THE ORAL HEALTH STATUS OF XHOSA SPEAKING ADULTS IN CROSSROADS

BY

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2 SUMMARY

There is an absence of both dental services and systematic planning to meet the oral health needs of the Black* population of greater Cape Town. Little epidemiological data exists upon which such planning can be based. This study describes the prevalence and treatment need related to tooth decay and periodontal disease of a Xhosa-speaking* squatter community on the outskirts of Cape Town.

An age and sex stratified sample of 290 adults attending the SACLA clinic in Crossroads were examined. Examiner variability was measured by a percentage intra-examiner agreement for the DMFT of 95% and for the CPITN 84%. Cohen's kappa statistic, for tooth-specific caries detection errors was k = 0.877.

The mean DMFT was 11.8 and varied little with sex or age below 55 years. After this age, the DMFT climbs steeply due largely to the rapid increase in the M value (missing teeth). The results show that for every tooth needing to be extracted, two teeth per subject required a restoration. Only three subjects already had some restorations.

Periodontal health was reflected by a high prevalence of calculus (TN2 = 99% ; MNS = 5.2) for the whole sample. Deep pockets were detected in 13% of those aged between 15 and 29 years, but only at a relatively low intensity (MNS = 0.1). This prevalence reached a high 60% for those aged between 45

and 64 years (MNS = 1.7). All subjects require oral hygiene instruction and gross scaling in at least four sextants, according to CPITN criteria.

In conclusion it is noted that there is a shortage of relevant epidemiological information necessary to the planning of oral health services to improve the oral health of the Xhosa-speaking community in the Western Cape.

Caries prevalence rates are already high in young adults and a high tooth mortality rate and an absence of fillings, suggests that extraction is the only form of treatment made available to this community. The absence of appropriate prevention strategies such as water fluoridation is reflected in these results.

The existence of small amounts of severe periodontal disease in young adults is of concern. The high prevalence of mild (and preventable) periodontal disease, seems to reflect a low awareness of the condition and/or a lack of resources to control it.

It is no coincidence that such poor oral health was observed in this, a poor, peri-urban squatter community. This study, serves as a sad reminder of the maldistribution of oral health and socio-economic resources in South Africa. The socio-economic and political character of this community is reflected by the epidemiological picture of oral health observed in the study.

It is clear that further data must be collected, especially a clear assessment of community-expressed needs. Active planning must take place urgently to integrate oral health with Primary Health Care to rectify the serious misuse and maldistribution of oral health resources required to improve the oral health of this population.

FOOTNOTES

* The term "Black" in the text is used in a descriptive sense only but refers to the definition created by apartheid political terminology and enshrined in the Population Registration Act of 1950 of the Republic of South Africa.

  This study considers this terminology to be a relevant reflection of the particular social reality existent in South African (Chikte et al 1989).

* The term "Xhosa-speaking" will be considered to refer to one of four variables by which selection into the sample took place.

OPSOMMING

Daar is 'n gebrek aan tandheelkundige dienste asook sistematiese beplanning om die mondgesondheidsbehoeftes van die Swart* bevolking van Kaapstad aan te voldoen. Min epidemiologiese data bestaan waarop sulke beplanning gebaseer kan word. Hierdie studie beskryf die algemeenheid en behandeling wat betrekking het op tandverrotting en periodontiese siektes van 'n Xhosa-sprekende* plakker-gemeenskap naby Kaapstad.

'n Ouderdom en geslagsmonster van 290 volwassenes wat die SACLA kliniek in Crossroads besoek het, is geondersoek. Die ondersoeker veranderlikheid was gemeet met 'n persentasie binne ondersoeker ooreenkoms van die DMFT van 95% en vir die CPITN 84%. Cohen's kappa statistiek vir tand-spesifieke karies foute was k = 0.87.

Die gemiddelde DMFT was 11.8 en verskil minder met geslag of ouderdom onder 55 jaar. Na hierdie ouderdom styg die DMFT skerper na aanleiding van die vinnige vermeerdering in die M waarde (vermiste tande). Die resultate toon dat vir elke tand waarvoor verwydering nodig is, twee tande per persoon 'n herstelling benodig. Net drie persone het herstellings gehad.

Periodontiese gesondheid word weerspie-l deur 'n hoe voorkomingsyfer van rekenmetode (TN2 = 99%; MNS = 5.2) vir die hele monster. Diep holtes was ontdek in 13% van daardie persone tussen die ouderdom van 15 en 29 jaar oud, maar alleenlik deur betreklik lae intensiteit (MNS = 0.1). Hierdie voorkomingsyfer het 'n hoe 60% bereik vir daardie persone

tussen die ouderdomme van 45 en 64 jaar oud (MNS = 1.7). Alle persone benodig mond higi-niese instruksies en gros verskaling in ten minste vier sekstants in ooreenstemming met die CPITN.

Ter afsluiting word gemerk dat daar 'n tekort is aan relevante epidemiologiese inligting nodig om 'n verbetering van mondgesondheid vir die Xhosa-sprekende gemeenskap in die Wes Kaap te beplan.

Karies se voorkomingsyfer koerse is alreeds hoog in jong volwassenes en 'n hoe tand mortaliteit en 'n afwesigheid van stopsels stel voor dat uittrekking die enigste middel van behandeling is, wat tot hierdie gemeenskap beskikbaar is. Die afwesigheid van geskikte voorkomingstrategie soos openbare water fluoridasie word weerspieel in hierdie resultate.

Die bestaan van klein hoeveelhede van ernstige periodontiese siektes in jong volwassenes is kommerwekkend. Die ho- voorkomingsyfer van matige (en voorkombare) periodontiese siektes verwys na 'n lae bewustheid van di- toestand en/of 'n tekort aan hulpmiddels om dit te beheer.

Dit is geen toeval dat sulke slegte mondgesondheid waargeneem is in die armmoedige stedige plakkergemeenskap nie. Hierdie studie dien as 'n hartseer herinnering aan die wanverdeling van gesondheid en sosio-ekonomiese hulpmiddels in Suid-Afrika. Die sosio-ekonomiese en politieke karakter van hierdie gemeenskap word weerspie-l deur die epidemiologiese voorstelling van mondgesondheid in hierdie studie.

Dit is duidelik dat verdere data gekollekteer moet word veral 'n duidelike skatting van gemeenskapsbehoeftes. Aktiewe beplanning moet dringend plaasvind sodat integrasie van mondgesondheid met "Primere Gesondheidsorg" reggestel kan word. So kan die beeindiging van die ernstige misbruik en wanverdeling van mondgesondheids hulpmiddels asook die verbetering van die bevolking se mondgesondheid begin.

NOTAS

* Die term "Swart" in die teks word alleenlik in 'n beskrywende betekenis gebruik en verwys na die defenisie wat geskep is deur die politieke terminologie van apartheid soos dit in die Bevolkings Registrasie Wet van 1950 van die Republiek van Suid-Afrika bestaan. Hierdie studie beskou die terminologie as 'n toepaslike refleksie van die besondere sosiale werklikheid wat bestaan in Suid-Afrika (Chikte et al 1989).

* Die term "Xhosa-sprekend" verwys na een van die vier veranderlikes wat vir die sortering van die monster gebruik is.

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4 INTRODUCTION

Some initial observations of a community's oral health occurred in 1982 at the Empilisweni SACLA Clinic in Crossroads, a squatter settlement at the periphery of Cape Town (See Appendix 12.1). Initial perceptions included surprise at the vast mounds of calculus, the apparent absence of any form of oral hygiene practice, the endless supply of people with decayed teeth needing extraction and the sobering thought that this was the only dental clinic present within the Black residential areas of greater Cape Town.

An attempt was made to deliver a balance of treatment services during the following four years that UWC was there. One was aware as we scratched the tip of this iceberg that one still understood very little about the extent of need and demand for dental care in this population. Moola (1981) collected data on children up to the age of about 12 but no record of the oral health status for adults of this community existed. This provided the motivation to obtain a profile of dental health status and treatment needs in this area. The hope was that such a study would help us to plan our own input more effectively and to have a working document with which to motivate or assist the authorities responsible for providing such services elsewhere in the Western Cape.

Periodontal health evaluation was of particular interest as it seemed that the preventive measures might just be that much more feasible to implement in the long term. That is, unlike the prevailing philosophy of cure by "drill and fill" which exists with caries, it does not automatically assume the need

for such capital-intensive and dentist-orientated treatment procedures. It was assumed that the treatment options available would continue to be limited to simple prevention strategies, scaling and finally tooth extraction. Except in a few selected cases complex periodontal treatment would not be available.

The prevalence of missing teeth, evidence of restorative treatment, severe and minor decay was to be recorded in order to get some indication of the dental caries status, treatment need and the rate and pattern of tooth loss.

Although this study does not use a questionnaire to specifically illustrate the connection between professional perceptions of need and patient perceptions of need, some of the conflict within this debate has important implications for planning oral health services. The treatment needs indicated by the study are discussed in this context.

5 LITERATURE SURVEY

5.1 CURRENT UNDERSTANDING OF PERIODONTAL DISEASE

The aetiology and progression of periodontal disease, has been the subject of a great amount of research in recent years. The brief outline of the main aspects of periodontal disease provided here, contributes necessary background knowledge for the subsequent selection and application of appropriate measurements to describe periodontal health.

AETIOLOGY

Three factors implicated in the precipitation of onset and progression of these chronic inflammatory conditions according to Lindhe (1982), Page (1986), Anderson (1979) and others, are various microorganisms, local environmental factors and host defence mechanisms.

The accumulation of bacterial plaque at the gingival margin or extending further apically along the root surface, leads to the inflammatory process that is observed clinically as gingivitis or periodontitis. There is evidence of a process of autogenic succession similar to that observed in the pathogenesis of caries. Several species of pathogenic bacteria can be isolated from active periodontal pockets of which some are capable of invading periodontal tissue leading to a destructive inflammatory response. As the micro-ecology of the area changes, a varying combination of the 150 or so observed bacterial species may be isolated. Generally there is a change from a predominantly Gram positive streptococcal

flora surrounding healthy gingivae to a more complex one including Gram negatives and spiral forms in gingivitis (Page 1986, Anderson 1979).

The existence of periodontal pockets is associated with a trend toward a mainly Gram negative, motile and anaerobic flora. And the existence of the two separate entities gingivitis and periodontitis is characterised by a predominance of entirely different populations of bacteria related to each. According to Page (1986), the main organisms associated with gingivitis include Actinomyces, Bacteroides, Eikenella, Streptococcus, Fusobacterium, Veillonella and Treponema. Those more commonly associated with periodontitis are Actinobacillus, Bacteroides, Fusobacterium, Eikenella, Capnocytophaga and Eubacterium.

Early onset periodontitis (eg. juvenile periodontitis) is characterized by a similar population of bacteria as this is considered to be an opportunistic infection since small numbers of these organisms may also be found in plaque taken from healthy teeth (Genco et al 1986, Page 1986).

It is suggested that this progression of bacterial species infecting in a sequential manner, a process entitled "autogenic succession" by Newbrun and others, may account for the great variability observed between sites and between subjects in both gingivitis and periodontal disease (Socransky 1984, Newbrun 1979).

Local environmental factors are considered to be of minor importance compared to that of bacteria. They include tooth anatomy and position, mouth breathing, food impaction, length of junctional epithelium, quality of gingival tissue, occlusal forces, defective restorations, prosthetic appliances, diet, tobacco smoking etc. They may promote periodontal disease by increasing retention of plaque, preventing its removal or making periodontal tissues more prone to bacterial damage.

Host defence mechanisms play an integral part in determining the severity of periodontal disease experienced by an individual (Anderson 1979). Studies on subjects who have malfunctioning phagocytic cells, especially neutrophils, show a predisposition to periodontal disease which is often both of early onset and extreme severity. The chemotactic ability of neutrophils is severely reduced in these patients and seems to be a genetically transmitted characteristic.

Specific antibodies to bacteria infecting the periodontium have been found in serum and crevicular fluid samples but whether they are protective or not is unknown. They may have a part in clearing certain bacterial species from the periodontal pocket and account for the cyclic, episodic pattern of early onset types of periodontitis. Together with the phagocytes, humoral immune mechanisms comprise the major determinants of the outcome of the disease (Page 1986).

PROGRESSION

The natural progression of disease as it has been assumed to occur is discussed by Loe et al (1978) and Anerud et al (1979) (1986) and Socransky et al (1984) describe pertinent aspects of the natural course of periodontal disease as it is currently understood to occur. This includes new perspectives on the onset of disease, stages in disease progression, the transition from gingivitis to periodontitis and the episodic nature of periodontal destruction.

For epidemiological purposes as well as at the individual treatment level it would be of great help to know exactly the point at which disease begins. The point at which the balance tips between host defence and bacterial onslaught is unclear although clinically, inflammation of the marginal gingiva is often considered to mark the onset of gingival disease.

Histologically, the presence of an acute inflammation with its infiltrate of inflammatory cells indicates the onset of disease . The gingival lesion may be classified as initial, early, established or advanced. This reflects a transition from a classical acute inflammation to a more cellular picture where plasma cells and B lymphocytes predominate. The first three stages are clinically evident as gingivitis and the fourth as periodontitis (Anderson 1979, Page 1986)

Longitudinal studies (Papapanou et al 1989, Socransky 1984) show that gingivitis at individual sites progresses only infrequently to periodontitis even in the absence of regular

prophylaxis. There are no reliable indicators that allow us to predict when or if this conversion will take place. Histologically it seems to be accompanied by an acute inflammation with a predominantly plasma cell infiltrate and clinically characterized by formation of a periodontal pocket with alveolar bone resorption and extensive soft tissue damage (Lindhe 1983, Anderson 1979, Page 1986).

Studies by Hugoson and others (1982a, 1982b), found that there was no progression of bony defects seen in the initial screening, over a period of five years, in spite of the sustained presence of gingivitis. Only a small proportion of individuals experienced severe periodontal destruction. The findings seem to indicate that recurrent gingivitis does not necessarily lead to periodontal damage, a fact supported by Morrison (1982) among others already mentioned. They also seem to support the hypothesis suggesting specific microbial and host/resistance factors as the likely risk factors.

When periodontal measurements of populations are recorded they seem to indicate that the destruction is progressive and linear. That is, a portion of sites with gingivitis will inevitably develop periodontitis with eventual mobility and exfoliation. More recently, researchers have observed bursts of acute inflammation in about 10 percent of sites in infected rats. Progression of attachment-loss through episodic bursts of activity also occurs in humans (Socransky 1984, Lindhe 1973, 1975).

Several models have been proposed to illustrate the seemingly random relation between time, disease activity and site or multiple sites. The first model is the linear progression model where a portion of sites deteriorate steadily with time. The second describes bursts of activity involving a single site at any one time. The third model illustrates bursts of destructive activity occurring simultaneously at several sites (Page 1986, Socransky 1984).

The implications of the latter two models are of immense importance. It means that the degree of pocket depth can no longer serve as a guide to disease severity and treatment planning since pockets may not necessarily deepen with time (Socransky 1984). Some will become active and others remain inactive but there seems to be no way to tell them apart. At the individual level, a conservative approach could still dictate that all pockets should be treated.

At the population level, the implications of this information is still rather unclear. This new thinking suggests that in most patients progression of periodontal destruction is infrequent and episodic, while in a small subgroup, progression is frequent, it affects most teeth and it may continue without remission to tooth loss. These are individuals that need to be identified but a diagnostic method still needs to be devised with this capability.

THE HIGH RISK INDIVIDUAL

Hausmann and Jeffcoat (1988) explore various potential indicators of periodontal disease activity, and conclude that an ideal test would approach an instantaneous measure of disease activity and would not integrate activity over time. Listgarten et al (1986) tested the ability of a microbial assay to predict disease recurrence in subjects receiving regular prophylaxis after treatment. The test appeared reliable in their one test group for up to a year but seems to have no application in screening role.

Wilton et al (1989) tested the ability of laboratory markers from salivary analysis to predict which individuals are at high-risk for periodontal disease or undergoing a period of increased periodontal disease activity. They note in conclusion that more research is needed to distinguish potential indicators in saliva. It is felt that though saliva may provide indicators of current disease activity it is unlikely to provide indicators of future disease-risk.

Gingival crevicular fluid is tested by the same workers (Curtis et al 1989). They describe the useful accessibility of this site and the wide range of factors present in the fluid that may provide an appropriate indicator of risk. The analysis of host enzyme activities directed against components of the extracellular matrix, the nature of glycosaminoglycans in the sulcus and certain mediators of the inflammatory process such as prostaglandin E2, are mentioned as potential indicators. It is noted that the prediction of future or

current disease activity is also dependent on the accurate description of periodontal health status using current clinical and radiographic methods.

Loe and Morrison (1986) comment that no single organism or group of bacteria can be directly implicated in the development of gingivitis and that also in periodontal disease, the concept of specific pathogenicity cannot be applied. The only exception to this appears to be in the case of Juvenile Periodontitis with which an increased prevalence Actinobacillus actinomycetemcomitans has been associated (Genco et al 1986, Loe and Morrison 1986). Genco et al describe both the localised and generalised forms of this condition in detail, distinguishing it from the other destructive periodontal conditions and discuss various treatment strategies. The condition will not be discussed further in this text however.

In 1978 Sheiham concluded that screening for periodontal disease was not justified. Instead, he suggested, research should be directed at answering questions about the natural history of periodontal diseases, effectiveness of prevention and treatment, significance of clinical signs and the validity, sensitivity, and specificity of these signs.

This reservation about population screening is a view repeated by Pilot (1984) and also Loe and Morrison (1986). The latter recognise that at this time none of the tests or technologies are ready for use in clinical practice. However they cite the 1971 comments of Richards and Barmes, who stated that as socioeconomic and educational levels of populations improve,

their oral cleanliness increases and the prevalence of slowly developing periodontitis decreases. It is in this light that they suggest socioeconomic factors and education provide possible markers for identifying risk groups for screening purposes.

Johnson (1989) states that high-risk groups susceptible to "destructive periodontitis" undoubtedly exist in the community, of which a very small proportion have it as an adjunct to systemic disease or a host-defence defect. He feels that screening for such conditions is impractical at a community level. Population screening should be approached clinically, to identify those with "severe disease for age" and the CPITN can facilitate this. The potential for use of gingival crevice fluid as a source of indicators for periodontal disease risk is also recognised and the hope that new screening methods will be developed that enable resources for treatment and prevention to become more focussed and therefore cost-effective, is expressed.

Lennon and Clerehugh (1984) warn that even if susceptible individuals can be identified, the question of whether effective treatment can be provided, remains debatable.

What is clear, however, is that in oral health surveys, the large number of individuals observed according to current clinical criteria to have periodontal disease are actually misdiagnosed. They probably have a periodontal disease state that is either in remission, inactive or unlikely to progress to a more severe state. Any estimate of treatment need based upon such a study, can almost certainly be considered an

over-estimate of the actual treatment needed to curb the development of severe periodontal disease in the community concerned. At the same time, such a survey will be unable to locate all the high-risk individuals who really need treatment to prevent further periodontal destruction.

These findings do not invalidate the descriptive value of such surveys however, but it certainly places the interpretation and application of the data under new restraints. In the very least, their use in treatment planning to curb or control the development of severe periodontal disease in the community, must be considered to be seriously challenged.

5.2 DENTAL CARIES

Dental Caries has been defined as a localized destruction of the teeth (the Latin word "caries" means "decay"). This infers a progressive destruction of enamel, dentine and cementum initiated by microbial activity at the tooth surface. Loss of tooth substance is characteristically preceded by softening of the dental tissues. Enamel destruction results mainly from dissolution of the hydroxyapatite mineralized component by organic bacterial acids such as lactic acid. Dentin demineralisation is accompanied by enzymatic breakdown of the organic collagen-like components. This is the end result of successive phases of bacterial adhesion, colonization, invasion and metabolic activity by specific groups of oral microorganisms (Silverstone et al 1981).

This perception has been gradually modified and the current perception sees caries as a dynamic equilibrium between successive phases of mineralisation and demineralisation. Edgar and Thylstrup describe caries as a predominantly local phenomenon arising from the action of acids formed from carbohydrates bay an acidogenic flora. They state that the interaction between the acid-base phenomona and the solubilisation of calcium and phosphate in plaque is a critical regulator of de- and remineralisation. This interaction is mediated by plaque pH in different sites, which is in turn related to the chemical and microbial composition of the plaque, and to saliva. This occurs against of background various environmental influences including diet, oral hygiene and other host factors.

