A COMPARISON OF THE ORAL HEALTH STATUS OF CHILDREN AND ADULTS LIVING IN LOW, OPTIMAL, AND HIGH FLUORIDE AREAS.

A dissertation submitted to the School of Oral Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in fulfilment of the requirements for the degree of Master of Science in Dentistry (by research only) in the branch of Community Dentistry.

MESHACK ITUMELENG MOLEFE

DECLARATION

I, MESHACK ITUMELENG MOLEFE DECLARE THAT THIS RESEARCH REPORT IS MY OWN WORK AND HAS NOT BEEN SUBMITTED FOR ANY DEGREE AT ANOTHER UNIVERSITY.

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MESHACK I. MOLEFE

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DEDICATION

OFENTSE, MMABATHO

SUMMARY

Dental caries prevalence in many developing countries is low but an increased prevalence has recently been reported from some of these countries. This is in contrast to the data from the industrialised countries which show a consistent decrease in caries prevalence, particularly in urban populations. The phenomenon of a low caries experience in areas having an optimal fluoride concentration in water is well documented. On the other hand, many reports show that higher than optimal levels of fluoride in drinking water are associated with varying degrees of fluorosis (Murry et. al, 1991). In developing countries, a high prevalence of periodontal disease has been reported in both teenagers and adults. The present study compared the caries profile, periodontal disease and fluorosis among children and adults residing in low, "optimal" and high fluoride areas in four villages in the Mankwe region, North-West Province of South Africa.

The population of the Mankwe region was approximately 63 000 in 1993 and fifty percent of whom were children (Development Bank of South Africa, 1994). The climateis hot and dry, and until recently, people depended on underground and rain water. Access to tap water was costly. Oral health facilities were limited and there were inadequate oral health personnel.

The method of sampling, examination techniques, instruments used and the statistical analysis were carried out under supervision of experienced epidemiologist and in consultation with expert statisticians. The indices used included the Decayed, Missing and Filled Teeth (DMFT, dmft), Community Periodontal Index of Treatment Needs (CPITN) (WHO 1987; Ainamo et al, 1982), Dean's Index (Dean et al. 1942) and the Tooth Surface Index of Fluorosis (TSIF) (Horowitz et al,1984).

A total of 360 subjects aged 6-7, 12-13 and 30-55 years were examined. More than 90 percent of the 6-7 year old children were caries-free in the permanent dentition at all four study villages. Both dmft and DMFT scores were very low. DMFT values for the 12-13 year old group was also well within the WHO goals in all the villages but increased in the adult group. The D-component was dominant in all groups with the occlusal surfaces most affected. There was a high percentage of periodontal disease but with low severity. Less than 30 percent of the adults aged 30-55 years

demonstrated bleeding on probing at all the four villages. In the 30-55 year age groups, calculus was predominantly found at Lerome and less than 32 percent and 20 percent had shallow and deep pockets respectively at all the four villages. All those in the 12-13 and 30-55 year age groups were assessed as needing oral hygiene instructions and less than 20 percent of the adults needed advanced periodontal care.

When using Dean's index in the 12-13 year age group, the highest percentage with fluorosis was found at Ruighoek which had an excessive amount of fluoride in drinking water, but fluorosis was also pronounced at Lerome. The central incisors were more affected than the lateral incisors when using the TSIF. Also, mandibular first molars were more affected than maxillary first molars. In the 30-55 year olds, there was a decrease in the severity of fluorosis with age at the high fluoride villages, but all of the adults examined had brown discolouration at Ruighoek.

Based on the finding of this study it is suggested that greater efforts be made to introduce proven preventive treatment programmes in these communities. More human resources particularly in the form of auxiliaries should also be employed in order to promote oral health education and provide basic periodontal intervention. The fluorosis problem could be addressed by introducing potable water and the unsightly brown discolouration in adolescents could be eliminated by either bleaching, composite veneers or crowns. However, the latter solution is expensive and is dependent on sophisticated equipment and highly trained dental personnel.

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CHAPTER 1

1. INTRODUCTION

In this chapter, specific features of a region in North-West Province (formerly known as Bophuthatswana) are described. These include the population, climate, water supply, health services and oral health status. Bophuthatswana was one of the (TBVC) homelands in the Republic of South Africa. It comprised of 14 regions scattered as islands throughout the Republic. It is now incorporated into North-West Province (Appendix 1). This research was undertaken prior to the elections of 1994 and before new political boundaries were established.

The total population of Bophuthatswana in 1993 was approximately 3.5 million with a density of 29,8 persons per km^2. The official rate of functional urbanisation was 43,9 percent. The absorption capacity of the potential labour force was 50,0 percent while unemployment was 36,3 percent. Gross Domestic Product (GDP) was R4 450 million and its main contributors were mining and quarrying 45,3 percent; community, personnel and social services 16,1 percent and manufacturing 12,6 percent (Development Bank of South Africa, 1994). The average household size was 5,9 persons with a personal monthly income of R4 995 per capita. The literacy rate among 13 years olds and older, with Standard 5 and higher, was 55,8 percent and children not attending school (6-14 year olds) was 13,7 percent. Life expectancy at birth was 64 years and infant mortality rate was 43,3 percent. Hospital beds per 1 000 population was 4,5 percent and medical officers per 1 000 population was 0,1 percent in 1992. (Development Bank of South Africa, 1994).

Tourism is a major attraction of the study area especially with the presence of Sun City and the Pilansburg National Park. According to the South African Tourism Board 1995, (Personal communication) the size of the domestic holiday market was 10,1 percent of 12 112 000 trips per annum. This equals 1 211 000 trips and its value was 6,7 percent of R12 355 million, that is R827 million. The size of overseas market was 9 percent of market ± 63 000 tourists per annum, and its value was 63 000 by 3.7 nights by R220 which equals R51 million.

1.2. MANKWE

Mankwe was one of the regions in the former Independent State of Bophuthatswana and is situated about 50 km from Rustenburg. A number of hills and dense vegetation are found in the region. The four villages selected for this study lie between longitudes $26^{0}48'$ and $27^{0}28'$ and latitudes $25^{0}5'$ and $25^{0}25'$ and are from 1 108 to 1 400 metres above the sea level. (Appendix 1.) These villages Elandskuil (V1), Morogong (V2), Lerome (V3) and Ruighoek (V4) were selected due to the differences in water fluoride levels between the different villages (Table 1), a factor which strengthen the possibility of comparison.

1.3. POPULATION

The majority of the people in this region were Tswana speaking and the total population of this region was about 63 000 (1993 figures), more than 50 percent of whom were children. The working middle age group who lived at the villages near the mines and factories, commuted from home to work on a daily basis and the lifestyle of their families were similar to that observed in urban areas. Eighty percent of the children, 6-18 years old attended school.

1.4. CLIMATE

This region has a typical hot, dry African climate. The average daily maximum temperature is about $31^{0}C$ in summer and $25^{0}C$ in winter. The average summer rainfall is 621,0 mm per annum (Table 2).

TABLE 1

FLUORIDE CONCENTRATION OF DRINKING WATER IN THE FOUR STUDY VILLAGES

VILLAGE	Fluoride (ppm)
Elandskuil Village 1 (V1)	0,1-0,3
Morogong Village 2 (V2)	0,4-0,9
Lerome Village 3 (V3)	3-6
Ruighoek Village 4 (V4)	7-8

Data source: Department of Public Works & Water Affairs, Bophuthatswana Government (Now Northwest Province 1984).

TABLE 2

TEMPERATURE AND RAINFALL OF MANKWE REGION

SEASON	AVERAGE	DAILY TEMPERATURE Min	Max	RELATIVE HUMIDITY	RAINFALL mm/year
SUMMER	31,1	15,6	23,3	68	621,0
WINTER	25,0	5,5	15,2	80	
MONTHLY	27,8	8,5	18,2	74	

Data source: Department of Civil Aviation, Pilansburg Airport, South Africa (1990).

1.5. WATER SUPPLY

At the time of this study, there were no dams in this region. Very few wells existed, but water from these wells were seldom used for human consumption. Until recently all the people depended on underground and rain water. In 1993, the Bophuthatswana Water Board had a plan to supply all the villages with tap water. Some of the villages had access to tap water, but this basic commodity was relatively costly because every household was required to pay an installation fee of approximately R1,600 per household tap. This cost was high particularly when considering the high unemployment, low wages and poor pensions.

1.6. BRIEF OVERVIEW OF ORAL HEALTH AND ORAL HEALTH SERVICES IN THE STUDY AREA.

There were small clinics at most of the villages. The main frontline providers of medical services were nurses stationed at all the clinics, although medical doctors visited the clinics periodically. Treatment of pain and sepsis, usually by extractions, was the only dental service provided at these peripheral clinics. Most extractions were carried out with patients seated on an ordinary office chair. Dental officers periodically visited clinics and referred patients to hospital or better equipped clinics for preventive and/or conservative treatment. However, very few patients could benefit from these services because of lack of transport or finance.

The concentration of fluoride in drinking water is often affected by seasonal fluctuation (Manji et al, 1988). The different communities in the study region had similar ethnic and cultural values, socio-economic status, nutrition and dietary habits. Severe fluorosis created aesthetic and psychosocial problems. Some of the people, especially females, requested extraction of their maxillary incisors and for the missing teeth to be replaced with dentures while others attempted to remove the unsightly discolouration with ash or sand paper (Bischoff et al, 1976).

Adults who visited the clinics demonstrated some form of periodontal disease, some with severe periodontal breakdown and mobility of teeth. Traditional tooth cleaning methods such as the use of ash were slowly being replaced by toothbrushes and toothpaste's, the latter containing fluoride.

The impact of the changing environment, the adoption of new habits and life styles, and the effects of different concentrations of fluoride on oral health need to be addressed. This study was therefore undertaken to explore the relationships of these factors, and their effects on the oral health status of the children and adults living in the Mankwe region of former Bophuthaswana homeland of South Africa.

CHAPTER 2

2. REVIEW OF THE LITERATURE

This chapter is divided into two parts. The first part defines and reviews some relevant global trends in oral health and briefly discusses current concepts of dental caries, periodontal disease and dental fluorosis. In part two, a review of the literature on dental caries, periodontal disease and fluorosis is presented with particular emphasis on southern Africa, Africa and some developing countries outside Africa.

An extensive review of relevant publications was done using data sources such as the MEDLINE. Key words such as 'dental caries', 'dental fluorosis', 'periodontal disease', and 'fluoridation' were used to identify relevant publications after which these were accessed in the libraries. Relevant books and monographs were also retrieved from library sources. Literature older than 10 years were only included where these are of special significance.

PART 1
INTRODUCTORY REMARKS

DENTAL CARIES

DEFINITIONS

Dental caries is a microbially mediated disease of the calcified tissues of teeth. It is characterised by demineralisation by acids of the inorganic portion and destruction of the organic substance of the tooth. The important disease producing elements of dental caries are: i) the nature of the causative agent ii) host tissue (the tooth) iii) bacterial substrate used by pathogens or dietary carbohydrate. When these three components interact, the necessary ingredients are present and over a period of time dental caries can occur (Holbrook, 1993).

Dental caries commonly occur on the pits, fissures or smooth surfaces of the teeth. Pit or fissure caries develops on the occlusal surfaces of molars and premolars, on the buccal and lingual surfaces of molars and in the palatal surfaces of maxillary incisors. Pits or fissures with high steep walls and narrow bases are those most prone to develop caries (Mann et al, 1990; Horowitz, 1992). Smooth surface caries develops on the proximal surfaces of the teeth or on the gingival third of the buccal and lingual surfaces. It is also preceded by the formation of plaque, which ensures the retention of carbohydrates and micro-organisms on the tooth surface in an area not habitually cleansed and the subsequent formation of acid to initiate the caries process. Proximal caries usually begins below the contact point, and appears in the early stages as a faint white opacity of enamel without apparent loss of continuity of the enamel surface (Shellis and Duckworth, 1994).

CURRENT CONCEPTS IN DENTAL CARIES

Current concept in dental caries indicate that the initial caries lesion, that is, the 'white spot lesion' is reversible and that, there is a balance between demineralisation and remineralisation (ten Cate 1990, Shellis and Duckworth 1994). Caries is therefore an alternating process of destruction and repair. When the destructive forces outweigh the reparative powers of saliva, the disease will progress. Conversely, if the reparative forces (particularly fluoride intervention) outweigh the destructive forces, the disease will be arrested or even retarded (Shellis and Duckworth, 1994).

EPIDEMIOLOGY OF CARIES

Dental caries reached a peak in the 1960s in industrialised countries after the Second World War. In the United Kingdom, since the early 1970's there has been a decline in caries experience by about 50 percent in the five year olds, 40 percent in the 12 year olds and 33 percent in the 15 year olds (Downer, 1984, 1998). Following the initial rapid decline, caries levels in 5-year old children appear to have stabilised over the past 10 years at a mean dmft of around 1.8 and to have started to level out in 12 year old children at about 1.0 DMFT. The proportions of 5 year old children free from caries has continued to increase slightly (Downer 1998).

From the data collected at the WHO global data bank, two major trends in dental health have been identified; deterioration for most of the developing countries and improvement for most industrialised countries (Renson, 1989).

In view of the emerging concepts and trends in caries prevalence, the WHO/FDI set global goals for the year 2000. Three of these are particularly relevant to the present study:-

1. 50 percent of 5-6 year olds should be caries-free.

2. a DMFT score of 3 or less for the 12 year olds.

3. 85 percent of the population should retain all their permanent teeth at age 18.

PERIODONTAL DISEASE

CURRENT CONCEPTS

There are at present three competing theories in periodontal disease. These include: (i) the linear progression of gingivitis to periodontal disease which occurs in only a small percentage of the population (ii) the random burst and (iii) the asynchronous burst theory, the latter two are now considered important theories in explaining the patterns of periodontal disease (Socransky and Haffajee, 1990; Baelum and Papapanou, 1996).

Gingivitis does not invariably progress to periodontitis in all people, and the erratic nature of bursts of destructive disease presents difficulties in defining periodontal health. The value of screening to detect periodontal disease at an early stage has therefore been questioned (Manji et al, 1988).

Another important implication is that the traditional intervention in cases of gingivitis and periodontal pockets may be unnecessary in many cases. The presence of a periodontal pocket is considered a legacy of past disease and gingivitis could be considered as an indicator of a healthy defence mechanism (Manji et al, 1988). In periodontal diseases, bacteria trigger inflammatory host responses which along with direct destructive effects of the bacteria, cause most of the tissue destruction (Genco, 1992).

EPIDEMIOLOGY OF PERIODONTAL DISEASE

Most of the populations in industrialised countries have gingivitis and some periodontitis. However, the rate of progression of the disease is usually slow and only a very small number require intensive periodontal therapy. The severity of periodontal disease is reported to be greater in developing countries (Pilot and Miyazaki, 1994). Despite the high levels of periodontal disease, tooth loss from the disease is uncommon (Baelum and Papapanou, 1996).

The use of the Community Periodontal Index of Treatment Needs (CPITN) has confirmed the earlier general picture of higher prevalence of periodontal disease in developing countries (Pilot and Miyazaki, 1994; Ainamo and Ainamo, 1994). When data from developed and developing countries are compared, the latter have much higher levels of bleeding and calculus but not necessarily higher levels of pocketing at an earlier age (Miyazaki et al, 1991). The available data on periodontal disease from WHO global bank show that there is a low or moderate level of bleeding or calculus in industrialised countries and generally high prevalence but low severity in developing countries (Cutress and Suckling, 1990).

DENTAL FLUOROSIS

Due to the importance of fluorosis in this study, a more detailed background of various aspects of fluoride is presented.

