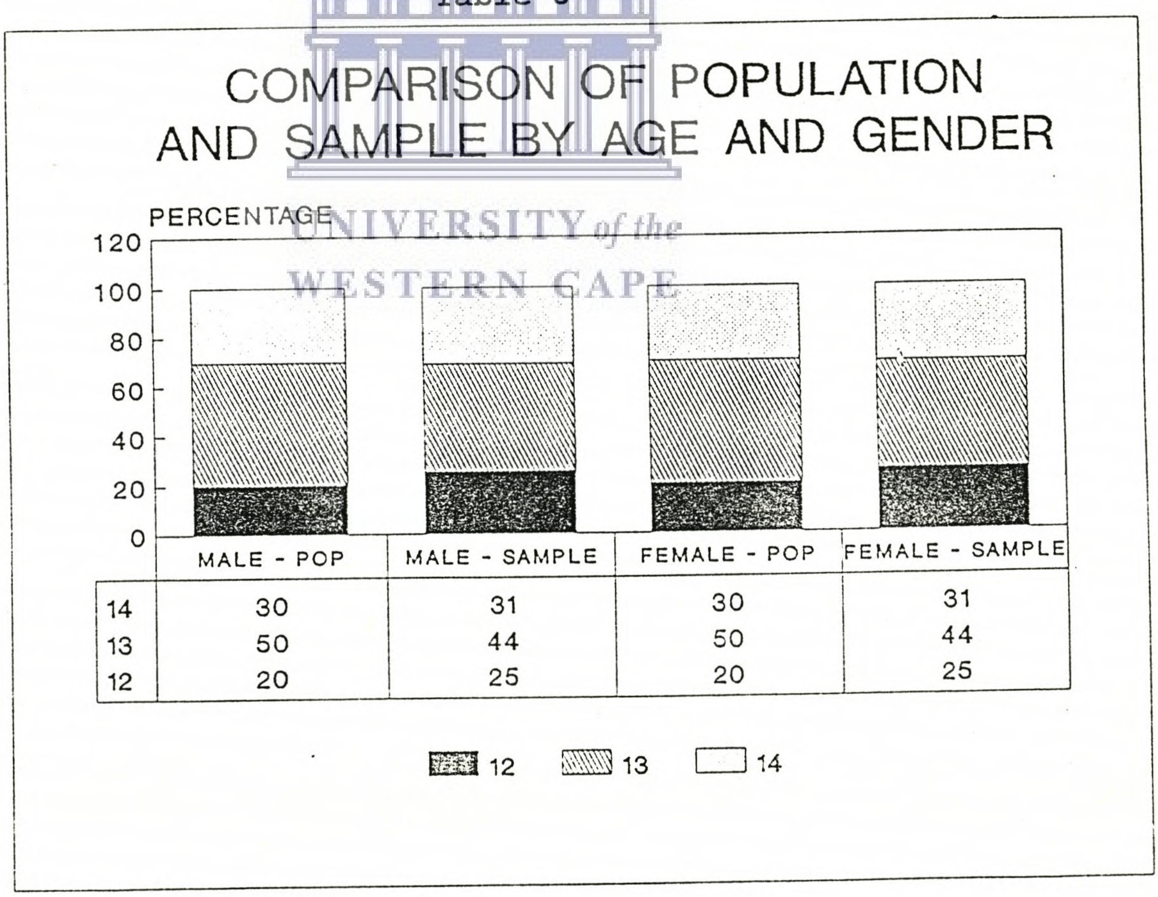


Figure 8

5.3 Dental Measurements

(a) The incidence of dental anomalies

The first part of the examination deals with the assessment of developmental anomalies of the dentition, missing teeth or retained primary teeth. The most interesting feature of this assessment, was the high number of individuals who had missing mandibular first molars (28) (7.8% of the population) due to extraction or trauma and this was followed by the number of persons with missing maxillary molars (19) (5.3% of the population). The next most common feature was the number of subjects with impacted teeth. Of these the impaction of the mandibular second premolars (21) 5.9% was found to be the most common followed by the impaction of the maxillary second premolars (14) (3.9% of the population). The frequency distribution of the other dental features are tabulated below.

(a) FREQUENCY DISTRIBUTION OF DENTAL ANOMALIES

MAXILLA	TEETH						
	11 21 CI	12 22 LI	13 23 C	14 24 1PM	15 25 2PM	16 26 1M	17 27 2M
Hypodontia			3	2	4	2	
Extracted	1	3	7	6	5	19	3
Impacted	1		9	5	14	4	
Malformed		8	5	1	4		
Transposed			2	1	1		
Unerupted			6				
Supernumery		1		2	1		
Retained Primary	2	3	1				

Table 7a

MANDIBLE	TEETH						
	31 41 CI	32 42 LI	33 43 C	34 44 1PM	35 45 2PM	36 46 1M	37 47 2M
Hypodontia	2		1	2		3	
Extracted	1	2	1	4	10	28	2
Impacted	1		3	5	21	3	1
Malformed						4	
Transposed				2	2		
Unerupted			2		2	2	
Supernumery		2					
Retained Primary	1	3	2				

Table 7b

KEY:

C1 : Central incisor
L1 : Lateral incisor
C : Canine
1PM: First premolar
2PM: Second premolar
1M : First molar
2M : Second molar

5.4 Intra-arch Measurements

Percentage Distribution of Space Conditions

SEGMENT OF ARCH	NORMAL	CROWDED	SPACED	A
Upper right lateral	85.5	10.3	2.2	2.0
Upper incisal	30.0	52.7	12.8	4.5
Upper left lateral	87.0	7.8	1.1	4.1
Lower right lateral	80.0	12.5	1.9	5.6
Lower incisal	43.0	48.9	7.1	1.0
Lower left lateral	79.4	13.8	3.8	3.0

Table 8

A = non recordable.

The upper and lower arches in each individual were divided into three segments: the incisal and two lateral segments. Each of these segments were examined for crowding or spacing.

The upper incisal area was found to be the most crowded area in the mouths examined. The lower incisal area was the second most crowded area in the mouth. Spacing of the dentition was also found to be common in the upper incisal area, followed by the lower incisal area.

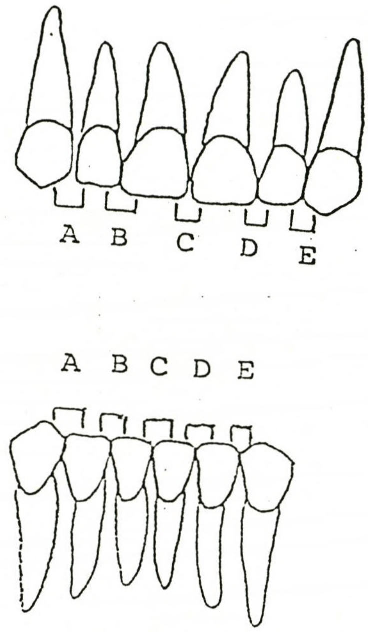


Diagram illustrating the areas considered when anterior irregularities were examined.

(Figure 9a)

EXAMPLES OF ANTERIOR INTRA-ARCH IRREGULARITY
(Figure 9b)

5.5 Anterior Irregularities

Percentage Incidence by Region

	A	B	C	D	E
Upper Jaw (in mm)					
0	80.8	81.9	82.2	85.2	87.9
1	0.8	3.8	2.2	2.7	0.4
2 - 3	10.7	11.5	13.4	6.1	7.4
4 - 5	4.8	1.9	1.9	2.2	2.6
6 - 7	2.9	0.9	0.3	0.8	1.8
Unrecordable	0	0	0	3	0
Lower Jaw (in mm)					
0	86.3	86.5	80.5	85.2	86.3
1	1.1	3.3	4.4	1.6	0.8
2 - 3	8	10.2	12.6	10.3	9.6
4 - 5	1.9	2	2.2	1.5	1.9
6 - 7	2.3	1.2	0.3	1.5	1.4
Unrecordable	0.4	0	0	0	0

Table 9

A = Right cuspid to right lateral incisor

B = Right lateral incisor to right central incisor

C = Between central incisors.

D = Left lateral incisor to left central incisor

E = Left cuspid to left lateral incisor.
(see Figure 9a)

The incisal area was divided into five regions between the anterior teeth and the region with the highest amount of crowding (in mm) was identified. The upper and lower segments were recorded separately. Table 8 shows that 80.5% to 88.5% of the arches examined showed no irregularities. When present the crowding was found to be most prevalent in the region of the central incisors. Where anterior irregularities were seen they were most commonly found to be in the range of 2-3mm. Very few individuals had anterior crowdings in the 6-7mm range.