SPECIFIC ORGANISMS

Microorganisms such as Streptococcus mutans, lactobacilli and certain Actinomyces species are considered to be the most important microflora involved. The former two can thrive and multiply in a low pH environment and produce acid which takes the pH below the critical level for enamel demineralisation i.e. a pH of between 5.3 and 5.7 (Krasse 1985).

The occurrence of demineralisation is a function of the microorganism rather than total number of plaque bacteria. Bacteria multiply at different pH values and produce alkali or acid of varied pH (Krasse 1985). The process of autogenic succession (Newbrun 1979) implicated here too, determines the changing character of plaque bacterial populations over time and thereby variation in the ability of plaque to damage tooth surfaces.

This means that the plaque index of a particular patient is limited in its value for predicting future caries activity (caries risk). Perhaps one should determine the extent to which caries-inducing bacteria such as lactobacilli and Streptococcus Mutans are present. And it is likely that some strains are more virulent than others.

DIET

Sucrose is still considered to have the central role in the development of dental caries. This relates to its ability to diffuse into dental plaque, its high solubility and role as substrate in extracellular polysaccharide production,

enhancement of Streptococcus Mutans colonization and lack of inhibitory factors toward plaque bacteria or enamel protection. Frequency of intake, concentration and stickiness rather than total sugar intake seem to be among the factors of importance in determining whether caries will develop (in Sreebny 1982, 1986).

In discussing the role of diet in the caries process, Newbrun (in Sheiham 1981) emphasises that "(1) overwhelming evidence incriminates dietary sugar as the major factor in caries aetiology, and (2) this represents a consensus view and is by no means controversial". Professor Bertram Cohen (in Sheiham 1985) is quoted as saying: "in all the experiments I have ever carried out, I have never found it possible to induce caries in monkeys without the addition of sugar in the diet". Sreebny (1982), in a wide ranging review of the major studies investigating the relationship between sugar and human dental caries, concludes: "There can be no doubt that, in toto, the results obtained from in vitro studies, investigations in experimental animals, as well as studies in humans all point to the existence of a powerful sugar-caries connection".

Bowen (in Newbrun 1981) also states that "Evidence incriminating sugars has continued to accumulate from the results of epidemiological and animal research and has now reached such proportions that no reasonable person would deny that frequent consumption of sugars by caries- susceptible humans will result in the development of dental caries".

Newbrun (1981) further states that the relationship between dietary sucrose content and caries need not be exactly linear, and increasing the sucrose level above a certain level may not lead to increased caries. This may of course happen when most susceptible surfaces are already affected. Conversely, until the percentage of sucrose in the diet is decreased below a certain level, there may be little reduction in caries.

There is therefore little doubt that the relationship between sugar and dental caries is a causal relationship with the only ambiguity relating to the actual threshold levels of frequency and net sugar consumption above which the formation of caries is likely to occur (Naylor 1986, Walker 1986, HEC 1979).

Sheiham (1985) discusses dietary guidelines in the NACNE Report, noting that the recommended sugar intake is 20kg per person per year. This is also the quantity calculated to be the world per capita sugar consumption average in 1981 (FDI 1985). Sheiham suggests that an intake greater than 10kg per year will promote caries although the higher level may still lead to the presence in the population of a fairly high percentage of caries-free individuals, if it is accompanied by water fluoridation (or widespread and regular use of fluoridated toothpastes).

Globally the per capita quantities of sugar consumed have been studied by Sreebny (1982) and others. Their conclusions are that there is a positive relation between the prevalence of dental caries and sugar supplies in nations throughout the world. In Sreebny's study, availability of sugar in an amount

less than 50gm per person per day was always associated with dmft or DMFT scores of less than 3.0 for both 6 and 12 year old children. A limitation of such data is the crude nature of the calculations involved, however the trends illustrated certainly complement the research findings mentioned earlier.

FLUORIDE (F)

In the presence of a mineralizing solution at appropriate pH levels, F effects a more rapid and effective rehardening of an enamel surface than the mineralizing solution alone. F promotes the formation of apatite rather than less stable crystal forms. It is now evident that defective apatite (low calcium:phosphorus ratio) is capable of repair and F can assist this process. In addition, when F is included in this process of remineralisation, the average crystal diameter increases significantly which in turn, means a reduction in surface-area to volume ratio of the crystals and a related decrease in susceptibility to dissolution (Newbrun 1986)

The FDI Technical Report on the prevention of dental caries and periodontal disease (FDI 1984) concludes by summarising nine important caries prevention strategies. The first four out of seven options listed, are fluoride based. These include community water fluoridation, other forms of ingested fluoride, fluoride mouthrinsing and finally the use of fluoride toothpastes. The authors Jeboda (1986) and Pasquale (1983) support the importance of pursuing fluoridation as a community level caries prevention strategy in the African context and Jackson (1986) amongst others reiterates the cost-efficiency of water fluoridation per se. A number of

examples of per capita costs for cities of various sizes are included in Murray (1986). Silverstein et al (1975) compare the cost of various fluoride strategies in terms of the cost-benefit, efficacy and practicality of each option.

As early as 1962, Staz refers to the more than 13 000 publications that have appeared on the many related aspects of teeth, fluorides, fluoridation and the control of dental caries. This vast body of material attests consistently and overwhelmingly to support the efficacy of fluoridation as a measure to control caries. Murray (1986) reviews a sizeable portion of this mass of material, confirming the appropriateness of community water fluoridation as a public health measure. Staz (1962) and Murray (1986) both refer to the large number of national and international bodies that have examined the evidence and stated their support for this measure.

There is clearly a worldwide consensus among oral health researchers, that water with a Fluoride concentration of 1 p.p.m. is a feasible, safe, cost-effective and ethically acceptable method for reducing caries in communities. Fluoridation of community water supplies is considered to be the least expensive and most effective way of providing fluoride to large groups of people of all ages. Water fluoridation has now been in operation for almost 40 years in a wide variety of setting around the world. This has also provided many opportunities for comparison between otherwise closely matched communities, differing only in their exposure to fluoridated water. The general and dental health of these

communities has been rigorously evaluated over long periods of time to monitor both positive and harmful effects of the intervention, with encouraging results.

The early debate around fluoridation in the RSA centred on the views expressed by people such as Ockerse, Sutton, Amies and Steyn. Their views are discussed by Staz (1962), Kenny (1963) and the RSA Commission of enquiry into Fluoridation (1966). The latter parties conclude that the safety of fluoride is not in doubt as a result of the assertions of these individuals. More recent dental research publications relating to fluoride issues continue to support the value of fluoride in the prevention of dental caries (Taljaard 1979, Van Wyk 1979, Retief 1979). Others describe the efficacy of various modes of fluoride delivery (Grobler 1983, Hadfield 1983, Van Wyk 1985).

HOST FACTORS

These include the character and state of the enamel tooth surface and its ability to be colonized by cariogenic organisms. The composition of saliva and the character of dental pellicle that develops on it will affect this. It is suggested therefore, that salivary flow and buffering capacity are useful indicators of caries risk. Genetic factors may have an important role in host susceptibility to dental caries (Krasse 1985).

PREDICTION OF CARIES ACTIVITY

Soderholm and Birkhed (1988) tested various factors for their ability to predict caries development in adults over a two year period. Evidence of a relationship between caries activity and unfavourable values for the DMFS score, dietary score and number of streptococcus mutans in saliva was found. They conclude however that it would not have been possible to predict the identity of the caries-active individuals in the sample using these variables.

Beck et al (1988) argue that since caries is the result of a complex set of host agent and environment related variable, only the development of a multivariate risk assessment model should be entertained. They use the detection of root caries in adults to construct a regression model taking into account oral, social/behavioural and medical risk factors. Discriminant analysis of the risk factors identified in this way were found to have both specificity and sensitivity values close to 0.80 for their ability to predict which individuals would get root caries. They feel it is possible to develop a clinically useful risk assessment model.

CLINICAL SIGNS OF PATHOGENESIS

The first clinically observable lesion of enamel has a chalk-like appearance as normal translucency is lost. The surface feels rough when probed. It is suggested that probing should be avoided at this stage as damage to the crystal

structure may impair remineralisation. In addition, bacteria colonizing this surface may become introduced into the next fissure examined with the probe.

A response to these concerns, is the suggestion that a much greater reliance upon visual examination occur, as this can give about the same information as a combined visual-tactile examination.

With extension into dentine, a soft, moist appearance that is light brown in colour characterizes the rapidly progressing type of lesion. Slowly progressing types of lesions tend to have a pigmented dark brown to black appearance. These two types reflect what is commonly called acute caries and chronic or arrested caries respectively.

The pattern of progress of caries through tooth material is a dynamic one and as the intensity of attack diminishes, demineralised tissue may become partly remineralised. Most lesions show evidence of this phasic progression and reversal (Silverstone 1981).

5.3 EPIDEMIOLOGY OF CARIES AND PERIODONTAL DISEASE

5.3.1 DENTAL EPIDEMIOLOGY

Smith (in Burrage 1987) defines epidemiology as "that branch of medical science that is concerned to interpret the health experience of human communities". The extent to which epidemiology is or must be the political study of health, is discussed in her paper and provides an appropriate point of reference for this study. The very existence of this study was precipitated by the juxtaposition of a range of characteristically South African conflicts around basic political and health issues. (See Appendix 12.1: Background History of Crossroads)

The WHO has stated that a high standard of oral health is a fundamental contribution to the achievement of the WHO goal of "Health For All by the year 2000" (FDI Report 1986). However, the achievement of better oral health in a community such as the one under study, will need to be informed by an epidemiological process that is based explicitly upon insights at the level of political analysis and of the meaning of social action (Burrage 1987).

One politically related determinant of health is urbanisation, which is taking place at an explosive pace in Africa and other developing countries with a mean per annum of 5% (Enwonwu 1978). Van der Merwe (1988) has enumerated the total demographic growth taking place in South Africa and noting particularly the very high rate of urbanisation occurring. WHO and UNICEF have stated (in Yach 1988) that urbanisation

has the potential to improve the health of populations but has led to an increase in certain categories of diseases. Yach warns that rapid urbanisation of an already poor group has profound implications for all aspects of development in South Africa. However, it also creates opportunities for rapid improvement in social, economic and health status of populations. An important pre-condition to such gains, is the acceptance of urbanisation as a desirable and inevitable process by government, including a legitimation of squatter existence at the urban fringe for example. If this transition is well-managed, it could lead to an improvement in all indices of physical health.

Appropriately focussed research into the impact of urbanisation and the determinants of health, including dental health, operating in such circumstances, must be considered a priority.

The role of epidemiological surveys in planning dental services, by contributing to feedback and review, setting of goals and objectives, problem identification, choices between alternative programmes, implementation and evaluation (Spencer 1985). The use of mini surveys to evaluate community health programmes is a complementary process motivated by Nosseir et al (1986). However such studies need to be modified to enable more accurate estimation of the resources necessary for programme implementation (Spencer 1985, Palmer et al 1984). The concept of a pathfinder survey has been promoted by WHO for the recording of baseline data for planning of services. It can for example, identify, major contrasts in caries prevalence in populations (Infirri and Barmes 1979). Data

collection in accordance with criteria proposed by WHO facilitates comparison of data at a global level (Barmes and Infirri 1977).

Dental caries and periodontal disease are common in industrialized countries but caries is increasing in non-industrialized countries. Tooth mortality has dropped in the former but increases with progressive urbanization in the latter (Barmes 1976b, Sheiham 1978). Some of the problems encountered in Africa include, the increasing consumption of cariogenic foods by rural immigrants and the universally poor oral hygiene in pre-industrialized countries. The problems are compounded by the inadequacy of all cadres of oral health manpower (Enwonwu 1978). As a consequence of this urgent measures to improve oral health are needed. The surveillance, especially of defined socioeconomic groups which are identified as being at risk, may help to initiate progress toward improved oral health.

MEASURING ORAL HEALTH

Most of the dental indices in use up to now score disease or factors preceding disease, represent dental care provider perceptions of disease or treatment needs, and nearly all measure each type of dental disease in a categorical rather than a combined fashion (Lewis 1979).

There is a significant conceptual problem with assessing "health" by scoring "disease". Considering that the role of every therapist is to attend to the maintenance of good health, it seems paradoxical that it is predominantly

measurement of disease-status that serves as the indicator of success. Surely the means for promoting health can be entirely different to the means required to contain ill-health and possibly reverse it. For dental health this can be very simply illustrated by contrasting the activities required to restore a damaged dentition with the educational, communicative and other skills required to plan and implement a fluoride or a toothbrushing campaign.

This sentiment is reflected in a comment by Locker (1988), that recent developments in the definition of health and in the measurement of health status have had little impact on dentistry. He proposes a conceptual model for measuring oral health that attempts to link clinical conditions with the personal and social outcomes of health or ill-health to which they are related. Although not proposing a method of measurement, Gilbert and Rudolph (1986) support the need to understand the oral health status of individuals in terms of the complex interaction of the numerous social, behavioural, physical and other factors that impact upon it.

Patient perceptions need to be understood (Kegeles 1974) as well as dental provider assessments. Social indicators of oral health status can and should supplement clinical indicators. Measures such as DMFT do not correlate well with measures of impact except "eating problems". And periodontal indices have no correlation but denture wearing does. The impact of dental disease rarely affects people's social role or general health (Cushing et al 1986). Issues such as "absence of discomfort" and "retain the teeth for life" reflect the different approaches of patient and dentist

(Ruel-Kellerman 1984). Cultures vary in their understanding of acceptable oral health status so a good understanding of the oral health status of a particular group should inform the development and implementation of government policies for the delivery of appropriate dental prevention and treatment strategies.

5.3.2 EPIDEMIOLOGY OF DENTAL CARIES

Dental caries is a major public health problem throughout the world. Countries with a low prevalence are experiencing increases in prevalence and severity of dental caries, often most marked in urban centres (Infirri and Barmes 1979). Epidemiological studies can sometimes reveal the dominant aetiological factor related to the host or the environment concerned and can give an indication of which preventative regimes may work or what services should be provided. Dental caries can also vary greatly in the intensity of its attack.

This is measured by an index, which in general terms, is "a numerical value describing the relative status of a population on a graduated scale with definite upper and lower limits, designed to permit and facilitate comparisons with other populations classified by the same criteria and methods". The index needs to be clear, simple, reproducible, amenable to statistical analysis and also have validity and reliability. The index must be selected for its sensitivity to the disease process to be measured (Silverstone et al 1981).

THE DMFT

The DMFT is the most commonly used caries index along with the DMFS. The DMFT measures a total lifetime experience of tooth decay i.e. it is an irreversible index. Despite certain shortcomings, the DMF index is a relatively simple, reproducible and can provide some indication of treatment needs and success of treatment for the public health planner (Barmes 1976b). Until now dental epidemiologists have assumed

a restored tooth was evidence of past dental disease but this is not necessarily true and must be borne in mind during data analysis (Bulman 1984). The same problem applies to missing teeth, and the older an individual is, the harder it may be to determine the original cause of extraction (Thylstrup and Fejerskov 1986).

The index comprises a number of categorical variables, a factor that must be taken into consideration in selecting an appropriate method of statistical analysis. The use of frequency distributions, comparison of median values and non-parametric statistical analysis is therefore advisable, however the widespread use of mean DMFT values in caries epidemiology, has led to its use in this study too.

Information about the contributions from decayed, missing and filled components greatly enhances the usefulness of the data because it can demonstrate the amount and kind of treatment received (Thylstrup and Fejerskov 1986). And a modification of the "D" component by subdivision into a number of components is advisable in populations with high exposure to dental treatment (Anaise 1984). A high filling component might need to be detailed to describe the type of restorations provided, whereas a community with little access to dental care might have only decayed teeth in various stages of disrepair. This merely indicates a high prevalence of unmet need but might not assist much in planning specific intervention strategies.

The DMFT may therefore require further modifications, dependent upon the objectives and design of a particular study. For example, subdivision of the "D" coding to include categories such as "decayed needing extraction; decayed needing restoration" and so forth may be of importance (James and Beal 1981). Birch (1986) recommends other improvements to the DMF index in order to allow more accurate assessment of dental health programmes. Some of the subcomponents of the DMF index are used to create "quality adjusted tooth years" for this purpose. However the DMFT is still the index of choice for describing, what one might regard as "crude" caries prevalence and intensity rates.

A major limitation is its inability to record progression in the dynamic process of mineralisation and demineralisation of teeth. A small lesion will count as much as a larger one and no provision is made for the fact that the lesion may change size, an important factor in longitudinal studies. Early diagnosis becomes an important issue for the same reasons. The degree of detail required or sensitivity of this early diagnosis will vary with the objectives of the study concerned. In this study, cross-sectional, descriptive data is all that is required and screening process is merely selected to identify presence or absence of gross carious conditions.

For this reason and in the interests of achieving high levels of reproducibility and comparability, the detection of cavitation and surface discontinuity are all that will be sought. It is accepted that such a screening will not reveal all the lesions actually present. Despite some of the

pitfalls mentioned above, the DMFT caries index nevertheless bears all the characteristics required of an index for screening purposes listed initially.

FACTORS WITH AN IMPACT ON CARIES EPIDEMIOLOGY

A wide range of host factors (age, sex, familial and genetic patterns) and environmental factors (geography and soil types, diet and the effects of dental treatment) are considered to influence the occurrence and pattern of caries in a community. (Silverstone 1981, Thylstrup and Fejerskov 1986)

Age is a powerful variable. From childhood to adolescence, the number of teeth in the mouth increases and generally speaking, so does the amount of caries present. From here the trend is toward increasing amounts of caries with increases in age as reflected in the DMFT. Later it loses some of its value as an index as other factors such as periodontal disease begin to play more of a role in the aetiology of tooth loss. In older age-groups, root caries may make a greater contribution to the caries score.

It seems that differences in sex distribution of the disease observed so far have more to do with social and cultural phenomena than inherent physical ones, although some differences in eruption times have been attributed to such determinants (Silverstone 1981). Some workers have reported a higher prevalence in women due to this early eruption, however later this may become seriously obscured by the provision of dental treatment. Women seem to be more likely to seek dental

treatment, and what might otherwise be recorded as caries, may instead have to be recorded as missing or filled teeth (Thylstrup and Fejerskov 1986).

Likewise differences in racial disease patterns are usually masked by social and cultural variables. In addition, attempts to correctly categorize persons in a particular group or to be certain that variables such as lifestyle, locality and diet are all constant is extremely difficult. Care should also be taken to ensure that the terminology used to describe real determinants of health and ill-health (in this case caries), are not obscured through the use of cultural or racial terms, unrelated to aetiology or progression of the condition. Thylstrup and Fejerskov (1986) comment that no group seems to be genuinely resistant to caries.

Familial and genetic patterns of caries can apparently exist although the manner of transmission is unclear. In spite of this possibility, it seems clear that other environmental factors have a far stronger influence on dental caries.

Geographic variation is also frequently masked by cultural and social factors. And the role of 13 trace elements so far identified may still be shown to influence caries in one or other direction (Curzen and Cutress 1983). Thylstrup and Fejerskov (1986) state that caries data from different populations should only be compared with caution unless similar means and methods have been used in collecting the data. This of course has provided a major impetus to the development of the WHO Oral Data Bank and the promotion of standardised methodology for collection of global caries data.

Another complication is the simple fact that caries varies within nations over time.

Diet, and especially the sucrose in it, together with fluoride, is established as the dominant variable in determining the caries prevalence rates of communities and in this capacity is capable of masking all the other factors. There is overwhelming evidence indicating that the low caries experience in Africans is due mainly to low sugar consumption and rising caries experience to increasing sugar consumption (Akpata 1978). One recognises that diet is a variable very dependent upon dominant social values, economic status and the lifestyle of a community.

The dental health status of the community is significantly influenced by the treatment it receives as well as by the disease pattern it experiences. Not only does dental treatment influence the progression of the disease and its consequences, but also its activity.

Another important factor is the contribution to the apparent caries disease profile of a community by the methodology imposed upon its detection by prevailing epidemiological practice.

Another area of dental caries epidemiology that plays a vital role, is that which measures the effectiveness of treatment or preventive strategies implemented within a particular population. Within this area of study, the initial information on water fluoridation efficacy, fissure sealants,

toothbrushing programmes etc emerged and now provides the basis for implementation of successful intervention and prevention programmes.