HISTORICAL BACKGROUND

McKay and Black (1916) observed dental fluorosis in Colorado Springs in 1901 and by 1916, the association with decreased caries incidence was reported. In 1931, Churchill suspected a correlation between mottled enamel and fluoride concentration in water. This correlation was confirmed later that year by Smith and Smith (1935), who experimentally produced mottled enamel in rats by feeding them with varying amounts of sodium fluoride. The classical studies of Dean (1936), Dean et al, (1941) and (1942) provided a basis for the generally accepted rule that optimal caries protection and minimal fluorosis were in the USA associated with drinking water containing fluoride level of about 1ppm.

Idiopathic mottling opacities are usually more oval in shape and more opaque in appearance than questionable fluorosis opacities where the drinking water contains high levels of fluoride. The critical level has been shown to vary according to how much one drinks water, and on other forms of fluoride being available. These alternative sources include tea, toothpaste's, and food processed using fluoridated water. Based on the above, the critical level may be as low as 0,5ppm. Idi athic mottling consists of irregular white flecks which are randomly distributed, but in the case of fluoride mottling, the irregular white flecks are said to be bilaterally symmetrical (Whitford, 1994; Shellis and Duckworth, 1994).

According to Cutress and Suckling (1990), fluorosis may be defined as the chemical reaction occurring between the fluoride ion and the organic compounds essential to the body's metabolism, whereby certain elements of these essential organic compounds are displaced or distributed by the fluoride ion with the resultant formation of new compounds. Fluorosis therefore, is a specific disturbance of tooth formation caused by excessive intake of fluoride during the formative period of the dentition. The manifestation of this form of chronic fluoride intoxication depends upon the amount ingested, the duration of exposure and the age of the subject.

The first signs of fluorosis are fine striae of accentuated perikymata appearing as horizontal white lines evenly distributed over the enamel surface (Kimmelman 1995, Lalumandier and Rozier 1995). In more affected teeth, the lines become broader and more pronounced; occasionally merging to form irregular scattered cloudy or paper white areas.

With increasing severity, the irregular e areas merge until extensive areas appear chalky white. Pitting can occur either as minute depressions or as single or multiple circular holes indicating a loss of the outermost surface enamel. Horizontal bands of pits are often observed, which in very severe cases tend to merge into large 'corroded' areas. The entire enamel appears corroded in the most severe areas. Depending on the post-eruptive environment, discolouration may occur to varying degrees but in general, increased levels of fluorosis are associated with a reduced resistance to abrasion (Horowitz, 1992).

Fluorosis occurs symmetrically within the dental arches; the premolar has been reported as the tooth most affected followed by the second molar, maxillary incisor, canine, first molar and mandibular incisor. Both the primary and permanent dentition may be affected. The primary dentition appears to be less affected because of the modifying effect of the placenta on fluoride transfer to the foetus, or due to a shorter period of enamel formation (Mann et al, 1990).

FLUORIDES IN THE ENVIRONMENT

Fluorine falls under a group of elements called halogens. These halogens comprise group VII of the periodic table. It is the seventeenth in the natural abundance of elements, representing about 0,03 percent of the earth's crust (McCaffrey, 1993).

Fluoride is the most electronegative of all chemical elements. It has an atomic weight of 19,0 and atomic number of 9. Chemically, fluoride is violently reactive, and is rarely or never encountered in nature as elemental fluorine. This element is found largely in industry as well as in nature in chemically combined forms. Among the manufactured fluorides, the inorganic materials constitute the larger volume, but organic fluoro-chemicals are increasing in volume and appearance (Whitford, 1994).

The principal source of fluoride include water, dust in certain parts of the world, some species of vegetation, certain marine animals, burning coal fires in populated areas and certain industrial gaseous waste (Burt, 1992).

FLUORIDES IN FOODS AND BEVERAGES

Food has been regarded as a small contributor to the total daily fluoride intake (Burt, 1992) with an estimated maximum of 0,27ppm fluoride per day.

Fish has elevated fluoride levels when compared to meats. Tinned fish in which the skin is present and the bones are edible may provide up to 20ppm of fluoride. However, even with relatively high fish consumption in the mixed diet, fluoride intake from fish alone will seldom exceed 0,2mg per day (Whitford, 1994).

A second source of high fluoride is tea. It averages about 1,5ppm and the dry leaves contain between 100-300ppm depending on the blend, but the infusion made from it extracts only a fraction of the total fluoride. In most diets, the fluoride intake is dominated by the concentration in the water and the amount of tea consumed (Shellis and Duckworth 1994, Whitford 1994).

Milk is known to have a low and rather constant level of fluoride in the order of 0,1-0,2ppm. Formulations made with evaporated milk and tap water containing 1ppm can have levels of fluoride up to 0,9ppm (Larsen et al, 1988). Cows milk is higher in fluoride than human milk with about 0,2ppm and 0,025ppm of fluoride respectively.

Water-borne fluoride has been said to present the largest single component of the element's daily intake. Fluoride intake from water is dependent upon the climatic conditions, the age and dietary habits of the individual, and the use of dentifrices like toothpaste and fluoride tablets (Horowitz, 1992).

ACTION OF FLUORIDES ON THE TEETH

Pre-Eruptive Maturation Stage

After completion of calcification and before eruption, fluoride deposition continues in the surface of enamel. Fluoride is taken up from the nutrient tissue fluids surrounding the tooth crown. Much more fluoride is acquired by the outer surface during this period than in the underlying layers of enamel during calcification. Children who are exposed to fluoride for the first time within the two years prior to eruption of permanent teeth, benefit from fluoride acquired during this pre-eruptive stage (Horowitz 1992, Whitford 1994).

Post-Eruptive Stage

After eruption and throughout the maturation stage of the teeth, fluoride is taken up from the drinking water, food and saliva. The uptake is rapid on the enamel surface during the first years after eruption and is greater at higher than at low levels of fluoride in the drinking water (Horowitz, 1992).

Enamel Crystal Structure

The principal mineral substance in enamel (also in dentine and bone) is apatite which has the general formula $Ca_5(PO_4)_3OH_7$ (Hydroxyapatite or HA). The fluoride ion has a strong affinity for mineralised tissue. When fluoride becomes incorporated into the enamel, the fluoride ion substitutes for the hydroxyl radical (OH^-) and fluorapatite ($Ca_5\,[PO_4]_3\,F$) or FA is formed. FA is more resistant to breakdown by acid (Shellis and Duckworth, 1994).

ENAMEL REMINERALISATION

The formation of apatite during mineralisation is essential because it is stable and less soluble. During the carious process of demineralisation of enamel, apatite is reduced to simpler compounds or ions, but during a subsequent remineralisation phase, the apatite will again be formed. Fluoride plays a role in increasing the formation of apatite during remineralisation at the expense of less stable, more soluble calcium phosphate compounds such as brushite and amorphous calcium phosphate. During remineralisation, fluoride becomes incorporated into the new crystal structure and it presumably comes from the oral environment (Shellis and Duckworth, 1994). It has been suggested that fluoride prevents dental caries by inactivating the enzymes produced by bacterial plaque. It can inhibit enolase in bacteria that plays a role in the metabolism of carbohydrates. Low concentration of fluoride (1-2ppm) is able to produce detectable reduction in acid production (Whitford, 1994). Inhibition of plaque formation occurs due to the ability of fluoride to reduce agglutination of bacteria on the surfaces of teeth (van Loveren, 1990).

THE INFLUENCE OF CLIMATIC FACTORS ON WATER AND FLUORIDE INTAKE.

The effect of climatic variation on water and fluoride intake, especially in warmer areas, has been extensively considered by Manji (1988) who pointed out that intrinsically the amount of water required is influenced by body size and weight, the kind of food eaten, habit patterns and by physical activity. Externally, environmental factors will influence the water metabolism of the body and climatic factors especially, may markedly affect water in take (Den-Besten, 1994). Therefore, mean annual temperature, excessive daytime temperature, radiant heat gain, relative humidity and wind movement are of the greatest importance when considering the optimal level of fluoride in drinking water.

OPTIMAL LEVEL OF FLUORIDES FOR WATER FLUORIDATION

Dean's research from 50 years ago established 1,0 mg/litre as the most appropriate concentration of fluoride in drinking-water (Dean 1936, Dean et al 1941 & 1942) . By "most appropriate", he meant the concentration at which maximum caries reduction could be achieved while limiting dental fluorosis to acceptable levels of prevalence and severity.

Because people in hot climates drink more water than do those in moderate climates, this figure of 1,0 mg/litre was modified into a range (0,7-1,2 mg/litre). The higher the average temperature in a community, the lower the recommended level of fluoride in the drinking water. The United States Public Health Service in 1962 adopted this range as a standard for fluoride concentration in drinking-water, and since then this standard has been widely used (WHO, 1994 a). Certainly it was found that the prevalence and severity of fluorosis in several Asian regions were unduly high when these guidelines were followed. Hong Kong, for example, has adjusted the fluoride concentration in its drinking-water several times since water fluoridation began there in 1961, using different levels in the hot and cooler seasons and then endeavouring to find an appropriate year-long concentration. However, fluorosis in children was found to be still unacceptably high at that level because of signs of dental fluorosis. (WHO, 1994b).

By the early 1990s, it became clear that these standards were not appropriate for all parts of the world. The concentration was reduced in several stages to 0,5 mg/litre (WHO 1994b). The recommended range for South Africa is 0,5-0,8ppm, taking into consideration variations in local conditions like climate and other sources of fluoride available in the form of toothpaste and fluoride tablets and drops. (Owen, 1994).

PART 2

i) DENTAL CARIES

a) DENTAL CARIES STUDIES IN SOUTHERN AFRICA (6 & 8-10 year old children)

TABLE 3: Mean DMFT(sd), dmft (sd) and percentage caries-free in 6 and 8-10 year old children in southern Africa

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	DMFT (sd)	dmft (sd)	CARIES FREE %
du Plessis,	JDASA 41:535-537 1986	8-10	Namibia	DMFT WHO 1977	1,4		43,8
Moola et al,	J Dent. Res. 69(4):32;1079 1990	6	S.A. (Cape Peninsula)	DMFT dmft WHO 1987	0,3	5,5	
Ramukumba et al,	J Dent. Res. 69(4):48;845 1991	6	S.A. (Venda)	DMFT WHO 1987	R 0,05 U 0,27		
du Plessis,	J Dent. Res. 1994	6	S.A. (Black Metropolitan Areas)	DMFT dmft WHO 1994	0,20	3,09	89,4 Perm. 33,8 Prim.

U= urban R = rural Perm. = permanent

Prim. = primary (sd) = standard deviation

The percentage of caries-free subjects in the metropolitan areas of South Africa was found to be low (33,8 percent) and dmft of 5,5 and 3,09 were reported in the Cape Peninsula and in black metropolitan areas in the primary dentition (Moola et al, 1990; du Plessis, 1994). The World Health Organisation's goal for the year 2000 is that the caries-free percentage in the primary dentition in five year old children should be less than fifty percent WHO, 1984). When considering the permanent dentition in this age group, the DMFT was found to be low, ranging from 0,05 to 1,4 (du Plessis, 1986; Ramukumba et al, 1991) (Table 3).

TABLE 4: Mean DMFT, (sd) and percentage caries-free in 12, 11-14 and 15 year old children in southern and South Africa

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	DMFT (sd)	CARIES FREE PERCENTAGE
du Plessis,	JDASA 41:535-537 1986	11-14	Namibia	DMFT WHO 1977	R 0,8	64,9
Walker et al,	JDASA 43:581-583 1988	10-12	Hekpoort	DMFT WHO 1977	0.46 (1,2)	78
Cleaton-Jones & Hargreaves	JDASA 43:357-359 1988	11-12	Soweto (U) Gelukspan (R)	DMFT WHO 1977	U 1,7 (2,3) R 0,4 (1,1)	U 48,3 R 80,9
WHO	WHO/ORH POHC Africa 1989	12	Lesotho	DMFT 1977	1,3	
	"	12	Swaziland	DMFT 1977	1,1	
	"	12	Botswana	DMFT 1977	0,5	
Hargreaves et al,	JDASA 45(3) 109-111 1990	11	KwaZulu	DMFT WHO 1977	U 2,0 (2,4) R 1,2 (2,0)	U 42 R 62
Hargreaves et al,	JDASA 45:3 109-111 1990	11	Namibia	DMFT WHO 1977	U 2,2 (2,4) R 2,7 (2,7) R 0,6(1,2)	U 33 R 27 R 74
Chikte et al,	JDASA 45:245-249 1990	12	Transkei, Engcobo	DMFT WHO 1977	R 1,7(2,3)	47
Moola et al,	J Dent Res 69(4):32-1079 1990	12	Cape Peninsula	DMFT WHO 1987	R 1,5	
du Plessis et al,	J Dent Res 69(4)68-1084 1990	12	Swaziland	DMFT (dmft) WHO 1987	R 0,9(0,08)	63
Ramukumba et al,	J Dent Res 69(4):845 1991	12	Venda	DMFT WHO 1987	U 1,03 R 0,44	
Chikte et al,	Comm Dent Oral Epidemiol 19:237-238 1991	12	Gazankulu	DMFT WHO 1987	U 0,3(,83) R 0,13(,46) T 0,25(,75)	U 85,4 R 92,3 T 87,4
Chikte et al,	Comm Dent Oral Epidemiol 19:237-238 1991	15	Gazankulu	DMFT WHO 1987	U 0,75(1,41) R 0,37(1.03) T 0,63(1.33)	U 69,6 R 83,7 T 73,6
du Plessis,	NOHS 1994	12	Black Metropolitan	DMFT WHO 1987	U 1,67	46

U=urban R=rural(sd) = standard deviation T = total

12 - 15 year olds

In numerous studies carried out in southern Africa and Namibia, the DMFT of urban blacks aged 12-13 years ranged from 0,3 to 2,2 and that of rural blacks from 0,1 to 2,7 (Cleaton-Jones and Hargreaves, 1988; Hargreaves et al, 1990; Moola et al, 1990; du Plessis et al, 1990; Chikte et al, 1990 & 1991; Hodges et al, 1991; Ramukumba et al, 1991). Carstens et al (1995) found dmft scores of 3, 31 and 0,22 for the 6 and 12 year old coloured children respectively. The corresponding figures for the DMFT were 0,08 and 1,45 respectively. In the study by Chikte et al, (1991), children from the previous homeland of Gazankulu (now Northern Province) had the lowest mean DMFT score of 0,13 in the rural group with the urban group being 0,3 In low fluoride rural areas of Namibia, there were more children with dental caries than in children in rural KwaZulu, but the DMFT in urban areas in the two regions were similar. More children had caries in urban compared to rural areas within KwaZulu, but no significant difference was found in a similar comparison in Namibia (Hargreaves et al, 1990).

The number of caries-free children in rural Bophuthatswana (now North-West Province) (Cleaton-Jones and Hargreaves, 1988) was higher than in rural KwaZulu, Namibia, Swaziland and Transkei (now Eastern Cape), but it was similar to urban and rural Gazankulu (Table 4).

These studies show that dental caries prevalence varies from region to region, between populations, geographic location and socio-economic levels.

TABLE 5: Mean DMFT, (sd) and percentage caries-free in 20-54 year old adults in southern Africa

AUTHOR(S)	JOURNAL	AGE	COUNTRY/REGION	INDEX	DMFT (sd)	CARIES FREE %
du Plessis	JDASA 41:535-537 1986	20-34 35+	Namibia	DMFT WHO 1977	1,4 2,6	55,5 47,2
Rudolph and Brand	JDASA 44:105-108 1989	31-50 51+	Transkei	DMFT WHO 1977	8,4(7,7) 6,0(6,8)	7,3 16,7
Ramukumba et al,	J Dent Res. 70(4):48:845 1991	35-44 45+	Venda	DMFT WHO 1987	2,08 3,5	
du Plessis,	NOHS 1994	30-54	Black Metropolitan Areas	DMFT WHO 1987	10,86	6,4

20 - 54 year olds

du Plessis, 1986 reported a DMFT of 2,6 for adults above 35 years in Namibia. In the National Oral Health Survey (NOHS) (du Plessis, 1994) a DMFT of 10,86 in an adult Black urban sample aged 30-54 years of age was shown. The DMFT of the Coloured sample (17,3) was higher than that of the Blacks and Indians (12,2) but was lower than that of the Whites (20,7). DMFT scores of 8,4 and 6,0 for the 31-50 and above 50 years age groups respectively were reported in the Transkei among patients seeking emergency dental care (Rudolph and Brand, 1989). In Venda, Ramukumba et al, 1991, reported a DMFT of 2,08 and 3,5 for the age groups 35-44 and 45+ respectively (Tables 5).

b) THE REST OF AFRICA

TABLE 6: Mean DMFT (sd), dmft (sd) and percentage caries-free in 6 and 7-11 year old children in some African countries.