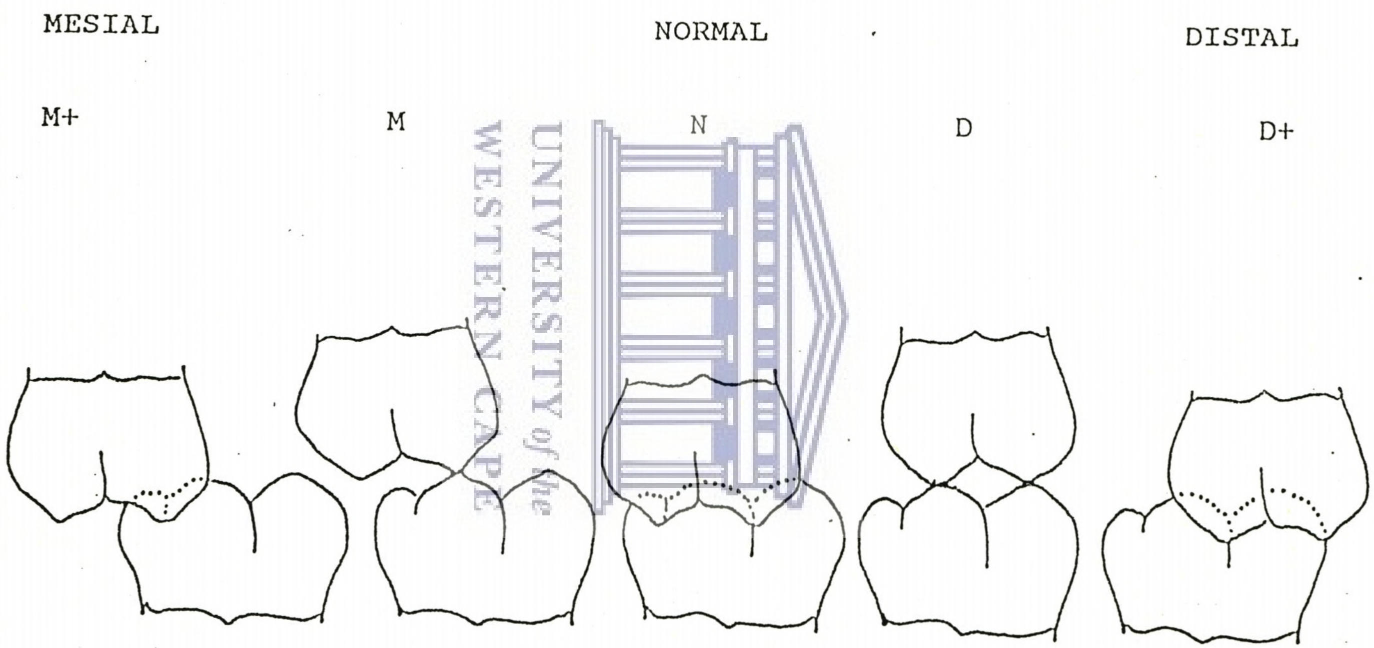
5.6 Percentage Distribution of Midline Diastema

Diastema in mm	Percent
None	87.4
1	2.9
2	6.1
= > 3	2.5
A	1.1

Table 10

A = non recordable: teeth missing or broken

The upper labial segment was examined. The presence or absence of a diastema was recorded in the maxilla. It was found that 87.4% of the candidates examined had no midline diastema. Most of the subjects who did present with this condition had diastemata of 2mm, which comprised 6.1% of the subjects examined. Only 2.5% of the candidates examined had diastemas equal to or greater than 3mm.



SCHEMATIC REPRESENTATION OF MOLAR RELATIONSHIPS
(Figure 10)

5.7 Percentage Distribution of Anterior-posterior Molar Relationship

Inter-arch Measurement:

Lateral segments

		L				
		M+	M	N	D	D+
R	M+	2.3	0.3	0.8	0	0
	M	0.5	3.5	0.5	0.4	0
	N	0.4	0.8	72.9	0.4	0.4
	D	0	0	0.4	10.3	0.9
	D+	0	0	0	0	5.2

Table 11

KEY:

M+ = The mesiobuccal cusp of the upper first molar articulates with the distobuccal groove of the lower first molar or the interproximal space between the lower first and second molars.

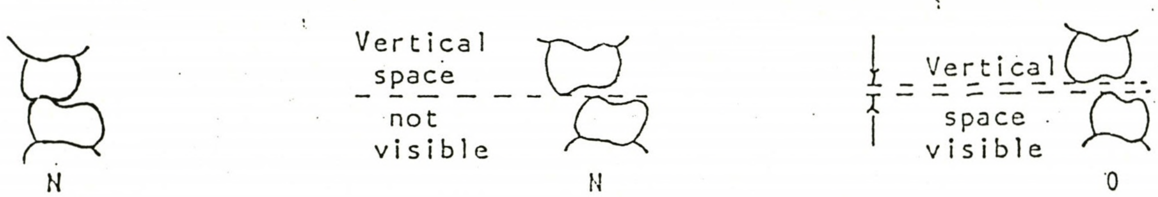
M = An end to end (cusp to cusp) relationship where the tip of the mesiobuccal cusp of the upper first molar articulates with the tip of the distobuccal cusp of the lower first molar.

N = Normal molar relation where the mesiobuccal cusp of the upper first molar articulates with the buccal groove of the lower first molar.

D = An end to end relationship in which the tip of the mesiobuccal cusp of the upper first molar articulates with the tip of the mesiobuccal cusp of the lower first molar.

D+ = The distobuccal cusp of the upper first molar articulates with the buccal groove of the lower first.

The buccal segments on the right and left side were examined in occlusion. The mesio-distal relationship between the first molars were recorded (Table 11). The extremes of these relationships were also noted with the addition of a + or - sign (See Fig.10). Most of the subjects in this study had a normal molar relationship on both sides of the mouth. There were more pupils with distal molar relationships (D = 10.3%; D+ = 5.2%) than those with mesial relationships (M = 3.5%; M+ = 2.3%).



CLASSIFICATION OF POSTERIOR OPENBITE
(Figure 11)

(i) <u>Vertical relationship</u>

5.8 Percentage Distribution of Posterior Openbites

Lower left side

	NORMAL	OPENBITE	N/R*
Cuspid	97.9	1.1	1
1st bicuspid	96.1	1.9	2
2nd bicuspid	95.0	1.5	3.5
1st molar	90.2	1.2	8.6
2nd molar	97.3	1.4	1.3

Table 12a

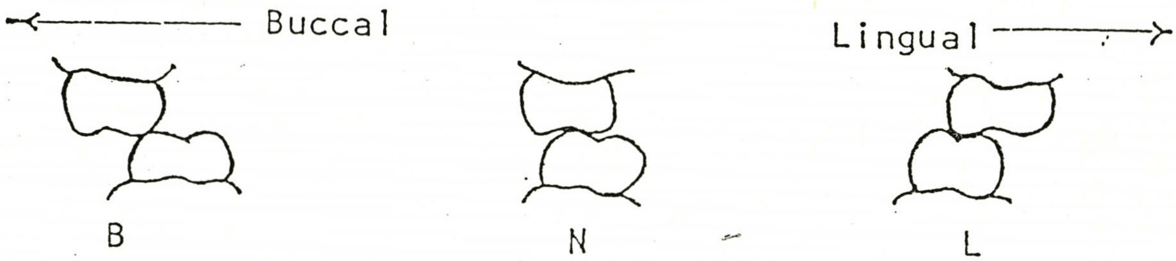
Lower right side

	NORMAL	OPENBITE	N/R*
Cuspid	93.8	4.1	2.1
1st bicuspid	96.4	0.6	3.0
2nd bicuspid	95.2	1.7	2.9
1st molar	96.4	0.6	3.0
2nd molar	96.5	2.3	1.2

Table 12b

* = measurement unrecordable (broken or missing teeth).

The buccal segments were examined to determine the presence or absence of an open bite. An openbite was recorded as being present in the cuspid, premolar or molar area. Where a tooth was missing or the tooth damaged the open bite was <u>not recordable</u>. The prevalence of posterior open bites was found to be very low. Open bites were most frequently found in the mandibular cuspid area (4.1%). Figure 11 illustrates a posterior open bite.



CLASSIFICATION OF POSTERIOR CROSSBITE
(Figure 12)

(ii) Transverse Relationships

5.9 Percentage Distribution of Posterior Crossbite

Lower right

	NORMAL	BUCCAL	LINGUAL	N/R*
Cuspid	95	3.6	1	0.4
1st bicuspid	93.1	5.1	1.1	0.5
2nd bicuspid	94.1	3.3	2.0	0.6
1st molar	91.8	6.1	2.1	0
2nd molar	98.8	0.6	0	0.6

Table 13a

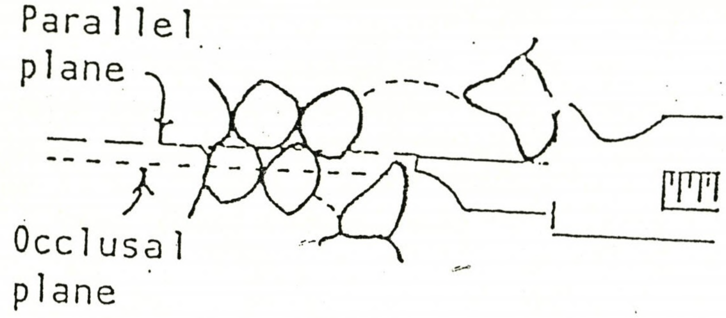
Lower left

	NORMAL	BUCCAL	LINGUAL	N/R*
Cuspid	94.2	3.2	1.4	1.1
1st bicuspid	94	3.1	0.4	2.5
2nd bicuspid	97.1	2.3	0.3	0.3
1st molar	94.7	3.3	0	2
2nd molar	96.3	1.3	1.2	1.2

Table 13b

*= measurement unrecordable broken or missing teeth

The table shows that between 91.8%-98.8% of the sample have a normal relationship in the posterior segments. The mandibular first molar was the most common tooth in crossbite (6.1%) followed by the mandibular first bicuspid (5.3%). Both were usually in buccal crossbite. See Figure 12 for a description of the different types of crossbites assessed.