SELECTED "THIRD WORLD" CARIES STUDIES (See TABLE 9.1.1)

Goracci (1980) examined students aged 18-30 years in Somalia, finding that caries is very rare, fluorosis is fairly prevalent and almost the only caries to be found is in urban adults.

Arain (1983) describe the oral health of 15-17 year olds in Lagos. Mean DMFT values of 2.3-2.8 and caries-free proportions of 56-59% are recorded, with some differences between the sexes. The mean decayed component was 1.9, representing 75% of the mean DMFT. It is felt by the author that a definite increase in caries prevalence with age is occurring.

Marseille (1984) found 69% of subjects to be caries-free in 15-19 year old and 60% in 35-44 year Zaireian adults. The mean DMFT values range from 1 to 1.2 in these groups.

In a Zaireian adult group attending a University Dental Clinic, Kowalski and Tuku Tuku (1983) recorded a mean DMFT of 3.94 before age 21 and rising to 5.6 thereafter. Unfortunately caries prevalence is calculated using teeth rather than subjects as the unit of measure so any attempt at comparison with this data is problematic.

Horton (1979) recorded that 90% of dental clinic-attenders in Zaire need at least one extraction and that need for simple restorative treatment is fairly prevalent. The study design and analysis is, unfortunately, very suspect.

Stone (1978) states caries practically non-existent in two rural Kenyan tribes, attributing this to a low sugar content in the diet and traditional chewing stick use.

Butt (1986) describes 10% of a sample of adult Kenyan clinic-attenders as caries free. 80-90% of the group are reported to be attending the clinic for extractions.

A low socio-economic Indonesian group is described by Sudjadi et al (1981) who find that the mean DMFT ranges from 2.6 at age 14-19, to a high 18.3 after 50 years of age. In the latter is a much greater prevalence of missing teeth.

Louw and Moola (1979), in a group of Cape Town adults ("Coloured"), record high mean DMFT values of 6.5 for 13-19 year olds, 21 for 35-44 year olds, and an average of 12 for the whole sample. The authors describe the high adult DMFT as largely comprised of the missing teeth component which rises very rapidly in the years beyond school leaving.

Gordon and Newbrun (1986) review data from 19-21 year old adults in several countries. No uniform trend in caries prevalence based on total DMFT scores, can be found and it is felt that the impact of preventive measures, especially fluorides, sugar use and the availability of dental personnel has had a profound effect on the trend within these countries.

It is also suggested that researchers look beyond the total DMFT scores to see what trends in meeting treatment needs is taking place by examining D and F scores.

CARIES PREVALENCE IN SOUTHERN AFRICA (See TABLE 9.1.2)

Low adult DMFT values were measured in !Kung Bushmen by Du Plessis (1986). Despite examining a sample with ages ranging from 4 to over 60, the mean DMFT of 1.3, is reported to be more or less constant throughout the sample. For carious mouths, a mean DMFT of 3 was calculated, with 13 being the highest value recorded. In terms of tooth loss, lower molars had the highest mortality in this group.

According to Olsson et al (1989), 25-34 year olds in Mozambique, had a mean DMFT of only 3.7 for the rural group, rising to 7.9 at 45-54 years of age, and 8.1 for the urban group followed by no further increase with age. This was accompanied by a very high "caries free" proportion, 31% in the rural 25-34 year olds, and by a low 7% in the other groups. It is suggested that access to markets and sugar consumption in urban areas provides some explanation for the differences. What is disturbing, is that there is no decrease in caries rate after the age of 15-18 years. Although current caries levels are not very high for age, the trend is disturbing and systematic promotion of prevention programmes is essential to curb it.

The 16-17 year olds studied by Retief et al (1975), found mean DMFT scores to vary widely across the ethnic divisions of their sample. Rural "blacks" had a value of 0.9 and urban

whites had a value of 11.6. Although the main focus of this study is the relationship of sugar consumption to race and caries experience, about which a somewhat equivocal conclusion is drawn, the description of caries across these strata is revealing. The black group is defined simply on the basis of the ideological apartheid race classification. No apparent consideration is given to other determinants of oral health status or the broader social, economic and political factors. In fact, assertions concerning the genetic basis of resistance to caries are brought into discussion at a later stage, without a word at the outset to define the suggested link that a politically defined term of ethnicity might have with genetic factors related to caries.

Cleaton-Jones and Walker (1980) examined 17 year olds across similarly problematic ethnic strata. In this study the mean DMFT for rural and urban "blacks" was similar, as it was in the Retief study, unless the caries free individuals were removed from the calculation. A much higher proportion of rural pupils were found to be caries-free. Somewhat vague assertions are made about the role of malnutrition and genetics to explain variation in caries vulnerability. A far stronger argument will be needed to explain the very great differences in DMFT evident across the ethnic strata.

A more recent study by Theron et al (1984) of white 16-18 year olds, found a very high prevalence of caries (99%) and median DMFT values ranging from 8-11 across the language and class groupings. It was found that pupils from low socioeconomic areas had a significantly greater caries experience, and they

received less dental treatment, which was mostly in the form of extractions. No comment is made here about genetic factors and the difference is attributed to social class.

Harris and Cleaton-Jones (1978), examined a sample of adult "black" sugar-cane chewers, and found low DMFT values (3.2). They comment that the caries prevalence is similar to values reported for "black" non-sugar-cane chewers, inspite of a large daily sugar intake. The mean DMFT values range from 0.8 to 7.8 across the age cohorts, with fewer females caries free (11.2%) compared with males (25.5%).

A study of rural Xhosa mine recruits by Cleaton-Jones (1979), revealed a 32% caries free portion and mean DMFT value of 2.5 for the sample and 3.5 per carious mouth.

Ritchie (1979) found 69% of first year male school teachers in Zimbabwe (ex. Rhodesia) to be caries free while significantly fewer females (40%) were free of caries. The mean DMFT value for males was 0.74 and for females 2.02, both extremely low.

Cleaton-Jones et al (1983) recorded mean DMFT values of 1.6 - 8 in Kwazulu adults, with higher values in the urban group. No fillings were found, a characteristic of almost all the studies elsewhere in this section. Decayed teeth contributed most to the DMFT but missing teeth contributed more with increased age and an urban location. The caries pattern by tooth-type indicated second molars followed by first molars except after 30 years, when the third molar predominated. For

rural 16-18 year olds a mean DMFT of 3.1 and a caries free proportion of 26% was found. For the urban group the values were 4.9 and 7% respectively.

Klausen and Fanoe (1983) found a very high caries prevalence in Swaziland. Only 8.5% of 20-24 year olds and 5.5% of 35-44 year olds were caries free. Fillings very rarely contributed to the DMFT values.

Rudolph and Cleaton-Jones (1984) examined pregnant black and white women of mean age 23.4 years in Johannesburg. The mean DMFT for the black group was 5.5 and was significantly lower than that for the white group at a mean of 14.5.

Rudolph and Brand (1985), commenting on the community service and student training aspects of Transkei visits by Wits dental students, mention that a vast reservoir of unmet need exists. Their report records a mammoth 22 579 teeth extracted from the 9 , 973 people treated by these teams, that is 2.3 teeth per attending patient. In a later study of, what is described as a poor rural Transkei adult community, Gilbert et al (1988) describe a mean DMFT for their sample of 10.7 and categorise 57% in the high or very high caries group. The reasons for extraction are listed as 78% due to caries and 12% due to periodontal disease. Only 0.7% were caries free, however since this is a self-selected "volunteer-type" group attending to obtain treatment, this is not at all surprising.

In a subsequent study of a similar group (Rudolph and Brand 1989), 84% sought care for caries-related pain. The mean DMFT was 5.7 and 17.0% were caries free. The DMFT ranged from 3.6

in one group to a high 10.6 at a military base, groups which are demographically quite different. Again, restorations were almost entirely absent and in the high caries group, the decayed (D) component contributed most to the DMFT.

COMMENT

An important reason for detailing the prevalence of decay and tooth loss in this study, is to ensure a number of things. It is likely in an underserved community such as this, pain and sepsis as an end result of caries will draw people to attend the clinic. With potentially low levels of awareness of periodontal disease available to bring about this contact between the dental health team and the community, the fate of any clinic-based intervention for periodontal disease is inevitably going to be closely tied to the level of decay in the community.

And where tooth loss is concerned, the prolongation of tooth survival times, is also likely to have a significant impact upon periodontal health. The finding that caries is one of the main causes of tooth loss even after age 50, makes it very important to assess levels of severe periodontal disease in the community. Differences in the distribution of M and D variables between the sexes and by age cohort, may determine a very different periodontal disease pattern.

In addition, the use of the CPITN depends upon the existence of certain key teeth, and although it is somewhat flexible in its use of various index teeth, the pattern of decay and extraction etc. can also have a potentially large impact on its ability to accurately describe periodontal health status.

In general, the description of high levels of caries in this community, may lead to a situation where secondary intervention for periodontal disease is irrelevant. However, if the levels are low or decreasing, one will expect to encounter much greater periodontal treatment needs as these cohorts become older.

One other reason for assessing the caries levels, is to identify the most appropriate preventive measure that will be promoted. As has been shown in the literature on prevention, toothbrushing per se is not crucial to the success of caries prevention, though the fluoride in the toothpaste which it applies, certainly is. However, it is the brushing exercise, commonly perceived by the community as preventing caries, which is critical to the control of gingivitis and possible subsequent periodontal disease. So the intervention for periodontal disease is also intimately tied to caries.

5.3.3 EPIDEMIOLOGY OF PERIODONTAL DISEASE

A report of the FDI-WHO Joint Working Group 10 on Periodontal Health Services (Pilot 1989) states that at present it is known that the prevalence of periodontal conditions like plaque, calculus and gingivitis is high in younger age groups around the world. Cahen et al (1977) identified a statistically significant linear correlation of both periodontal and caries indices with age. Grappin and others (Grappin and Lacour 1978, Grappin and Dupiot 1979) express the sentiment that periodontal disease is the main problem of oral care in the African region. The high prevalence, particular severity and the very early age at which the diseases appear in the region are cited. But it is now felt that the more advanced stages of periodontal destruction are not present as frequently as was once thought. Overviews of CPITN data in the WHO Global Oral Data Bank presented by Pilot et al (1986, 1987a, 1987b) and Cutress (1986) provide the evidence supporting these comments. Pilot (1989) feels that although this raises a bit of a dilemma it nevertheless suggests there is now a better prospect for controlling the periodontal problem and maintaining periodontal health around the world than previously thought.

Up to now the universality of periodontal disease has been frequently cited. This is based on data which varies greatly according to indices used, sampling method, and interpretation (Croxson 1984). It is probably for this reason that Barmes (1976a) comments that there is a great need to refine the criteria of periodontal disease and identify the significance of the various signs of gingival and periodontal pathology.

He feels that the ingredients of a useful assessment of periodontal disease should indicate overall disease status as a yardstick for preventive and curative service achievements and direction, show treatment needs on which manpower calculations can be based, measure treatment met and treatment failed (Barmes 1976a).

Barmes (1984) notes that up to that time all the data available tended to indicate one simple though important fact, that is, that good oral hygiene reduced the prevalence of plaque, gingivitis and calculus. However there was clearly a need to know more than this. As new findings on periodontal disease aetiology and progression emerged, a complete rethink on measurement of these conditions had to take place. Hunt (1988) feels that in the light of new information on periodontal disease aetiology and prevalence, the public health implications of periodontal diseases should also be reassessed.

Burt (1988) summarises current perceptions of periodontal disease as:

1 A small proportion of individuals get severe disease;
2 Different microflora are associated with gingivitis and periodontitis and the latter does not necessarily follow the former;
3 Periodontitis is not a natural consequence of aging;
4 Periodontitis is not a major cause adult of tooth loss.

Some of the implications of this are that routine professional care for everybody is questioned, but susceptible individuals and priority groups should be identified using epidemiological data. Burt comments that those from lower socio-economic groups of all races have been consistently identified to be susceptible.

U.S. data from Capilouto and Douglass (1988) indicated that the prevalence and severity of gingivitis had declined, that serious periodontitis still affects the same proportion of adults though less severely, and that the prevalence of severe disease is still higher in older age groups. Close to 22% of over-65 year olds have pockets deeper than 4 mm and 4%, pockets deeper than 6 mm.

Christenson et al (1984) observed that more than 99% of their sample (Copenhagen 35-44 year olds), had levels of gingivitis, calculus or pockets regardless of the frequency of dental visits. However, the prevalence of pockets was lower in frequent dentist visitors. And like a number of other workers, their calculation of treatment needed, generated enormous figures. As a result, they conclude that periodontal conditions are not likely to be significantly improved unless the main emphasis is placed on preventive measures, primarily aimed at changing oral hygiene behaviour through health education.

SELECTED AFRICAN STUDIES

Grappin & Lacour(1978) found a direct and clear relation between periodontal lesions in children and poor oral hygiene. Also, the high frequency of periodontal disease, rapid development toward complex periodontitis and the onset at early age were characteristics shared by many African populations. In addition, he states (Grappin and Dupiot 1979) that although caries should not be considered typical in the Tropics, periodontal diseases have a heavy prevalence in the conditions of the original life of Africans.

In a study of Nigerian populations, the severity of periodontal disease was closely related to the socioeconomic status of the individual and was commonly found in its most severe form, in malnourished, under-privileged societies (Enwonwu 1978, 1981). Kumar (1980) described a higher prevalence of gingival recession in Nigerian males and rural subjects than females or urban dwellers. The facial surfaces of incisors are most severely effected. It is suggested that causes other than periodontal disease pathology are the reason for the observed recession. Sheiham and Jeboda (1981) review the various Nigerian studies, most of which note the great severity and high prevalence of periodontal diseases in all categories of Nigerian people. The association of poor oral hygiene levels, low socio-economic group and poor periodontal health is mentioned.

Lembariti et al (1988) described high levels of plaque, gingivitis and calculus prevalence (93-100%). After age 45 this rural Tanzanian group seems to have more teeth with signs

of disease and also a greater number of teeth missing. Karska (1979) found 50% of a sample of adults in Zaire to have periodontal diseases and Djossou (1985) confirmed the frequency and seriousness of periodontal diseases in Benin as similar to other parts of Africa.

In a Kenyan study, Baelum et al (1988), examined all ages from 15-65 years and concluded that although plaque and calculus levels are very high, the findings do not support the concept of inevitable progression from gingivitis, to periodontitis and finally tooth loss. Budal et al (1985) described a similar situation for a remote tribe in the Cameroons, setting the periodontal disease prevalence at 96% and severe periodontal destruction at 23%.

Reddy et al (1985) describe an apparently periodontal disease-resistant group in South Africa. High levels of plaque and gingivitis are present but very little evidence of periodontal destruction. 60% of the surfaces examined exhibited bleeding on pobing and only 3% were free of inflammation, however, a mean pocket depth of 2.5 mm was measured in this group and only 9% of pocket depths were greater than 4 mm.

The pre-CPITN era in Africa, produced data which strongly suggested that periodontal disease in this region was more severe than in industrialised nations, was present at earlier ages, seemed to be increasing in severity and prevalence, and apparently had a association with poverty and nutritional status. Most African nations also shared in common an absence

of appropriate intervention strategies with which to limit or prevent this periodontal destruction. The advent of the CPITN enabled more systematic attempts to intervene, to be planned.

CPITN STUDIES

A large number of CPITN studies were carried out in the industrialised nations, many of them testing the CPITN index against previously used indices. The findings from some of these studies are included below.

Freitas et al (1983) tested the CPITN against Russell's PI in 15-40 year old Portuguese. Severity was found to increase with age and be more prevalent in males and rural subjects. Both indices revealed a low prevalence of complex periodontal disease and treatment need, although there was a great need for simpler forms of treatment. They feel the PI less frequently underestimates pocket-prevalence. Beck et al (1984) tested a precursor of the CPITN in Iowa, to find a high prevalence of calculus and gingivitis. Moderate pockets were found in 30% and deep pockets in only 1.3%. Age, income and frequency of dental visit are listed as possible risk factors.

Srivastava et al (1985) estimate the periodontal treatment needs of Asian women in England. A substantial 13% were described as showing complete periodontal health but a large amount of treatment is required by the rest of this sample: 13% require complex periodontal treatment (TN3), 50% require scaling and root planing (TN2) and 24% require Oral Health Education (TN1).

An awareness project run in the United Kingdom using the CPITN is evaluated by Chesters et al (1987). The potential of the CPITN as a method for raising awareness and promoting self assessment in patient-oriented programmes is supported.

With data from a French sample, Miller et al (1987, 1988) argue that where some teeth in an individual require TN3 (complex treatment), a higher proportion of the remaining teeth can be expected to require treatment in the form of scalings and root planing. In this sample only 3.4% were healthy and 6.2% require simple oral hygiene measures. A substantial 48.2% have calculus, 32.1% moderate pockets, i.e. 80% require TN2 (scale and root plane) and 10.1% require TN3.

In Finland, Ainamo et al (1986) compared subject perceptions of "bleeding gums", "gum inflammation" and clinical signs of gingival health, finding 40% recognised the first, 16% the second and a mere 2% were clinically healthy. This is an alarming discrepancy in perception. The prevalence of TN3 was low until after age 35 years, reaching 17% in the 50 year old group and 27% at 65 years. It is also suggested that edentulous subjects be excluded from such assessments of periodontal treatment need at the population level.

Nordblad et al (1986) compared the periodontal health of Finnish and Thai under-20 year olds. The 17-19 year group presented with calculus in 39% of the Finns and 55% of Thai subjects. Moderate pockets occurred in 3% and 44% respectively and deep pockets occurred in 1% of the Thai sample. The treatment needs for the two groups was substantially different. The mean number of sextants requiring TN2 was 0.6 (Finn) and 4.5 (Thai). In addition,

three healthy sextants was recorded in 47% of Finns and only 6% of Thai subjects. A startling discrepancy between similar age cohorts of individuals differentiated by levels of affluence and underdevelopment.

In another Thai study (Songpaisan and Davies 1989b) described the 35-44 age group as having a prevalence of 0.7% healthy individuals, 0.4% with bleeding, 62% with calculus, 24% with moderate pockets and 13% with deep pockets. Of the 15-18 year group 93% had calculus. Concern was expressed that such excessive estimates of treatment need arise from the assumption that everyone found with calculus automatically requires scaling.

Djukanovic (1986) describes the prevalence of periodontal disease in Yugoslavia, using the CPITN. The group of Slovenia 15 year olds for example, display a prevalence of TN1 of 73%, TN2 of 18% and TN3 0.8. A large amount of tooth loss (>35% and rising) in groups over 40 years is attributed to periodontal disease.

In the South-East Asian and Pacific region, a sample of Philippine adults surveyed by Garcia and Cutress (1986) had a low prevalence of TN3 (4%) and healthy mouths but experience endemic calculus and gingivitis. Young adults had a 70% prevalence of calculus and 4% prevalence of moderate pocketing. Older adults had prevalences of 40% and 60% for these entities respectively. In Indonesia,Wibowo et al (1988) found results similar to other South-East Asian and Pacific

populations. In 18 year olds shallow pockets are present at a prevalence of (25%; MNS=0.6) and in 35-44 year olds, most have shallow pockets and 10% have deep pockets.

A Santo Domingo sample of 12-16 year olds studied by Garcia-Godoy et al (1986) revealed that treatment need in two socioeconomic groups was not significantly different. In the sample, TN3 is required by 0.4%, TN2 by 81%, TN1 by 6% and no treatment by 13%.

In East Asia, Shanghai factory workers aged 35-44 (Pilot et al 1989) presented with TN2 close to 87% and TN3 around 11%. Calculus and shallow pockets shared approximately equal prevalence. In Japan, Miyazaki et al (1989) recorded a prevalence in dentate persons aged 15-19 of 12% and 14% of healthy and bleeding subjects respectively while all other ages had negligible proportions with such mild levels of disease. Once more calculus predominates with a prevalence of 68% at 15-19 years to 40% by age 45-64. Moderate pocketing occurs in 6%, 17%, 30% and 37% of the four age cohorts and deep pocketing in 0%, 1%, 6% and 21% of the groups. However the mean number of affected sextants (MNS) reaches a maximum of 1.8 only in the 45-64 male group, with an average of for males and females in this cohort of 1.3. In 15-19 year olds it reaches a low 0.1.

And in Hong Kong, Corbet et al (1989) found a significant difference between male (23%) and female (9%) prevalences of TN3. Significance was also found for the mean number of sextants needing TN3 (males 0.4, females 0.1) and for the

proportion of healthy sextants in the two groups. Reason suggested did not include oral hygiene measures but included the lower mean number of teeth present in the females.