AUTHOR(S)	JOURNAL	AGE	COUNTRY REGION	INDEX	DMFT (sd)	dmft	CARIES FREE %
Frencken et al,	Comm Dent Oral Epidemiol 17:227-229 1989	7-11	Tanzania Urban Rural	Marthaler 1966			Md. 76 Mx. 90 TDent 74
Kubota et al,	Comm Dent Oral Epidemiol 18:197-199 1990	6-8	Nigeria Urban Rural	DMFT WHO 1977	U 0,4(,8) R 0,03(,2)		U 56,8 R 94,4
Tirwomwe & Ekoku	J Dent Res 69(4):3:1017 1990	6	Uganda	DMFT dmft Manji & Fejerskov	0,5	0,8	65
Kerosuo & Honkala	Comm Dent Oral Epidemiol 19:272-276 1991	3-7	Tanzania	dmft WHO 1977		2,7 (3,2)	37
Bourgeois et al,	Comm Dent Oral Epidemiol 19:239 1991	7-9	Algeria	DMFT WHO 1987	0,32(,8)		
Ng'ang'a & Valderhaug	Acta Odontol Scand 50:269-272 1992	6-8	Kenya (Nairobi)	DMFT WHO 1977	0,3	1,7 (2,4)	54
Kubota et al,	Bull Tokyo Med. Dent Univ. 40:59-78 1993	6-8	Nigeria	DMFT WHO 1987	U 0,07 R 0,04		U 79,8 R 81,4
Sathananthan et al,	Comm Dent Oral Epidemiol 24: 21-4 1996	5-6	Zimbabwe	dmft WHO 1987		0,6	R 74.8

U = urban R = rural Md=mandibular (sd) = standard deviation

T.Dent = total dentition Mx = maxillary

6-9 year old (dmft & DMFT)

Tirwomwe and Ekoku in Uganda (1990) and Kerosuo and Honkala in Tanzania (1991) reported dmft scores of 0,8 and 2,7 respectively. The latter authors suggested that the frequent consumption of sweet snacks and drinks increased the risk of caries in Tanzanian children where only 37 percent were caries-free. In several other countries in Africa, the DMFT was found to be very low, ranging from 0,03 to 0,5 (Kubota et al, 1990; Tirwomwe and Ekokn, 1990; Bourgeois et al, 1991). A low sugar consumption together with clearly demonstrable occlusal attrition resulting in shallow pits and fissures in Nigeria were thought to be reasons for the low caries prevalence (Table 6). In Kenya, 54 percent of 6 to 8 year olds were caries free with dmft of 1,7 and DMFT 0,3 (Ng'ang'a and Valderhaug, 1992). Seventy four percent of the 5 to 6 year olds were caries free with dmft of 0,6 in Zimbabwe (Sathananthan et al 1996).

TABLE 7: Mean DMFT, (sd) and percentage caries-free in 12 and 10-15 year old children in some African countries.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/REGION	INDEX	DMFT (sd)	CARIES FREE PERCENTAGE
Frencken et al,	Comm Dent Oral Epidemiol 14:94-98 1986	12	Tanzania Dar-Es-Salaam(D) Kenya Nairobi (N)	DMFT WHO, 1977	D 0,67 (1,2) N 0,51(1,2)	D 67,8 N 77,8
Chironga & Manji	Comm Dent Oral Epidemiol 17:31-33 1989	12	Zimbabwe	DMFT WHO, 1977	U 0,57(1,13) R 0,49 (1,42)	U 72,4 R 79,1
Chimimba & Qech	J Dent Health 68(4):651 1989	12	Malawi Blantyre	DMFT WHO, 1977	U 1,3 R 0,6	U 46 R 70
Olsson et al,	Comm Dent Oral Epidemiol 6:139-145 1989	11-13	Mozambique: Vigillencia} R Moamba} R Maraquene} R Maralane} R Maputo} U	DMFT WHO, 1977	0,50(1,20) 0,98(1,98) 1,27(1,55) 1,[illegible]4(2,04) 2,09(2,58)	77 67 49 54 35
Kubota et al,	Comm Dent Oral Epidemiol 18:197-199 1990	12-14	Nigeria Ashipa}R Origbo} R Ife} U	DMFT WHO, 1977	U 0,66(0,14) R 0,18(0,54)	U 69,4 R 91,4
Bourgeois et al,	Comm Dent Oral Epidemiol 19:239 1991	10-12	Algeria, Constantine Area	DMFT WHO, 1987	1,63 (2,2)	
Bourgeois et al,	Comm Dent Oral Epidemiol 19:239 1991	13-15	Algeria, Constantine Area	DMFT WHO, 1987	3,52 (3,75)	
Ng'ang'a & Valderhaug	Acta Odontol Scand 50:269-272 1992	13-15	Kenya (Nairobi)	DMFT WHO, 1987	1,8 (2,2)	50
Kubota et al,	Bull. Tokyo Med. Dent Univ.40:59-78 1993	12-14	Nigeria	DMFT WHO, 1987	U 0,73 R 0,21	U 63,6 R 88,9
Sathananthan et al,	Comm Dent Oral Epidemiol 24: 21-24 1996	12	Zimbabwe	DMFT WHO, 1987	R 0,3	R 75-87
Ibrahim et al,	Int J Paediatr Dent 7(3): 161-166 1997	6-16	Sudan	DMFT		R 25-34

U= urban R = rural D = Dar-es-Salaam N = Nairobi (sd) = standard deviation

11-15 year old (DMFT)

Some studies have indicated that dental caries in black children in developing African countries is on the increase (WHO 1993, du Plessis 1997; Ibrahim et al 1997)). However, other recent surveys from Africa have indicated that in 12 year olds, the level of caries is still relatively low by international standards (Ng'ang'a and Valderhang, 1992; Kubota et al, 1993; Sathananthan et al 1996). The caries experience of similar age groups within the same country may also differ.

The DMFT of Dar-es-Salaam children was higher than Nairobi children which could be explained by the greater availability of fluoride from drinking water in Nairobi (Manji et al, 1986; Frencken et al, 1986). The mean DMFT in 13-15 year olds in Kenya was 1,8 and 50 percent were caries-free (Table 7). In Nigeria, DMFT of the 12-14 year olds in urban and rural communities were 0,73 and 0,21 respectively (Kubota et al, 1993).

The prevalence of caries in urban and rural Zimbabwe, rural Malawi, rural Mozambique (Vigilancia) and Nigeria's rural and urban areas ranged from DMFT of 0,2 to 0,7 (Chironga and Manji, 1989; Chimimba and Qech, 1989; Olsson et al, 1989; Kubota et al, 1990). Reports indicate that there was only limited use of fluoridated toothpastes in rural Zimbabwe (Table 7).

c) COUNTRIES OUTSIDE AFRICA

TABLE 8: Mean DMFT (sd), dmft (sd) and percentage caries-free in 3-7 and 6 year old children in countries outside Africa.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	DMFT (sd)	dmft	CARIES FREE PERCENTAGE
Robertson et al,	Comm Dent Oral Epidemiol 17:44-46 1989	6	India	DMFT dmft WHO 1977	D 0,1 Bd 0,05	D 5,8 Bd 3,6	Pri. 20 Prm. 96,9
Ran	Comm Dent Oral Epidemiol 17:217 1989	6	Israel (Jerusalem)	DMFT WHO 1977	4,9		22
Gordon et al,	Comm Dent Oral Epidemiol 18:108 1990	5-6	Israel	dmft WHO 1977		4,7	
Al-Shammery et al,	Comm Dent Oral Epidemiol 18:320-321 1990	6	Saudi Arabia	DMFT dmft WHO 1987	0,2(0,6)	3,8(3,5)	Pri. 23,3 Prm. 88,6
Kerosuo & Honkala	Comm Dent Oral Epidemiol 19:272-6 1991	3-7	Finland	dmft WHO 1987		1,3(2,5)	66
Kubota et al,	Bull. Tokyo Med. Dent Univ. 40:59-78 1993	6-8	Japan (Tokyo)	DMFT 1987	U 1,02 R 1,18		U 6,4 R 5,2
Dini and Silva	Int Dent J 44:613-616 1994	7	Brazil (Araraquara)	DMFT 1987	U 0,5 R 1,1		
Downer	British Dental J 185: 36-41 1998	5	United Kingdom	dmft		1,69	58,0

D = day school Bd. = boarding school Prm. = permanent

Pri. = primary (sd) = standard deviation U = urban R= rural

3-7 and 6 year olds

In developing countries such as India, the percentage caries- free for primary teeth was low; 20 percent. The negligible resources available for prevention or treatment and better socio-economic status of some Indian (Tibetan) families resulted in the frequent intake of cariogenic diet and ultimately high caries prevalence in primary teeth (Robertson et al, 1989; Al-Shammery et al, 1990). The DMFT for the 6 year olds in both studies ranged from 0,05 to 0,2 and compares with the results of studies done in Africa (Table 3 and 6). A slightly higher DMFT was found in Namibia and rural Brazil (Tables 3 and 8).

A high prevalence of caries was reported in Israel with dmft of 4,7 (Gordon et al, 1990) and also only 22 percent caries-free (Ran, 1989). The increase in caries prevalence could be attributed to the change in dietary habits and an increase in the frequency of fermentable carbohydrate consumption, combined with the small number of public preventive programmes. However, 58 and 66 percent of the children were reported to be caries-free in the United Kingdom and Finland which were considered as industrialised countries (Kerosuo and Honkala, 1991; Downer 1998) (Table 8).

TABLE 9: DMFT (sd) and percentage caries free in 12 and 15 year old children in some of the developing countries outside Africa

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	DMFT	CARIES FREE PERCENTAGE
Robertson et al,	Comm Dent Oral Epidemiol 17:44-46 1989	12	India Dharamsala	DMFT WHO 1977	Bir. 1,05 Day 0,6 Bd. 1,6 Av. 1,[illegible]	53
Robertson et al,	Comm Dent Oral Epidemiol 17:44-46 1989	15	India	DMFT WHO 1977	Day 1,5 Bd. 3,4	22
Burt	Int Dent J. 44:403-413 1994	12-14	Mexico	DMFT 1987	U 5,98 R 3,57	U 10 R 18
Dini & Silva	Int Dent J. 44:613-616 1994	12	Brazil	DMFT 1987	U 3,8 R 4,0	
Akpata et al.	Comm Dent Oral Epidemiol 25: 324-7 1997	12-15	Saudi Arabia	DMFT 1977	R 2,9	

Bd.= boarding school Bir.= Birmingham Av.= average
U= urban R= rural

12 - 15 year olds

In India, and Saudi Arabia the DMFT was found to be 1,1 and 2,9 respectively (Robertson et al, 1989; Akpata et al, 1997). In India, it was indicated that individuals were encouraged to reduce the intake of sugar. A higher prevalence of dental caries was found in Mexico and Brazil with DMFT ranging from 3,6 to 6 (Table 9).

ii) <u>PERIODONTAL DISEASE</u>

a) SOUTHERN AFRICA

TABLE 10: The highest CPITN score and mean number of sextants affected in 12 and 6-16 year olds in southern Africa.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	SCORE 0	1	2	3	4
Rossouw	JDASA 41:539-541 1986	11-14	Namibia	CPITN (Ainamo et al 1982)	0	6,4	31,9	57,4	4,3
Chikte et al,	JDASA 45:245-249 1990	12	Transkei (Engcobo)	CPITN WHO 1987	5,7	23,2	71,3	-	-
Gugushe et al,	J Dent Res 69(4):1084 1990	12	Swaziland	CPITN WHO 1987	2,2	-	64	-	-
					Treatment Needs				
					TN 1 97,8	TN 2 65,8	TN 3 -	-	-
Gugushe et al,	NOHS 1994	12	Black Metro Areas	CPITN WHO 1987	2,7	15,9	81,2	0,2	0,0
					Treatment Needs				
					TN 1 95,2	TN 2 79,9	TN 3 0,0	- -	- -

12-16 year olds

In several studies, healthy mouths (as defined as free from any gingivitis) were an uncommon finding with the Western Cape sample demonstrating the highest average 53,6 percent for the 6-16 year old group (Vergotine et al, 1990). About 20 percent had bleeding and the lowest percentage was found in Namibia (6,4 percent). Calculus was the predominant score recorded with 81 percent of the subjects affected in the Black metropolitan areas (Gugushe et al, 1994a) (Table 10). About 95 percent of the subjects needed oral hygiene instruction and more than 60 percent of the subjects required oral prophylaxis (Table 10).

TABLE 11: Periodontal disease in 7-45; 20-35 and 30-54 year old adults in southern Africa.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	SCORE 0	 1	 2	 3	 4
Rossouw	JDASA 41:539-541 1986	20-35+	Namibia	CPITN WHO 1987	1	5,4	30,7	51,8	11,8%
Louw et al,	JDASA 44:233-236 1989	7-45	Eastern Cape	CPITN WHO 1987	Treatment Needs				
					TN 1 94%	TN 2 79%	TN 3 5%	-	-
Gugushe et al,	NOHS 1994	30-54	Black Metro Areas	CPITN WHO 1987	0,5	1,1	63	22,9	12
					Treatment Needs				
					TN 1 98,9	TN 2 97,7	TN 3 11,9	-	-

(NOHS = National Oral Health Survey 1988/89)

20-54 year-olds

Evidence of deterioration of periodontal tissues could be demonstrated in all dentate adults in all sample groups. The percentage of adults with bleeding as the highest score was found to be low (Rossouw, 1986; Louw et al, 1989; Gugushe et al, 1994a). The mean number of sextants with calculus as the worst score was high (3,7). Shallow pockets were frequently found in adults in Namibia but deep pocketing was found to be less severe in all southern African regions.