MEASUREMENT OF OVERJET
(Figure 13)

2. <u>Incisal Segments</u>

5.10 Percentage Distribution of Overjet to closest mm:

A. ANTERIOR-POSTERIOR RELATIONSHIP

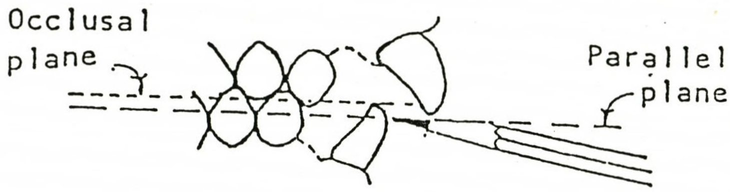
± mm	Right Lateral Incisor	Right Central Incisor	Left Central Incisor	Left Lateral Incisor
-3	0.5	0.3	0.2	0.8
-2	3.0	0.3	0.5	3.0
-1	3.6	1.4	1.9	3.6
0	5.8	3.3	2.7	5.2
1	7.9	4.7	4.1	9.6
2	**52.8**	**38.4**	**38.6**	**51.2**
3	**12.3**	**17.3**	**17.0**	**11.5**
4	7.4	10.7	11.5	8.8
5	3.8	13.4	13.2	2.7
6	0.8	3.8	3.2	1.5
7	1.1	3.6	3.6	1.1
8	0.3	1.1	1.9	0.3
9	0.3	1.1	0.8	0.3
7 - 10	0.4	0.8	0.8	0.3

MEAN (mm)	2.09	3.16	3.19	2.07
SD	± 1.81	± 2.01	± 2.05	± 1.81
MEDIAN	2	2	2	2

Table 14

KEY: Negative value = reverse overjet

Incisor overjet was assessed and recorded as either positive or negative. The distribution of overjet patterns on the right and left sides is fairly equal. The majority of the sample showed an overjet of 2-3mm. The mean overjet for all incisors was 2.65mm and the median was 2mm. The mean for all incisors yields a positive overjet of 2.6 ± 0.63mm (Figure 13). Between 10.7% and 13% of the subjects recorrect overjets of 4-5mm for the central incisors. There were more negative overjets affecting the lateral incisors than (±7%) the central incisors (2.0% on the right central incisor and 2.6% on the left central incisor).



POSITION OF PENCIL IN RECORDING OVERBITE
(Figure 14)

(iii) **Vertical Relationship**

5.11 Percentage Distribution of Overbite to Closest mm

± mm	Right Lateral Incisor	Right Central Incisor	Left Central Incisor	Left Lateral Incisor
-5	0.3	0.3	0.2	0.3
-4	0.3	0.2	0.3	0.3
-3	3	0.3	0.3	0.4
-2	4.4	0.8	1.6	4
-1	2.3	0.8	0.5	3.3
0	3	3	3.3	4.9
1	8.2	4.4	4.4	8.2
2	52	45.8	45.5	53.2
3	15.9	20.3	19.5	15.3
4	3.6	7.1	6.8	3.6
5	4.1	11.5	12.4	4.1
6	1.1	2.5	2.2	1.1
7	1.8	3.0	3.0	1.3

MEAN (mm)	2.03	2.7	2.67	1.93
SD	1.72	1.7	1.76	1.7
MEDIAN	2	2	2	2

Table 15

KEY: Negative value = openbite

The distribution of overbite was determined and expressed in percentages. Anterior openbites were recorded for values 0 to -5mm and anterior overbite for values 0-7mm. The distribution of overbites was found to be symmetrical on the right and left sides. Most of the children examined had overbite values of between 2-4mm. Of the subjects examined 17-17.6% had an overbite greater than 5mm (Table 15) in the central incisor region.

(iv) <u>Transverse Relationships</u>

5.12 Percentage Distribution of Midline Deviations

mm	Right	Left
1	12.9	6.3
2	7.3	11.3
3	4.2	3.7
4	1.6	1.3
5	0.3	0.4
6	0	0.2
7	0	0.3
8	0	0.4
Coincident	0	46.8
A	0	3.0
Mean	0.49	0.50
SD	0.96	1
Median	0	0

Table 16

A = unrecordable

The midline relation between the mandible and the maxilla was examined and measured in millimetres. Where the upper and lower midlines coincided it was recorded as 0mm. The side to which the lower midline was deviated was recorded as left or right.It was found that in 46.8% of cases,the midlines were coincident. 23.9% of midlines deviated to the left and 26.3% deviated to the right.

5.13 Percentage Distribution of Soft Tissue Impingement

		Left		
		LABIAL	NORMAL	LINGUAL
Right	LABIAL	3.3	0	0
	NORMAL	0	87.20	0
	PALATAL	0	0	3.8

Table 17

Unrecordable: 5.7%

The sole assessment of the soft tissue is made in the region of the occlusion of the four upper and four lower teeth and on the left and right side. Any occlusal palatal impingement due to the lower incisors or any lower labial impingement due to the upper incisors was recorded lingual or labial respectively.

It was noted that 87.2% showed no soft tissue impingement. Of the 7.1% that did have soft tissue impingement 3.8% were found to be on the lingual aspect and 3.8% on the labial aspect.

<u>THE PREVALENCE OF MALOCCLUSION USING ANGLES CLASSIFICATION</u>:

(WITH THE DEWEY-ANDERSON AND AL-MANGOURY-MUSTAFA MODIFICATION)

The prevalence of a normal occlusion, was found to be very low. Some 82.9% of the sample were found to have some form of malocclusion. The most common type of malocclusion was the Angle's Class I type I. There were 16.9% of subjects with an Angle's Class II malocclusion. The majority of whom were of the Division I pattern. There was a low prevalence occurrence of Angle's Class III malocclusion. Table 18 summarises the results.

5.14 RESULTS BASED ON ANGLE'S CLASSIFICATION WITH THE DEWEY-ANDERSON AND EL-MANGOURY AND MUSTAFA (1991) CLASSIFICATION

OCCLUSAL VARIATION	OCCLUSAL VARIATION	DIVISION/ TYPE (%)	ANGLES (%)
NORMAL OCCLUSION			17.1
ANGLE CLASS I	Crowded maxillary anterior teeth Type I	24.5	
	Maxillary incisors in labio version Type II	9.7	
	Maxillary incisors in linguo version Type III	4.5	
	Molars or premolars in bucco or linguo version Type IV	2	
	Mesio version of the molars only Type V	6.1	
	Diastemata Type VI	7.5	
	Deep anterior overbite Type VII	0.6	54.9
ANGLE II	Division I	13.4	
	Division II	3.5	16.9
ANGLE III	Type I	3.1	
	Type II	1.3	
	Type III	1.1	5.5
ANGLE IV		5.6	5.6

Table 18

ANTERIOR ARCH FEATURES OF OCCLUSAL TRAITS
(IN PERCENTAGE)

	Cons et al 1978 New York	Jacobson 1967 S.A. Black	Johnson et al 1978 Indon*.Engl*.Chinese	Ingervall & Hedegaard Finnish 1975	Isiekwe 1983 Lagos	Horowitz 1970 White Negro	Thilander & Myburgh 1973 Swedish	Helm 1968 Danes	Fergusson 1988 West.Cape	Hill 1992 Glasgow	Woon et al 1989 Chin*.Malay.Indian	Present Study
Crowding	43.2	24.5	83 57 74	25	15.1	43 30	26.3	39.4	33	61.2	58.3 50.8 45.9	58.2
Spacing	15.9	13.2				10 26	8.6	8	7.3	9.2	5.6 6.1 5.7	12.7
Overjet			10 52 37	7	24.1	13 8			11.4	18	12.5 16.1 9.5	26.7
Neg.Overjet			2 1 8	1.5	6.2	1.2 .5						8.5
Overbite			16 60 32	17	13.5	49 16			8.6	2.7		16.1
Neg.Overbite			3 3 5	2	10.2	1.5 5	3.8		6.8	2.3	40.9 44.6 11.9	7.9
Diastemas	.4	20.5		2.5		8 19	5		8.4			11.5
Midline Deviations	16					57.9 45.8					37.8 36.9 24.2	53.5

TABLE 19

* Indon = Indonesian

* Engl = English

* Chin = Chinese

PERCENTAGE DISTRIBUTION OF POSTERIOR RELATIONSHIP

	Johnson *et al*. (1978)			Thilander and Myberg (1975)	Ferguson (1988)	Hill (1992)	Woon *et al*. (1989)			Present Study
	Indon.	Eng.	Chin.	Swedish	West Cape	English	Chin	Mal.	Ind	
Crossbite	1	13	5	2.7		9.6	6.5	5.9	4.8	8.3
Post. open bite					7.3					6.5

Table 20

KEY:

Indon = Indonesian
Eng = English
Chin = Chinese
Mal = Malays
Ind = Indians

PERCENTAGE DISTRIBUTION OF DENTAL ANOMALIES

	Cons et al. 1978 New York	De Muñiz 1986 Argentineans	Ingervall & Hedegaard Finns 1975	Ferguson 1988 West-Cape	Present study
Freq. of missing first lower molars		12.5	12.7	28.3	7.8
Freq. of missing first upper molars		6.0	17.3	15.06	2.5
Hypodontia	4.7		17.5	7.3	5.3

Table 21

7. DISCUSSION

Introduction:

This study will be compared with that of other global studies which used the FDI or similar methods, so that comparisons can be drawn. Most studies done in South Africa used either the Angles classification to assess malocclusion or determined treatment needs using a variety of occlusal indices that may or may not have examined occlusal traits pertinent to this discussion.

DENTITIONAL STATUS: (Table 21)

The present study showed that the mandibular first permanent molar was the most common tooth missing due to extraction or trauma (7.8%). This compared with the findings of De Muñiz (1986) on Caucasian Argentineans and that of Ingervall and Hedegaard (1975) on Finnish subjects. Although Ferguson (1988) showed a higher prevalence of tooth loss (21%), the type and pattern of the most common tooth loss was similar in this study, i.e most frequently the lower first molar, followed by the upper first molar. The prevalence of tooth loss in Ferguson's (1988) sample was three times that of the present sample. The prevalence of upper tooth loss was found to be lower (2.53%) than that reported by De Muñiz (1986) (6%) amongst Argentinean children and in Finnish children (Ingervall and Hedegaard, 1975) (17.3%). Ferguson's (1988) results showed the prevalence of missing upper first molar to be four times greater than that of the present study. Educational and socio-economic factors which normally influence the type of treatment received could probably be responsible for this difference (De Muñiz, 1986). This pattern of tooth loss is in agreement with the findings of the National Oral Health Survey (1991).