GLOBAL AND AFRICAN CPITN DATA

Data based on CPITN (FDI 1985) show generally low or moderate levels of bleeding or calculus in industrialized countries and generally high levels in developing countries. Estimates in the literature indicate that between 10-15% of people may be considered at high risk of succumbing to the progressive form of periodontal disease. WHO data for 35-44 age groups indicates a very high prevalence (>75%) in seven countries (out of 35); a high prevalence (40-75%) in 13 countries; and a moderate to low prevalence (<40%) in 15 countries. When early signs of disease are included in the measurement, the prevalence rates are even higher. New Zealand for example show 2% of population over 15 years free of gingival disease. 86% had established gingivitis and 12% advanced periodontal disease (Lang et al 1986).

A summary of the CPITN data from a number of African nations collected between 1982 and 1986 is tabulated in the Discussion section in TABLE 9.1.3 and 9.1.4.

Rossouw (1986) examined the !Kung Bushmen using the CPITN, to find that gingival bleeding had a very high prevalence of 99%, shallow pockets around 60% and deep pockets 3.6% at age 15-19 and 7.1% at age 35 an over. Calculus for ages 15-35+ was present in a mean 3.5 sextants per person and shallow pockets in 1.3.

Louw et al (1989) describe a sample of farm labourers to have a TN1 prevalence of 94%, TN2 of 79% and TN3 of 3%. Like Sheiham and Manji above, some reservation about the magnitude of treatment need estimated on the basis of this information is expressed. They conclude however that the CPITN still appears to be an appropriate tool for planning dental services, but that it is essential to consider the limitations of resources actually available.

Cutress (1986) summarises the main findings of CPITN based on surveys worldwide by saying that the data agrees on the prevalence of gingivitis, and reveals a higher prevalence of calculus associated with gingivitis in young people than previously reported. He also notes that plaque is clearly marked as the culprit in gingivitis aetiology. Juvenile periodontitis and other destructive forms of periodontal disease are however, not common.

5.3.4 MEASURING PERIODONTAL DISEASE

The need to reduce clinical observations to a convenient index has been discussed by numerous authors. Braga (1980) notes that epidemiologists have different needs to clinicians in this respect and are more interested in establishing criteria and in quantitating accumulated data with regard to the incidence or prevalence of a disease. Ainamo (1984) confirms this assertion, and lists the four main characteristics of a periodontal index for prevalence studies defined by Davies. (1974). These include the need for an index to:

1 be simple, take minimum time and cost;
2 have clear criteria amenable to reproducibility;
3 be amenable to statistical analysis;
4 be equally sensitive throughout the scale if it measures severity.

However, despite the apparent clarity of these requirements, the debate around periodontal indices has been extensive and confusing. Jenkins (1984) comments that the conflict in the findings of numerous UK studies, reflects the lack of reliable diagnostic criteria. A great deal of effort has been spent on devising the best indices to use in recording periodontal disease in an objective and repeatable manner.

Russell's PI is said to underestimate periodontal disease severity. The WHO TRS 621 system underestimates the most serious stages of periodontal disease by 30-50% because this method uses only the six Ramfjord teeth for examination. Others report that the PI is more subjective. Studies on the

site prevalence of periodontal disease suggests that the proximal edge of first molars is the predominant site, followed by central incisors. Radiographic studies note acceptable levels of correlation between clinical probing depths and bone loss when scored to the nearest 1-2 mm. It is stated that probing force, instruments used and the degree of inflammation present in the pocket to be examined were important variables to be taken into consideration. Some workers have made use of tooth loss as an indicator of dental health while others have been assisted by the use of a "recession" index. Anerud et al (1983) describe loss of attachment increasing with age, especially on the buccal surfaces. Loe and Morrison (1986) consider the use of early measurement of attachment and alveolar bone levels as essential in young adults.

Papapanou et al (1989) found that 75% of subjects exhibited ≥ 0.5 mm of bone loss over a ten year period, while only 7% showed a mean bone loss of ≥3 mm. The same study found that 15% of the subjects accounted for half of all recorded tooth sites with a ≥ 6 mm longitudinal bone loss. In another paper, Papapanou et al (1988) stated that teeth in the incisor regions consistently showed the highest frequency of advanced alveolar bone loss and the lowest frequency of tissue support. The molar teeth were found to have precisely the opposite situation, although they were the most commonly missing teeth. Bjorn and Halling (1987) describe similar results, commenting that the average bone height in the upper jaw was less than in the lower jaw in all regions except the incisor area. They suggest that a representative bone loss measure for the dentition could be obtained by assessing the mandibular

molars, as their values were closest to the total mean. If these teeth were absent, the mandibular incisors and canines should replace them.

Jensen and Solow (1989) found that in periodontal patients, local crowding and tooth angulation were factors predisposing the subjects to increase bone loss.

Davies et al (1974) were amongst the many attempting to simplify diagnostic criteria for measurement of periodontal disease. Ekanayaka and Sheiham (1980a) explored the relationship between a large number of indices in current use and suggested that simple indices may yield just as much information as more complex methods. The best correlations were between the reversible indices of inflammation and bacterial plaque according to Hancock and Wirthlin (1977). Davies and Barmes (1976) affirmed in a practical test the difficulty of calibration for diagnosis of intense gingivitis and advanced periodontal involvement. Lang et al (1986) consider bleeding on probing a limited but useful prognostic indicator in clinical diagnosis for patients in periodontal maintenance phase. This suggestion issupportedby Lobene et al (1980) who propose the use of a Modified Gingival Index but argue against the use of probing to induce bleeding, indicating preference for a completely non-invasive technique. Clerehugh and Lennon (1984, 1986), Yoneyama et al (1988) and Carlos et al (1987) establish the validity of attachment level as a measure of early periodontitis and note various factors affecting assessments including probing force, use of unstandardised inaccurate probes, examiner experience and presence of inflammation in the periodontal tissues themselves

are considered. Gaengler (1984) proposed a full mouth recording index to present data of the progression of periodontal disease by the increment of tooth related Periodontitis/T and Missing teeth/T.

Some workers assert that the earliest stage of periodontal disease is gingivitis (discussed elsewhere in the text) characterised by bleeding on probing which is a reversible condition. Oliver (1976) feels that pocket depth is the best available measure of periodontal disease, while Bjorn and Halling (1983) utilise radiographs to identify both calculus on proximal surfaces and bone loss, to indicate the need for treatment. And Srikandi and Clarke (1982) found that more than 90% of pockets were detected interproximally, a finding that may support the rationale for partial recording.

PARTIAL RECORDING

Partial recording is one potentially valid means of time saving (Marthaler 1963). Fleiss et al (1987) assess the use of six Ramfjord teeth for epidemiological purposes and conclude that they are more than adequately representative of the rest of the dentition for gingivitis but inadequately represent the rest of the mouth for periodontitis. Aucott and Ashley (1986) conclude that although the ten CPITN sites reflected the bleeding and pocket depths of the other sites in their periodontal disease-susceptible group, the use of pocket depth measurements alone seriously underestimated the proportion of individuals with a high past or present susceptibility to periodontitis. The inclusion of attachment loss measurements is apparently required to increase the

likelihood of identifying such high risk subjects according to Aucott and Ashley. Gettinger et al (1982) found a consistently strong correlation between the Ramfjord teeth subset and whole mouth indices in two different populations.

Ainamo and Ainamo (1985) concluded that average severity scores were obtained as accurately from six Ramfjord teeth as from full mouth examinations for all periodontal indicators except pockets deeper than 6 mm. The ten CPITN teeth improved upon this although it underestimated the prevalence of shallow and deep pockets in the sample. It is concluded that such a partial examination is not reliable enough for determining the needs of individual patients, however its value for epidemiological purposes is not challenged.

AN INDEX TO INFORM PLANNING

The need for a much simpler index that uses minimal time for recording yet reflects the prevalence and severity of periodontal disease in subjects in a way that enables a useful estimate of community treatment needs to be made, has became evident. There has been a gradual shift in emphasis from the collection of information on the prevalence, aetiology and prevention of periodontal diseases, toward the measurement of these variables to assess the need for treatment in the populations examined (Horowitz 1979).

Ekanayaka and Sheiham (1980b) attempted to develop a new screening index, to assess periodontal treatment needs based on presence of one or more bleeding points, presence of calculus and depth of pocketing at the mesio-buccal line angle

of each tooth. Cutress et al (1978) compared the PSI system with others and concluded that the respective indices are associated and measure the same kind of criteria. In addition, calibration and consistency were similar.

Macaulay et al (1988) consider three periodontal indices against their ability to inform oral health planning. It is suggested that plaque and subgingival calculus are suitable indicators for planning purposes but that the value of gingival bleeding measurements is equivocal. They argue for the inclusion of plaque as a measure because of its relationship with a population strategy. The inclusion of calculus is both for its ease of diagnosis and because it is a measure that identifies a small but high risk group in need of special treatment strategy. On this basis, it is suggested that a gingival index is redundant. The use of population strategy related indices is supported by Blount and Stokes (1986) who discuss toothbrushing effectiveness evaluations and propose the OHI-S or PHP plaque related indices for this purpose.

A very recently published attempt to develop a periodontal index is that proposed by Eaton and Woodman (1989). It is stated that their Periodontal Index of Treatment (PIT) periodontal screening technique, when used in conjunction with bitewing radiographs, achieves both specificity and sensitivity levels between 90% and 100%. If it does in fact provide the simple, rapid and reliable periodontal screening stated, it may be an important new development in the field.

Horowitz (1979) challenges the usefulness of a treatment needs index, asserting that it is questionable because of the probability that treatment needs could not be fully met even in developed countries. This assertion will need to addressed in subsequent discussion.

5.3.5 CHOOSING THE CPITN

Based upon some of the information presented above, periodontal disease indices used for epidemiological purposes were modified by reducing the number of teeth to be examined, allocating single scores to groups of teeth and the use of dichotomous criteria instead of different gradings of severity. The CPITN exemplifies this attempt at economy and aims at recording the maximum treatment need of each subject. A serious conceptual problem however, is the fact that current disease status has not been shown to be a good indicator of future breakdown.

The Community Periodontal Index of Treatment Need (CPITN), described by Ainamo and others and developed by FDI and WHO (Ainamo 1982, Ainamo 1984, Cutress et al 1987), has now been used in numerous studies around the world. A substantial amount of effort has gone into the development, field testing and statistical evaluation of the index (WHO 1984a).

The Community Periodontal Index of Treatment Need (CPITN) utilises a ball-ended probe and this is used with a dichotomous scoring system which records presence or absence of clinical criteria such as gingival bleeding, subgingival calculus and pocket depths. The mouth is subdivided into sextants and an index tooth in each of these is examined and given a score based on the severest criterion observed.

One advantage is that this assessment of periodontal disease can be performed in only 1-3 minutes. The CPITN can identify the treatment needs of either individual or group. It

indicates immediately the treatment needed by the individual and on collation of the sample data can give the percentage of a given age group that requires complex treatment, scaling or oral hygiene instruction. Like with the PTNS this can also be used for the estimation of time, manpower and other resources required to provide treatment to the group (Ainamo 1982).

Barmes and Leous (1986) discuss the applicability of CPITN data to the assessment of periodontal disease status and its use in the development of measurable objectives for health of the periodontal tissues. The number of healthy sextants at age 12 (not less than 3 by the year 2000) is identified as a potential global indicator of periodontal health. Zero sextants with pocketing at age 15 is also suggested as a feasible aim.

Cutress et al (1986) compared the CPITN with existing indices and concluded that it is more sensitive in identifying existing periodontal conditions and treatment needs. Croxson (1984) considers the CPITN to offer the most realistic screening and monitoring technique yet developed and adapts well to use in dental practice. Gjermo et al (1983b), in a study of a population with a high periodontal disease prevalence found the CPITN to overestimate the need for treatment in young age groups. They suggest disregarding the complex treatment component of the index but when using it for screening a young population to give priority to those showing loss of attachment. The justification is based on the concept that gingivitis per se does not cause serious health problems, and that a community approach to control periodontal disease may be based on secondary prevention. Gaengler et al (1988)

found the CPITN to under-estimate deep pocketing, especially in older age groups, and in younger age groups it over-estimated the need for scaling.

Ainamo et al (1984) examine the use of the CPITN in populations under the age of 20 years and suggest that the second molars be excluded in such cases; that assessment of periodontal treatment needs begin at age 7; that from 7-11 years age bleeding, calculus and overhangs alone be sought. At ages 12-19 full examination of index teeth should be done. They suggest that radiographs be excluded in epidemiological surveys of this age group.

Tervonen and Ainamo (1986) found that in a population with high caries (and restorative treatment) experience the recording of overhangs is important and the relative influence of calculus (both code 2) might be higher in the aged than the young population. Takahashi et al (1988) also challenge Code 2 recordings. They found that up to half of the sextants coded 2 showed no bleeding after probing. Their proposal is that, to make it more useful for public health planning purposes, the CPITN should be modified to record presence or absence of bleeding and pocket formation whenever calculus is detected.

Tala (1987) reviews the testing and use of the CPITN in Finland and comments that the first national data on CPITN indicate that it is an index both suitable and useful in the monitoring of the periodontal health of the population.

Ainamo et al (1987) also discuss the additional information provided by the accumulated CPITN data bank on, for example, the distribution of indicators of current periodontal disease within various age groups of the population. They present the use of CPITN cross-tabulations as a method of analysing survey data for the assessment of both preventive and therapeutic needs.

Louw et al (1989), Gugushe and Rudolph (1989) quote the reservations expressed by Manji and Sheiham (1986) about the CPITN. Briefly, these include assumptions about the natural progression of periodontal disease, that the recommended treatment strategies are effective in halting progression of the disease and the fact that it is a community index, but the treatment strategies are all based on a single patient-to-operator situation. As a result, Louw et al arrive at an enormous estimate of time and manpower required to meet the treatment needs of the community they surveyed, according to CPITN criteria. Although both sets of authors recognise these shortcomings of the CPITN, acknowledgment is given of its value in describing community periodontal health status and providing at least some guideline to the planning of appropriate prevention and treatment strategies to the community.

5.3.6 TOOTH MORTALITY

Data on tooth loss in developing countries may indicate the dental health status in young people and serve as baseline data for evaluating future dental health programmes (Gjermo et al 1983a). In a study of a Brazilian population, the latter found an average 1.7 teeth were missing by age 16 years, that the first molar tooth was most commonly effected and that men and women did not differ in their experience of extractions. A South African study of High school children found the one group ("Coloured") also had a mean 1.7 missing teeth (Cleaton-Jones and Walker 1980).

These sort of figures do not bode well for the future dental health of these communities and Barmes commenting on WHO data, notes the inability of all systems studied to prevent large mean scores for missing teeth by age group 35-44. It is an alarming trend, especially since the pattern of tooth loss did not bear any consistent relation to disease patterns observed. Achievements or non-achievements in prevention did not seem to be tied to any specific structural factors (Barmes 1978).

Tooth extraction has been with us a long time although in historical terms, edentulousness seems to be a recent phenomenon (Ainamo 1984). Indications are usually toothache or chronic irritation from a fractured or decayed tooth. Whether Nature intended us to keep our teeth for life is an area for much speculation. The mechanism of compensatory eruption to match the occlusal attrition that occurs with age is one argument in support of this. Whatever the case, it is

evident that different populations undergo differing rates of tooth loss in relation to age and in each case a varied combination of factors is thought to bring this about.

By way of example, the findings of Norheim (1979), were that the number of teeth remaining, decreased with increasing age and decreasing income and/or social class. And in general, women, young people, and those with high socioeconomic status had less caries, better oral hygiene and periodontal health and had received more restorative dental care. These findings are also supported by the much earlier findings of the UK adult dental survey of 1968 (Gray et al 1970). This study found that although tooth losss was directly affected by levels of disease, attitudes of patients and the type of treatment offered by dentists, the composite effect of all factors produced a pattern of tooth loss that varied by age, sex, social class, regional location of the subjects and whether they belonged to a pre- or post NHS dental service cohort.

This has also led to the widespread use of tooth mortality as a crude but useful indicator of the dental status of the community. It usually assumes that tooth loss is the ultimate result of untreated dental caries and periodontal disease (Ekanayaka 1984). However this may be challenged by the assertion that tooth loss be considered an iatrogenic problem (Ainamo 1984).

LOSS DUE TO PERIODONTAL DISEASE ?

Much of the debate around tooth loss has assumed that caries is the dominant causative factor up to about age 40 years and thereafter it is superceded by periodontal tooth loss. A contrasting view is taken by Cutress et al (1982) who assume the observed tooth loss in two South Pacific populations to be associated with periodontal disease because the prevalence of caries was found to be so low. After remarking that caries had increased and that treatment services had been improved markedly in another South Pacific population, Speake and Malaki (1982) describe more than half the 55-64 year age group as edentulousness. Unfortunately no comment is made about the main reason for tooth loss.

Ainamo et al (1984) tested the dominant assumption to find that in Finland all age groups from 16-20 to 71+, caries was the most frequent indication for extraction (in 60.4%). Periodontal disease accounted for 18.3% overall and up to 45% in the oldest age group. Baelum and Fejerskov (1986) supported this assertion in their study of Tanzanian adults. The mean number of teeth lost due to dental caries ranged from 2.1-7.0 and far exceeded the loss due to periodontal breakdown which was only observed in their oldest age groups. Ekanayaka (1984) found that 0.5 and 1.7 teeth per subject needed extraction due to caries and periodontal disease respectively. The mean number of missing teeth (7.1) he recorded in the 35-44 age group resembles the Tanzanian figures. Burt et al (1985) similarly take to task the assumption stated and find that half the dentate persons in the 65+ age group are free of destructive periodontal disease despite the fact that 46% of

this age group overall, are edentulous. He reports that severity of periodontal disease among dentate subjects aged 20-70 hardly varies with increasing age whereas mean tooth loss and the proportion of edentulous persons both increase with age.

Baelum and Fejerskov (1986) describe how the distribution of dental caries within the dentition showed a closer resemblance with the pattern of tooth loss than did the distribution of loss of attachment. They further state that although a substantial number of teeth present exhibited severe loss of attachment, only a few were lost for this reason.

Niessen and Weyant (1989) found in a U.S. veteran population 63% of the tooth loss attributed to caries, 33% to periodontal and 4% to prosthodontic reasons. It was also found that the order of extraction in this group most frequently began with maxillary and mandibular anteriors, followed by premolars and molars, an order different to that in most other studies.

Linden (1988) found that only 15% of subjects had generalised advanced periodontal destruction at clearance. It was also found that men had more periodontal disease than women but that severe periodontal disease was limited to a very small group. Serious doubt was expressed that the periodontal condition was of any consequence when the decision was taken to remove the remaining teeth.

A Kenyan study of tooth mortality by Kaimenyi et al (1988) also confirmed the prevalence of caries as the main reason for extraction in 81% of subjects, whereas periodontal disease

only contributes to loss in over-45 year olds. In addition, 30% of extractions are done on 20-29 year olds and no sex difference appears to exist.

Two South African surveys investigate the reasons for tooth loss in Transvaal Black populations. Shakenovsky et al (1986) found caries responsible for 67%, periodontal disease for 19%, and trauma 5%. While this study supports the concept of periodontal disease as an unimportant reason for tooth loss except in the over-65 age group, it does not consider the role that social, political, economic and iatrogenic factors may play in producing this picture of tooth loss. Du Plessis (1987) found a similar situation, with an even higher proportion of tooth loss due to caries (72%), with periodontal disease and trauma responsible for 21% and 4% respectively. He suggests that this population may be entering a phase of rapidly increasing caries incidence and motivates careful monitoring of the situation and development of an intensive prevention campaign.

TOOTH LOSS IN WESTERN COMMUNITIES

Ahlqwist et al (1986) found in an age-standardised sample of Swedish women a substantial decrease in edentulousness and frequency of missing teeth over a 12 year interval. This was attributed to preventive measures and the increased availability of dental services during the same period.

The same workers (Ahlqwist et al 1989) found, after controlling for other variables, that smoking seems to play an important part in the rate of tooth loss in this group. Mohlin

et al (1979) found the dental status of Swedish men to be related to age, place of birth, educational level and smoking habits. They also found greater tooth loss in the molar regions, with mandibular segments exceeding the maxillary in frequency.