According to the CPITN tables, about 96 percent of the subjects required oral hygiene instruction. Ninety per cent of these required scaling and polishing with a mean of 3,7 sextants affected. Less than 15 per cent of the subjects from different regions required complex periodontal treatment (Table 11).

b) THE REST OF AFRICA

TABLE 12: Periodontal disease in 12; 11-19 and 3-84 year old subjects in some African countries.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	SCORE 0	1	2	3	4
Cutress	Int Dent J 36(3):146-151 1986	11-19	Malawi Nigeria Libya Ethiopia Morocco	CPITN 1987	4,5 1,1 1,2 1,7 3,0	1,5 4,9 4,8 4,3 3,0	1,4 4,0 3,8 1,2 1,9	0 0 0,2 0,2 0	- - - - -
			Nigeria Libya Ethiopia Morocco		Treatment needs				
					TN 1 91 92 94 97	TN 2 76 87 71 63	TN 3 0 0 0 0	-	-
Mumghamba et al,	J Dent Res 68(4) 650 1989	12	Tanzania Bukoba	CPITN 1987	0	56,3	41,7	2,5	-
Mumghamba	J Dent Res 69(4) 1019 1990	3-84	Tanzania Dar-es-Salaam	CPITN WHO 1987	33	79	66	0,5	-
					Treatment needs				
					87,6	66	0,5	-	-
Pilot & Miyazaki	Int Dent J 44: 553-560 1994	35-64	Kenya Namibia Zimbabwe	CPITN WHO 1987	1	4	32	45	13
					2	14	22	34	28
					0	86	4	0	0
Baelum et al,	J Clin Periodontal 22:146-152 1995	15-19	Kenya	CPITN 1987	2	6	26	58	7
Baelum et al,	J Clin Periodontal 22:146-152 1995	45-49 50-54	Kenya	CPITN 1987	-	2	7	52	38
					-	-	17	43	41

11-19 year-olds

In Tanzania 66 percent and 42 percent of the subjects had calculus in Dar-es-Salaam and Bukoba respectively, and in Kenya 26 percent (Mumghamba et al, 1989; Mumghamba, 1990; Baelum et al, 1995). Eighty seven per cent needed oral hygiene instruction but there was very little need for complex periodontal treatment in both Dar-es-Salaam and Bukoba. In Malawi and Morocco subjects had 4,5 and 3,0 healthy sextants respectively, but in Nigeria, Libya and Ethiopia, healthy sextants ranged from 1,1 to 1,7 (Cutress, 1986). More than 90 percent of the subjects needed oral hygiene instruction and over 60 percent were recommended for oral prophylaxis (Cutress, 1986) (Table 12). In Zimbabwe 86 percent of the sample population had bleeding on gentle probing, but no subject with deep or shallow pocket was recorded (Pilot and Miyazaki; 1994).

c) COUNTRIES OUTSIDE AFRICA

11-19 year-olds

Sixty-three percent of the subjects in urban West Malaysia did not show any signs of periodontal disease and had an average of 4,4 healthy sextants. Very few subjects showed bleeding on probing with a maximum of 2,9 percent in India. The percentage of children with calculus ranged from 28 to 36 in West Malaysia and India (Abdul-Kadir, 1990). except in Brazil where it was found to be 72 percent (Dini and Guimaraes, 1994).

Healthy sextants, ranging from 2,7 to 5,1 were reported in the Philippines, China, New Zealand and Australia. Subjects with a lower average of healthy sextants ranging from 0,3 to 1,7, were also reported in Papua New Guinea, Bangladesh, Cuba and Brazil but no subjects with healthy sextants were found in Thailand. The majority of subjects needed oral hygiene instruction and only 10 percent were recommended for scaling in Israel, compared to 100 percent in Thailand (Cutress, 1986). In the Philippines, 42 percent of the index teeth were scored as having calculus. Eighty per cent of subjects with an average number of 2,6 sextants needed scaling (Garcia and Cutress, 1986; Flores-de-Jacoby et al, 1989) (Table 13).

TABLE 13: Periodontal disease and treatment needs in 11-19 year old subjects in countries outside Africa.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	SCORE 0	1	2	3	4
Cutress	Int Dent J 36(3) 148-171 1986	11-19	Bangladesh	CPITN WHO 1987	1,1	4,9	3,4	1,5	-
			China		3,3	2,7	2,6	0,1	-
			New Zealand		4,8	1,2	0,3	0,1	-
			Papua N G		0,3	5,7	5,0	2,0	-
			Phillipines		2,7	3,3	2,7	0,0	-
			Thailand		0,0	6,0	5,5	3,8	-
			Australia		5,1	0,9	0,8	0,0	-
					Treatment needs				
					TN 1	TN 2	TN 3	-	-
			Bangladesh		95	89	0	-	-
			China		95	91	0	-	-
			Israel		73	10	0	-	-
			Jamaica		99	91	0	-	-
			Papua N G		99	90	0	-	-
			Sri Lanka		87	79	10	-	-
			Thailand		100	100	10	-	-
Garcia & Cutress	Comm Dent Oral Epidemiol 14 313-316 1986	15-19	Phillipines	CPITN WHO 1987	2,7	0,7	2,5	0,5	-
					TN 1 87	TN 2 80	TN 3 -	-	-
Abdul-Kadir	Comm Dent Oral Epidemiol 18 324 1990	16	West Malaysia [illegible]	[illegible]	63,2	0,8	36,0	-	-
					MNS				
					4,4	0,6	0,7	-	-
Abdul-Kadir	Comm Dent Oral Epidemiol 18 324 1990	[illegible]	India	CPITN WHO 1987	63,8	2,9	33,3	-	-
					MNS				
					4,9	[illegible]	0,6	-	-
Anil et al.	Comm Dent Oral Epidemiol 18 329 1990	15-19	India	CPITN WHO 1987	3	18	68	9	2
					MNS				
					0,5	5,3	3,9	1,6	0,6
Dini & Guimaraes	Int Dent J 44 309-311 1994	18-19	Brazil	CPITN WHO 1987	2	24	72	2	-
					MNS				
					0,5	5,5	2,2	0,0	

MNS = mean no. of sextants TN = treatment needs

TABLE 14: Periodontal disease in 25-44, 35-44 and 30-59 year old adults in countries outside Africa.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	INDEX	SCORE 0	1	2	3	4
Garcia & Cutress	Comm Dent Oral Epidemiol 14:313-316 1986	30-65	Philippines	CPITN WHO 1987	0,6	0,3	3,6	0,8	0,03
					TN 1 98.5	TN 2 98.5	TN 3 2.5	-	-
Pilot et al,	Comm Dent Oral Epidemiol 17:216 1989	35-44	China(Shanghai)	CPITN WHO 1987	1	1	43	44	11
					MNS 0 = 0,7 1+2+3+4 = 5,3 2+3+4 = 4,8 3+4 = 1,3 4 = 0,2				
Aril et al,	Comm Dent Oral Epidemiol 18:325 1990	25-44	India	CPITN WHO 1987	1	10,5	34,5	34,5	19,5
					MNS 0 = 0,5 1+2+3+4 = 5,3 2+3+4 = 3,9 3+4 = 1,6 4 = 0,6				
Dini & Guimaraes	Int. Dent J. 44:309-311 1994	35-64	Brazil	CPITN WHO 1987	0	2	35	49	13
					MNS				
					0,1	3,9	3,6	1,6	0,2

MNS = mean number of sextants

25-65 ye. -olds

Only one percent of adults did not have signs of periodontal disease in China and India (Pilot et al, 1989; Anil et al, 1990; Wierzbicka et al, 1990). Garcia and Cutress (1986) reported a reduction in prevalence of calculus with age accompanied by an increase in shallow pockets in their study in the Philippines. Bleeding on probing also declined with increasing age (Table 14). The mean number of deep pockets was approximately the same in China and Brazil.

DENTAL FLUOROSIS

a) SOUTHERN AFRICA

TABLE 15: Dental fluorosis in 1-17 year olds in southern Africa

AUTHOR(S)	JOURNAL	AGE	COUNTRY/ REGION	F(PPM)	INDEX	FLUOROSIS PERCENTAGE
Ockerse & Meyer	SADJ 62-72 1941	6-15	Pilanesberg	0,33-35	Dean's	94
Ockerse	JADA 28:936-941 1941	6-15 12-17 6-16 6-16	Upington Kenhardt Pofadder	0,38 6,8 2,46	Dean's	13,3 (U1) 18,8 (U2) 82,4 (K) 94,0 (P)
du Plessis et al,	J Dent Res. 60(25): 1272 1981	6-15	Bophuthatswana Syferfontein	0,7-2,44	Dean's	incisor > lateral
McInnes et al,	Comm Dent Oral Epidemiol 10:182-86 1982	1-5	Kenhardt (High F) Keimoes (Low F)	2,2-4,1 0,2	Dean's WHO 1971	51 (High F) 0 (Low F)
van Wyk et al,	J Dent Res. 62(4):99:508 1983	6-17	Namibia Bethanien Mariental	High F Low F	Dean's	CFI 2,7 (H) 0,15 (L)
Burger et al,	Comm Dent Oral Epidemiol 15:95-97 1987	1-9	Bophuthatswana, Oskraal	0,98-2,7	Dean's	Highest in max. 2nd molars 25 Lowest in mand. central incisors 4,6. Total 15,3
Lewis et al,	Comm Dent Oral Epidemiol 20:53-54 1992	6-8	KwaNdebele Kliplaatdrift=H Pieterskraal=L	High F 8,9-9,4 Low F 0,6-1.6	Dean's	High F 3-5=58 Low F 3-5=9
Lewis & Chikte	J DASA 50:467-471 1995	6-8	KwaNdebele	High & Low	TSIF	High F 4-7 Pr 5: Pe. 29 Low F Pr. 0 : Pe. 5

H = high fluoride area L = low fluoride area Pr. = primary

Pe.=permanent U1= Upington Lower School

U2 = Upington High School K = Kenhardt P = Pofadder

6-9 year-old in Southern Africa

Different communities throughout this part of the subcontinent have been exposed to naturally fluoridated water whose fluoride concentration exceeds the optimal range of 0,7-1ppm. The concentration of fluoride in water in several different localities in southern Africa has varied from no trace to as much as 10ppm.

In one of the earliest studies carried out, Ockerse (1941) reported 94 percent of the subjects with fluorosis. In a study by McInnes et al, (1982) 50 percent showed some degree of fluorosis of which 19 percent was classified as moderate and 8 percent severe in the primary teeth of 5 year old children in Kenhardt. This was greater than 15 percent reported in Oskraal (Burger et al, 1987), 4 percent reported by Ockerse (1941), and 5 percent reported by Lewis et al, (1990) in KwaNdele (Table 15). Seventy-two per cent were caries free with a dmft of 1,4 $\pm$ 2,9 in Kenhardt (Table 15).

Fifty eight percent of the 6-8 year old children had fluorosis of the permanent teeth with scores of 4 to 5 according to Dean's Index in KwaNdebele's high fluoride area compared to 9 percent in the low fluoride area. More children were caries free in the high than in the low fluoride area (Table 15). According to du Plessis et al (1981) the permanent central incisors were significantly more affected by fluorosis than the lateral incisors. In most of these studies, the Dean's Index was used (Table 15).

When using the TSIF, 29 percent had fluorosis varying from scores 4-7 in the permanent dentition (Lewis and Chikte, 1995).

TABLE 16: Percent caries-free subjects in 12-23 year olds in some South African communities with fluorosis.

AUTHOR(S)	JOURNAL	AGE	COUNTRY/REGION	F(PPM)	DMFT (sd)	dmft	CARIES FREE PERCENTAGE
Bischoff et al,	J Dent Res 55(1):37-42 1976	14-23	Bophuthatswana, Saulspoort	0,4-6	1,0 (2,2)		59
van der Merwe et al,	Comm Dent Oral Epidemiol (5):61-64 1977	15-19	Bophuthatswana, Mabeskraal	0,02-0,2	1,4 (2,1)		50,6
Retief et al,	J Oral Pathology 8:224-236 1979	14-16	Kenhardt, N.W. Cape	3,2	2,7 (+0,4)		25,8
Grobler et al,	Caries Res 20:284-288 1986	12-13	N.W. Cape Nourivier Tweerivier	H 3,70 L 0,62			H 23,5 L 36,4
Lewis et al,	Comm Dent Oral Epidemiol 20:53-54 1992	12-13	Kwandebele Klipfaatdrift (H) Pietersktaal (L)	H 8,9-9,4 L 0,6-1,6			H 92 L 74

H = High fluoride area L = Low fluoride area

12-20 year old

The severity of fluorosis was found to be approximately the same at all the high fluoride areas in southern Africa. When using Dean's and TSIF Indices (Lewis et al, 1990; 1992) the authors concluded that both indices compared favourably in measuring severity. A study conducted by Cleaton-Jones and Hargreaves (1990) showed that less subjects (50 percent) had fluorosis when using the TSIF Index compared to (67 percent) when using Dean's Index.

The percentage of caries-free subjects was found to be low in the high fluoride areas in the

North Western part of the Cape Province, ranging from 23 percent to 36 percent (Retief et al, 1979a; Grobler et al, 1986). This was in contrast with the results obtained from black children in high fluoride areas in former Bophuthatswana and KwaNdebele (Bischoff et al, 1976; Lewis et al, 1992) (Table 16).

b) COUNTRIES OTHER THAN SOUTH AFRICA.

TABLE 17: Dental fluorosis in 5-54 year olds in some African countries.

AUTHOR	JOURNAL	AGE	COUNTRY/REGION	F(PPM)	INDEX	FLUOROSIS PERCENTAGE
Moller et al,	Archs Oral Biol 15:213-225 1970	5-19	Uganda, Toro (H) Kigezi (L)	H 2-3 L 0,2-0,3	Dean's CFI	H 91,3 (CFI 1,74) L 3,4 (CFI 0,04)
Olsson	Comm Dent Oral Epidemiol 6:38-343 1978	6-7 13-14	Ethiopia (Arussi)	0,2-0,3	Dean's	very mild :14 mild :4 Total :18
Olsson	Comm Dent Oral Epidemiol 6:338-343 1978	30-34 45-54	Ethiopia (Arussi)	0,2-0,3	Dean's	18% of total sample (T = 18)
Manji et al,	J Caries Res 20:473-480 1986	11-15	Kenya	H 0,5-1 L 0,5	Thylstrup & Fejerskov	H 71,0 L 36,4
Ibrahim et al,	Int J Paediatr Dent 7(3):161-66 1997	6-16	Sudan	0,25-2,5	Dean's	
El-Nadeef & Honkala	Comm Dent Oral Epidemiol 26(1): 26-30 1998	12-15	Nigeria	0,0 - 0,4	Dean's	Very mild: 41 Mild: 7 Moderate/severe: 3

H = high fluoride area L - low fluoride area CFI = community fluorosis index

6-7 year olds

Very few studies concerning the degree of fluorosis in the primary dentition have been conducted. In Ethiopia with 0,2-0,3ppm fluoride in drinking water, 38 percent of the children had decayed primary teeth and 51 percent decayed permanent teeth. Less than 18 percent of the children had fluorosis (Olsson, 1978). (Table 17). Although a different index was used in assessing the severities of fluorosis in the primary dentition of 6-8 year olds, in Kenya, 18 percent were diagnosed as having fluorosis (Ng'ang'a and Valderhang, 1993). In a study conducted in Nigeria, 15 percent of the 12-15 year olds had signs of fluorosis (El-Nadeef and Honkala, 1998).

11-15 year-old

As expected, the percentage of individuals with dental fluorosis was relatively negligible in low fluoride areas in Uganda and Ethiopia (approximately 0,3ppm) (Moller et al, 1970; Olsson, 1978). In contrast 36,4 per cent of the subjects had some degree of fluorosis in Kenya (Manji et al, 1986c) and these authors suggested that populations living at high altitudes may be more susceptible to fluorosis than those at low altitudes for a given concentration of fluoride in drinking water (Table 17). 98 percent of the 13-15 year olds living in an area served with borehole water had fluorosis when using Thylstrup and Fejerskov index (Ng'ang'a and Valderhaug, 1993).

30-55 year-old

In a low fluoride area of 0,2-0,3ppm in Ethiopia, adults aged 30-34 and 45-54 had a DMFT of 2,65 and 3,36 respectively. Less than 18 percent of this group showed signs of fluorosis (Table 17).

c) COUNTRIES OUTSIDE AFRICA

6-8 year olds

In an area, with 5ppm fluoride in drinking water in Israel, 152 subjects aged 6-8 years were examined. Fourteen cases in the primary dentition and 41 cases in the permanent dentition had a more severe fluorosis level (Mann et al, 1990). The decay rate in the permanent dentition gradually increased with increasing fluorosis severity.

13-16 year olds

There was an increase in the severity of fluorosis in maxillary anterior teeth of subjects living in Illinois - USA (at 4x optimal F). The authors supported the hypothesis that the increased prevalence of severe fluorosis in communities with more that 4x optimal water-fluoride concentrations was associated with higher caries prevalence (Heifetz et al, 1988). One hundred per cent of the subjects drinking water with 5ppm fluoride concentration showed signs of dental fluorosis in Israel (Mann et al, 1987).