The extraction of permanent teeth especially molars, has been reported as a cause of occlusal anomalies (Ast et al., 1962; McEwen and McHugh, 1970; Thunold, 1970). The loss of one or two teeth may cause rotations and inclinations of adjacent teeth and sometimes severe functional disturbances (Laine and Hausen, 1983). The high prevalence of this trait in Ferguson's (1988) study may be a matter of concern and therefore an important determinant for treatment. The low prevalence in this sample is not an important factor to consider in a public health programme.

Hypodontia: (Table 21)

The absence of radiographs and comprehensive dental histories places a limitation on the interpretations of these results. The teeth recorded as being absent due to hypodontia may be ectopic or unerupted. Baume et al. (1973) has stated that the COCSTOC-MOT method recognized these limitations and made provision for this shortcoming.

The occurrence of hypodontia was found to be 5.3% and compared well with the groups studied by Ferguson (1988) (7.3%) and by Cons et al., (1978) (4.7%). In this study the tooth most frequently affected was the maxillary second premolar. This was followed by the maxillary first molar and the mandibular canine. Ferguson (1988) found the maxillary lateral incisor to be the tooth most commonly affected. Unlike the Finnish children studied by Ingervall and Hedegaard (1975) (17.5%) the prevalence of hypodontia in this study was found to be very low and its consideration as an indicator of orthodontic treatment need seems to be unimportant in this community.

B. INTRA-ARCH MEASUREMENTS

SPACE CONDITIONS (Table 19)

The crowding of anterior teeth takes into consideration all crowding beyond 2mm. The percentage of individuals with a crowded dentition in this sample (58.2%) exceeds that of many other national findings (see Table 19). Spacing of the anterior teeth was found in only 12.7% of the population. This value was higher than that obtained by Ferguson (1988) (7.3%). It can be seen from Table 19 that the prevalence of spacing is similar to that reported by a number of other studies. Together with crowding of the dentition this may have a marked influence on aesthetics and may be an important trait to consider when determining criteria for treatment needs. Shaw et al. (1975) have shown that aesthetics is an important consideration in orthodontic treatment and a strong influence on the perceived need for treatment. Gosney (1986) also found that crowdings, rotations and to a lesser extent spacing usually caused concern in patients. Ingervall and Hedegaard (1975) have shown that the perception of irregular alignment and spacing is greater than the perception of overjets.

MAXILLARY MIDLINE DIASTEMATA: (Table 19)

The percentage distribution of maxillary midline diastema was found to be 11.5%. Ferguson (1988) found the prevalence of maxillary midline diastemas to be 8.4% in his Western Cape sample. The findings of this study differ widely from that of Nainer and Gnanasundarum (1988) on South Indians (1.6%). The present finding when compared with other studies is found to be higher (11.5%) (see Table 19), but cannot be considered an important factor for an orthodontic public health programme.

This study could not identify the precise etiology of midline diastema. Spacing in the upper anterior region appears to be an influential factor associated with midline diastemas in this and other studies (Steigman and Weissberg, 1985; Popovich and Thompson and Main, 1977). As in the study by Lavelle and Foster (1969) a greater incidence of spacing was noted in the anterior region of the maxilla compared with other areas of the mouth. These observations coupled with the anthropological data of Schultz (1948) suggests the involvement of the premaxilla. Diastemata affect aesthetics its consideration for treatment will depend on the response of this community to midline spaces of different widths, before diastemata can be included in the list of important occlusal traits that warrant treatment.

Theunissen (1993) in his study of children from the same geographical area as the present sample found only a 50% acceptability of maxillary midline diastemata.

INTER-ARCH MEASUREMENTS:

OVERJET (Table 19)

The relationship of the dental arches in the anterior region of the mouth has a direct influence on aesthetics, mastication, speech and the anterior oral seal (Kinaan, 1986). For practical purposes this relationship is considered in both the horizontal dimension (overjet) and the vertical dimension (overbite). These are of vital importance in orthodontic diagnosis as they strongly affect the determination of the need and type of orthodontic treatment required. That is why overjet and overbite have been considered in most malocclusion assessment indices (Foster and Menezes, 1976). It is common practice for orthodontists to refer to increased "overjet" or "reduced" overjets without reference to a standard datum. There would be no need for these vague descriptions if overjet values were measured in millimetres which could then be related to those values considered to be within an accepted range of biological normality.

This study was also concerned with the distribution of overjet to establish what may be considered a biologically normal range in this sample. The frequency distribution and the mean overjet value together with its standard error was calculated. The mean overjet for all incisors was found to be 2.65mm.(Table 19)

There was a moderately high prevalence of individuals (16.7%) with overjets greater than 4mm. The presence of an increased overjet is a complaint often cited by patients seeking orthodontic treatment. The negative influence of an increased overjet on aesthetics has been shown by Theunissen (1993) in children from the same geographical area. He found a low aesthetic rating for an increased overjet. An increased overjet also influences facial profile and Samsodien (1986) has shown that the convex profile (associated with an increased overjet) was the least preferred profile in subjects from the Western Cape. The associated aesthetic problem may be the main complaint. Patients frequently complain of being teased at school for this condition and parents particularly seem alarmed and concerned when presenting their children for treatment. Many patients who present for treatment at the U.W.C. Dental School have as their main complaint, "teeth sticking out". The larger the overjet the greater the perceived problem seems to be. Graber and Lucker (1980) found that overjet was a significant factor in the request for treatment in girls, while boys were more concerned with dental crowding. Compared with Johnson et al. (1978) (refer to Table 19) report this study showed the third highest prevalence of overjet. This is certainly a trait of concern. An orthodontic public health programme will have to take this into consideration.

Negative overjet: (Table 19)

Compared with the other population groups, the prevalence of negative overjet in the present sample was also high but this may not be important. Negative overjets of between -1 and -2 was not of concern to patients. Their prevalence was very low and patients rarely present to the U.W.C. Orthodontic Department complaining of a small reverse overjet. The reason could be that the profile of patients with overjets less than -1 to -2, may be acceptable or even attractive. Larger negative values may need treatment.

Overbite: (Table 19)

The studies reported in Table 19 did not specify the values of an increased overbite, making comparisons difficult. The determination of an overbite norm in different population groups is necessary before an assessment of a treatment need is determined. However, excessive overbites that may impinge on the soft tissue are likely to need treatment. This study has shown that in 7.1% of the overbites present the lower incisor were found to impinge on the soft palate.

In fact, approximately 50% of patients with increased overbites had an extremely deep overbite that impinged on the hard palate. In this sample, an overbite measurement of 2-4mm could be regarded as being the biological norm and values above this as increased overbite and those below as decreased overbite. As this is an anterior relationship it is regarded as important for similar reasons described for increased overjet. 16% of the sample were found to have an overbite greater than 4mm.

Negative overbite values present as open bites and influence the anterior region of the mouth causing similar problems to increased overjet and overbite. The prevalence of open bites in this study (7.9%) is similar to that found by Ferguson (1988), but is higher than the values presented in other findings reported in the literature (see Table 19).

Orthodontic treatment planning usually considers open bites as an occlusal trait that may need treatment. Patients presenting with open bites at the U.W.C. Dental Faculty often also complain of speech impairment. Helm et al. (1975) reported a modest but statistically significant correlation between both maxillary overjet and frontal openbite recorded at adolescence and unsatisfactory biting ability in adulthood. The above data indicated that occlusal traits examined were found to be higher and may need consideration for treatment.

Though the FDI classification states that the issue of treatment need is very subjective the combination of some of the occlusal traits can provide an estimation of treatment needs. The motivation for orthodontic treatment is often based on negative aesthetic effect of the malocclusion. Shaw (1981) and Shaw et al. (1975) and others emphasised the aesthetic factors as important determinants of treatment need and many patients present at the Orthodontic Department of the U.W.C. Dental Faculty for aesthetic reasons. McLain and Proffit (1985) have stated that there is clear evidence that dental and facial aesthetics play a significant role in self-esteem and self-image. If aesthetics is an important consideration and one that could affect the psycho-social status of the individual it can be regarded as an important determinant of treatment need. As the anterior teeth are the primary concern of these patients it may be prudent to group those occlusal traits concerned with the anterior dentition such as overjet, overbite, crowding, spacing, midline diastemas and midline deviations. Abnormal values in these features can be established as criteria for treatment need. This study has found the prevalence of crowding and increased overjet to be high and these two factors could be isolated to prioritise patients for treatment. The limited financial and human resources should be utilised to address these problems first.

The importance of aesthetics in assessing treatment needs has led to the inclusion of an aesthetic factor in many indices of malocclusion.

On the basis of a professional judgement increased overjet and crowding have been identified as important for treatment, but a study determining the occlusal preferences and treatment priorities in this community will have to be done. The need for orthodontic treatment cannot be determined without an assessment of the particular community's perception of malocclusion (Jago, 1974). Orthodontic criteria have determined that there is a need for treatment in the community under investigation, but this will have to be combined with what the community may perceive as an abnormality. Consideration has to be given to the discrepancy which may exist between lay and professional judgement concerning the acceptability of variations from an aesthetic ideal (Goldstein, 1969; Shaw et al., 1975), otherwise treatment may be suggested to improve dental appearance in cases where no aesthetic handicap is apparent to the general community. Socio-cultural differences which may exist also have to be considered as Kiyak (1981) found a significant difference between the aesthetic values of Caucasians and Pacific-Asians in the Seatle area.

The combination of the professional assessment of treatment need, the patients awareness of what constitutes problems and the resources available can be utilized by the relevant health bodies to establish appropriate orthodontic services and train the necessary personnel to address this need. The cost involved in fixed orthodontic treatment will make a publically based program prohibitive and strong emphasis and an intensive training in removable appliance therapy may be needed to address the needs of this community.

The importance of orthodontic treatment in the community under examination can be seen from the increasing demand for treatment at the Orthodontic Department of the U.W.C. Parents are often the people most concerned. This is in agreement with the findings of Shaw et al. (1979) and Tulloch et al. (1984) who found that a high percentage of parents expected positive benefits from orthodontic care and who believed that straightening the teeth would make their child more attractive, better liked and was important for the child's future occupation and also that straight teeth were important for their child's good dental health!