Anagnou-Varelzides et al (1986) analysed loss by tooth type in an Athens population and found that mortality for canines was low, the two mandibular incisors had the lowest rates of loss in their sample, there was no difference in loss between left and right sides, mandibular molars were lost more often than their maxillary counterparts and upper premolars more often than their mandibular counterparts. In addition they echo the recorded value of 40% for tooth mortality in the 60+ age group observed by Ainamo et al (1984). Anterior teeth seem to predominate the extractions for periodontal disease and posterior teeth predominate extractions due to dental caries (Baelum et al 1986, Anagnou-Varelzides et al 1986).

Bouma et al (1986b) found edentulousness in two Netherlands communities to vary with the availability and accessibility of dental care. This was evident in a rural-urban difference, with a higher prevalence of tooth loss in the former despite similar levels of caries experience. An attempt to explain these differences on the basis of demographic variables such as the age, sex, income and educational characteristics of the groups was inconclusive (Bouma 1986a). It was established that given a background of similar levels of caries and periodontal disease, these groups, only a small proportion received extractions because of periodontal disease, with the majority of extractions due to caries and other non-disease reasons

(Bouma 1987a). The combination of dental anxiety and a positive attitude towards full dentures are considered to be important determinants leading to edentulousness and denture wearing at an early age (Bouma 1987b).

Meskin and Brown (1988) say of an employed adult and senior U.S. population that although a substantial reduction in total edentualism has occurred, the concern about future quality of life in these individuals is evident in growing demand for sophisticated dental services. It is suggested the market for implants may expand dramatically as a result.

OTHER REASONS FOR TOOTH LOSS

Ainamo et al (1984) mention the large cultural and geographical variation between populations and cites India as a typical example of a country where extractions due to periodontal disease dominate. Caries dominates in Canada, Scandinavia, Australasia, Israel and in the USA it appears to be equivocal. Ekanayaka (1984), Ainamo (1984) and Burt et al (1985) comment on the effect that even simple dietary and oral hygiene education could have in the developing world populations which still have low caries rates. The suggestion that increasing gingivitis and pocketing does not necessarily equate with tooth loss as long as oral hygiene is maintained, is made. And where excellent oral hygiene is maintained, age does not seem to be an important independent variable in periodontal disease status.

According to Burt et al (1985), the calculus associated with low to moderate levels of periodontal disease still seems to be compatible with the retention of teeth.

Various authors have sought an association between tooth loss and dentist populations etc. Tuominen et al (1984) conclude: "the fact that increasing availability of dentists also decreased edentulousness when associated with decreasing levels of income or with increasing distance, indicates that scarcity of services is the factor which mainly prevents people from preserving their natural dentition".

Kay and Blinkhorn (1985) investigate the assertion that treatments received by patients is not related to the level of dental disease. They found the decision to extract teeth was influenced by the year the dentist graduated and also by the frequency with which the patient visited the dentist (an inverse relationship).

This may be true in the Cape as well and should be considered in assessing the oral health of the Crossroads community.

Among other reasons for tooth loss listed in African studies, are extraction for orthodontic purposes (1.9% Du Plessis 1987; 6.5% Kaimanyi et al 1988), trauma (5.3% - Shakenovsky et al 1986; 3.6% Du Plessis 1987; .03% Kaimanyi et al 1988) and miscellaneous other reasons in very low proportions. Louw (1982) found that the reasons given for tooth loss also included bleeding gums (6.9%), and fashion (3%). He also established that 64% of the sample were not bothered by the thought of wearing dentures one day.

Finally, it is interesting to consider the shortened dental arch concepts described by Kayser (1984) and others (Kayser et al 1985) since their origin lies in the widespread "problem" of tooth loss. It challenges the assumption that "all is lost" when a complete functioning dentition has been disrupted by tooth loss. And it can certainly affect treatment planning thereafter.

Ainamo (1984), commented that "loss of all teeth is closely related to a historically rather rapid change in dietary habits, combined with ignorance of prevention, unfortunate social circumstances, and insufficient dental manpower at the right time in the right place."

A clearer understanding of the magnitude of tooth loss in the community by cohort, and the pattern of loss by tooth type will hopefully inform the decisions taken in planning to meet the periodontal treatment needs described in this study. Let us hope that we can heed the warning that emerges from the Finnish experience.

5.4 PREVENTION AND TREATMENT OF DENTAL DISEASES

5.4.1 DENTAL CARIES

Prevention rather than treatment is the more desirable and in the long run a more effective strategy for eliminating dental diseases. Achievements in prevention of caries in developed countries is admirable although the same is far from true in developing countries. Despite evidence of improving oral hygiene, little clinically significant prevention of periodontal disease has been achieved in children or adults from both developed and developing countries (Stamm 1984). Woolfolk et al (1985) show that this can be no less true in disadvantaged communities elsewhere, such as the migrant worker population they found to be weak in the knowledge of the relation between sweet diet and caries, oral hygiene and periodontal health and the role of fluorides in caries prevention, in the USA. But preventive measures are still lacking and costs for curative services could outstrip the financial resources of even the wealthiest countries (Barmes 1976b, 1977). It is with this in mind that George (1988) suggests the pursuance, wherever possible of traditional methods of prevention and control such as the chewing stick, and proposes a method of use.

Ames and James (1987) describe the overriding purpose of prevention as the creation of a social and physical environment that promotes the establishment and maintenance of good health behaviours and discourages health-damaging choices. They emphasise the need to evolve an approach to primary prevention which is more integrated. Burt (1984)

motivates that the types of prevention programmes conducted should be determined according to the disease patterns in the community, its demographic character, the resources available and the level of educational and economic development. He also strongly suggests that community-based programmes should make up the major portion of the total preventive effort in any given society.

Acceptance of preventive measures by institutions and communities is limited for dental diseases according to Silversin and Kornacki (1984). Altering any single factor does not result in sustained behaviour change. Institutions and communities are, however,the sites where the determinants of individual behaviour can be altered and preventive services can be delivered. The FDI working group (FDI 1984) promotes the value of prevention procedures even where the special problems of developing countries exist. Saparamadu (1984) states that prevention of oral diseases in developing countries should follow the Primary Health Care approach by having prevention and education as the priorities, being field based and implemented with maximum community participation. Utilization of teachers, parents, senior students, village health volunteers, religious leaders, traditional healers and others is a practical and achievable method of introducing oral health improvements.

PREVENTION OF DENTAL CARIES

Stamm (1984)and Murray (1986), in defining future challenges in prevention, cite two patterns visible in developing countries. In some nations caries experience is moving slowly

from low to moderate levels, and in others, it appears to be moving from moderate to high levels. On the basis of both observed and expected trends in caries, and noting the shortage of dental manpower, and also the inherent inability of curative methods to deal with the caries burden in these nations, he urges a greater emphasis on preventive strategies. The findings of Spencer (1978) Christen et al (1979) and Bowden et al (1973) all record levels of treatment needs per individual, running to many hours (from 2 to 11 hours/person) of restorative and preventive work. For even the most efficient, bargain-price service delivery system this amounts to an enormous cost, which could never be implemented at population level, a fact supported by Forbes & Donaldson (1987).

This traditional perception of treatment need or more specifically, restorative need in individuals, has contributed to the provision by dental professionals, of expensive services to the privileged few. Preventive aspects have been neglected in the face of this emphasis (Leatherman 1979).

FDI Technical Report No.20 (1984) nine point priority list of preventive measures for caries, includes water fluoridation; fluoride in salt, supplements, school supplies; mouthrinses and gels; fluoride toothpastes; an educational component targeted for community and individual; public policy control of cariogenic foods; fissure sealants; toothbrushing and scaling; recall procedures. Silverstone et al (1981) elaborate on three main levels for caries prevention, i.e. plaque control, dietary control and enhancement of tooth resistance and two of these are reviewed below.

CONTROL OF DIETARY SUGAR TO PREVENT DENTAL CARIES

Although some community approaches to dietary change have been effective in achieving significant changes in the patterns of eating, Sheiham draws attention to the importance of tackling the issue at all levels. Strategies for reducing the risk of major life threatening non-communicable diseases may overlap with those for reducing oral diseases and such efforts should be integrated. (Sheiham 1981, 1985, 1988, 1989).

Walker (1986) argues that for the meagre funds available in developing countries, dental services will have to compete with very basic health care services. However a major emphasis of the Primary Health Care approach, as promulgated at Alma Ata (WHO 1978), is that it embrace the coordination of food, agricultural, health, economic and social policies across sectoral divides. It is essential that appropriate relations between cash crop and basic foods; between health policy and economic benefit; between community well-being and political stability, be established in developing nations. In this context even the relationship between sugar and health, becomes an important political issue.

FLUORIDES TO PREVENT CARIES

Regular toothbrushing is of value for general oral hygiene (Addy 1986, Axellson et al 1976) and the prevention of periodontal disease but seems to have no restricting effect whatsoever on the progression of caries. In spite of this, Brand et al (1988), in an article to identify levels of awareness of oral health determinants in South African

mothers, discovered that most believed that caries and periodontal disease could be prevented by brushing and flossing. Ainamo (1980), writing about the relative roles of toothbrushing, sucrose consumption and fluorides in the maintenance of oral health in children, confirmed that the mechanical cleaning of teeth, so emphasised in traditional approaches to oral health education and promotion, does not reduce the cariogenic effect of an excessively frequent sucrose consumption. He states however, that toothbrushing alone reduces dental caries only when it includes application of fluoride dentifrice.

Noting the disparate trends in developed and under developed countries, a WHO report on prevention (1984b) suggests that greater use of fluorides on the one hand and increased sugar consumption by persons not protected by fluoride on the other hand, have lead to this situation. Evidence suggests that a food policy directed at lowering the refined sugar consumption level to about 10kg per person per year in conjunction with fluoride supplementation could virtually eliminate caries in industrialized countries (Sheiham 1978). Pasquale (1983) discusses the various fluoride options that could be used in Africa but Jeboda (1986) points out that existing water fluoride levels are not established for many areas of Africa and fluorosis is endemic in large regions.

Whereas many governments and professionals support fluoridation, much work needs to be done before it can be implemented. However fluoridation of public water supplies is without doubt the most theoretically incontestable means of prevention currently available (Ainamo and Parviainen 1979).

South Africa meets all nine criteria for water fluoridation laid out by Murray and the WHO (1986). Staz (1962), the Commission of 1966 and others have presented coherent arguments for this position and yet nowhere in South Africa has water fluoridation been introduced.

Perhaps it is in the most distinguishing characteristic of the majority of the South African community, i.e. socio-economic oppression, that the strongest motivation for introducing water fluoridation can be found. In the field of oral health in South Africa, the most appropriate intervention must be one which transcends the barriers of class and race. Fluoridation of public water supplies is the only measure capable of meeting these requirements and will be an important contribution in efforts to provide equitable oral health care to the community.

5.4.2 PERIODONTAL DISEASE

Saxen (1985) reviews the scientific basis of periodontal treatment and concludes that despite increasing knowledge of pathogenesis, microbiology and immunology, the methods of treatment have not changed essentially in the past 30 years. Oral hygiene instruction, scaling and root planing are still the methods of choice. Pockets up to 5mm can be maintained by plaque control combined with scaling and root planing (Oliver 1976).

It is interesting that the FDI working group (FDI 1984) suggest periodontal disease control in adults at this secondary level of prevention because "treat rather than prevent" has been the dominant response of health authorities up to the present. But the most important and needed approach to periodontal disease is in public health education and prevention (Kumar 1981). However, although a community-based approach to caries has received massive success, especially compared to the individual approach, as yet periodontal disease has not been shown to be very amenable to such an approach. In addition, the role of individual behaviour in the control of periodontal disease is more dominant than it is with caries (Burt 1983)

An understanding of the perceptions that the community has of periodontal health and disease, is important in the development of any approach to prevention and control of the disease. Murtomaa and Ainamo (1977) found that the Finns in their sample did not recognise gingival bleeding as a symptom of gingival inflammation. They felt increased knowledge of

periodontal disease could help. A decade later, Bader et al (1989) however, found younger patients in North Carolina to have positive beliefs about keeping their teeth for life and few misconceptions that might damage their oral health. They too however, had a lack of awareness about the significance of bleeding gums.

In Europe, Honkala and Freeman (1988) reviewed toothbrushing behaviour in adolescents and found that it is influenced by both environment and social factors, that these factors both affect the incidence of periodontal disease and that when they are incorporated into community-based health education programmes, they can bring about meaningful behaviour change. On the contrary, a mass media campaign directed at periodontal disease in Norway in 1981/2, did not achieve the behaviour changes included in the campaign objectives. Only retention of the most simple campaign message reflected the gain in knowledge achieved by the campaign (Rise and Sjogaard 1988). Likewise Horst and Hoogstraten (1989) in testing a film on periodontal disease prevention in Holland, concluded that although it was simple to improve knowledge about such issues, changes in attitude and behaviour requires a lot more than 20 minutes of celluloid.

Addressing the Symposium on the Public Health Aspects of Periodontal Disease, Craft (1984) argues strongly for the development of a national strategy for prevention in the United Kingdom, noting that treatment services alone can never overcome the social conditions that produce disease. He

emphasise the need to harness and co-ordinate the efforts of all the agencies active in the field, commercial as well as professional.

Speaking more specifically about periodontal programmes of prevention, Pilot (1984) reviews a number of existing programmes and states that periodontal disease should be acknowledged as a major public health problem. He suggest that the objective "Enough teeth to smile, enough molars for stable comfort", should guide prevention planning. He also feels that improved oral cleanliness provides one of the only viable targets for the present, and therefore the attainment of mass plaque control should be the major thrust of periodontal disease prevention activities.

TREATMENT OF PERIODONTAL DISEASE

Before considering various aspects of treatment for periodontal disease, the sobering thoughts from a UK National Dental Health Education Group conference (Whyte 1986) are worth repeating. The view expressed is that much "pocketing" can improve with no clinical intervention, so why scale and plane shallow pockets which actually deepens them and damages connective tissue ? Also, the dentist/patient approach to reducing tooth loss is ineffective at community level. The suggestion is that our present periodontal health goals are unrealistic and objectives should rather include the preservation of the strategic part of any remaining dentition, rather than meticulous restoration of what is damaged or missing (Whyte 1986, Sheiham 1972, 1979, 1984a).

Lang (1984) outlines the predominant surgical and nonsurgical periodontal treatments justified by longitudinal studies over the preceding two decades. He verifies much of what has already been said here, and confirms that moderate pockets (4-7 mm) should first receive careful nonsurgical therapy (including scaling and root planing) before the indications for a surgical or "complex" procedure are assigned. This has important implications for the CPITN TN3 category. It suggests that even when "complex" treatment is indicated by a CPITN code 4, i.e. pocket of 6 mm or greater, a substantial proportion of these might still be treatable within the TN2 category of treatment. Lang concludes by saying that treatment of deep periodontal pockets may still be performed successfully by surgical intervention, but that serious attention to maintenance and follow-up must be given.

Takahashi et al (1989) investigated the impact of a single ultrasonic scaling on subjects rated with codes 3 and 4 by the CPITN. The number of teeth with pathological pockets was significantly reduced (by 45%), largely due to improvements in the shallow pockets. The time taken was about 30 minutes per patient and subjects aged 20-29 years experienced a higher proportion of improvements than those aged 30-44 years. The implications are important for the application of CPITN data in the subsequent dental service planning process. This study also offers some encouragement to use the CPITN for such purposes but to interpret the results slightly differently to the manner originally anticipated.

According Markkanen et al (1980) socioeconomic factors, dental status, health behaviour and certain environmental factors can explain 30% of periodontal disease treatment need. Of these, number of teeth (13%) and age (13%) are the main indicators. Glavind (1986) tested the impact of various background factors on the result of periodontal treatment and found no statistically significant result. He did establish that defaulting from treatment was associated with unfavourable dental beliefs and young age.

Estimates of treatment time need by subjects increases with age (Johansen et al 1975). Correlation analyses identified commonly used periodontal disease indices that can be used to estimate treatment times and types of personnel required to perform them (Ekanayaka and Sheiham 1978). They found that average times for education and scaling patients at an industrial clinic took 8 min and 27 min per patient respectively. In a teaching hospital the times were 56 min and 73 min. Surgery took 21 min or 12% of the total time. In the calculation of mean treatment times needed, one must remember that the three different levels of treatment will be subject to the treatment philosophies prevailing in the area where the indices are used (Ekanayaka and Sheiham 1980b). But planners also need to estimate levels of oral cleanliness which are compatible with a rate of bone loss that will ensure that the teeth, although periodontally diseased, remain functional for an individual's lifetime (Ekanayaka and Sheiham 1979)

Tervonen et al (1988a) describe the time required to treat different age cohorts between the ages of 25 and 65 in a Finnish population. A total treatment time of 4 hours for 25-35 year olds and 5 hours for 50-65 year olds was recorded. The proportion of time spent on conservative treatments was 86% and 36% respectively. Extractions required only 1-3% of the treatment time. The comment is made that the average treatment time per elderly subject will increase in future, however it should be noted that this is a first-world community, and both expectations and the opportunity to receive sophisticated restorative treatments may be quite high in this group.

Three findings are common to many treatment need studies. There is a great need to reinforce preventive behaviour and services; regulated contact between consumer and provider is effective in meeting treatment needs; and it is important to concentrate on quality as well as volume of care in providing adequately for the needs of child and adolescent populations (Barmes 1976b). The main response in developing countries should be to improve oral hygiene and not provide more professional care. Grappin and Lacour (1978) support the suggestion that in Africa certainly, prevention is the best means of attack, the cheapest, the most effective, and the most profitable in the long run, especially if strategies are directed at the child and young adults.

Sheiham and Jeboda (1981) caution that the success of programmes to prevent or control periodontal disease will have to be closely associated with broader social changes.

5.5 NEED AND DEMAND FOR DENTAL TREATMENT

Application of modern tools of management science to the planning and evaluation of health services has necessitated a more objective look at needs, demands and the resources available to meet them, especially in developing countries (WHO 1972, 1976, 1980). If dental care is mainly provided by the private sector and paid for on a fee-per-service basis as in a free enterprise economy, the services will be regulated by supply and demand with dental care regarded as a consumer commodity. Planning will then relate mainly to manpower whereas in countries with centrally planned economies, all aspects of a national dental service will impact on planning.

These are some of the issues that will need to be addressed in the process of converting unmet need for care into effective demand, an interaction upon which the planning of future services will need to be based.

DEFINING NEEDS AND DEMANDS

"Needs" for dental treatment normally far exceed demands for treatment, a discrepancy entrenched in the differing perceptions of oral health and disease held by professional and community. Alternative definitions of need that have been proposed include: "wants"- patient's perceptions of their dental care needs; "demands"- wants which the patient turns into actions, for example by seeking the assistance of a dentist; "need"- a state of dental health deemed in "need" of intervention by a dental practitioner. To these can be added "comparative need" and "unmet need".

Cohen (1987) defines "unmet need" as the amount of existing and untreated oral diseases or dysfunctional conditions found in a particular group in the population,and "effective demand" as that segment of need that eventually turns into utilisation of services.

Decisions on dental health needs vary depending on who makes them (Gilbert 1988); patients, dentists or society and from what point of view they are made. The task of setting priorities and of trading off one need against the other at an aggregate level is the role of the policy makers and the aim of public policy is to meet as many needs as possible. Situations where reduction in unmet need per R1 spent is greatest, should be first to be considered.

MEASURING NEED, DEMAND, SATISFACTION WITH CARE

A number of clinically measured dental health indicators have been promoted by the FDI, WHO and others. Barmes (1983) discusses their usefulness in developing countries, noting both the change in emphasis of the indicators from dental caries to all forms of tooth loss, and the absence of specific indicators of disorders of the periodontal tissues.

Recognising the limitation of clinical indicators, Segovia et al (1989) attempt to verify the existence of a range of separate non-clinical dimensions in the overall concept of health status. They find that self-rated health status is valid as a single measure of overall health status in their

sample, and that it is associated with both disease and subjective assessment components (such as "worry about health").

Gilbert (1988) discusses self-assessment in terms of oral health variables and recognises the wide discrepancy between community and professional assessments of dental need. Sheiham et al (1982) state that "a more realistic assessment of treatment needs should include the functional and social dimensions of dental diseases and an assessment of the socio-motivational factors which predispose people towards dental health and influence the effectiveness of treatment and education". Sheiham et al argue that the assumption that the need for health care can be objectively determined is incorrect. An attempt is made by Sheiham et al (1987) to develop a new composite indicator of dental health to more accurately reflect these sentiments, and concludes that the number of "functioning teeth" or "sound-equivalent teeth", provides a more reliable indicator of dental health status than the conventional DMFT.