It is well established that once the concentration of fluoride in drinking water exceeds 3ppm, the preventive effect for dental caries become diminished (Den Besten, 1987). Fewer studies have been done, especially in South Africa, concerning the effect of fluoride on periodontal disease (Jinabhai et al, 1983; Walker et al, 1988; Gugushe et al 1994b, Moola 1996).

PURPOSE OF THE STUDY

Earlier studies in the former Bophuthatswana did not include a comprehensive investigation of dental caries, periodontal disease and fluorosis, or the relationship of these diseases. Furthermore, the National Oral Health Survey of 1988/89 concentrated mainly on the metropolitan areas in South Africa. Therefore, there was a need for the collection of epidemiological data in the rural areas of South Africa. The Mankwe district selected for the present investigation is predominantly rural, and this study was undertaken to determine the oral health status in low, optimal and high fluoride areas in the district.

OBJECTIVES

(a) To determine and compare levels of caries at low, optimal, high and very high fluoride villages in:

- (i) Primary dentition of 6-7 year old
- (ii) Permanent dentition of 6-7 year olds
- (iii) Permanent dentition of 12-13 year olds
- (iv) Permanent dentition of 30-55 year olds

(b) To determine and compare the CPITN at low, optimal, high and very high fluoride villages in:

- (i) The 12-13 year olds
- (ii) The 30-55 year olds

(c) To determine and compare levels of fluorosis in low, optimal, high and very high fluoride areas using Dean's ana TSIF indices.

(i) Primary dentition of 6-7 year olds (TSIF)

(ii) Permanent dentition of 6-7 year olds. (Dean's and TSIF)

(iii) Permanent dentition of 12-13 year olds. (Dean's and TSIF)

(iv) Permanent dentition of 30-55 year olds. (Dean's and TSIF).

CHAPTER 3

METHODS AND MATERIALS

STUDY DESIGN

a). PERMISSION FOR THE STUDY

Permission was granted by the then Bophuthatswana Government (now Northwest Province), Department of Oral Health Services, Mankwe Circuit School Inspector, the local chiefs and the Committee for Research on Human Subjects at the University of the Witwatersrand (Appendices 6-9).

b) SAMPLING

One primary school was randomly selected from each village as the research site using a list obtained from the Circuit school inspectorate. All the primary school children in the each village were then asked to report at the study sites selected for their respective communities. Thirty children, 15 males and 15 females, were then selected for each age group 6-7, and 12-13 years olds, from each of the 4 villages using stratified random sampling. In all, 120 children were selected in each age group giving a total sample of 240 children.

For the 30 to 55 year old age groups, all adults were requested to assemble at the respective tribal offices for the villages, which were also used as the research sites. Those who were outside the age bracket 30 to 55 years or have not been life long residents of the villages were excluded from the sample frame. Thirty subjects were then randomly chosen from each of the four study villages giving a total adult sample of 120. (Table 18).

c) CLINICAL ORAL EXAMINATION

Dental caries was assessed using the dmft and the DMFT indices. Periodontal disease was estimated using the CPITN (Appendix 3). Both the Dean's index (Dean, 1942) and the Tooth Surface Index of Fluorosis (TSIF) as described by Horowitz et al. (1984) were used for the assessment of dental fluorosis. The clinical oral examinations were conducted in accordance with the criteria recommended by the World Health Organisation (WHO, 1987).

TABLE 18: Sample of the population by age and gender

VILLAGE	AGE						TOTAL
	6-7		12-13		30-55		
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	
Elandskuil V1	15	15	15	15	15	15	90
Morogong V2	15	15	15	15	15	15	90
Lerome V3	15	15	15	15	15	15	90
Ruighoek V4	15	15	15	15	15	15	90
TOTAL	60	60	60	60	60	60	360

d) POSITIONING OF THE SUBJECTS

Both the children and adults were examined in a supine position on a portable dental chair using natural light. The investigator sat on a portable dental stool.

e) RECORDING CLERK

The recording clerk received training and instructions in order to be familiar with the record sheet and the overall process of the study.

f) RECORD SHEET

A standardised record sheet based on the WHO form was used (WHO, 1987). (Appendix 2)

g) INSTRUMENTS

Several sets of sickle shaped blunt probes, periodontal probes (CPITN) and plain mouth mirrors were used. These were sterilised daily before use on each subject.

h) PILOT SURVEY

A pilot survey was done at Ruighoek to test the application of the proposed indices, and to assess the co-operation of the subjects. The diagnostic criteria described by the WHO (1987) was adopted for the survey. Twenty volunteers were used in the pilot study. No problems were encountered in the pilot study and there was maximum co-operation from the subjects. A sickle shaped probe was used and a low pressure level was applied for caries detection. For the diagnosis of periodontal disease, the CPITN criteria were thoroughly discussed and the problems clarified. Under the guidance of the supervisor the examiner practised the applications of the index on volunteer adults. The pilot study was conducted at the high fluoride village. Both Dean's and the Tooth Surface Index of Fluorosis using natural light under supervision.

During the actual field survey for caries duplicate examinations were done on every tenth subject. Intra-examiner reproducibility was found to be 87% (Shaw and Murray 1975).

i) FLUORIDE ANALYSIS

The fluoride concentrations of the drinking waters from the four villages were provided by the Department of Public Works and Water Affairs of the Bophuthatswana Government 1984 (Now Northwest province). (Table 1). (Appendix 10). At the time when the research was conducted this department was involved with many projects. Therefore, available data on fluoride levels was for 1984.

j) STATISTICAL ANALYSIS

Data entry and analysis was done in association with the Institute of Biostatistics of the Medical Research Council of South Africa. The Chi-Square test, Kruskal-Wallis and the U-test of Mann-Whitney were used as appropriate. All data were analysed using the Statistical Analysis System (SAS) software package on an IBM compartible microcomputer (SAS Institute, 1985). Differences were taken as significant at the level of $p<0.05$.

CHAPTER 4

RESULTS

DENTAL CARIES

6-7 YEAR OLD SUBJECTS - PRIMARY TEETH

TABLE 19: Number and percentages of caries-free subjects in 6-7 year old school children (primary teeth)

VILLAGE	F(ppm)*	Number (n)	PERCENTAGE CARIES FREE
Elandskuil V1	0,1-0,3	30	76,7
Morogong V2	0,4-0,9	30	80,0
Lerome V3	3-6	30	74,2
Ruighoek V4	7-8	30	93,3

F(ppm) = Fluoride concentration (parts per million).

* Data source : Department of Public Works and Water Affairs, Bophuthatswana Government(now North West Province) 1984.

In this study, the prevalence of dental caries was found to be low among the school children. The percentage of caries-free children was very high including subjects at Elandskuil village which had a low level of fluoride in the water. There were more caries-free children at Morogong than at Lerome. The highest percentage of caries-free children was found at Ruighoek which also has the highest fluoride level (Table 19).

TABLE 20: Mean dt, mt, ft, dmft (sd) in 6-7 year old school children at all four villages

VILLAGE	MEAN d,m,f,t dmft				
	n	dt(sd)	mt(sd)	ft(sd)	dmft(sd)
Elandskuil	30	0,76 (1,90)	0,13 (0,43)	0,00 (0,00)	0,90 (2,18)*
Morogong	30	0,23 (0,67)	0,13 (0,57)	0,00 (0,00)	0,36 (0,00)
Lerome	30	0,35 (0,83)	0,12 (0,56)	0,00 (0,00)	0,48 (0,9)
Ruighoek	30	0,10 (0,40)	0,00 (0,00)	0,00 (0,00)	0,10 (0,40)*

n = number of subjects (sd) = standard deviation

*(p <0,05)

The dmft of all the four villages were low, ranging from 0,1 (Ruighoek) to 0,90 (Elandskuil). No filled teeth were found in any of the four villages. The d component ranged from 0,10 at Ruighoek to 0,76 at Elandksuil. Very few missing teeth were recorded in the children in all villages (0,13). *The dmft at Ruighoek was significantly lower than at Elandskuil (p< 0,05) (Table 20).

PERMANENT TEETH

TABLE 21: Number and percentage of caries-free subjects in all age groups at all four villages
(permanent teeth)

VILLAGE	F (ppm)	AGE IN YEARS						
		6-7		12-13		30-55		
		(n)	%	(n)	%	(n)	%	P Value
Elandskuil	0,1-0,3	30	93,3	30	65,4	30	17,7*	0,006*
Morogong	0,4-0,9	30	94,7	30	80,0	30	20,0*	0,006*
Lerome	3-6	30	96,8	30	91,2	30	54,8*	0,006*
Ruighoek	7-8	30	100,0	30	74,2	30	36,7*	0,006*

F(ppm)=Fluoride concentration (parts per million) (n)= number of subjects

In the 6-7 year old group, the percentage of caries-free individuals with permanent teeth was very high in all villages, ranging from 93 percent at Elandskuil (low f) to 100 percent at Ruighoek (high fluoride) (Table 21).

The percentage of caries-free individuals in the 12-13 year old group was also high for all four villages, ranging from 65 percent at Elandskuil to 91 percent at Lerome with the percentage at Ruighoek [F(ppm 7-8)] being, 74 percent.

In the 30-55 year old group, the percentage of caries-free individuals were relatively low in all villages, ranging from 18 percent at Elandskuil to 55 percent at Lerome but surprisingly still lower at Ruighoek (37 percent) (high fluoride village). The difference in the percentage caries-free among all the four villages was highly significant (p=0,006) but this should be considered with caution because of the small number. There was expectedly, an inverse relationship between age and percentage caries-free subjects. The younger the subjects, the higher the percentage caries-free and the older the subjects, the lower the percentage caries-free. The difference in the percentage caries-free between 12-13 and 30-55 year olds was high. Although there were more carious lesions found in the adult group, the missing component contributed the most of the total DMFT. This aspect of the DMFT must also be considered with caution due to the possible error of recording missing due to caries when it may have been due to other reasons such as periodontal disease and trauma.

TABLE 22: Mean DMFT, (sd) of permanent teeth in all age groups at all four villages

AGE	ELANDSKUIL F(ppm) = 0,1-0,3 n=30	MOROGONG F(ppm) = 0,4-0,9 n=30	LEROME F(ppm) = 3-6 n = 30	RUIGHOEK F(ppm) = 7-9 n=30
6-7 years				
DT	0,1 (0,6)	0,03 (0,2)	0,03 (0,2)	0,0 (0,0)
MT	0,0 (0,0)	0,0 (0,0)	0,03 (0,2)	0,0 (0,0)
FT	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)
DMFT	0,1 (0,6)	0,03 (0,2)	0,06 (0,4)	0,0 (0,0)
12-13 yrs				
DT	0,7 (1,2)	0,3 (0,6)	0,18 (0,6)	0,5 (0,9)
MT	0,0 (0,0)	0,0 (0,0)	0,03 (0,2)	0,0 (0,0)
FT	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)
DMFT	*0,7 (1,7)	0,3 (0,6)	*0,2 (0,8)	0,5 (0,9)
30-55 yrs				
DT	1,6 (1,4)	1,3 (2,1)	0,5 (1,0)	1,0 (1,7)
MT	2,9 (3,8)	2,9 (3,8)	1,3 (2,5)	3,3 (5,1)
FT	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)	0,0 (0,0)
DMFT	**4,5 (4,2)	4,2 (4,1)***	**1,8 (3,0)***	4,3 (6,0)

n = number of subjects F(ppm) = fluoride concentration (parts per million)
* DMFT p value = 0,0171 (Elandskuil vs Lerome) - Statistically significant at p<0,05
** DMFT p value = 0,001 (Elandskuil vs Lerome) -Statistically significant at p<0,01
*** DMFT p value = 0,003 (Morogo[illegible] [illegible]ome) "

The DMFT was extremely low [illegible] group, with only a few decayed and missing teeth recorded.

The DMFT in the 12-13 year old group was also low for all villages according to WHO standards for the year 2000 (WHO, 1984). The DMFT at Lerome was significantly lower than at Elandskuil (p=0,017) although it is not clinically relevant. The D component comprised 100 percent of the total DMFT except at Lerome where only one missing tooth was recorded.

The overall DMFT in the 30-55 year old group was statistically higher at Elandskuil than at Lerome (P=0,001) and also at Morogong than at Lerome (p=0,003). Only the D and M components contributed to the total DMFT. At all the four villages DMFT increased with age. The lowest caries prevalence was found at Lerome.

TABLE 23(a): Periodontal disease status and the highest CPITN (percentage) for 12-13 and 30-55 year olds

5.2. PERIODONTAL DISEASE

VILLAGE/ AGE	n	TOTAL DENTATE	EDENTULOUSNESS %	0 NO PERIODONTAL DISEASE	1 BLEEDING ONLY	2 CALCULUS	3 SHALLOW POCKETS	4 DEEP POCKETS
V 1								
12-13	30	30	0	0	44,8	58,6	-	-
30-55	30	30	0	0	18,8	40,6	25,0	15,6
V 2								
12-13	30	30	0	0	66,7	33,3	-	-
30-55	30	30	0	0	12,5	50,0	18,8	18,8
V 3								
12-13	30	30	0	0	41,2	52,9	-	-
30-55	30	29	3,0	3,0	27,3	57,6	6,1	6,1
V 4								
12-13	30	30	0	0	45,5	54,5	-	-
30-55	30	30	0	0	18,2	36,4	30,3	15,2

V 1 = Elandskuil V 2 = Morogong V 3 = Lerome V 4 = Ruighoek

Almost 67 percent of the 12-13 year old group had bleeding at Morogong compared to an average of 43 percent at the remaining three villages. Fewer subjects had bleeding in the 30-55 year old group, ranging from 13 percent at Morogong to 27 percent at Lerome. (Table 23a)

In the 12-13 year old group, an average of 55 percent of subjects had calculus in three villages but a lower percentage was found at Morogong (33 percent). In the 30-55 year old group the percentage with calculus ranged from 36 percent at Ruighoek to 58 percent at Lerome.

The percentage with shallow pockets ranged from 6,1 percent at Lerome to 30 percent at Ruighoek for 30-55 year olds. The lowest percentage of deep pockets was also recorded for subjects from Lerome.

TABLE 23(b): Mean number of sextants affected by periodontal disease according to age and village

VILLAGE/ AGE	n	TOTAL DENTATE	EDENTULOUNESS PERCENTAGE	0 NO PERIODONTAL DISEASE	1+2+3+4 BLEEDING OR HIGHER SCORE	2+3+4 CALCULUS OR HIGHER SCORE	3+4 SHALLOW POCKET OR HIGHER SCORE	4 DEEP POCKETS	X EXCLUDED (LESS THAN 2 TEETH)
V 1									
12-13	30	30	0	0,2	**4,6*	1,2	0	0	0
30-55	30	30	0	0,3	2,9	1,4	0,7	0,2	0,5
V 2									
12-13	30	30	0	0,3	***4,9*	0,8	0	0	0
30-55	30	30	0	0,4	*** 2,5	1,6	0,7	0,4	0,5
V 3									
12-13	30	30	0	0,6	***4,7*	1,2	0	0	0
30-55	30	30	0	1,0	2,9	1,8	0,2	0,1	0,2
V 4									
12-13	30	30	0	0,06		1,1	0	0	0
30-55	30	30	0	0,3	**5,0** ** 2,9	1,4	0,9	0,3	0,3

*   V1 vs V3 p value =0,011   **   V1 vs V4 p value =0,01

***   V2 =V3 p value =0,02   ****   V 2 = V4 p value = 0,03

Very few subjects in both age groups and in all four villages had periodontally healthy sextants except one subject at Lerome in the 30-55 year olds. The mean number of sextants with bleeding or higher score in the 12-13 year age group was higher at Lerome and Ruighoek than at Elandskuil (p value=0,011 and 0,01 respectively). An average of 2,8 sextants in the adult group were scored as having bleeding or higher score. The number of sextants with calculus or higher score increased with age. In the adult sample, the number of sextants with shallow pockets or higher score was significantly higher at Ruighoek than at Lerome (p value=0,006) (Table 23b).