This study characterised the components of malocclusion well, documenting data showing that a large percentage of this sample of Indian school children residing in the Western Cape have a pronounced malalignment or malrelationship. What is needed is to convert these findings into "need values". An assessment of the psychosocial component of malocclusion is also important because it will continue to be one of the strongest motivators of orthodontic treatment (McLain and Proffit, 1985). Ongoing epidemiologic data collection is necessary to detect trends or determine changes in the prevalence of malocclusion.

ANGLE'S CLASSIFICATION

Zietsman (1979) showed that 23% of children classified Indian in his Transvaal study had no malocclusion. This study found that 17.5% could be said to possess a normal occlusion. The current findings are similar to those of Wood (1971) (82%) malocclusion on American Eskimos, Zietsman (1979) on South African Indians (76.5%) malocclusion and Garner And Butt (1985) (83.2%) on Kikuyu Kenyans and that of Sputh (1980) (84.5%) in Americans. The influence of genetic factors in the determination of occlusal traits or malocclusion therefore becomes questionable. The most prevalent malocclusion was found to be Angle's Class I malocclusion. Typification of this malocclusion according to the method described by El-Mangoury and Mustafa (1991) gives an indication of the most prevalent type of malocclusion seen, i.e. (the one needing the most attention) one with the molars in a Class I relationship but with the maxillary anterior teeth crowded. Labioversion of the maxillary incisors was found to be the next most common type of Angle's Class I malocclusion. The low prevalence of the Type III Angle Class I malocclusion suggests that it may not be an important factor to consider in the determination of treatment needs. The prevalence of Angle's Class II malocclusion was also found to be moderately high, of which the Angle Class II Division I malocclusion was found to be most prevalent. The present finding (16,9%) corresponds reasonably with Zietsman's (1979) assessment (13,8%) and that of Goose <u>et</u> <u>al</u>. (1957) (16,1%).

It differed from the findings of Grewe et al. (1968) (9.6%) done on Chippewa Indians.

The Angle Class III was found to be the least frequent of malocclusions (5,5%) and corresponds with the findings of Baume and Marèchaux (1974) on Polynesians (5.5%) and Horowitz (1970) (5.5%) on Americans. The occlusal variation amongst South Africans of Indian origin differs numerically from other world populations. These differences cannot be attributed to a genetic background as some forms of Angle's malocclusions were found to be similar to groups from diverse genetic pools. This agrees with the findings expressed by Corruccini and Whitley (1981), Corrucini (1984), Corrucini and Pacciani (1989), that genetics is not an important consideration in differences of occlusal patterns.

The general pattern of occlusal variation, however, was similar to other world populations, i.e. the incidence of Angle Class I malocclusion tends to be more common than Angle Class II and Angle Class II Division I occurs more often than Angle Class II Division II. Angle's Class III malocclusion is least common.

SIMILARITIES BETWEEN THE FDI COCSTOC-MOT METHOD AND ANGLES CLASSIFICATION:

The finding of this study using Angle's classification with the Dewey-Andersen and El-Mangoury and Mustafa (1991) modification compared well with the occlusal trait assessment of the FDI. The most common occlusal trait according to the FDI was crowding of the anterior teeth - a feature found to be most common with the El-Mangoury and Mustafa (1991) method of malocclusial typification.

Labioversion of the maxillary incisors was found to be the next most common type of Angle's Class I malocclusion which corresponded to the FDI finding of a high frequency of individuals with increased overjet. Angle's Class I type VI, indicating the presence of diastemata, was also found to be similar with both methods of occlusal assessment. These three features - crowding, protrusion and diastemata - indicate in accordance with the FDI and Angle's classification, the prevalence of features important for aesthetics and may therefore be important determinants of treatment needs.

As with the FDI method assessment of the prevalence of negative overjet, (Angle's Class I type III) was also found to be low suggesting that it may not be an important factor in the determination of treatment needs.

The high prevalence of incisor overjet found with the FDI method also corresponds with the prevalence of Class II Division I malocclusion.

Both the FDI and the Angle's classification have shown the prevalence of mesial molar relations to be low.

The FDI findings have indicated that crowding, increased overjet and midline diastemas were the most prevalent factors. This agrees with the study where the Angle's (Dewey-Anderson; El-Mangoury and Mustafa) classification was used. These are issues that influence the aesthetics of the patient as well and are important therefore for treatment. The FDI method in addition indicated a high prevalence of missing mandibular molars and maxillary molars. As the likelihood of these teeth being missing due to trauma is low, we can assume that the loss is most often due to extractions. The Angle classification (with the most current modification by El-Mangoury and Mustafa, 1991, Appendix II) and the FDI COCSTOC-MOT method have described the occlusal status of this sample similar terms. Because of the simplicity of its application, its extensive use and universal usage the Angle classification (with the El-Mangoury and Mustafa, 1991, typification) should be used in epidemiological studies. This will make communications with other dental personnel easier and comparisons with international malocclusion studies possible.

TREATMENT SUGGESTIONS:

Orthodontic treatment is not a priority in public dental health care services, due to the limited resources in South Africa. Therefore, an orthodontic public health service will have to establish priorities. Customarily the highest priority is given to the greatest need. Public health orthodontists therefore need a system not only for identifying malocclusion but for arranging cases on a sliding priority scale. This would enable authorities to select a cut-off point according to its manpower and material resources. The FDI method has grouped occlusal traits of significance to both the patient (aesthetics) and the orthodontist making feasible the task of deciding which feature to treat.

Identification of children at high risk for conditions best treated in childhood should be a major emphasis in dental education. The timing of orthodontic treatment for optimal results should also be an important component of the dental curriculum. An increased emphasis should be placed on identification of orthodontic problems and treatment approaches in the undergraduate curriculum. This includes an understanding of orthodontic diagnosis so that individuals at risk for development of oral health problems can be appraised of their risk. The availability and efficiency of various treatment alternatives should be included in the curriculum. Some of these occlusal deficiencies can be treated with removable appliances and others with fixed appliances. The determination of which Angle's malocclusion or occlusal trait be treated with a particular method is very subjective. Approximately 40% of patients presenting for treatment at the U.W.C. Dental Faculty are treated with removable appliances. The rest appear to need fixed appliance treatment and even those who are treated with a removable appliance ideally will eventually need fixed orthodontic treatment to obtain a good result.

The determination of whether to use a fixed or removable appliance to treat the occlusal condition may be done during the examination of the patients as was done in the 1991 National Oral Health Survey. This is subjective and was not a factor recorded in this study.

8. CONCLUSION

1. The high prevalence of the crowding of anterior teeth and increased overjets needs to be addressed with a well co-ordinated public orthodontic programme.

2. The need to establish an index of treatment needs will have to precede any orthodontic programme. This index of treatment need will have to incorporate the aesthetic and cultural values of the community concerned as well as a psychosocial component.

3. Both the Angle's classification (with the Dewey-Anderson and El-Mangoury and Mustafa, 1991) modifications and the FDI method of occlusal trait determination were found to be efficient in emphasising the prevalence of occlusal aberrations.

   The FDI method could also be used to develop norms for different occlusal traits in a particular population group.

4. Ideal occlusion, as defined by Angle (1899) was found to be very rare.

5. The pattern of distribution of Angle's Class I, Class II and Class III in this sample was similar to that found in other population groups.

APPENDIX IA

(CORRESPONDENCE: PERMISSION FOR STUDY FROM THE DEPARTMENT OF EDUCATION AND CULTURE, HOUSE OF DELEGATES)

HDE 1

Republic of South Africa
Repupliek van Suid-Afrika

ADMINISTRATION: HOUSE OF DELEGATES
ADMINISTRASIE: RAAD VAN AFGEVAARDIGDES

Department of Education and Culture
Departement van Onderwys en Kultuur

☎ (031) 3606911 Fax: (031) 374261

Truro House
Trurohuis
17 Victoria Embankment
Victoria Embankment 17
Private Bag
Privaatsak X54323
DURBAN
4000

Ref. No.
Verw. No. A10/29/2/8

Enquiries
Navrae S. Pillay

1992 -01- 06

Dr J. Kaka
Faculty of Dentistry
University of Western Cape
Private Bag X12
TYGERBERG
7505

Sir

REQUEST FOR PERMISSION TO CONDUCT RESEARCH
Your letter dated 23 November 1991 has reference.

1. Permission is hereby granted to you to conduct your research at the schools in the Western Cape provided that:

1.1 parental consent is obtained in respect of each child to be used in the examination;

1.2 prior arrangements are made with the principals concerned;

1.3 participation in the research is on a voluntary basis;

1.4 the investigation is carried out with the least amount of disruption at schools.

2. Kindly produce a copy of this letter when visiting schools.

3. The Department wishes you every success in your research and looks forward to receiving a copy of the findings.

Yours faithfully

for CHIEF EXECUTIVE DIRECTOR

92-01-31/research/nn

APPENDIX IB

The South African Indian

The earliest emigrations of Indians to South Africa involved individual adventurers. It was not until the middle of the nineteenth century that Indians arrived in great numbers and came to constitute a separate community. They came in two categories, namely as indentured Indians and as free passengers, the latter mainly as traders. After serving their indentures, the first category of Indians were free to remain in South Africa or return to India. Those who indentured themselves to the British abroad were from the Madras Presidency and the dominions of the Nizam at Hyderabad. The former had been drawn from what are now Tamil Nadu and Andhra Pradesh. They were Hindu, but retained much of the rural animistic culture of the South Indian countryside. Racially they were closer to the aboriginal dark Dravidian-speakers than to the Caucasoids. The "free" settlers, though they included a number of Tamil Telugu-speakers, also included large numbers of speakers of the Indo-European languages, Hindi, Bengali and Oriya. The third category comprised of the Vaisya traders, who were principally Muslims from the Gujerat and Maharashtra, speakers mostly of Gujerati and Kacchi and related languages. There has been very little intermarriage among the descendants of the three categories, or with other population groups. Most of the immigrant labourers remained in Natal, principally along the coast, which presents an environment not unlike that of South India. The traders, however, have spread widely. Though debarred from residence in the Orange Free State until relatively recently, they flourish in the Transvaal and form the great majority of Indians in the Cape and are particularly concentrated in Cape Town. Not all those in the Cape and the Transvaal were originally part of the Natal migrations. Portuguese influence, and to a lesser extent official British colonial activities, drew in a few persons from other parts of India. Though the origins of the different Indian language groups differ they are probably all of caucasoid stock (Bhana and Pachai, 1984; Nurse, Weiner and Jenkins, 1985).