Further work to describe socio-dental indicators of oral health by Cushing et al (1986), suggests that the impact of dental disease in their sample is limited to a personal level of discomfort and functional difficulty. Only rarely does it affect the social role or general health of people. The need to continue the search for meaningful indicators of oral health is expressed.

Melsen et al (1987) attempt to relate a range of social and behavioural factors to dental health. Their study is unable to establish a strong relationship between the variables tested, and suggests that a less direct interaction between them may exist. They conclude that dental health should be considered an integrated part of general health.

COMMUNITY PERCEPTIONS AND PARTICIPATION

The case for incorporating society's values in assessing needs is important when deciding how resources should be allocated to dental care (Yule 1984). This concept has found tangible expression in South Africa through the inclusion of three important clauses in the Freedom Charter (Congress of People 1955) which states: "A preventive health scheme shall be run by the state. Free medical care and hospitalisation shall be provided for all with special care for mothers and young children. The aged, the orphans, the disabled and the sick shall be cared for by the state."

This is echoed by Solomons (1988) who describes community demands expressed in a hospital campaign. The community explained their campaign on the basis of belief in the demands in the Freedom Charter, and the belief that "A healthy life is the democratic right of all South Africans". Clearly the omission of serious consultation with the community in the development of any kind of health services is potentially disastrous.

The apparent lack of awareness, on the part of the community, of oral diseases and the options available for their prevention is a concern expressed by many professionals and seriously investigated by few.

According to Warnakulasuriya (1985), people seem to seek treatment only when an acute disturbing symptom is apparent and although epidemiological data shows a high prevalence of periodontal disease, only 19.6% of the subjects in his Sri Lankan study were demanding periodontal treatment. As a result there is a large component of "unmet need" for periodontal disease. Johansen et al (1975) also found that patients are unaware of their periodontal treatment need. Murtomaa and Ainamo (1977) found that an adult Finnish population did not associate gingival bleeding with a state of gingival or periodontal ill-health. Woolfolk et al (1985) found that migrant Mexican-Americans were weak in their knowledge of the relation between a sweet diet and caries, the relation between oral hygiene and periodontal health, and the role of fluorides in caries prevention.

Tervonen and Knuuttila (1988b) describe how 40% of their sample noticed gingival bleeding and 20% "gum disease", but on clinical examination using the CPITN, 98% were coded 1 to 4 and 38% received code 3 or 4. The recognition of caries was far more accurate, with 70% of the group acknowledging the presence of a decayed tooth in their mouths and 76% of the group being found to actually need a restoration. The study reflects a similar underestimation of dental needs seen in the other studies, especially with regard to periodontal disease.

The authors therefore urge that more emphasis be given to improving people's awareness and knowledge of their own dental disorders.

UTILISATION OF DENTAL CARE SERVICES

Utilization of services is an important predictor of treatment need ratio although so far this rational has neglected to confront the problem of periodontal disease (Barmes 1976a). Petersen and Pedersen (1984) use a structural model to examine demand for dental care as reflected by dental visits and age in relation to socioeconomic criteria in a Danish community. They find that dental visits are influenced by dental health status, expectations about the value of dental care, income and the cost of dental care. They conclude that residence in rural areas during childhood and age have a negative affect on dental care early in life whereas years of schooling have a positive affect on both expectation and service utilisation.

Razak and Jaafar (1987) found that in an urban Malaysian population, toothache accounts for the most frequent complaint and the subsequent need for extraction provides the reason for 50% of service utilisation for the first visit to the oral surgery department at their Faculty. It was uncertain whether extraction was related to patient choice or the dentist's suggestion however, a question that needs to be dealt with. Clearly the existence of such a large demand for emergency care has serious implications for the deployment of manpower and services in this community.

Another factor that affects utilisation, is patient satisfaction with health care received. A central problem in the assessment of patient satisfaction with health care is the availability of reliable and valid methods. Sutherland et al (1989) test a number of variables related to satisfaction with care, finding that a paired choice method shows marginally better reliability and logical consistency than a rating method. They suggest that the technique is suitable for use in developing patient satisfaction indices.

Reisine (1987) used a path analysis to measure utilisation in a US sample, and found sex was the most important variable affecting use of dental services whereas income was, surprisingly, not a factor.

The findings of Wissa and Zahran (1986) in Egypt that only 31% of peripheral clinics had dental facilities, and that extractions were the predominant form of treatment at the others, illustrates the importance of differentiating assessments of accessibility and utilisation for emergency, curative and preventive forms of treatment. They conclude with the sobering comment that even the increased allocation of dental manpower to various regions did not improve dental health care in the rural centres.

BARRIERS TO DENTAL CARE AND IMPROVED ORAL HEALTH

Cohen (1987) makes the point that just as there is a need to assess the level of unmet need in the community, there is a need to assess the nature, variety and magnitude of the barriers standing between the professional and target groups

within the community who have unmet oral health needs. She quotes the 1985 FDI report on Improving Access to Oral Health Care (FDI 1986) which lists the main barriers under the three headings: Individuals, The Dental Profession and Society.

A US report on access to dental care (AAPHD 1984) introduces its discussion by noting that "... all segments of society do not have equal access to dental health or dental treatment". An ADA definition of access is quoted as: ".... the opportunity for each individual to enter into the dental care system and to make use of dentist's services as the best way of preventing and controlling oral disease". This appears to reflect the treatment oriented approach of North American dentistry and the freedom of treatment-choice with which affluence has provided the citizens of this region. The American Indian dental programme is mentioned separately, with the comment that availability and continuity of care are at the heart of its long-term planning.

Also speaking from an environment of relative affluence, Hingstman and Boon (1989) define "place utility" as a reflection of the various factors determining where a practitioner will end up practising. It is sad that these variables are almost entirely devoid of community health interests.

In contrast to this, in a discussion about whether to centralise facilities to satisfy patient access needs, Hosia (1984) found that on establishment of a new peripheral health post closer to the community, 90% of the sample said it was easier to get an appointment with the practitioner than

before. The response suggested that this improved accessibility was related to the improved levels of satisfaction recorded in this community. It was felt that in addition to the availability of the practitioner, a positive psychological effect of his/her presence contributed to personal satisfaction with the primary health care service as a whole.

Tobias and Smith (1987) found that only 3% of a sample of elderly people in Britain experienced difficulty in obtaining dental treatment, despite having a range of disabilities and the restraints of age.

Rogers et al (1984) attempt to relate dental visits to the home situation of pre-school children. It was found that only 18% of the full time working parents who would lose money if they missed work, actually took there children to the dentist. They feel that the variables studied may be intervening factors in the relationship between social class and service use but no causal relationship could be demonstrated. Experience locally seems to reflect a similar basis in social class. Dentists in working-class communities extend their clinic times to beyond the end of the working day and even into the weekends, whereas this does not occur in more affluent communities. Unfortunately availability is under-reported in most studies, so comparison is not possible.

In a wide ranging discussion of barriers to dental health in developing countries, Hobdell and Sheiham (1981) cite the historical sequelae of slavery and colonialism, enormous dentist to population ratios, widespread poverty and

undernutrition, and problems related to adopting Western models of treatment and prevention, as major determinants in the availability. Underlying much of this scenario is the current global hegemony controlling development and under-development held by Western capitalist interests.

Apart from this, they too state that only when oral health policy is integrated with all aspects of general health policy involving an awareness of the pertinent economic, social and cultural factors, can it be successful.

What is clear from the discussions reported above, is that the planning process must take account not only of needs and demand, but also of major influences on oral health such as the dental care delivery system, lifestyle and the environment. The successful marketing or delivery of better oral health to the community will depend upon this. Rudolph et al (1985) note that the participation of all sectors: the profession, public and private sectors, and the community, is necessary to achieve this.

5.6 SERVICE PLANNING AND MANPOWER

Health in developing countries is poor and many oral conditions are functions of the poverty and undernutrition prevalent. Dentist to population ratios are 1:100 000 and worse. And as illustrated by Sheiham et al (1979), based on established (Western) methods of needs assessment, 15 year olds, for example, would require a ratio of 1:2180 to restore and maintain their dentitions. This is clearly unattainable in most (if not all) developing countries. And the direct transfer of technology from developed countries frequently meets with failure and relates to the very different social, political and economic circumstances and disease profiles that exist (Hobdell and Sheiham 1981).

In terms of health policy, integration of oral health policy with general health policy is essential and the Primary Health Care (PHC) approach provides an appropriate way to do this. Some of the principles of the Primary Health Care approach described at Alma Ata (WHO 1978) are discussed further in the next sub-section. These include, the involvement of local people from the early stages of problem identification through to implementation, the giving of priority to health promotion and education activities and application of preventive technologies ahead of curative inputs. One thing is certain. To attain these goals a major shift in emphasis toward prevention of dental caries and control of periodontal disease in dental health worker training will be necessary (WHO 1984b).

ORAL HEALTH GOALS

Ross (1988) emphasises the need in manpower planning to clearly define goals related to the nature of disease, the shift from treatment to prevention and consumer expectations. The establishment of clear and attainable community oral health goals is a necessary first step in this process. The WHO/FDI objectives for oral health toward the year 2000 have been discussed by various authors including Agerryd (1983). While caries and tooth loss goals have received a great deal of attention, and are widely embraced, a similar concensus on acceptable levels of periodontal disease has yet not been achieved.

Although any set of objectives will need to tailored to suit local needs, dependent on existing disease levels, dominant determinants and the resources available, the guidelines suggested by Gjermo (1984) are helpful. An important assumption underlying his comments is the concept of an acceptable level of disease.

Acceptable levels of disease could include:

- A gingivitis which does not cause spontaneous bleeding or pain, does not involve the aesthetically important front teeth, associated with a CPITN code not greater than 2 elsewhere, be considered normal.
- Radiographic bone loss in not more than four sites with minimal attachment loss in young adults could also be considered acceptable

Unacceptable levels of disease in adults would include:

- Deep pockets of CPITN code 4.
- In older adults over the age of 45-50, the molars should be excluded from this consideration.

An overriding requirement should be that the above disease levels should be considered compatible with a life-long functioning dentition with a minimum use of resources. This implies that most of the efforts required to maintain it should be patient administered, with an oral health worker only required for screening and to deal with complications.

MANPOWER

Socioeconomic development closely affects availability of manpower. Where resources are scarce in relation to needs there is little room for an elaborate system of planning since demand for emergency treatments makes full use of existing manpower.

Shanley and Hobdell (1983) and Ross (1988) offer guidelines to help answer the question of how many dentists and other oral health workers to train, although there has been an unfortunate dominance of therapeutic theory present in the development of some of these proposals. Barmes (1984) offers a number of models designed to provide the three CPITN levels of treatment and prevention. Various combinations of services and personnel are presented, to be modified according to the type of oral hygiene education, personnel and care patterns anticipated locally. An important consideration is that oral health goals should be agreed upon by all parties concerned -

consumers and providers. Preventive and curative strategies should follow before the roles of different types of oral health workers are defined and their numbers calculated. The need for planners to be aware of the politics of the professional as roles in the oral health care team change, is stated by Mabelya and Freeman (1985).

In South Africa a dentist to population ratio of 1:1928 has been calculated, of which by far the majority is white urban located practitioners (Wilding et al 1986). And practitioner opinion is that there is an excess of dentists in practice whereas there is an acute shortage of black dentists. They also suggest that manpower planning take place along ethnic lines. Whether this is their reflection of the current state viewpoint or a genuine wish to see a fairer proportional ethnic balance in dental manpower is unclear.

Some of the other problems affecting manpower and dental health care are listed as maldistribution of dentists, lack of equipment and materials, emigration of dentists and lack of dental awareness among the people (Ghandour et al 1986). Ibikunle (1985) describes the current scenario for dentists in developing countries as including excessive work load, high cost of dental services and the continued neglect of preventive dental care. He also expresses reservation about whether existing auxiliaries (especially hygienists) can cope with the worsening picture of dental disease in Africa.

Topic (1986) and Carranza (1986) write from the Yugoslavian and US experiences respectively, and both highlight the multidisciplinary approach required for periodontal therapy.

They feel that the major portion of periodontal care of the population belongs in the hands of the general practitioner, but that there will always be a need for specialists.

However, using professional personnel is a very expensive way of gaining a modest return in disease prevention. We know enough today, to bring about a dramatic reduction in both dental diseases but future preventive strategies will depend increasingly on government and public health measures.

Songpaisan (1985), writing from the perspective of the Thai experience, comes to the conclusion that the extent and severity of oral diseases and demands in developing populations, suggests the services needed are mostly basic restorative, rehabilitative and preventive. Such services can be delivered by dental auxiliaries and non-dental personnel.

The use of traditional health workers in national dental health services is one recommendation because they are more accessible and more economically and socially acceptable. The utilization of primary health care workers for screening of oral malignancies has already been shown to be feasible. Such workers would enhance dental manpower and help to improve oral hygiene and dietary practice in rural communities (Warnakulasuriya 1983). Mosha and Normark (1984) in Tanzania, consider children from birth to 15 years to be a priority group and they are accessible in primary schools, and via maternal and child health clinics. Given that an acute manpower shortage exists, it is recommended that school teachers and MCH-aides (Maternal and Child Health-Aides) be involved in the establishment of oral health care programmes.

Jeboda (1984) supports the advantages of utilizing dental auxiliaries in Botswana. Eriksen and Condon (1983) propose an appropriate curriculum for dental therapists in Botswana and state that a decent salary is a prerequisite for job satisfaction and stable manpower. Also that their self-esteem must be based upon real qualifications and not lead to feelings of frustration at being a "semi-dentist". Utilisiing a slightly different source of dental manpower, Ghandour et al (1986) describe the successful training of nurses to provide dental health care in the Sudan.

THE PRIMARY HEALTH CARE APPROACH

The proposal that dentistry be integrated into general public health policy through the PHC approach is especially crucial in developing countries (Franklin 1985, Songpaisan 1985, Hendricks 1988).

The primary health care approach includes five principles that make up the philosophy of this approach; equitable distribution of services, preventive orientation, appropriate technology, community involvement and a multisectorial approach (Mabelya and Freeman 1985). The concept of equal access to oral health services by all population groups, a key principal of PHC, is supported in the AAPHD Report (1984). A PHC approach should ensure treatment services for high risk groups such as the poor, elderly, insitutionalized, migrants, handicapped etc. and require a reasonable expenditure in relation to the resources available.

Dental care is currently provided in a form which is almost the complete antithesis of these five key principles of the PHC approach. Sheiham and Barmes (Sheiham 1984b, c, Sheiham and Barmes 1985) note that dental services are amongst the least equitably distributed of health services. They seem to have been planned to meet the needs of the providers and have been planned and developed without much in the way of community participation. Therapeutically the providers have focussed on treatment rather than prevention, even though caries and periodontal disease are amenable to prevention strategies.

Although use of community fluoridation and sealants to prevent caries indicates an appropriate use of technology, many of the commonly used periodontal treatments are now considered to be either ineffective or damaging and this needs to be revised.

Lastly, the elimination of dental caries is dependent on a multisectoral approach to oral health care involving the agricultural, food manufacturing, advertising, health education and health care sectors (Sheiham 1984b, c).

Sheiham (1988) also states that one of the most basic principles of primary dental health care should be coverage, and a strategy for levels of referral. He comments that precisely because dental care deals with extremely high prevalence diseases which has high costs in terms of pain, suffering, discomfort and treatment delivery, it is a really worthwhile case for a change in policy toward PHC.

Jeboda and Eriksen (1988) offer a simple PHC structure for Primary Oral Health Care defining three main levels of activity. They motivate strongly for the adoption of this approach, illustrating its appropriateness in the dental field and encouraging the community and professionals to recognise the role they have in its implementation.

Leatherman (1979) emphasises the important point that PHC (including dental health) cannot be developed without the support of national resources. And Dissanayake (1985) raises a number of problems associated with the lack of political will to pursue the introduction of PHC in the dental arena. The restructuring of oral health worker selection and training, use of appropriate levels of auxiliary heath workers, emphasis on PHC, management skills and team work are among the issues that also require urgent attention. In addition to these points, Hollist (1985) recognises the need for more active research in the dental field and also the importance of ensuring that in developing countries, the directorate of dentistry is led and controlled by dentally qualified personnel.

Avery (1976) comments at the end of a study on poor migrant and seasonal farm workers, that the elimination of pain and infection is dependent on the cycle of poverty experienced by these people being broken. Pasquale (1986) underlines the fact that development of health care is inseparable from economic development. But dentistry is not mentioned in the ten first causes of mortality and therefore is not recognised as a priority. The high prevalence of dental disease in the population should give it some priority. However financial

6 MATERIALS AND METHODS

6.1 THE SAMPLE

The sample comprised of dentate adults attending the Empilisweni SACLA Clinic in Crossroads. The rationale for using a sample self-selected in this way i.e. clinic-attenders, is twofold. The first reason relates to access to adults in the community at household level which was extremely difficult. Employed individuals only return home late in the afternoon or early evening and in addition, fluctuating levels of violent conflict and peace (See Appendix 12.1) made data collection at this level both difficult and risky.

The second reason is based on the fact that the Empilisweni SACLA Clinic in Crossroads was the only medical service in this community and other surveys (Olver 1983, Toms 1983) have shown that by far the majority of Crossroads residents attend this clinic. Clinic records reached 70 000 in 1985 when the population estimate for the area was just reaching 80-90 000. There seemed to be support for the assertion that if one was to plan services for dentate adults in this community, then the target group should most certainly include those already expressing a felt need for dental care by attending the clinic. For this reason the sample might be considered representative of adults in this community who demand dental care.

The original intention in this study, was to follow this first sample with a cluster sample from 5-6 different geographical areas within the community but this had to be abandoned as did

the collection of any further clinical data when the violence and turmoil of South Africa's struggle for liberation erupted once more upon this community.

STRATIFICATION

The age and sex stratification of the sample was designed to reflect the same proportions existent in the general population from which they came (See FIGURE 6.1.1). The relevant figures for this estimation were drawn from the 1985 census. This was compared with the age and sex profile of clinic-attenders over an adjacent two-week period. The very similar proportions for population, sample and clinic-attenders is evident in the table and graphical illustration.

The sample was stratified using the age cohort groupings recommended by WHO (1977). These were: 15-19, 20-24, 25-29, 30-34, 35-44, 45-54, 55-64, 65+ years of age. Equal numbers of male and female subjects were included in each age group (See TABLE 6.1.1).

The sample reflects the same demographic characteristics as the broader Cape Town Xhosa adult community and perhaps on this basis, and subject to certain reservations, it may be considered to offer a reasonable approximation of this community's oral health status.