TABLE 23(c): Periodontal treatment needs by age and village

VILLAGE/ AGE	n	Edentulousness %	Total Dentate %	Oral Hygiene Instruction TN1 %	Prophylaxis TN2	Complex Care TN3
V 1						
12-13	30	0	100	100	58,6	0
30-55	30	0	100	97,0	78,8	15,2
V 2						
12-13	30	0	100	100	33,3	0
30-55	30	0	100	100	33,3	18,8
V 3						
12-13	30	0	100	100	58,8	0
30-55	30	3,0	97	97,0	69,7	6,1
V 4						
12-13	30	0	100	100	54,5	0
30-55	30	0	100	100	81,8	15,2

V1 = Elandskuil V2 = Morogong V3 = Lerome V4 = Ruighoek

n = number of subjects

Approximately 100 percent of 12-13 and 30-55 year olds required TN1 in all the four villages, 51 percent of 12-13 year olds required TN2 and 79 percent of 30-55 year olds required TN2. Complex periodontal care (TN3) was required only in 6 percent of subjects at Lerome while the average percentage of adults in the other 3 villages was 16.4 percent, according to the CPITN (Table 23c).

DENTAL FLUOROSIS

TABLE 24: Percentage distribution of fluorosis for all permanent teeth by village and age (Dean's index)

VILLAGE/ AGE	n 30	SCORE (%)					
		0	1	2	3	4	5
V1							
6-7	30	95,2	4,8	0	0	0	0
12-13	30	100,0	0	0	0	0	0
30-55	30	100,0	0	0	0	0	0
V2							
6-7	30	36,7	63,3	0	0	0	0
12-13	30	76,7	20,0	0	3,3	0	0
30-55	30	83,3	16,7	0	0	0	0
V3							
6-7	30	0	0	20,0	55,0	15,0	10,0
12-13	30	0	0	0	35,3	52,9	11,8
30-55	29	0	0	9,7	9,7	48,4	32,3
V4							
6-7	30	3,4	0	10,3	17,2	41,4	27,6
12-13	30	0	0	0	3 2	22,2	74,2
30-55	30	0	0	0	3,3	36,7	60

n = number of subjects.

In the 6-7 year old group, the highest severity as expected was found at Ruighoek with 41 percent moderate and almost 28 percent severe while at Lerome 10 percent were scored severe according to Dean's index. When using Dean's index, only questionable fluorosis was detected at Elandskuil and Morogong; 4,8 percent and 63,3 percent respectively. In the 12-13 year old group, the severity was very high at Ruighoek with more than 74 percent scoring 5 compared to almost 12 percent at Lerome. Brown discolouration was not recorded at the other two villages. The distribution of fluorosis did not differ by gender. In the 30-55 year old group, 60 percent recorded a score of 5 at Ruighoek and 32 percent at Lerome. Every subject at the two high fluoride villages showed some degree of fluorosis (Table 24).

TABLE 25: Percentage distribution of TSIF scores for primary teeth of 6-7 year old school children

VILLAGE	PERCENTAGE DISTRIBUTION OF TSIF SCORES							
	0	1	2	3	4	5	6	7
Elandskuil F(ppm) = 0,1-0,3	100	0	0	0	0	0	0	0
Morogong F(ppm)= 0,4-0,9	90,1	6,6	3,3	0	0	0	0	0
Lerome F(ppm)= 3-6	0	19,3	35,5	22,6	16,1	6,5	0	0
Ruighoek F(ppm)= 7-8	0	0	11	45,7	33,3	6,7	3,3	0

The majority of children had white opaque areas at both high fluoride areas, Lerome and Ruighoek. Brown discolouration was found to be more pronounced at Ruighoek. Pits without discolouration were found to be approximately the same at both high fluoride areas (6,5 percent vs 6,7 percent). Only 3 percent had pits with brown discolouration at Ruighoek. Three children were recorded as having white opaque areas at Morogong (Table 25).

TABLE 26: Percentage distribution of TSIF scores for the labial and palatal surfaces of permanent maxillary anterior teeth according to tooth type and water fluoride levels in 6-7 year old subjects

VILLAGE	SC	TOOTH TYPE											
		13		12		11		21		22		23	
		L	P	L	P	L	P	L	P	L	P	L	P
Elandskuil F(ppm)=0,1-0,3	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0
Morogong F(ppm)=0,4-0,9	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	7	0	7	0	3	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0
Lerome F(ppm)=3-6	0	0	0	0	0	0	3	0	7	3	3	0	0
	1	0	0	0	0	7	13	7	10	0	0	0	0
	2	0	0	0	0	0	10	0	10	3	3	0	0
	3	0	0	3	3	13	10	13	10	0	0	0	0
	4	0	0	0	0	3	0	3	0	0	0	0	0
	5	0	0	0	0	3	0	3	0	0	0	0	0
	6	0	0	0	0	10	0	10	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0
Ruighoek F(ppm)=7-8	0	0	0	0	3	0	10	0	7	3	3	0	0
	1	0	0	3	3	7	13	3	10	7	7	0	0
	2	0	0	0	0	3	10	7	17	3	3	0	0
	3	0	0	7	7	3	17	10	13	0	0	0	0
	4	0	0	0	0	17	0	10	0	0	0	0	00
	5	0	0	0	0	10	0	3	0	0	0	0	0
	6	0	0	3	0	13	3	20	7	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	

SC = score L = labial P = palatal

F(ppm)=fluoride concentration (parts per million)

No canines exhibited signs of fluorosis at all four villages in the 6-7 year age group. The percentage of fluorosis was higher in the maxillary central incisors than in the lateral incisors. The percentage of subjects affected was higher at Ruighoek than at Lerome. The labial surfaces were more affected than the palatal surfaces (Table 26).

TABLE 27: Percentage distribution of TSIF scores for the labial and palatal surfaces of permanent maxillary anterior teeth according to tooth type and water fluoride levels in12-13 year old subjects

VILLAGE	SC	TOOTH TYPE											
		13		12		11		21		22		23	
		L	P	L	P	L	P	L	P	L	P	L	P
V1 12-13	0	0	0	0	0	0	0	0	0	0	0	0	0
V2 12-13	0	97	97	93	97	90	97	90	97	93	97	97	97
	1	-	3	3	-	7	-	7	3	7	3	-	3
	2	3	-	3	3	-	3	3	-	-	-	3	-
	3	-	-	-	-	3	-	-	-	-	-	-	-
V3 12-13	0	12	59	3	56	3	29	3	30	9	50	24	68
	1	27	30	24	27	15	27	15	27	21	32	27	24
	2	32	9	41	15	21	32	21	30	22	15	15	6
	3	27	3	15	3	6	9	6	10	27	3	29	3
	4	3	-	15	-	44	3	44	3	12	-	6	-
	5	-	-	0	-	3	-	0	-	-	-	-	-
	6	-	-	3	9	9	-	19	-	3	-	-	-
V4 12-13	0	19	26	3	13	0	13	0	7	13	19	19	26
	1	0	10	3	13	0	16	0	20	7	19	0	10
	2	10	10	10	29	0	23	0	26	10	26	3	10
	3	29	42	29	26	0	26	0	23	26	19	48	52
	4	10	3	26	16	39	16	42	19	23	19	7	3
	5	13	3	16	3	3	0	3	0	0	13	10	0
	6	19	0	3	0	42	7	39	7	16	0	7	0
	7	0	7	13	0	16	0	16	0	7	30	0	0

Sc = score L = labial P = palatal

V1 = Elandskuil V2 = Morogong V3 = Lerome V4 = Ruighoek

There was no sign of fluorosis in the maxillary anterior teeth of the 12-13 year olds at Elandskuil. Very few subjects of the same age group had TSIF scores of 1-3 (whitish discolouration of intact enamel) at Morogong. Signs of fluorosis were observed on the canines of subjects from villages 3 and 4, but the severity was more pronounced at Ruighoek.

The labial surfaces of the central incisors were more affected by fluorosis than the lateral incisors. Dental fluorosis was also more clearly pronounced on the palatal surfaces of maxillary anterior teeth in this age group at Ruighoek (Table 27).

TABLE 28: Percentage distribution of TSIF scores for the labial and palatal surfaces of permanent maxillary anterior teeth according to tooth type and water fluoride levels in 30-50 year old subjects

VILLAGE	SC	TOOTH TYPE											
		13		12		11		21		22		23	
		L	P	L	P	L	P	L	P	L	P	L	P
V1 30-35	0	0	0	0	0	0	0	0	0	0	0	0	
V2 30-55	0	97	97	97	97	97	97	93	10	100	100	100	10
	1	-	-	-	-	3	3	7	-	-	-	-	0
	5	3	-	3	3	-	-	-	-	-	-	-	-
V3 30-55	0	13	65	13	45	19	45	23	48	16	52	16	55
	1	13	10	0	29	0	29	0	26	13	19	10	7
	2	13	3	13	7	7	7	7	13	10	10	10	7
	3	7	3	13	0	7	0	3	0	7	0	23	3
	4	42	16	52	19	65	19	61	13	52	19	36	29
	5	3	0	0	-	0	0	0	0	0	0	0	0
	6	7	3	7	-	0	0	3	0	0	0	3	0
	7	3	-	3	-	3	0	3	0	3	0	3	0
V4 30-55	0	13	50	13	53	7	4	17	43	7	43	7	40
	1	0	7	0	0	0	7	0	1	0	13	0	13
	2	0	3	0	7	0	10	7	13	7	13	0	7
	3	3	0	3	10	0	13	0	10	3	7	10	10
	4	57	37	70	27	90	30	80	23	77	23	70	30
	5	7	0	0	0	0	0	0	0	0	0	3	0
	6	20	3	13	0	3	0	3	0	7	0	10	0
	7	0	0	0	0	0	0	0	0	0	0	0	0

Sc = score   L = labial   P = palatal

V1 = Elandskuil   V2 = Morogong   V3 = Lerome   V4 = Ruighoek

One subject had a score of 5 (pits with discolouration) on the palatal surface of maxillary anterior teeth at Morogong. Scores 6-7 were more pronounced in the canines than in both the central and lateral incisors at Ruighoek in the 30-55 year age group. The labial surfaces were more affected by fluorosis than the palatal surfaces at the two high fluoride villages (Table 28).

TABLE 29: Percentage distribution of TSIF scores for the labial surfaces of permanent maxillary anterior teeth in 6-7, 12-13 and 30-55 age groups

VILLAGE	PERCENTAGE DISTRIBUTION OF TSIF SCORES							
	0	1	2	3	4	5	6	7
V1 F(ppm) = 0,1-0,3								
6-7	100	0	0	0	0	0	0	0
12-13	100	0	0	0	0	0	0	0
30-55	97	0	0	0	0	0	0	0
V2 F(ppm) = 0,4-0,9								
6-7	100	0	0	0	0	0	0	0
12-13	97	10	3	3	0	0	0	0
30-55	93	7	0	0	0	0	0	0
V3 F(ppm) = 3-6								
6-7	3	7	0	13	3	3	10	0
12-13	24	50	65	44	50	3	12	0
30-55	19	26	29	39	77	3	13	3
V4 F(ppm) = 7-8								
6-7	3	10	7	23	17	10	20	0
12-13	23	10	19	74	58	26	61	16
30-55	7	0	7	17	100	10	23	0

F(ppm) = fluoride concentration (parts per million)

V1 = Elandskuil V2 = Morogong V3 = Lerome V4 = Ruighoek

In the 6-7 year olds, there were no signs of fluorosis on the labial surfaces of maxillary anterior teeth at villages 1 and 2. The severity of fluorosis was higher at Ruighoek than at Lerome. In the 12- 13 year olds there were few subjects with whitish discolourations of intact enamel at Morogong (Village 2). Clinical signs of fluorosis were observed at both high fluoride areas but scores 5, 6 and 7 were more pronounced at Ruighoek. In the 30-55 year olds, there was a decrease in the severity of fluorosis with age but 100 percent of the adults had brown discolouration at Ruighoek (Table 29).

TABLE 30: Percentage distribution of TSIF scores for buccal, palatal, lingual and occlusal surfaces of maxillary and mandibular first permanent molars in 6-7 year old subjects

VILLAGE/AGE 6-7 years	SC	TOOTH TYPE											
		16			26			36			46		
		B	P	O	B	P	O	B	L	O	B	L	O
V1 F(ppm)=0,1-0,3	0	0	0	0	0	0	0	0	0	0	0	0	0
V2 F(ppm)=0,4-0,9	1	0	7	0	0	7	0	0	0	0	0	0	0
V3 F(ppm)=3-6	0	0	3	23	0	3	19	0	10	29	0	7	29
	1	10	19	36	3	19	29	7	19	32	3	32	36
	2	13	13	0	19	13	0	19	10	0	16	10	0
	3	36	16	0	29	7	0	32	26	0	48	29	0
	4	3	10	3	3	13	7	10	3	7	7	0	10
	5	0	0	0	0	0	0	0	0	0	3	0	3
V4 F(ppm)=7-8	0	0	3	17	0	10	17	3	7	17	0	3	23
	1	3	17	43	7	10	47	3	17	47	3	20	37
	2	20	10	7	7	10	0	10	10	3	10	0	3
	3	37	20	3	47	23	7	40	43	3	33	60	0
	4	10	33	20	23	20	17	37	20	27	37	13	33
	5	10	3	0	3	3	0	0	0	0	7	0	0
	6	10	3	0	3	13	3	3	0	0	7	0	0

Sc= score B= buccal P= palatal L= lingual O= occlusal

F(ppm) = fluoride concentration (parts per million)

Mandibular first permanent molars were more affected by fluorosis than maxillary first molars, on the buccal surface, at both the high fluoride villages. Discrete pitting and staining of enamel was only found in the mandibular first molars of children from Ruighoek (Table 30).

TABLE 31: Percentage distribution of TSIF scores for buccal, palatal, lingual and occlusal surfaces of maxillary and mandibular first permanent molars in 12-13 year old subjects

VILLAGE/AGE 12-13	SC	TOOTH TYPE											
		16			26			36			46		
		B	P	O	B	P	O	B	L	O	B	L	O
V1 F(ppm)=0,1-0,3	0	100	0	0	0	0	0	0	0	0	0	0	0
V2 F(ppm)=0,4-0,9	0	100	0	0	0	0	0	0	0	0	0	0	0
V3 F(ppm)=3-6	0	10	12	74	3	44	85	15	41	77	21	56	91
	1	10	53	15	24	27	3	26	38	15	27	24	0
	2	30	9	0	21	6	0	27	0	0	15	0	0
	3	50	12	3	35	9	0	12	12	0	12	9	0
	4	15	15	9	15	12	12	21	9	9	27	12	9
	5	-	-	-	[illegible]	3	-	-	-	-	-	-	-
V4 F(ppm)=7-8	0	0	0	39	0	0	45	7	7	55	3	3	39
	1	0	0	13	0	3	10	3	0	0	3	7	10
	2	3	3	3	3	0	3	3	16	0	0	0	0
	3	10	13	3	32	16	7	13	32	0	19	39	10
	4	45	58	42	48	58	35	48	39	45	45	42	42
	5	13	10	0	0	10	0	7	7	0	10	7	0
	6	26	13	0	16	13	0	16	0	0	19	3	0
	7	3	3	0	0	0	0	3	0	0	0	0	0

Sc= score B= buccal P= palatal L= lingual O= occlusal
F(ppm) = fluoride concentration (parts per million)

Fluorosis was more pronounced in the buccal surfaces of mandibular first permanent molars than on the lingual surfaces at Ruighoek. The percentage of children with brown discolouration on the occlusal surface was higher at village 4 than village 3. Brown discolouration was more pronounced on the palatal surfaces of maxillary molars and on the buccal surfaces of mandibular molars (Table 31).