APPENDIX IC

Dear Parent

The University of the Western Cape Dental Faculty is busy accumulating data on the orthodontic treatment needs of the community so that a better orthodontic service could be established. To do this, we need to examine your child's teeth.

Kindly indicate with an (X) if you wish to have your child's teeth examined.

☐ Yes ☐ No

Thank you

....

APPENDIX IIA

(MEASUREMENT OF OCCLUSAL TRAITS - RECORDING FORM)

MEASUREMENT OF OCCLUSAL TRAITS

RECORDING FORM

Name...

Date of Birth | | | | | | | Sex | |

A. Dental Measurements

	CODE
1. Anomalies of Development	
a. Congenitally Absent Teeth	C
b. Supernumerary Teeth	S
c. Malformed Teeth	M
d. Impacted Teeth	I
e. Transposed Teeth	T
2. Missing Teeth Due to Extraction or Trauma	X
3. Retained Primary Teeth	R

CODE	TOOTH

B. Intra-arch Measurements

1. Crowding (insufficient arch space)	C
2. Spacing (excessive arch space)	S
Normal	N
Non-recordable segment	A

	RIGHT LATERAL	INCISAL	LEFT LATERAL
UPPER			
LOWER			

3. Anterior Irregularities

Score only the largest irregularity for each arch to the nearest whole millimetre

	2	1	1	2
UPPER				
LOWER				

4. Upper Midline Diastema

If non-recordable, enter "A" in Box

| | ±mm

C. Inter-arch Measurements

1. Lateral Segments

	CODES	47	46	45	44	43	33	34	35	36	37
		RIGHT					LEFT				
a. Anteroposterior - Molar Relation	D+, D, N, M, M+										
b. Vertical - Posterior Openbite	N, O										
c. Transverse - Posterior Crossbite	B, N, L										

If a tooth is ABSENT, measurement is unrecordable A

2. Incisal Segments

		RIGHT 2	RIGHT 1	LEFT 1	LEFT 2
a. Anteroposterior - Overjet	±mm.				
b. Vertical - Overbite	±mm.				
c. Transverse - Midline Deviation	±mm., side				
d. Soft Tissue Impingement	L, P				

If a tooth is ABSENT, measurement is unrecordable A

<u>The FDI Method</u> (Baume <u>et</u> <u>al</u>. (1974):

<u>A method for measuring occlusal traits</u>:

Developed by the FDI Commission on Classification and Statistics for Oral Condition (COCSTOC). Working group 2 on Dentofacial Anomalies, 1969-72.

The FDI Commission on Classification and Statistics for Oral Conditions (COCSTOC), was established at the time of the FDI Conference in New York (1969). Its assigned task was to study the problem of assessing the occlusal status and to develop a system of measuring occlusion which could be applied widely.

Observations and measurements are designed to be made directly in the mouth. Although there are certain advantages and conveniences.

Measurements are limited to certain assessments of the teeth themselves, to relations among teeth in the same arch and to inter-arch relations of teeth; no general assessments of soft tissues are indicated, e.g. soft tissue profiles, because such assessments are too subjective.

The measurements made on each child are divided into three general categories: dental measurements, intra-arch measurements and inter-arch measurements. Under each of these categories the following specific variables are measured and recorded:

A. *Dental Measurements*

1. Anomalies of Development
   - (a) Congenitally Absent Teeth
   - (b) Supernumerary Teeth
   - (c) Malformed Teeth
   - (d) Impacted Teeth
2. Missing teeth due to extraction or trauma
3. Retained Primary Teeth

B. *Intra-arch Measurements*

1. Crowding (insufficient arch space)
2. Spacing (excessive arch, space)
3. Anterior Irregularities
4. Upper Midline Diastema

C. *Inter-arch Measurements*

1. Lateral Segments
   - (a) Antero-posterior - Molar Relation
   - (b) Vertical - Posterior Openbite
   - (c) Transverse - Posterior Crossbite
2. Incisal Segments
   - (a) Antero-posterior - Overjet
   - (b) Vertical - Overbite
     - Anterior open bite
   - (c) Transverse - Midline Deviation
   - (d) Soft Tissue Impingement

A tentative format for recording the findings of the examination has been drafted and is included. Whenever a tooth is identified, the new FDI system of tooth numbering is to be used. It should be emphasised that the format of the recording form included in this document is intended solely to help readers organize their thoughts on the variables to be measured.

Method of examination:

The method of examination will depend largely on available facilities. The examination may be made indoors, out-of-doors in open shade or wherever else natural or artificial lighting is adequate. The examination may be made with the subject sitting with his head supported in an upright position or standing with his back and head supported against a wall or other vertical flat surface. Whether the subject is sitting or standing, the examiner must have a direct view of both sides of the mouth.

In order to make the assessments in Category C (Inter-arch Measurements) the subjects must achieve centric occlusion, the position of habitual, maximal intercuspation.

Instrumentation:

The following items are required to conduct this examination of occlusal traits: a plane surface mouth mirror, a sharply pointed pencil and a Boley gauge or, if not available, another metric ruler.

Measurements:

A. Dental Measurements

These measurements are assessments of the status of individual teeth. Each tooth (and each space) is assessed for the condition listed. Pertinent questions to the subject may often be helpful in making differential diagnoses within this category of conditions.

1. Anomalies of Development

(a) Congenitally Absent Teeth (Code: C)

Considering the subject's chronological and dental ages, list those teeth which are assessed to be congenitally absent. If the subject gives a history of no previous extraction(s), and if the contour of the underlying alveolar ridge does not indicate an impacted tooth, the examiner can assume the tooth to be congenitally absent.

(b) Supernumerary Teeth (Code: S)

Every extra tooth is recorded irrespective of its shape or size. A supernumerary tooth should not be recorded as a malformed tooth. If a supernumerary tooth occurs buccal or lingual to the arch line, its location is recorded by assigning the tooth number of the closest tooth. If the supernumerary tooth lies in the arch line, it is recorded by assigning the number of the permanent tooth immediately distal to the supernumerary.

(c) Malformed Teeth (Code: M)

A malformed tooth is recorded only when the mesiodistal width of the tooth is larger or smaller than its normal range because of the malformation.

(d) Impacted Teeth (Code: D)

Considering the subject's chronological and dental ages, list those which are assessed to be impacted. If a subject gives a history of no previous extraction(s), and if the contour of the underlying alveolar ridge indicates the presence of a missing tooth, the examiner may assume the tooth to be impacted.

(e) Transposed Teeth (Code: T)

A transposition is recorded when the positions of two or more teeth are interchanged. All teeth involved are recorded. For example, if the upper right canine lies between the upper right premolars, a recording of transposition is made for both the right canine and first premolar.

2. Missing teeth due to extraction or trauma (Code: X)

The presence of spacing, the contour of the underlying alveolar ridge, the caries-experience of present teeth and pertinent questions to the subject will usually allow a correct assessment of missing teeth due to extraction or trauma.

3. Retained Primary Teeth (Code: R)

A primary tooth, retained for a year or more beyond the upper limit of its range in age for normal exfoliation, is recorded as a retained primary tooth. The permanent successor of the retained primary tooth should also be assessed, if it is erupted.

When recording these category A dental measurements, each condition is listed by code (C, T, S, M, I, X or R) and by tooth number (FDI tooth numbering system) in the appropriate boxes on the recording form. Because of the relatively low frequencies of these conditions, provisions is made for only ten entries. The method of recording is shown in the following example:

These conditions were noted in a subject:

i) Congenitally absent upper right permanent lateral incisor.

ii) Malformed lower left second premolar.

iii) tooth missing due to extraction lower right first permanent molar.

iv) Retained primary upper left canine.

These conditions would be recorded as:

Code	Tooth No.
C	12
M	35
X	46
R	63

B. Intra-arch Measurements

For the assessment of intra-arch measurements, each arch is divided into three segments: right lateral, incisal and left lateral. Each lateral segment includes the canine, both premolars and both molars; each incisal segment includes the four incisors. The points of demarcation between the incisal segments and their adjacent lateral incisors and not the mesial surfaces of the canines.

1. Crowding (insufficient arch space. Code: C)

Crowding is recorded for each segment where it is estimated that there is a shortage of 2mm or more of space preventing the correct alignment of all teeth in that segment. The Boley gauge (or metric ruler) may aid in this estimation. For those segments where crowding exists, a C is entered in the appropriate box of the recording form.

2. Spacing (excessive arch space Code: S)

Spacing is recorded for each segment where it is estimated that there is an excess of 2mm or more of space beyond that required for the correct alignment of all teeth in that segment. The Boley gauge (or metric ruler) may aid in this estimation. For those segments where spacing exists, an S is entered in the appropriate box of the recording form. Where neither crowding nor spacing exists for a segment, an N (Normal) is entered in the appropriate box of the recording form. Measurements of crowding or spacing are not made for a segment if any of the conditions listed in Category A (Dental Measurements) have been recorded for the same segment. For such segments, enter an A in the appropriate box of the recording form.

3. Anterior Irregularities

To make this measurement, the four incisors of each segment are visually scanned to locate the greatest irregularity between adjacent teeth. (The distal aspect of each lateral incisor is assessed in relation to the mesial aspect the adjacent canine). A separate measurement is made separately for the upper and lower segments.