SAMPLE & POPULATION SIZE BY AGE

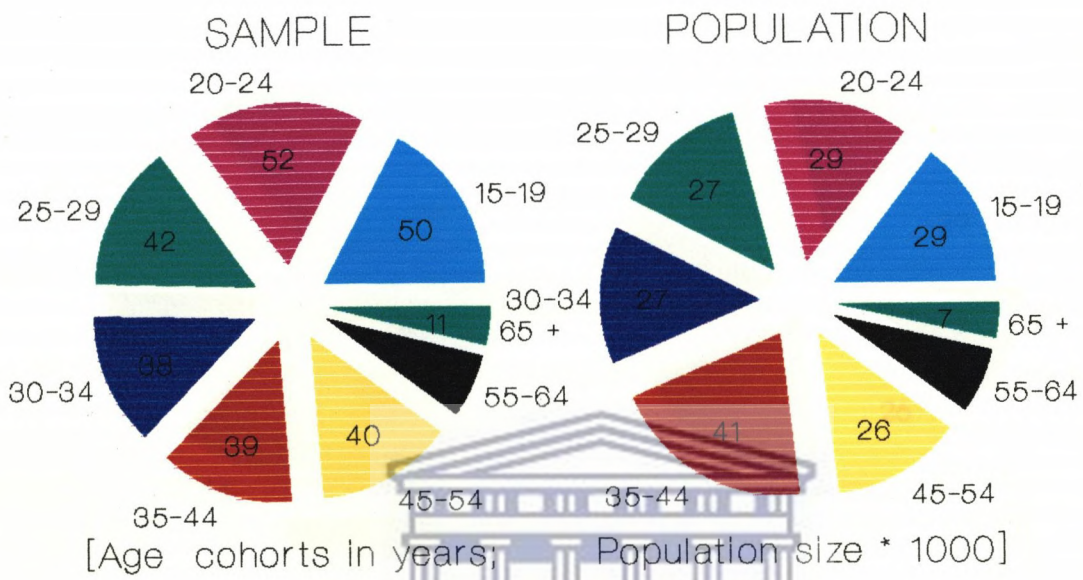


FIGURE 6.1.1

SOURCE: 1985 CENSUS

SAMPLE SIZE BY AGE AND SEX

AGE -	(MEAN) -	MALE -	FEMALE -	TOTAL
15-19	(17.2)	25	25	50
20-24	(21.7)	27	25	52
25-29	(26.8)	19	23	42
30-34	(32.2)	20	18	38
35-44	(39.2)	20	19	39
45-54	(48.2)	20	20	40
55-64	(58.9)	10	8	18
65 ++	(70.2)	6	5	11
ALL	(42.5)	147	143	290

TABLE 6.1.1

SIZE

A sample size (n) to estimate a population mean DMFT, was calculated, accepting an error (d) of 0.5 DMFT at the 95% confidence level, and a likely standard deviation (σ) of 5, to yield the following sample size:

$$n = 4\sigma^2 / d^2$$
$$= 4 * 5^2 / 0.5^2$$
$$= 200$$

Periodontal disease prevalence is measured as a proportion. The prevalence of less severe levels of disease is observed to be very high so this calculation is based on an estimate that will be important to detect, that of the prevalence of moderate pocketing. The sample size (n) required was calculated using an estimate of 25% prevalence (p), selected from values recorded in the literature, and error (d) of 5%.

$$n = 4p (1 - p) / d^2$$
$$= 4 * 0.25 (1 - 0.25) / 0.05^2$$
$$= 300$$

This coincides closely with Cutress et al (1987) who suggest that a sample of 200-250 and covering 6-9 sampling units, is adequate for planning purposes. A sample of 300 was therefore anticipated and the age stratification planned as mentioned above, noting the recommendation of Infirri and Barmes (1979), and Cutress et al 1987) that the minimum number of subjects to be examined in each age group at any one location should be approximately 20.

Unfortunately, only 290 subjects were examined by the time the data collection came to an end. The 65+ age cohort eventually comprised a total of 10, male and female subjects instead of 20, with 10 of each sex.

SELECTION CRITERIA

In summary, the inclusion criteria consisted of:

1 The subjects were Xhosa speaking.
2 The subjects attended the SACLA Dental Clinic.
3 They were male or female aged 15 years and over.
4 They were willing to be examined prior to receiving other treatment at the clinic.
5 The subjects were dentate with at least two teeth present in their dentition

There were no specific exclusion criteria and when age/sex cohort quotas were filled, using a randomised allocation process, no further subjects were taken into the sample. The sample was drawn at all times throughout the day, on every working day of the week for the one month duration of the study which was from 7/5/85 to 10/6/85.

A sub-sample of just over 10% (n = 31) was randomly selected (by other clinical staff) to undergo duplicate examinations. This is dealt with in the section on Examiner Variability.

What emerges on analysis of the demographic data, is that a fair portion of the sample actually came from the Guguletu, Nyanga and New Crossroads areas (See FIGURE 8.1.6 and TABLE

8.1.8). I suggest that this sample therefore does in fact reasonably approximate the oral health status of the wider Cape Town Xhosa population.

6.2 MEASUREMENT OF DISEASE

The Community Periodontal Index of Treatment Need (CPITN) was selected for use. The procedure followed was described by Ainamo (1982, 1984) and reviewed more recently by Cutress et al (1987).

Use is made of the ball-ended Morita probe to record presence or absence of gingival bleeding, subgingival calculus and pocket depths. The probe has a 2 mm coloured band located 3.5 to 5.5 mm from the tip to facilitate detection of pocket depths. The 0.5 mm diameter ball-tip facilitates detection of calculus. An attempt was made to consistently apply a probing force of 20-25 gm, as suggested by Ainamo (1982, 1984) and others.

The mouth is divided into sextants and ten index teeth in these sextants are examined and given a score based on the severest criterion observed.

The teeth examined were:

17,16	11	26,27
47,46	31	36,37

A third molar was only recorded if it effectively replaced the second molar in the sextant. Sextants with fewer than 2 teeth not indicated for extraction, were excluded. Extraction for periodontal reasons will be considered necessary if vertical mobility and discomfort to the patient are present. If only

one tooth remained in a sextant, it was included with the recording of the adjacent sextant in the same arch. If none of the index teeth were present in the sextant, then all the remaining teeth in that sextant were examined. Where the centrals 11 and 31 are missing, adjacent centrals 21 and 41 were recorded.

Each sextant was given one of the following scores:

0 Healthy gingiva with no bleeding on probing
1 Bleeding on probing
2 Subgingival calculus present +/- bleeding
3 Pocket depth between 3.5 and 4.5 mm
4 Pocket depth greater than 4.5 mm
X Sextant excluded; less than 2 teeth present

The detection within each sextant followed a sequence from the bottom to the top of this list. After completion of probing etc. a delay of 20-30 seconds before allowing the patient to swallow, enabled the presence or absence of bleeding in the last sextants to be detected.

Code 2 in this study represents only the presence or absence of calculus since almost no restorations were in evidence and certainly no overhangs to contribute to this code.

The prevalence of treatment need was calculated for the sample on the basis of an assumed relationship between the codes listed above and four major treatment categories.

The four treatment need categories are:

TN 0 No treatment needed (Code 0)

TN 1 Improvement in personal oral hygiene (Code 1)

TN 2 TN1 + scaling/root planing (Codes 2 and 3)

TN 3 TN1 + TN2 + complex treatment (Code 4)

Ainamo (1982, 1984) and Cutress et al (1987) note that in addition to a potential 20% underestimation of deep pockets in adults, care must taken to avoid overestimating Code 4 in under-20 year-olds by misdiagnosis of false pockets.

MEASUREMENT OF DENTAL CARIES

The examination was performed with new and identical probes throughout and use of the clinical criteria for detecting caries outlined by WHO (1977, 1979) were used. All examinations were performed with illumination provided by a tungsten filament dental light throughout, as recommended by WHO (1977) and discussed by Cheung and Holt (1986).

According to Palmer et al (1984), the proportion of caries free subjects and mean DMF indices should be presented with corresponding confidence intervals for the true caries prevalence of the district. This was a dentate sample of adults seeking dental care, so the likelihood of any subjects being caries-free was remote.

The DMF(T) was used in one of its modified forms for this study, with scoring as follows:

0 Sound no decay or treatment need

1 Decayed in need of restoration

2 Decayed in need of extraction

3 Filled decay also present

4 Filled sound / no decay

5 Missing due to caries

The D component was diagnosed on the basis of cavitation being present, assessed primarily by visual examination. The probe was only used to confirm dubious lesions or as a diagnostic aid on posterior approximal sites. No attempt to detect "sticky fissures" was made.

Discrimination between the need for extraction versus need for restoration was based on the probability of endodontic treatment being necessary and the degree of sophistication that the restoration would have to take e.g. no crowns could be offered.

The M component recorded teeth missing due to caries, however, discrimination between this and loss due to periodontal or other reasons was not possible in this study.

The F component was only described in the crude terms listed above. No attempt to describe the restoration was to be made, a task considered unnecessary in this study due to the very low probability of exposure to restorative treatment.

The aim in collecting this data was to have an assessment of the prevalence of sound teeth and dental caries in this population and gain some insight into the rate of tooth loss; the latter in relation to both periodontal disease and decay within each age cohort.

6.3 CLINICAL PROCEDURE

Subjects attending the SACLA Clinic were asked if they would mind being examined. If they consented, their demographic details were established in Xhosa and recorded by the examiner on the data sheet (See appendix). This data included name, age, sex, home address, length of time lived in Cape Town, date, registration and examination numbers.

The subject was then examined clinically and the DMFT and CPITN indices recorded by the examiner.

A chairside assistant facilitated the random recall of a 10% subsample for re-examination to establish intra and extra-examiner variability.

Intra- and extra-oral photographs were taken at regular intervals when conditions of special interest were observed and simply at whim to collect a fairly representative set of illustrations of subjects examined and oral conditions present. These additional notes were also recorded on the data sheet.

Finally, much appreciation was expressed to the subjects for their co-operation and any treatment they requested was provided by the rest of the clinical team working in the dental clinic or by referral where necessary.

NOTE: No additional consent was obtained from the Committee for research on Human Subjects for this study. It was felt the survey examination could legitimately be considered as merely a more thorough pre-treatment oral examination.

6.4 RECORDING AND ANALYSIS OF DATA

The data for each patient was written onto a single A4 size sheet as illustrated in Appendix 12.2. A daily record was kept of every subject record completed, duplicate examination performed and by whom, photographs taken. Index numbers were listed for each subject examined and according to age cohorts to ensure that balanced numbers were eventually seen for each age and sex grouping.

Also on a daily basis, the data was checked for recording discrepancies or omissions and the sub totals for DMFT and CPITN calculation entered.

Data files were set up using the AS system via a UWC Dental Faculty computer terminal linked to the IBM mainframe in Cape Town. Printouts of every subject's record were obtained and checked against the original data sheets, after data input had taken place. Corrections were made where necessary. Data processing took place when the appropriate programmes had been written and a printout of the results obtained for examination.

The use of a micro computer for immediate data collation and analysis is suggested by Pieper et al (1981). In this study such facility only became available later when summary data was entered and manipulated using a PC to achieve a more presentable format for the data and to draw preliminary graphs with the Framework II software programme.

The examiner-variability data, also recorded in the daily record book, was initially monitored with a pocket calculator, independently of the larger data processing operation. Subsequently this was investigated in detail, as described in a previous section.

DEMOGRAPHIC SECTION OF DATASHEET

The patients' area of residence and length of stay in the city was recorded in order to test for a correlation between these two factors with DMFT values. This possibility was rejected on the basis of a student t-test and a Spearman rank correlation for every age cohort and the group as a whole.

CALCULATIONS USING THE CPITN DATA

The sextant scores were recorded in six boxes on the data sheet. Four main tables were prepared giving the following information:

TABLE 8.2.1 - Percentage of subjects, distributed according to each stage of disease.

TABLES 8.2.2-4 - Mean number of sextants affected per person, for each stage of the disease.

TABLE 8.2.7 - Treatment needs expressed as a percentage of subjects distributed according to the type of treatment required, where TN1 = oral hygiene instruction; TN2 = prophylaxis; TN3 = complex treatment (may include extraction)

For the second and third levels of need, the mean number of sextants requiring treatment appears in brackets.

TABLE 8.2.6 - the frequency distribution of treatment need by number of affected sextants, for each age cohort.

For further details see Appendix 12.5.

CALCULATION OF PERIODONTAL TREATMENT TIMES

Gjermo et al (1983) and Srivastava et al (1985) describe a method for converting the clinically determined treatment need into quantitated time units for the sample.

Gjermo et al tabulate the relationship as follows:

Criteria	CPITN Need Treatment	type	Time Unit/Sext.
Healthy	Code 0 TN0	None	TU 0
Gingivitis	Code 1 TN1	OHE	TU 1
Calculus	Code 2 TN2	OHE + SC	TU 3 (1+2)
Pocket ≤ 5mm	Code 3 TN2	OHE + SC	TU 3 (1+2)
Pocket < 5mm	Code 4 TN3	OHE + SC + C	TU 7 (1+2+4)

OHE - Oral hygiene education; SC - Scaling and root planing; C - Complex treatment.

Gjermo et al (1983) consider that the needs for treatment of the complex kind may conveniently be combined with the TN2 category in a young population. They reason that this form of treatment is rarely needed in such a group and when it does

exist, involves very few relatively shallow pockets. The manpower implications are significant, since the use of auxiliary personnel is possible for all except the TN3 category of treatment, and an exponential increase in costs will be experienced when it has to be provided.

The findings of Takahashi et al (1989) support the focussing of TN2 (scaling) on the group with moderate pockets, since these have the greatest potential for remission. However they also found some success in the ability of this type of treatment to improve the situation of some pockets deeper than 5mm.

The data from this study will be separately calculated to reveal the time unit required for each need separately.

The method for calculation of Time Unit information is contained in Appendix 12.7.

CALCULATIONS USING THE DMFT DATA

Numbers of sound, decayed (D1 and D2), filled or missing teeth were summated individually and together to obtain totals and mean values. First this was mapped out by tooth-type and then by age cohort, and sex using various combinations of individual or subtotalled values eg. male, female, total for both sexes.

7 EXAMINER VARIABILITY

7.1 CHOICE OF METHODOLOGY

Inter and intra-examiner consistency in standardized diagnosis of dental conditions in oral health surveys is important (Marthaler 1963). The value of a reliable methodology for assessing this repeatability, both between different examiners and by the same examiner is apparent. The goal is to reduce the between and within examiner variability as much as possible so that it will have little effect on inferences about treatment needs etc. It has nothing to do with the validity of an index although certain characteristics of the indices either promoting or inhibiting reproducibility may be highlighted (Clemmer and Barbano 1974). Variability between repeat ratings has important effects on the precision and power of the statistical treatment of the survey data and on any attempt to generalise it to a wider population (Heifitz et al 1985).

Until recently the majority of published oral health survey reports offered "percentage agreement" between examinations as their measure of repeatability. These measures are potentially misleading as they do not take into account the agreement that can be expected purely on the basis of chance. (Hunt 1986, Fleiss 1981, Fleiss and Chilton 1983).

Clemmer and Barbano (1974) note that measures such as the paired t-test, analysis of variance and correlation coefficient can all measure the alikeness of a summary score (e.g. a mean of observations over a number of sites) of an

individual however, since the indices in use are mostly ordinal measures, these and other parametric statistical methods should not be used. Where repeated measurement of average values does occur, a continuous scale may be approached and the normal assumptions may be satisfied adequately enough to use these measures. They therefore also recommend the use of a proportion-of-agreement method that takes account of agreement reached on the basis of chance alone.

Hunt notes that Pearson's correlation coefficient used by some, measures only the associations between sets of ratings and does not take into account any systematic biases in ratings. It is only in studies where prevalence of the observed criteria is low that percentage agreement is more meaningful. Barbano and Clemmer (1974) support the use of a dichotomous index and since the indices to be used in this study share this characteristic, the Kappa statistic is recommended as it is able to quantify agreement beyond chance for dichotomous judgements.

Fleiss and Chilton (1983) also describe the use of Kappa for dichotomous judgements such as presence or absence of disease. Hunt notes in addition that when the study focuses on site-specific differences such as comparing tooth type or caries increments on the same tooth over time, Kappa is the preferred statistic.

What also emerges from these authors, however, is that standards for acceptable reliability on dental measures have not yet been developed. Some have suggested a rule of thumb

assessment which considers Kappa in the range 0 - .40 to represent poor agreement; 0.40 - 0.70 to represent fair to good agreement; and greater than 0.75 to represent excellent agreement. In reality, clinical medicine appears to generate values around 0.35 while dental caries studies have managed to generate values around 0.80.

Another common flaw in oral health survey reports, arises from the fact that repeatability is tested on a small proportion of the study sample, so the small test sub-sample is expanded by utilising separate observation recorded on each tooth. For example where a sample of 300 subjects is examined with 10% duplicate examination, a test sample of 30 subjects is available. Taking 32 teeth as separate sample units enlarges this test sub-sample to 960 which offers attractive levels of statistical power to the researcher.

This seems to give rise to error at a number of different levels. The first is empirical, in that the teeth in one subject are all exposed to the same aetiological environment and measurements taken from each tooth are in effect multiple observations on the same aetiological unit of disease/health (the oral environment of that one subject).

Secondly, the effect on an examiner measuring caries on a tooth in this environment, can be subjectively influenced by the overall impression of the health status of that environment. That is, one is more likely to register the presence of caries on lesser effected teeth when large numbers

of teeth in that mouth are obviously carious and oral hygiene is poor, than in a mouth where one's impression is of an altogether "tidier" state of affairs.

A final objection is that the effect of tooth type on diagnostic repeatability is "smoothed over" by their inclusion as individual units in the test. Any variability observed might in part derive from the fact that certain teeth are easier to diagnose or inherently more often associated with an "easy to diagnose" category. This means they will contribute a larger proportion of the total agreement that can mask the agreement attained on diagnoses which are more difficult. An example of this is the effect of missing teeth on a composite measure of agreement. It is clearly easier to note a tooth's presence or absence than whether it has minor or major caries.

Where the CPITN (or other invasive periodontal disease measurement) is used, there are some additional conceptual problems. Where bleeding has been noted on initial examination, the likelihood of detecting bleeding on the second observation, is clearly increased. Janssen et al (1988a) in assessing the effect of repeat probing depth measurements, observed that probing depths, even though they were conducted 100 minutes apart, showed a trend to deeper recordings. It was also found (Janssen et al 1988b) that probing depth had the largest effect on the reproducibility of probing measurements. Of the variable bleeding tendency observed it was noted that this was not caused by biological changes but was merely the result of inaccuracy of the

bleeding tendency measurement. The need to approach repeated periodontal measurements with circumspection, is therefore encouraged.

Hartshorne et al (1987) discuss some of the implications of using the Kappa statistic to assess repeatability in the use of CPITN measurements. Their sample is even smaller (n=21) than in this study and although many of the necessary statistical concepts applied are sound, the concept discussed in this study seem to have been overlooked. The study is subject to limitations of sample size and excessive examinations on a few subjects but it does achieve good Kappa intra-rater values of .61 to .83 and concludes that this statistic is a more meaningful method for assessing agreement on CPITN measurements than the percentage method.

The proposal that repeatability in oral health surveys should be assessed using Cohen's Kappa statistic, is endorsed by the results in this study. And the use of individual subjects as the sampling unit for application of such tests is strongly recommended. A tooth by tooth comparison to identify where critical areas of agreement/disagreement lie, is suggested as crucial. Finally, although caries diagnosis appears to render a high degree of repeatability in this study, the ability to reproduce periodontal disease measurements is very poor in most categories and reflects a need for better diagnostic criteria.

In this study, repeat examinations were performed on a randomly selected ten percent of the sample (31 subjects). Intra-examiner agreement was analysed using both the Kappa

statistic and the percentage agreement method. Inter-examiner agreement was analysed using the percentage method. The results are discussed below and in Appendix 12.3.

7.2 RESULTS: INTRA-EXAMINER AGREEMENT (KAPPA)

PERCENTAGE VERSUS KAPPA

The customary "percentage agreement" method, calculates the total number of agreements as a proportion of the grand total of all diagnoses made. The mean proportion of agreement (PT) on tooth diagnosis is 95.4% for this sample. The average Kappa value of 87.7% is significantly different at the 95% confidence level.

Confidence intervals were constructed around tooth-specific PT values. 60% actually lie within the 95% confidence interval defined around Ka, the remaining 40% being significantly different.

A more specific assessment of significant overlap between PT and Ka is attained when individual teeth are compared with each other rather than using mean PT or Ka values. For caries, 78% of the agreements fall within the 95% confidence intervals for both PT and Kappa statistics but in 22% of the teeth, there is a significant difference in agreement between the two statistics. Further, the "percentage agreement" method consistently measures agreement higher than the Kappa statistic in 22% of cases. The suggestion is that this mostly occurs in relation to premolars.

The periodontal data reveal a similar pattern when the sextant by sextant comparison is made (analogous to the tooth-specific comparison above), one finds an even bigger difference in agreement. The Ka 95% confidence interval for 80% of the

sextants, lies outside the PT described confidence interval. In this distribution the overlap between the two statistics is only 17%.

Caries has four diagnostic categories and the CPITN has five so the potential for chance to contribute to the measurements is considerable. The use of Kappa instead of percentage agreement is therefore important. The overstatement of agreement by the latter is illustrated by the proportion of teeth attaining a Kappa repeatability value significantly lower than that calculated by the percent method.

TOOTH VERSUS SUBJECT

There are conceptual problems with the tooth as a unit of sample rather than the subject. The proportion of agreement calculated on the basis of a sample mean PT value was seen to differ significantly for 40% of the teeth in relation to Ka confidence intervals. When individual teeth are compared directly, only 22% are found to lie outside the established confidence intervals. This supports an argument in favour of the more meaningful tooth-specific agreement testing.