TABLE 32: Percentage distribution of TSIF scores for buccal, palatal, lingua land occlusal surfaces of maxillary and mandibular first permanent molars in 30-55 year old subjects

VILLAGE/AGE	SC	TOOTH TYPE											
		16			26			36			46		
		B	P	O	B	P	O	B	L	O	B	L	O
V1 F(ppm) = 0,1-0,3 30-55	0	100	0	0	0	0	0	0	0	0	0	0	0
V2 F(ppm) = 0,4-0,9 30-55	0	100	0	0	0	0	0	0	0	0	0	0	0
V3 F(ppm) = 3-6 30-55	0	16	69	81	26	36	81	29	39	90	29	45	90
	1	3	3	0	3	13	3	13	13	3	10	13	0
	2	3	3	0	10	0	0	0	0	0	3	0	0
	3	19	3	0	3	0	0	10	19	0	7	7	0
	4	48	48	13	48	48	16	39	29	7	45	36	10
	5	7	0	0	0	0	0	0	0	0	3	0	0
	6	3	3	0	10	0	0	10	0	0	3	0	0
V4 F(ppm) = 7-8 30-55	0	20	27	77	23	30	83	7	17	73	20	33	70
	1	0	3	0	0	0	0	0	3	0	3	0	0
	2	3	3	3	3	7	0	0	0	0	0	7	3
	3	3	3	0	3	0	0	10	10	0	3	0	0
	4	40	40	20	43	57	17	77	70	27	60	57	27
	5	3	0	0	7	0	0	3	0	0	0	3	0
	6	30	23	0	17	7	0	3	0	0	13	0	0
	7	0	0	0	3	0	0	0	0	0	0	0	0

Sc = score B = buccal P = palatal O = occlusal L = lingual

F(ppm)= fluoride concentration (parts per million)

There was a decrease in the severity of fluorosis with age. No significant difference was observed in the fluorosis status of both the maxillary and mandibular first permanent molars on the buccal surfaces of adults at village 4. The occlusal surfaces were less affected by fluorosis in this age group because of attrition. At village 1 and 2, there were no subjects with signs of fluorosis (Table 32).

CHAPTER 5

DISCUSSION

The present study sought to investigate and compare the relationship between caries, periodontal disease and fluorosis among children and adults, residing in low, optimal and high fluoride areas. The three oral diseases mentioned above will be discussed in detail with a focus on different age groups and in comparison with other similar studies.

DENTAL CARIES

Epidemiological surveys have reported a decrease in caries prevalence in industrialised countries, particularly in urban populations (Dini and Silva 1994, Downer 1998), and an increase in developing countries. Recent studies indicate a low prevalence of dental caries in most rural African countries (Ng'ang'a and Valderhaug, 1992), and this is consistent with the findings of the study.

Primary dentition

6 - 7 year olds

The percentage of caries-free primary teeth in 6-7 year old children was found to be high in all four rural villages of Mankwe ranging from 74 to 93 percent and which is well above the goal set by the World Health Organisation (WHO, 1993) for the year 2000, that is, 50 percent of 5 year children should be caries free. The data from this study is consistent with studies in other developing countries where caries prevalence is generally low (Tirwomwe and Ekoku, 1990). du Plessis (1991), however reported that only 37 percent of primary teeth in six year old urban black children were caries free. Possible reasons given for these differences between the urban and rural caries profiles include the eating of traditional fibrous foods in rural areas, and the scarcity of money to purchase cariogenic foods. Also the lack of access and availability of these in the stores, and in some areas the high fluoride content of the drinking water contributed to this low caries status. However, the fluoride factor cannot be the only consideration because high caries-free percentages were also found in the village with very low fluoride content in the drinking water in Mankwe.

The dmft scores from this study for the 6-7 year old children ranged from 0,1-0,9 (Table 20) and were lower than the results of other studies in southern or South Africa (Moola et al, 1990; du Plessis, 1994), in Tanzania (Kerosuo and Honkala, 1991) as well as in countries outside Africa (Robertson et al, 1989; Ran, 1989; Al-Shammery et al, 1990; Gordon et al, 1990; Kerosuo and Honkala, 1991; Downer, 1998). There was a similarity in the dmft at Elandskuil (Table 21) and Uganda (Table 6).

Permanent dentition

6 - 7 year olds

The DMFT of the 6-7 year old subjects of this study was extremely low in both the low and high fluoride villages. The caries profile of this age is comparable with the results of other studies in southern and South Africa (Moola et al, 1990; du Plessis, 1994; Ramukumba et al, 1991) although slightly higher DMFT scores were recorded in Namibia (Table 3). The DMFT of this study was similar to the results in rural areas of Nigeria (Table 6). Although the DMFT was found to be low in the rest of Africa, it was nevertheless slightly higher than in the Mankwe region (Table 22). In India, also considered to be a developing country, the DMFT was similar to the results of the present study.

12 - 13 year olds

The WHO has set as a goal for the year 2000 for 12 year old children of a DMFT of not more than 3 (Barmes 1983, WHO 1994a). The prevalence of dental caries for the 12-13 year olds in this study was found to be far lower than this goal. The consumption of high fibre foods and unrefined carbohydrates, the low frequency of intake of cariogenic diet particularly in-between meals, the naturally occurring fluoride in the water, and to some lesser extent the use of fluoridated toothpastes, are factors which may have contributed to the low caries status in this region. These factors have also been suggested by Manji et al, (1986b) and Cleaton-Jones and Hargreaves, (1988).

Of interest was the relatively low percentage (74 percent) caries-free at Ruighoek which has the highest fluoride content in water (7-8 ppm). This may be due to the fact that once the concentration of fluoride in drinking water exceeds 3 ppm, the preventive effect becomes diminished (Den-Besten & Crenshaw, 1987). The excessive amount of fluoride interferes with the normal formation of enamel and the tooth can become porotic. Debris and plaque become entrapped in the porotic areas thereby rendering the tooth to be more susceptible to caries (Mann et al, 1990). DMFT of the present study was lower than that reported in Mexico and Brazil (Burt 1994, Dini and Silva, 1994). Although the percentage of children with caries was low in Mankwe, the available treatment facilities and oral health personnel at the time were inadequate to cope with the backlog of treatment need. There were no subjects with filled teeth at any of the four villages (Table 22). These villages are situated far away from any clinic or hospital where basic equipment and oral health personnel were available for more comprehensive treatment. The study population also lack sufficient funds to reach the few hospitals which had dental equipment for preventive and curative treatment. Additionally, in most clinics only an extraction service was offered by a dental officer who would visit these regions periodically. Also some of the people may have chosen extractions rather than receiving comprehensive care due to inadequate knowledge of the advantages of restorative dentistry.

The utilisation of mobile dental units could be an appropriate delivery system which would make basic preventive and restorative services more accessible and available to communities in remote areas. With the aid of a mobile unit, early lesions can be treated which would prevent the loss of permanent teeth and the recognised sequelae of tooth loss. It could act as a platform for health education programmes in schools or primary health clinics (Rudolph et al, 1992).

Presently, the government has proposed a national clinic-upgrading programme including oral health care but, this development may take several years before it is implemented in most rural areas.

The findings of the present study for the 12-13 year age group compares favourably with the low caries prevalence reported in most of the rural areas in southern and South Africa (du

Plessis 1986 & 1994; Cleaton-Jones and Hargreaves, 1988; Walker et al, 1988; 'VHO, 1989; Hargreaves et al, 1990; Ramukumba et al, 1991; Chikte et al, 1991). The DMFT for other 12-13 year age groups was found to be slightly higher in many urban areas and even in some rural areas than in the present study (Tables 7 and 22). This may purport an association between changing lifestyles, dietary habits and greater accessibility to refined foods.

Although nutritional status was not assessed in this study, several of the children (with low dental caries) were observed to have visible signs of malnutrition, like low weight for age. It is extremely difficult to demonstrate an association between caries and malnutrition and this probably accounts for the few studies that have investigated the relationship of malnutrition and dental caries. Only two of such studies have been reported from South Africa (Jinabhai, et al 1983; Walker et al, 1988). Jinabhai et al (1983) conducted a study in an urban Indian community in Kwazulu Natal, and found that 90 percent of the children from birth up to the age of 8 years showed signs of dental caries and 69 percent undernutrition. The other study among school children aged 10-12 years in rural Hekpoort, situated ± 80 km from Johannesburg, indicated that malnutrition as assessed anthropometrically did not have any disadvantages to their dentition status (Walker et al, 1988).

Recent information about caries in East Africa indicated that the levels of caries tends to be relatively low by international standards (Chironga and Manji, 1989; Olsson et al, 1989; Kubota et al, 1990; Bourgeois et. al, 1991) (Table 7). It was thought that the apparent increase in caries prevalence in this part of Africa was associated with the improvements in life style and purchasing power of sections of the population that came about in the wake of political independence. In particular, reference has been made by several authors to the increasing consumption of sugar (Khan & Cleaton-Jones, 1998; du Plessis, 1997; and Ng'ang'a and Valderhaug, 1992). The DMFT of the low fluoride village (0,1-0,3) of the present study among the 12-13 year old children compares with the findings in Kenya and Tanzania where a DMFT of 0,51 and 0,67 were reported respectively (Table 7 and 22). The caries experience of 12 year old children in Zimbabwe was also similar to that of Tanzania and Kenya indicating that the finding of low levels of caries in this age group is not a phenomenon confined only to East African countries (Chironga and Manji 1989, Sathananthan et al 1996). Although fluoridated tooth pastes have been available in urban areas in both Zimbabwe and Kenya for some years , the limited extent of their use, especially in rural areas, could not account for the low levels of caries observed. In Malawi and Mozambique more 12 year old children were affected by caries in urban than in rural areas because of a recent increase in exposure to cariogenic factors (Chimimba and Qech, 1989; Olsson et al, 1989). In Nigeria, the observed low caries status could be attributed to lower sugar consumption together with the occlusal attrition (which eliminates the susceptible pits and fissures) in the rural areas (Kubota et al, 1990) and compares with the results of the present study. Studies in Algeria found a DMFT score of (1,63) slightly higher than that of most African countries and the authors suggested that the necessity for integrated preventive measures be encouraged (Bourgeois et al, 1991).

In India and Saudi Arabia, the DMFT for the 12 year olds compares with the results of most urban areas in some of the African countries. One of the explanations for the higher caries experience of young children in India is that the families' better financial status allowed for more Indian sweetened soft drinks and candies to be eaten (Robertson et al, 1989; Al-Shammery et al, 1990). The prevalence of dental caries among the 12-13 year olds in Israel was higher than in the majority of the African countries because of the difference in culture, an increase in the frequency of fermentable carbohydrate consumption and a lack of preventive programmes (Gordon et al, 1990).

30-55 year olds

In the present study, DMFT increased with age. In the 30-55 year age group, the DMFT ranged from 1,8 at Lerome to 4,5 at Elandskuil. There were no adults with filled teeth and the DMFT of the present study was comparable to that of Namibian adults (du Plessis, 1986). A higher DMFT was reported in the urban blacks of South Africa (10,9) and also in rural Transkei (8,4) (Rudolph & Brand, 1989; du Plessis, 1994). This difference may be due to the change in diet among rural and urban blacks, and variations in the sampling criteria used in different studies. These results were also similar to the findings of studies in Africa for the 35-44 year age group in Burkina Faso, Kenya, Malawi, Mauritius, Zaire, Zambia and Zimbabwe (WHO, 1989). In the South African National Oral Health Survey (1988/1989), the DMFT of adult blacks was found to be lower than that of the other racial groups.

With the introduction of free primary health services in South Africa, more South Africans will have access to treatment for oral diseases. However, in addition to this positive step of making services available, equally strong efforts should be introduced to promote oral health and prevent oral diseases.

PERIODONTAL DISEASE

The extent to which periodontal disease constitute a public health problem is currently an issue of debate (Pilot and Miyazaki,1991). Periodontal disease appears to be a universal disease of adulthood (Baelum and Papapanou, 1996).

In the present study, the CPITN index was used to assess the periodontal status and resultant periodontal needs of the 12-13 and 30-55 year age group. The percentage of the 12-13 year olds with bleeding ranged from 41-67 percent and was high at Morogong. There was no single child in this region who did not demonstrate signs of gingivitis. The high prevalence of gingivitis in Mankwe region may be due to plaque accumulation, improper methods of tooth brushing or even an absence of oral hygiene in some of the subjects aged 12-13 years. Even though a different index was used, a high percentage of bleeding was reported in Klipfontein, also a high fluoride village in the western part of the Cape Province (Reddy et al, 1985). The findings of this study are, however, in contrast with the results of some of the studies in southern Africa where the percentage of the same age group with bleeding did not exceed 25 percent (Rossouw, 1986; Chikte et al, 1990; Vergotine et al, 1990.) The higher percentage of bleeding in this study may have been due to lack of awareness of the importance of oral hygiene as well as a lack of toothbrushes which many could not be able to purchase.

Less than 60 percent of the 12-13 year old subjects in Mankwe had calculus as compared to some other areas in South Africa (Table 10). Diet also may have contributed to less accumulation of calculus in this region due to the consumption of high fibre foods. The gingivitis-calculus complex predominates as the most common scores among the 12-13 year age group in South Africa. Based on the CPITN, more than 95 percent of the subjects in Mankwe needed oral hygiene instruction and this was consistent with studies done in South

Africa and Namibia (Tables 10 and 23 (c)). Furthermore, more than 50 percent of both studies were identi 'ed as needing oral prophylaxis. The findings of this study are consistent with other populations where routine/daily oral hygiene is not practised and where gingivitis and calculus are highly prevalent in young adults and may remain so for a lifetime (Garcia and Cutress, 1986; Baelum & Papapanou, 1996). The gingivitis-complex is reportably common in the rest of Africa for the 12-13 year age group (Mumghamba et al, 1989; Mumghamba, 1990).

In contrast to the findings in most African countries, periodontally healthy mouths are very common in adolescents in countries outside Africa (Garcia and Cutress, 1986; Flores-de-Jacoby et al, 1989 and Abdul-Kadir, 1990) (Table 13). Factors such as culture, heredity, diet and geographical location may play a role in these differences. In the adult population, the high percentage regarding loss of teeth may be due to periodontal disease. Some of the studies done in South Africa (Rossouw, 1986; Louw et al, 1989; Gugushe et al, 1994a) [Tables 11 and 23(a)] indicated that almost all dentate adults had periodontal disease in southern Africa.

In the present study, the percentage with calculus ranged from 36 percent at Ruighoek to 58 percent at Lerome. Shallow pocket and particularly deep pockets were uncommon. The apparent calculus reduction with age was explained by the increasing prevalence of shallow pockets which were observed in only 1,5 percent of 15 year olds compared to 29,7 percent of the 45-54 year olds. Bleeding on probing was less common among the adult age group. Shallow pockets and particularly deep pockets were uncommon with an average, less than one index tooth affected. This is consistent with an earlier report by (Gugushe et. al, 1994a).

Approximately 100 percent of the 30-55 year age group in this study required oral hygiene instruction and very few needed complex periodontal care. This finding is similar to that reported by Garcia and Cutress (1986) for adults in the Philippines.

Although in the present study population, the recommended treatment intervention for the majority of the subjects would include prophylactic scaling with oral hygiene instructions (Tables 23a, 23b, 23c). The CPITN index has undergone a test period of about sixteen years and has been extensively used, a simplification of the index is being considered where the concept (shallow pocket) should be discontinued in favour of giving the pocket depth in millimetres. This is because the CPITN overestimates the prevalence of periodontal attachment loss among younger age groups and in the adults, it underestimates attachment loss. It has therefore been suggested that the concept of treatment 'needs' require revision.(Baelum et al, 1995).