To make the measurement, a point on the two adjacent teeth (with the largest irregularity) is located in the middle of the incisal edge (labiolingually) at the mesio-proximal or disto-proximal angle. This point will usually be located where the mesio- or disto-lingual marginal ridge joins the incisal edge. The measurement is the distance between the points along a line at right angles to the ideal arch line in the region. Record to the nearest whole millimetre. When all teeth are correctly aligned, the score for each incisal segment will be zero. Examples of anterior irregularity are given in Figure 9b.

4. Upper Midline Diastema

A recording of upper midline diastema is made in addition to the recording of spacing in the upper incisor segment because upper midline diastema is frequently a separate clinical entity. The measurement of diastema is made to the nearest whole millimetre at the level of the gingival margin and recorded. If no diastema exists, enter a zero, O in the box. Enter an A in the box if midline diastema is non-recordable because of conditions listed in Category A.

C. Inter-arch Measurements

For the assessment of inter-arch measurements, the dentition is divided into three segments: right lateral, incisal and left lateral. Each lateral segment includes the upper and lower canines, premolars and molars; the incisal segment include: upper and lower incisors.

1. Lateral segments

(a) Antero-posterior - Molar Relation

The measurement of the antero-posterior lateral segment relation is made with the subject in centric occlusion by direct inspection of the buccal segments on each side. To view the contact relation properly, a mouth mirror is used to retract each cheek successively and the molar relation is viewed directly or in the mirror at right angles to the buccal surfaces. One of five separate relations is recorded on each side of the mouth for the antero-posterior interdigitation of the upper and lower first permanent molars.

Code N: A cusp-and-groove relation in which the buccal groove of the lower first permanent molar articulates with the mesiobuccal cusp of the upper first permanent molar.

I: An end-to-end relation in which the tip of the mesiobuccal cusp of the lower first permanent molar articulates with the tip of the mesiobuccal cusp of the upper first permanent molar.

F: A cusp-and-groove relation in which the buccal groove of the lower first permanent molar articulates with the disto-buccal cusp of the upper first molar.

M: An end-to-end relation in which the tip of the distobuccal cusp of the lower first permanent molar articulates with the tip of the mesiobuccal cusp of the upper first molar.

M+: An articulation in which the distobuccal groove of the lower first molar or the interproximal space between the lower first and lower second molars articulates with the mesio buccal cusp of the upper first molar.

Any occlusion that is not precisely cusp-to-cusp tip (codes D or M) is given the designation of the closest cusp-to-groove or cusp-to-interproximal space relation (codes N, D+ or M+). For example, if the occlusion is between D and D+, D+ is recorded; if between D and N, N is recorded. If one or both of the first permanent molars on a side are missing, the relation of the first premolars is substituted for the first permanent molars; the cut-off points for the first premolars are like those of the first molar. (The first premolar is used as a substitute rather than the canine or second premolar because, if crowding exists, the upper canine and lower second premolar may be out of arch alignment because they are usually the last teeth to erupt into the lateral segments in their respective arches).

In recording this inter-arch measurement, where one of the first permanent molars is missing, record an A (Absent) in the box under 6 and record the appropriate code for antero-posterior relation under 4 (Refer to recording form).

(b) Vertical - Posterior Openbite

A measurement of the vertical relation of the lateral segments is made by direct inspection of the lateral segments of both sides of the mouth with the subject in centric occlusion. Each lower tooth in each lateral segment is assessed. Openbite is recorded only if there is no overlap of cusps (visible vertical space exists between the teeth when viewed at a right angle to the lateral segment).

<u>Note</u>:

When one of the first permanent molars is missing, an entry is also made under A. Dental Measurements, 2. Missing Teeth Due to Extraction or Trauma.

<u>Two codes are used</u>:

Code: N Normal: no vertical space is visible between a lower tooth and its antagonists).

O: Openbite vertical space is visible between a lower tooth and its antagonist(s).

(c) Transverse - Posterior Crossbite

The measurement of the transverse lateral segment relation is made with the subject in centric occlusion by direct inspection of the lateral segments. No instruments are necessary. One of three separate relations is recorded for the transverse interdigitation of the lateral segments (refer to Appendix II, FDI-form).

Code: N Normal relation: A buccal cusp of a lower tooth lies between the maximum heights of the buccal and lingual cusps of an opposing upper tooth.

B: Buccal crossbite: A buccal cusp of a lower tooth lies lingual to the maximum height of a lingual cusp of an opposing upper tooth.

L: Lingual crossbite: A buccal cusp of a lower tooth lies buccal to the maximum height of a buccal cusp of an opposing upper tooth.

The relation of each lower tooth to the upper opposing tooth in both right and left lateral segments is recorded. The lower tooth is scored. In order to avoid placing multiple N for subjects without posterior openbite and/or posterior crossbite, these situations may be indicated by placing an N in the respective box for tooth 7 for the right half of the mouth and then drawing a horizontal line to the right, through all remaining boxes; this designation will indicate that all recordings for that row are N's.

If any tooth of the lateral segments is missing, it is recorded as A (Absent) in the appropriate boxes.

2. Incisal Segments

(a) Antero-posterior - Overjet

Measurements of the horizontal relations of the incisors are made with the aid of a Boley gauge or a metric ruler while the subject is in centric occlusion and with his occlusal plane horizontal. If a Boley gauge is used, the end of the fixed scale of the gauge is placed against a lower incisor and the sliding scale is adjusted to touch the most labial part of the corresponding upper incisor. A measurement is made for each pair of upper and lower incisors. The long axis of the fixed scale is placed parallel to the occlusal plane. The measurement of overjet is recorded to the nearest whole millimetre. If any of the upper incisors is in crossbite, a measurement of the negative overjet is made and recorded.

(b) Vertical - Overbite - Open bite

Measurement of the vertical relations of the incisors is made with the aid of a Boley gauge or a metric ruler while the subject is in centric occlusion with his occlusal plane horizontal. The amount of vertical overlap of the upper incisors on the lower incisors is marked with the pencil on the labial surface of the lower incisors, using the incisal edge of the upper incisor to guide the pencil. The upper conical plane of the sharpened part of the pencil and not the shaft of the pencil itself is placed parallel to the subject's occlusal plane. The measurement from the incisal edge of the lower central incisor to the pencil mark is made to the nearest millimetre with the Boley gauge or ruler. A measurement is made for each pair of corresponding upper and lower incisors. If there is a lack of vertical overlap between any of the opposing pairs of incisors (openbite), the amount of openbite is measured directly with the Boley gauge or ruler and recorded to the nearest whole (negative) millimetre.

(c) Transverse - Midline Deviation

Measurement of midline relation is made with the subject in centric occlusion and with the aid of a Boley gauge or metric ruler. The distance from the midpoint between the two lower central incisors to the midpoint between the two upper central incisors in a horizontal (transverse) plane is recorded to the nearest whole millimetre. In addition, the side toward which the lower teeth deviate is recorded (R - Right or L - Left)

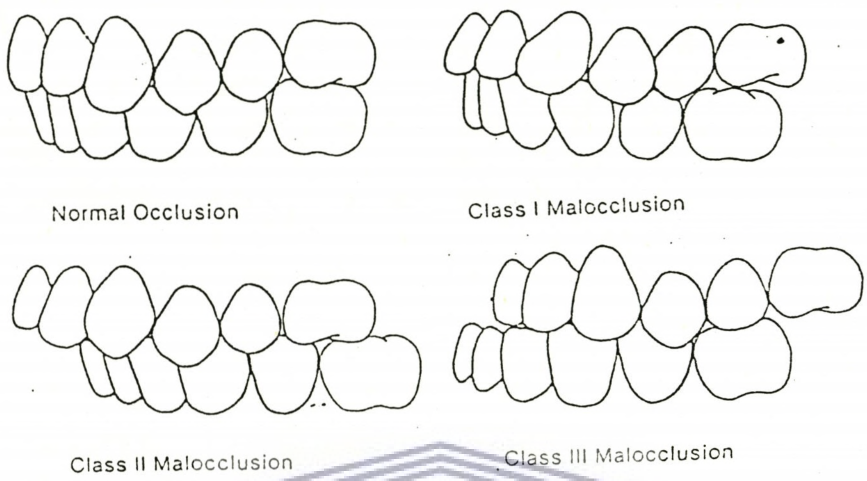
(d) Soft Tissue Impingement

This sole assessment of the soft tissue is made in the region of the occlusion of the four upper and four lower anterior teeth. Record any occlusal palatal impingement due to the lower incisors (score as a P) or any lower labial impingement due to the upper incisors (score as an L).

If any tooth of the lateral segments is missing and a measurement or assessment cannot be made, enter an A in the appropriate boxes.

APPENDIX IIB

(ANGLE'S CLASSIFICATION)



Normal occlusion and malocclusion classes as specified by Angle (1899).

(Figure 15)

ANGLES . CLASSIFICATION

ANGLE CLASS I

Type 1	Crowded maxillary anterior teeth	
Type 2	Maxillary incisors in labioversion	
Type 3	Maxillary incisors in lingioversion	
Type 4	Molars and premolars in bucco- or linguoversion	
Type 5	Mesioversion of the molars only	
Type 6	Diastemata	
Type 7	Deep anterior overbite	

ANGLES CLASS II

DIV I	
DIV II	

ANGLE CLASS III

Type 1	Edge to Edge bite	
Type 2	Normal anterior overbite	
Type 3	Anterior overbite	

ANGLE CLASS IV

Class II on the one side and Class III on the other side

Angle's Classification with the Dewey-Anderson and El-Mangoury and Mustafa (1991) modification:

The occlusion is recorded in centric occlusion. Angle's postulate was that the first molars were the key to occlusion and that the upper and lower molars should be related so that the mesiobuccal cusp of the upper molar occludes in the buccal groove of the lower molar. If this molar relationship exist and the teeth are arranged on a smoothly curving line of occlusion then normal occlusion will result.