DENTAL FLUOROSIS

Numerous studies have shown that the ingestion of optimal levels of fluoride reduces the incidence of caries. On the other hand, excessive amounts of fluoride in drinking water leads to increased prevalence and severity of fluorosis which may be of public health concern (Ng'ang'a and Valderhaug, 1993)

In this study both Dean's Index and the TSIF were used to describe the clinical appearance of dental fluorosis. Whereas the Dean's Index (Dean et. al, 1942) which has been used for over fifty years provides more references for comparison with the present study, the TSIF (Horowitz et al, 1984; Horowitz 1992) provides clearer diagnostic criteria for an analysis and is based on aesthetic concern.

The caries inhibitory effect of optimally fluoridated water is well documented (Murray et. al, 1991). The inverse relationship between dental caries and fluoride in the drinking water and the direct association between dental fluorosis and fluoride level in the drinking water has been well established (Horowitz, 1992; Moola 1996). These two phenomena are well demonstrated in this study.

The upper limit of the appropriate range of fluoride in drinking water varies according to how much you drink and, on the other forms of fluoride being available. An accepted recommended concentration range is 0,5 - 1,2ppm depending on the average temperature (Whitford, 1994; Owen, 1994). The lower levels are recommended for warmer regions. In the Mankwe district, water intake tended to be high and therefore the recommended water fluoride levels may need to be as low as 0,5ppm.

When the fluoride concentration in drinking water exceeds 3ppm, the preventive effect against caries becomes diminished (Driscol et al, 1983). There was some evidence of this phenomenon in the study. There was a positive correlation between fluorosis and caries, that is, the more severe the fluorosis the higher the DMFT.

In the United States, the major sources of fluoride are foods, drinking water, beverages and fluoride containing dental products (Burt, 1992; Whitford, 1994). In Mankwe district, the major source of fluoride was water but other sources included tea and fluoridated toothpaste which was increasingly available in the area from local markets.

In Mankwe, the concentration of fluoride in drinking water (underground water) was high. In the present study there was a clear dose-response relationship with regard to both prevalence and severity of fluorosis for Dean's and TSIF indices. The effect of high levels of fluoride clearly demonstrated serious cosmetic problems and thus constitute a public health problem particularly in young women. This problem earlier reported by Bischoff et al (1976) was manifested on an individual level where a number of females tried to remove the discoloured enamel by manual abrasion with sand, sandpaper or ash. These attempts of removing the unsightly enamel was in keeping with Helm et al, (1985) study which show that dental appearance plays an important role in young adults self-perceived general body image.

The severity of fluorosis was less pronounced in primary teeth than in the permanent dentition. Fluoride does not readily pass through the placenta, which may act as a partial barrier thereby protecting the foetus against toxic levels of fluoride (Burger et al, 1987). The reduced severity of fluorosis in primary teeth may be due to the shorter duration of enamel formation and maturation of primary teeth and their much thinner enamel layer, which allows only a smaller amount of fluoride to be deposited into the developing enamel. An additional factor might be the higher exchange of fluoride during development of the primary dentition as compared to the permanent dentition (Mann et al, 1990, Mann et al, 1994).

The percentage of the 6-7 year old children with scores of 4-5 of the TSIF index in primary dentition at Lerome and Ruighoek was 22,6 and 40,0 respectively (Table 25). The severity of fluorosis at Lerome with 3-6ppm fluoride in water was similar to the findings at Kenhardt with more or less the same concentration of fluoride in drinking water (MacInnes et al, 1982). However, comparisons between these studies is difficult because of the different indices and diagnostic criteria used.

In permanent teeth in Mankwe in 6-7 year old the severity of fluorosis when using Dean's index was higher at Ruighoek (7-8ppm) than at Kliplaatdrift (8-9ppm), but the percentage of caries-free subjects was approximately the same (Tables 21 and 15).

Using Dean's index for the 12-13 year age group in the present study, scores 4-5 at Ruighoek and Lerome, were 97 and 65 percent respectively (Table 22). These findings agree with the results obtained by Akpata et al (1997) in their study of 12-15 year old children from a rura, high fluoride region in Saudi Arabia (0.5-2.8 ppm) where 90 percent of the subjects had dental fluorosis. The prevalence of fluorosis was more severe at Ruighoek than at Kliplaatdrift (Lewis et al, 1992) possibly because of the higher temperature found at the former. Eighty-three percent of the 14-23 year old age group had fluorosis at Saulspoort also a high fluoride area in Mankwe (Bischoff et al, 1976) compared to 65 percent of the 12-13 year olds at Lerome situated less than 15 km away. The difference in the severity may be due to age and fluctuation in the concentration of fluoride in drinking water, because at one of the bore-holes in Lerome there was absolutely no trace of fluoride. At Mabeskraal, also situated in Mankwe region, 11,4 percent of the 15-19 year age group exhibited signs of fluorosis and of those with fluorosis 22 percent were classified as moderate (van der Merwe et al, 1977). The findings of this previous study are in contrast with the results of the present investigation at Elandskuil, where there was no fluorosis, although situated in the same region with approximately similar concentrations of fluoride in drinking water (Table 22). Variation in the severity of fluorosis between the two villages may be due to the fact that Mabeskraal is situated near the high fluoride village, Ruighoek. It is possible that some of the children from Ruighoek attended school at Mabeskraal. The difference in the severity of fluorosis may also be due to different diagnostic technique used in both studies.

Other sources of fluoride may have contributed to the presence of fluorosis in the nearby villages with low fluoride levels (El-Nadeef and Honkala 1998). The ingestion of fluoridated toothpaste could contribute significantly to the occurrence of fluorosis even in communities with negligible amounts of fluoride in the drinking water (Horowitz, 1992).

The percentage of children 12-13 with fluorosis in Lerome was approximately the same as that in the Northern Cape with the same amount of fluoride in drinking water (Retief et al, 1979a). The percentage caries-free which was higher at Lerome than at Kenhardt and Tweeriviere may be due to a difference in culture and geographic location (Tables 16 and 21).

The severity of fluorosis was higher in Ethiopia than at Elandskuil with approximately the same amount of fluoride in drinking water when the permanent dentition of 6-7 year olds were considered. The percentage caries-free was however, higher at Elandskuil (Olsson, 1978). This difference might have been due to the increased intake of sugar in Ethiopia. In Lerome with (3-6 ppm) of fluoride, almost 80 percent of the children aged 6-7 years had fluorosis. The high percentage of fluorosis in Lerome may be due to the fluctuation of the concentration of fluoride in underground water. In the present study, no differences were observed in the gender distribution of fluorosis. This is in agreement with the report of Moller et. al, (1970).

The average daily water consumption in Mankwe is relatively high because the average maximum daily temperature is about 31°c in summer and 25°c in winter (Bischoff et al, 1976). The percentage of people with dental fluorosis is therefore high at the villages with more than optimal amount of fluoride in drinking water. Recently some of the villages in this region have been supplied with tap water but only few inhabitants can afford it due to the high cost.

In Illinois, USA, only 11,6 percent of children aged (8-16 years) had fluorosis scores of TSIF of (4-7) in an area with 4x optimal amount of fluoride in water in Illinois. These latter communities are in the position to regulate the concentration of fluoride in drinking water and therefore their findings are not truly comparable with the present study (Heifetz et.al, 1988). The Tooth Surface Index of Fluorosis was very useful in assessing fluorosis related to the aesthetics of maxillary anterior teeth and has been shown to be effective in other studies (Clark, 1995).

Fewer studies have been done in South Africa to determine the severity of fluorosis in adults. In the 30-55 year age group of this study, there was a decrease in the severity of fluorosis with age but 100 percent of the adults had brown discolouration at Ruighoek. Although drinking water in Mankwe region appears to be the main contributor to fluorosis, the ingestion of fluoridated toothpaste as an additional source of fluoride must be considered as a further contributing factor (Horowitz, 1992; Riordan, 1993).

Research over the years have not only quantified the dose relationship between ingested fluoride and fluorosis prevalence and severity, but has also defended the relationship between fluoride and caries prevalence. However, in the past two to three decades, ingestible fluoride has become available from a number of sources, particularly toothpaste. This has led to a reconsideration of the hitherto recommended optimal water fluoride concentration of 1ppm (Horowitz, 1992). Furthermore, severe mottling can be as destructive to teeth as dental caries (Den-Besten and Crenshaw, 1987). If the concentration of fluoride in drinking water exceeds 3ppm, degeneration of ameloblasts occurs resulting in defective erosive enamel. Changes in developing enamel caused by the chronic ingestion of high levels of fluoride in drinking water have been shown to occur in both the secretory and maturation stages of enamel formation resulting in the formation of hypomineralised enamel (Den-Bestein and Crenshaw, 1987). Once enamel is hypomineralised, the tooth becomes porotic and susceptible to caries as debris and plaque are trapped in the hypoplastic areas (Mann et al, 1987).

CONCLUSION

In Mankwe region, dental caries was found to be very low in children although an increase was observed in adults. The higher DMFT in adults may be due to the missing component where the teeth may have been lost due to caries or even periodontal disease. An attempt must be made in this region to prevent the present caries levels from rising through health promotion, health education and available preventive strategies. Every effort should be made to encourage and promote the positive dietary habits of the population which undoubtedly contributed to the relatively healthy status of the teeth. It is important to limit the introduction of cariogenic snacks and drinks through aggressive health education and positive anti-sugar policies. The provision of a mobile dental unit could be an alternative means in providing dental services in these remote areas. This is justified by the high unmet oral health needs in the communities. Organised school oral health services should also be introduced.

Most of the children in this region had signs of periodontal disease which could be controlled by effective daily oral hygiene measures. A similar high percentage of adults presented with a low severity of periodontal disease which could also be controlled by the use of preventive and treatment strategies. These measures can be effectively implemented by auxilliary personnel.

Many individuals from high fluoride areas had moderate to severe fluorosis which manifested in some adolescents demanding that their teeth be extracted. Others attempted to remove the unsightly brown discolouration with ash or sand paper. The psycho-social consequences of fluorosis was not part of the present study and any findings in this area can only be tangential. It is therefore recommended that this aspect be further investigated in the study community.

In the high fluoride communities where the provision of potable pipe-borne water is not immediately feasible, monitoring of fluoride concentration and defluoridation is recommended. Restorative and other treatment options should also be considered for those who had already developed dental fluorosis. The results of this study will be presented to the Department of Water Affairs to further motivate and speed up the process of providing these communities with potable water. The oral health division of North West Province has an enormous challenge to achieve good oral health for the people of this area. The availability of adequate funds and the employment of more oral health personnel is therefore essential.

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APPENDIX 3

PERIODONTAL DISEASE [COMMUNITY PERIODONTAL INDEX OF TREATMENT NEEDS (CPITN)] (Ainamo et al, 1982, WHO 1987).

0 = Healthy

1 = Bleeding observed during or after gentle probing.

2 = Calculus or other plaque retentive factors such as ill-fitting crowns or poorly adapted edges of restorations are either seen or felt during probing.

3 = Pathological pocket of 4-5mm, that is, gingival margin situated on black area of the probe.

4 = Pathological pocket of 6mm or more, that is, black area of the probe not visible.

X= When only one tooth or no teeth are present in a sextant.

APPENDIX 4

DEAN'S INDEX

Only the most severely affected tooth in the maxilla and mandible were recorded.

Normal	0
Questionable	1
Very mild	2
Mild	3
Moderate	4
Severe	5

CLASSIFICATION OF FLUOROSIS

Several indices have been used to describe the clinical appearance of dental fluorosis. The continued use of Dean's classification system is testimony to its simplicity and ability. Furthermore, its wide spread use over an extended period serves as a standard of comparison (Rozier, 1994). The Dean's Index is based on tooth measurement and provides a maximum of 28 scores per subject (Appendix 4).

APPENDIX 5

DESCRIPTIVE CRITERIA AND SCORING SYSTEM FOR THE TOOTH SURFACE INDEX OF FLUOROSIS (TSIF) AS DESCRIBED BY HOROWITZ ET AL (1984).

Numerical Descriptive Criteria Score	
Score	Description
0	Enamel shows no evidence of fluorosis
1	Enamel shows definite evidence of fluorosis namely, areas with parchment (white colour) that totals less than one third of the visible enamel surface. This category includes fluorosis confined only to incisal edges of anterior teeth and cusp tips of posterior teeth (snowcapping).
2	Parchment (white) fluorosis totals at least one third of the visible surface, but less than two thirds.
3	Parchment (white) fluorosis totals at least two thirds of the visible surface.
4	Enamel shows staining in conjunction with any of the preceding levels of fluorosis. Staining is defined as an area of definite discolouration that may range from light to very dark brown.
5	Discrete pitting of the enamel exists, unaccompanied by evidence of staining of intact enamel. A pit is defined as a physical defect in the enamel surface with a rough floor that is surrounded by a wall of intact enamel.
6.	Both discrete pitting and staining of the intact enamel exist.
7.	Confluent pitting of the enamel surface exist. Large areas of enamel may be missing and the anatomy of the tooth be altered. Dark brown stain is usually present.

The TSIF described by Horowitz et al, 1984 is based on surface measurement and makes a useful contribution because it provides clearer diagnostic criteria (Cleaton-Jones & Hargreaves, 1990). This system provides a maximum of 72 scores per subject. It therefore has an advantage over Dean's Index because it describes the scoring of surfaces rather than individual teeth. Surface score allows for analysis of fluorosis on the labial surfaces of maxillary anterior teeth (Appendix 5).

APPENDIX 2

ORAL HEALTH, CARIES, CPITN IN MANKWE DISTRICT BOPUTOTSWANA

NAME ....

STUDY NO	GENERAL INFORMATION
[ ][ ][ ] 3	Age in years 4 [ ][ ][ ] 6
	Sex (M=1, F=2) 7 [ ]

VILLAGE	PERIODONTAL STATUS (CPITN)
[ ] 8	
1=Elandskuil	
2=Ruighoek	
3=Lerome	
4=Morogong	

PERIODONTAL STATUS (CPITN)

	17/6	11	26/27	
9				11
12				14
	47/46	31	36/37	

0= healthy
1= bleeding
3= pocket 4-5mm
(black band of probe partially visible)
4= pocket 6mm or more
(black band of probe not visible)
x= excluded sextant

DENTITION STATUS AND TREATMENT NEED

	55	54	53	52	51	61	62	63	64	65							
	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28	
status 15																	30
treatment																	

STUDY [ ][ ][ ] 1-3

[5] 72

	85	84	83	82	81	71	72	73	74	75							
	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38	
status 31																	46
treatment																	

STATUS

Permanent teeth

0= sound
1= decayed
2= filled & decayed
3= filled no decay
4= missing due caries
5= missing any other reason
6= sealant, varnish
7= bridge abutment or special crown
8= unerupted tooth
9= excluded tooth

STUDY NO [ ][ ][ ] 1-3

1st QUADRANT

	B	L	M	D	O	
17						4-8
16						9-13
15						14-18
14						19-23
13						24-27
12						28-31
11						32-35

2nd QUADRANT

	B	L	M	D	O	
27						36-40
26						41-45
25						46-50
24						51-55
23						56-59
22						60-63
21						64-67

STUDY NO [ ][ ][ ] 1-3 [7] 72

3rd QUADRANT

	B	L	M	D	O	
37						4-8
36						9-13
35						14-18
34						19-23
33						24-27
32						28-31
31						32-35

4th QUADRANT

	B	L	M	D	O	
47						36-40
46						41-45
45						46-50
44						51-55
43						56-59
42						60-63
41						64-67

DEAN'S INDEX

	Tooth number 68
	Fluorosis score 69

TOOTH SURFACE INDEX OF FLUOROSIS

	B/L	P	O	
17				1-3
16				
15				
14				
13				
12				
11				

17-18

	B/L	P	O	
27				19-21
26				
25				
24				
23				
22				
21				

35-36

	B/L	L	O	
37				37-39
36				
35				
34				
33				
32				
31				

53-54

	B/L	L	O	
47				5
46				
45				
44				
43				
42				
41				

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