Figure 15:

Angle described three classes of malocclusion based on the occlusal relationship of the first molars.

Class I: Normal relationship of the molars, but line of occlusion incorrect, because of malposed teeth, rotations or other causes. This class was divided into 5 types by Dewey (1919) and Anderson (1960). El-Mangoury and Mustafa (1991) added two more types to this form of Angles Class I malocclusion.

Class II: This malocclusion is seen when the lower molars are positioned distally relative to the upper molar. The line of occlusion is not specified. The class of malocclusion was divided into two divisions:

(i) Division I

Where the molar relationship is Class II and the maxillary incisors proclined.

(ii) Division II

Where the molar relationship is Class II, but the maxillary incisors retroclined (The lateral incisors may overlap the distal surfaces of the central incisors).

Class III: This malocclusion is when the lower molars are mesially positioned relative to the upper molars. The line of occlusion is not specified.

The Dewey-Anderson modification (1919 and 1960) describes 3 types based on the relationship of the upper anterior teeth (molars Class III).

See Tables 22(a) and 22(b)

Types of Angle Class III

Dewey-Anderson modifications for typification of Angle Class III	
Type I	(edge-to-edge bite)
Type II	(normal anterior overbite)
Type III	(anterior crossbite)

Table 22(a)

Types of Angle Class I

Dewey-Anderson modifications for typification of Angle Class III	
Type I	(crowded maxillary anterior teeth)
Type II	(maxillary incisors in labioversion)
Type III	(maxillary incisors in linguoversion)
Type IV	(molars or premolars in bucco- or linguoversion)
Type V	(mesioversion of the molars only)
Type VI*	(diastemata)
Type VII*	(deep anterior overbite)

Table 22(b)

*Types VI and VII were added by El-Mangoury and Mustafa to the original Dewey-Anderson modifications for typifications of Angle Class I.

APPENDIX III

KAPPA TEST FORMULAE

$$K = (Po - Pe) / (1 - Pe)$$

WHERE: K = Kappa Value

Po = Proportion observed agreement

Pe = Proportion of agreement which could be expected by chance.

Kappa Test: Sample:

Using the value for the crowded upper incisal area for the first and second examination of the standardization process, the Kappa result was calculated as follows:

The Kappa Test was done to determine variability, explained by Bulman and Osborn (1989). An example of the method applied follows. The variable used was that of the crowded upper incisal area for the first and second examination of the standardization process.

Experiment I

		Normal	Abnormal	
Experiment II	N	85	2	87
	A	0	13	5
		85	15	

Table of observed values

Applying the formula:

K = (Pa - Pe) / (1 - Pe)

WHERE: K = Kappa Value

Po = Proportion observed agreement

Pe = Proportion of agreement which could be expected by chance.

	Normal	Abnormal	
N	74	13	87
A	11	2	13
	85	15	

Table of expected values

1. The observed probability of agreement (Po) was:

   0.85 + 0.13 = 0.98

2. The expected probability of agreement (Pe) was:

   0.74 + 0.95 = 0.76

Po - Pe = 0.98 - 0.76 = 0.22

1 Pe = 0.24

1-Pe

i.e. Kappa = 0.22 / 0.24

= 91.67
------->

APPENDIX IV

PILOT STUDY

INTRA-EXAMINER VARIATION: (Table 23)

VARIABLE	FIRST EXAM	SECOND EXAM
Frequency distribution of overjet (in percentage): **Left Lateral Incisor**		
Negative	10%	10%
Between 2-4mm	65%	65%
Increased overjet Between 7-9mm		
Frequency distribution of overbite (in percentage): **Left Lateral Incisor**		
Negative overbite	10%	10%
Between 2-4mm	70%	70%
Increased overbite Greater than 5mm	0%	0%
Percentage distribution of midline deviations:		
Normal: No Deviations	55%	50%
Percentage distribution of space conditions:		
Crowded upper incisal area	45%	50%
Crowded lower incisal area	45%	45%
Spaced upper incisal area	15%	15%
Spaced lower incisal area	15%	15%
Percentage distribution of antero-posterior molar relationship:		
Normal	70%	70%
Distal	15%	15%
Mesial	10%	10%
Percentage distribution of soft tissue impingement:		
Normal	85%	85%
Lingual	5%	5%
Labial	5%	5%

Frequency of dental anomalies missing teeth due to trauma or extraction:		
Maxillary molars	0%	0%
Mandibular molars	10%	10%

INTRA-EXAMINER VARIATION BASED ON ANGLE'S CLASSIFICATION: (PILOT STUDY)

Angles Class I Type II Maxillary incisors in labioversion	20%	20%
Angles Class II Division I	15%	15%
Angles Class III Type III	5%	5%

SUMMARY OF THE FINDINGS OF THE PILOT STUDY: (Table 24)

	MOST COMMON FEATURE
Dental measurements missing due to extraction or trauma:	
1. Overjet	- few teeth with reverse overjet. - most teeth had an overjet of 2-4mm. - central incisors showed more increased overjets than lateral incisors.
2. Overbite	- few teeth with reverse overbite. - most teeth showed an overbite of between 2-3mm.
Space conditions:	
1. Crowding	- most prevalent in the upper incisal area, followed by the lower incisal area.
2. Spacing	- most prevalent in the upper incisal area, followed by the lower incisal area.
Anterior irregularities:	- most subjects did not show any irregularities in their anterior teeth (80-90%). Where such irregularities were present, they were most often found to be in the range of 2-3mm.
Percentage distribution of midline deviation:	- most candidates examined had no midline deviation.
Soft tissue impingement:	- 85% of subjects had no soft tissue impingement. The number of candidates with either labial or lingual soft tissue impingement were normal.
Molar relation:	- a normal molar relationship was seen in 70% of the candidates. A distal molar relation was found in 15% and in 5% of the subjects, a mesial molar relationship was noted.

RESULTS OF PILOT STUDY BASED ON ANGLE'S SYSTEM OF CLASSIFICATION WITH THE DEWEY-ANDERSON AND EL-MANGOURY MODIFICATIONS

(Table 25 continued)

	- 20% of cases had a normal occlusion. 50% of the candidates had an Angles Class I malocclusion with the Type I (crowded maxillary anterior teeth most common). Angle Class II was present in 20% of cases with the Division I more common than the Division II. Only 5% of the candidates had an Angle Class III malocclusion.

STANDARDIZATION: (Table 25)

20 Plaster models of patients were taken at random. These were examined according to the COCSTOC-MOT method.

VARIABLE	FIRST EXAM	SECOND EXAM
Frequency distribution of overjet (in percentage): **Left Lateral Incisor**		
Negative	10%	10%
Between 2-4mm	60%	60%
Increased overjet Between 7-9mm	5%	5%
Frequency distribution of overbite (in percentage): **Left Lateral Incisor**		
Negative overbite	15%	15%
Between 2-4mm	60%	65%
Increased overbite Greater than 5mm	0%	0%
Midline diastema:		
None	90%	90%
2mm	10%	10%
Percentage distribution of midline deviations:		
Normal: No Deviations	59,3%	58,2%
Percentage distribution of space conditions:		
Crowded upper incisal area	15%	13%
Crowded lower incisal area	15%	15%
Spaced upper incisal area	10%	15%
Spaced lower incisal area	5%	5%
Percentage distribution of antero-posterior molar relationship:		
Normal	35%	35%
Distal	20%	20%
Mesial	45%	45%

Percentage distribution of soft tissue impingement:		
Normal	95%	95%
Lingual	5%	5%
Labial	0%	0%
Frequency of dental anomalies missing teeth due to trauma or extraction:		
Maxillary molars	2 (cases)	2 (cases)
Mandibular molars	2 (cases)	2 (cases)

STANDARDIZATION ON ANGLE'S CLASSIFICATION WITH THE DEWEY-ANDERSON AND EL-MANGOURY (1991) MODIFICATION

Angles Class I Type II Maxillary incisors in labioversion	10%	10%
Angles Class II Division I	15%	15%
Angles Class III Type III	5%	5%

INTRA-EXAMINER VARIATION: (Table 26)

VARIABLE	FIRST EXAM	SECOND EXAM
Frequency distribution of overjet (in percentage): **Left Lateral Incisor**		
Negative	5,8%	5,8%
Between 2-4mm	69,7%	79,8%
Increased overjet Between 7-9mm	5,8%	5,8%
Frequency distribution of overbite (in percentage): **Left Lateral Incisor**		
Negative overbite	8,7%	8,7%
Between 2-4mm	74,3%	74,3%
Increased overbite Greater than 5mm	8,5%	8,5%
Midline diastema:		
None	88,5%	88,5%
2mm	8,6%	8,6%
Percentage distribution of midline deviations:		
Normal: No Deviations	51,4%	51,4%
Percentage distribution of space conditions:		
Crowded upper incisal area	57,2%	57,2%
Crowded lower incisal area	56%	57%
Spaced upper incisal area	8,6%	8,5%
Spaced lower incisal area	5,8%	5,8%
Percentage distribution of antero-posterior molar relationship:		
Normal	80%	80%
Distal	11,3%	11,3%
Mesial	5,9%	5,9%

Percentage distribution of soft tissue impingement:		
Normal	94,3%	94,3%
Lingual	0%	0%
Labial	5,7%	5,7%
Frequency of dental anomalies missing teeth due to trauma or extraction:		
Maxillary molars	2 (cases)	2 (cases)
Mandibular molars	3 (cases)	3 (cases)

STANDARDIZATION ON ANGLE'S CLASSIFICATION WITH THE DEWEY-ANDERSON AND EL-MANGOURY (1991) MODIFICATION

Angles Class I Type II Maxillary incisors in labioversion	8,5%	8,5%
Angles Class II Division I	14,3%	14,3%
Angles Class III Type III	8,5%	8,5%

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