For the caries data, only 41% of the teeth lie within the confidence interval predicted on the basis of a mean Ka value. This means that agreement cannot be predicted for 60% of the teeth on the basis of the sample mean. Again, the individual pattern of variation by tooth type seems to have a strong influence on agreement. Second and third molars can best be represented by a sample mean value but anterior teeth have the highest Ka values. Such an observation would be obscured if

data from all teeth were pooled in a single sample. This suggests that agreement testing should preferably focus upon the molars.

For the CPITN data, all sextants have Ka values within the 95% confidence interval defined around the mean Ka value. This occurs at a much lower Ka value (.682) than with caries data.

In conclusion, the assessments of agreement based upon confidence levels about either mean PT or mean Ka for the whole set of teeth, are unable to predict more than 40% of the proportion of teeth in agreement. Tooth type seems to have a role in this. The position is slightly better for periodontal data but the magnitude of agreement is much lower. It would seem that a tooth-specific analysis can overcome many of these limitations. An assessment of agreement based on Kappa testing of three tooth types, molars, premolars and incisors, perhaps even of index teeth, will be a more accurate method than the pooling of all tooth measurements into a single homogenous test sample.

DIAGNOSTIC CATEGORY

The data was reduced to a 4X4 table reflecting the presence or absence of diagnostic category by tooth type. Standard error values were calculated for each tooth by category and confidence intervals constructed. Individual tooth Kappa values were then compared with the sample mean Ka value.

The distribution of agreement predicted on the basis of confidence intervals around the tooth-specific Ka value and mean Ka value are listed in TABLE 7.2.1.

Without exception, the category-specific Kappa values locate the sample in or above the given confidence limits. For sound versus affected teeth (Ks); presence of any caries (Kp); and presence of minor caries (Kb), 60% of the teeth experience agreement within the confidence limits around the mean Ka value and about 40% above. For the categories "missing" (Km) and "major caries" (Kc), the Ka confidence interval only predicts the location of about 20%. The balance lie above these limits which means that these two categories have a significant impact on agreement.

This means that Kc and Km are significantly higher than Ka in 80% of the teeth. The implications are, that in a study population such as this where severe caries and loss of teeth is fairly prevalent, the examiner agreement will be large. Likewise, intra-examiner agreement will be less when these more severe and easily identifiable forms of disease are less prevalent, and it becomes necessary to more frequently determine differences between minor caries and sound teeth.

The use of a tooth-specific K value, means that teeth which are more likely to be missing, will lead to significantly higher levels of agreement than other tooth types when they are examined. In this study, second premolars and first molars are most difficult to agree on for each category.

INTRA-EXAMINER VARIABILITY (k)

CARIES: TOOTH Kα versus MEAN Kα

K	ABOVE	IN	BELOW	ABOVE	IN	BELOW
Ks	0.00	0.97	0.03	0.38	0.59	0.03
Kb	0.00	0.97	0.03	0.41	0.53	0.06
Kc	0.31	0.69	0.00	0.78	0.22	0.00
Kp	0.00	0.97	0.03	0.41	0.53	0.06
Km	0.38	0.63	0.00	0.81	0.19	0.00

PERIO:

Ks	0.83	0.00	0.17	0.67	0.00	0.33
Kb	0.00	1.00	0.00	0.50	0.33	0.17
Kc	0.50	0.33	0.17	0.00	1.00	0.00
Kp	0.38	0.63	0.00	0.17	0.50	0.33

TABLE 7.2.1

KEY TO EXAMINER VARIABILITY TABLE

CARIES DATA

Kα Mean kappa for sample as a whole
Ks Presence/absence of sound teeth
Kb Presence/absence of minor caries
Kc Presence/absence of major caries
Kp Presence/absence of any caries
Km Presence/absence of missing tooth

PERIO:

Ks Presence/absence of healthy sextant
Kb Presence/absence of calculus
Kc Presence/absence of pockets
Kp Presence/absence of deep pockets

TABLE 7.2.2

The CPITN data experiences greater variation in agreement than the caries data by diagnostic category. The K value for the presence or absence of pockets (Kc) is the only agreement able to be predicted on the basis of Ka. 50% of deep pockets (Kp) might be agreed upon based on Ka as an estimate. Agreement on the presence of calculus can be predicted poorly on the basis of Ka although agreement is generally high for this variable. The variation observed between different sextants is unpredictable, and probably has no biological basis. The sample is also too small to deal with in statistical terms.

Non-tooth-specific methods of agreement testing assume that every tooth (or sextant) offers an equal probability for agreement on any diagnostic category. The previous section illustrated that some teeth are more likely to have higher levels of agreement. There is a significant ability to agree on whether a tooth is missing and whether the subject has a healthy periodontal status.

The distribution of agreement predicted on the basis of confidence intervals around the tooth-specific Ka value and mean Ka value are listed in TABLE 7.2.1.

Although a mean Ka value with 95% confidence limits forms the baseline for comparison of Kappa statistics discussed in this section, use of tooth-specific values provides a more meaningful measure of agreement. The prediction is better in all areas of caries diagnostic agreement but agreement on sound tooth, any caries and minor caries diagnosis is clearly better predicted on the basis of the tooth-specific values.

This is an important consideration in favour of evaluating agreement in a tooth specific manner rather than on the basis of sample mean values or a pooled sample. Two of the categories identified above are of the difficult-to-diagnose type so it is useful to know that their measured degree of agreement can be predicted with such certainty.

COMMENT

In summary, DMFT agreement as measured by the mean Kappa statistic, was k = 0.87 and for the CPITN, k = 0.68 . Percentage agreement measured DMF(T) agreement at 96% and for the CPITN 84%. This compares favourably with figures reported by Davies and Barmes (1976). Caries detection values of 97-100% were recorded for the various categories and for periodontal disease, agreement of 75% was measured.

By either of these measures, the current study achieves an acceptable level of agreement. The Kappa analysis has also provided some insight into the limitations and advantages of various agreement assessment methods and should prompt further research into the subject with the use of a larger sample, a serious limitation for this analysis.

Note: The methodology is described in the Appendix 12.4.

7.3 RESULTS: INTER-EXAMINER AGREEMENT (PERCENTAGE)

In order to standardise the clinical examinations, the supervisor, and the author reviewed the diagnostic criteria described by WHO (1977) before conducting duplicate examinations on a small group of patients prior to the start of the study. During the course of the study, duplicate examinations were performed on a further ten subjects.

The percentage reproducibility method was applied to measurement of both CPITN and DMFT variables.

MEASUREMENT OF DENTAL CARIES - DMFT

1) 21 discrepancies occurred on the 320 teeth examined.
   This represents agreement on 93.4% of the data.

2) A closer look at the error breakdown;
   score 1 instead of 0 - 12 errors
   score 0 instead of 1 - 4 errors
   score 1 instead of 2 - 2 errors
   score 0 instead of 2 - 1 error
   score 2 instead of 5 - 1 error
   score 5 instead of 0 - 1 error

The greatest discrepancy occurred in decision making about minor decay (76%).

MEASUREMENT OF PERIODONTAL DISEASE - CPITN

1) Only 70% of the sextants examined had identical scoring by both examiners. (A total of 18 errors)

2) A closer look at the error breakdown;

score 3 instead of 2 - 7 errors

score 2 instead of 3 - 8 errors

score 3 instead of 4 - 1 error

score 1 instead of 2 - 1 error

score 0 instead of 1 - 1 error

The proportion of such errors should be seen in the light of a very much higher prevalence of scores 2 and 3 in the sample population seen later. Very small numbers of sextants scoring 0 and 4 were observed so estimation of error between these categories is not possible here.

4) Calculation of the impact of these errors on total CPITN scores reveals that the discrepancy is very small.

8 RESULTS

8.1 DENTAL CARIES

TOOTH DECAY AND AGE

Dental caries is cumulative by nature, with its prevalence and severity expected to increase with age if there is no intervention. This is suggested by the data in this study. Given the proviso that this is a cross-sectional rather than a longitudinal study, and cohorts are therefore compared as separate entities rather than groups with the same experiences over a continuum of time. Each cohort was subject to differing influences in the past, present and future and is therefore likely to experience different rates of disease progression or regression.

This study illustrates that the older age cohorts have slightly higher DMFT values than the younger cohorts, but the range is a small difference of 5.2, from 11.3 at ages 15-19 to 16.5 after age 65. TABLE 8.1.1 illustrates a much greater variation between cohorts in the female scores where a range of 7.5, from 12.3 to 19.8 for the same cohorts was recorded.

From the TABLE 8.1.1, it can be seen that the actual difference in DMFT between successive younger to older age groups is not great. Only after age 50+ is a somewhat larger DMFT observed, a fact that seems to be related especially to the large female DMFT values recorded. Data variability seems to be greater in the higher age cohorts,

with a Standard Deviation (SD) of 4.5 at 20-24 years and 7.9 after age 55. The greater prevalence of missing teeth may contribute to this variability. This is examined below.

A high DMFT was recorded in the 25-29 year age group (13 ± 6.8) and may be reason for real concern. It may indicate the onset of rapid caries destruction in this cohort. It is a DMFT level comparable to that experienced more commonly in the over-55 age cohort.

Upper and lower 95% confidence limits (CL) around the DMFT values for four selected age cohorts were constructed to give some indication of where significant statistical differences may exist. An assumption that a normal distribution existed was made initially and the values calculated are listed in TABLE 8.1.2.

This data suggests that only the 55-64 cohort DMFT may be significantly higher than that of any other cohort.

Because of the limitations of treating this quasi-categorical data in this manner, the Chi-square test for non-parametric data was applied to the frequency distribution of DMFT values by age. The total DMFT value was not found to have statistically significant differences between the various age cohorts (p not $<.05$).

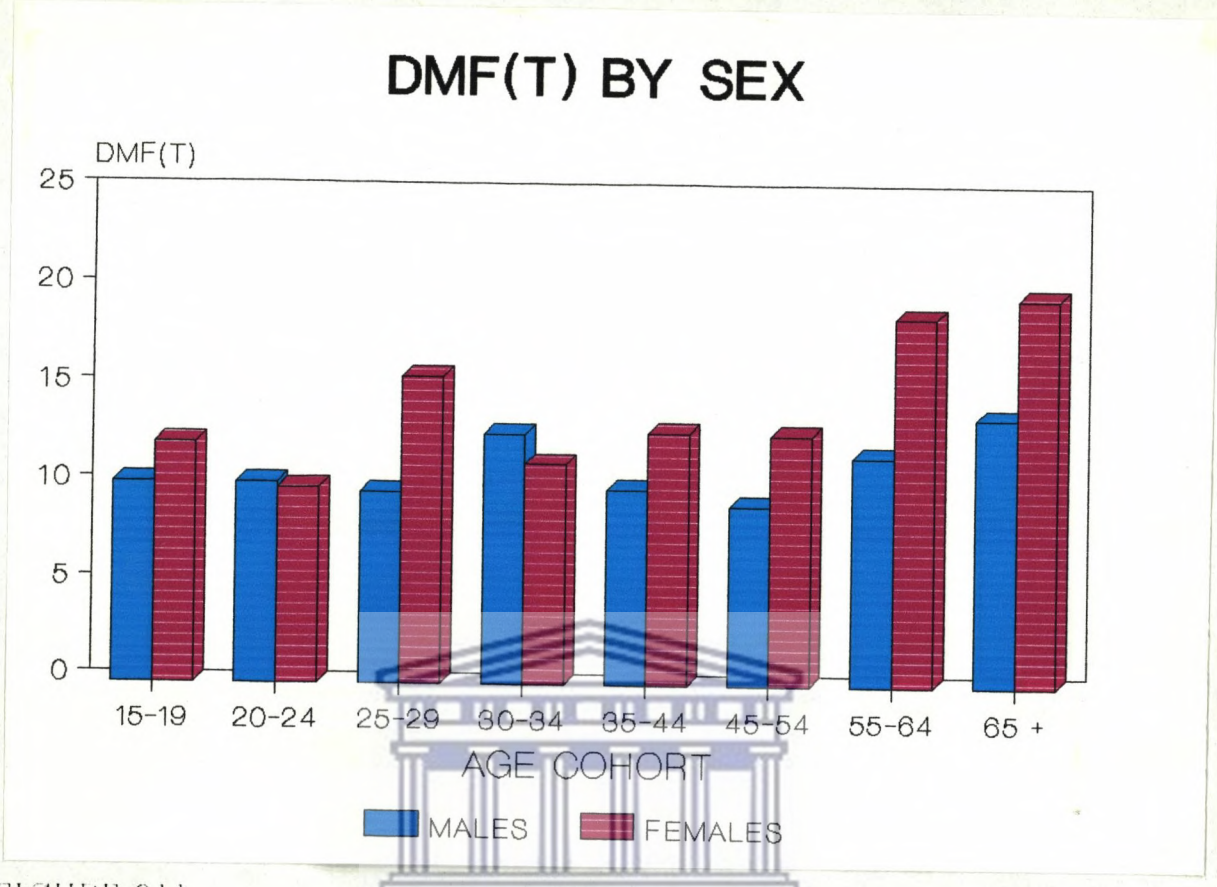


FIGURE 8.1.1

DMFT BY AGE AND SEX

AGE	MALE	FEMALE	BOTH	(SD)
15-19	10.3	12.3	11.3	(5.0)
20-24	10.3	10.0	10.1	(4.5)
25-29	9.8	15.7	13.0	(6.8)
30-34	12.8	11.3	12.1	(6.4)
35-44	10.0	12.9	11.8	(6.6)
45-54	9.2	12.8	11.0	(6.0)
55-64	11.7	18.8	14.8	(7.9)
65 ++	13.7	19.8	16.5	(6.7)
TOTAL	10.7	13.1	11.8	(6.2)

TABLE 8.1.1

INTRA-EXAMINER VARIABILITY (k)

CARIES: TOOTH Ka versus MEAN Ka

K	ABOVE	IN	BELOW	ABOVE	IN	BELOW
Ks	0.00	0.97	0.03	0.38	0.59	0.03
Kb	0.00	0.97	0.03	0.41	0.53	0.06
Kc	0.31	0.69	0.00	0.78	0.22	0.00
Kp	0.00	0.97	0.03	0.41	0.53	0.06
Km	0.38	0.63	0.00	0.81	0.19	0.00

PERIO:

Ks	0.83	0.00	0.17	0.67	0.00	0.33
Kb	0.00	1.00	0.00	0.50	0.33	0.17
Kc	0.50	0.33	0.17	0.00	1.00	0.00
Kp	0.38	0.63	0.00	0.17	0.50	0.33

TABLE 7.2.1

KEY TO EXAMINER VARIABILITY TABLE

CARIES DATA

Ka Mean kappa for sample as a whole
Ks Presence/absence of sound teeth
Kb Presence/absence of minor caries
Kc Presence/absence of major caries
Kp Presence/absence of any caries
Km Presence/absence of missing tooth

PERIO:

Ks Presence/absence of healthy sextant
Kb Presence/absence of calculus
Kc Presence/absence of pockets
Kp Presence/absence of deep pockets

TABLE 7.2.2

TOOTH DECAY BY AGE AND SEX

In TABLE 8.1.1 one can observe that in most instances the female groups have higher DMFT values (by 2-3) than the male groups. Differences are greatest in the 25-29 age cohort and in both groups older than 55 years when the males have been significantly outstripped by the amount of decay and tooth loss experienced by their female counterparts. This is very noticeable in the 65+ group where the female DMFT is 19.8 and that of the males 13.7

In the same way that total DMFT values by cohort were compared using an assumption of normality and 95% confidence limits, DMFT values by sex were compared (TABLE 8.1.2). The frequency distribution upon which FIGURE 8.1.1 is based, suggests that the differences are largest in the 25-29 and the 55-64 year age cohorts so these were selected for testing below. The over-65 group was deliberately left out of this assessment because of its small sample size (n=11).

This data suggests that although the mean Male DMFT values are located outside the lower female 95% confidence limits, and are therefore significantly different to the female values, the great variability in the male data has led to the construction of very wide and overlapping confidence intervals.

The Chi-square test was applied to the appropriate frequency distribution, with the DMFT categorised into intervals 0-6, 7-12, 13-18, 19+ (WHO in Infirri 1984, Appendix 12.10) for the

sample. It was established that a statistically significant difference between male and female DMFT values does exist for the sample at a level where p = 0.03 (df=3).

From FIGURE 8.1.2, it seemed likely that the Missing teeth component (M) could be largely responsible for this difference, so both the D and M components were compared across the sexes in the same way.

Even by the method used in TABLE 8.1.3, a significant difference is strongly suggested in the 25-29 year age group. And when the contingency table was collapsed around M≤10 and M>10 for the Chi-square test, the females were found to have a statistically significant increase in M values over the males at a level of p = .02 (df=1) across the sample as a whole.

COMPONENTS OF THE DMFT

The mean numbers of Sound (SND), Decay-needing-conservation (DC), Decay-needing-extraction (DX), and Missing (MS) teeth for each cohort were calculated and the composite picture is presented in TABLE 8.1.4 and in FIGURE 8.1.2.

COMPONENTS OF THE DMFT - FILLED TEETH

The prevalence of filled teeth was a low 0.4%, compared to those decayed 21%, missing 11% and sound 68%. For all the decayed teeth present in the sample as a whole, about half require extraction and the other half need fillings. The treatment implications of this finding are profound if a restorative strategy is contemplated.

DMF(T) SUBCOMPONENTS BY AGE

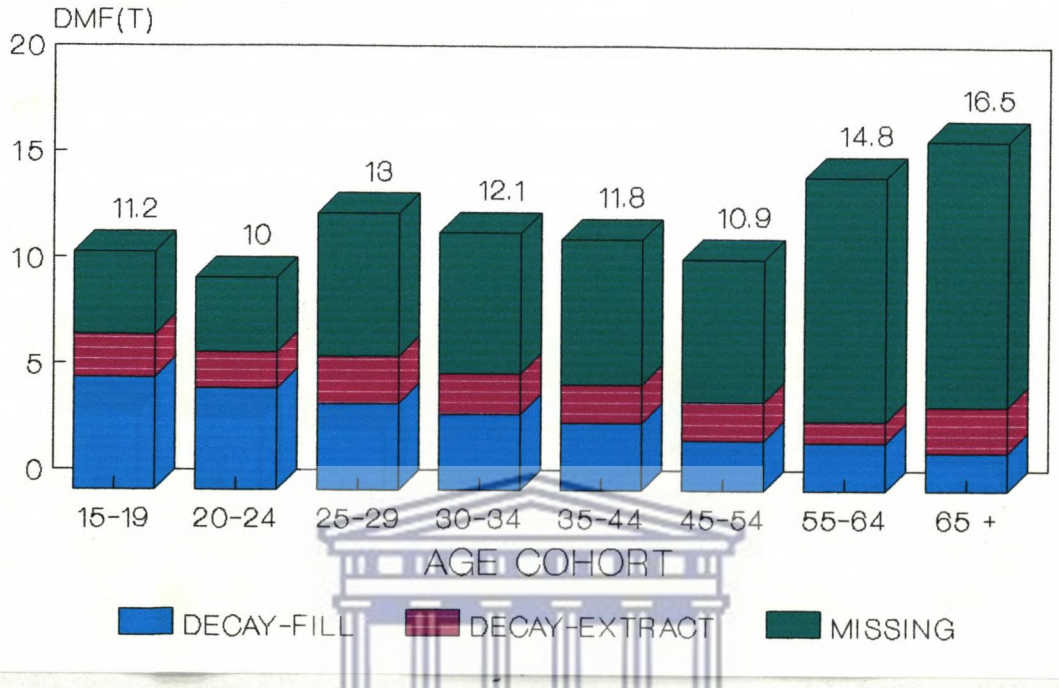


FIGURE 8.1.2

DECAY-FILL = TOOTH NEEDS RESTORATION
DECAY-EXTRACT = TOOTH NEEDS EXTRACTION

DMFT COMPONENTS BY AGE

AGE	SND	DC	DX	MS	DMF
15-19	20.7	5.3	2.0	3.9	11.3
20-24	21.9	4.8	1.7	3.5	10.1
25-29	19.0	4.1	2.2	6.7	13.0
30-34	19.9	3.6	1.9	6.6	12.1
35-44	20.2	3.2	1.8	6.8	11.8
45-54	21.0	2.4	1.8	6.7	11.0
55-64	17.2	2.3	1.0	11.5	14.8
65 ++	15.5	1.8	2.2	12.5	16.5
TOTAL	20.1	3.8	1.9	6.2	11.8

TABLE 8.1.4

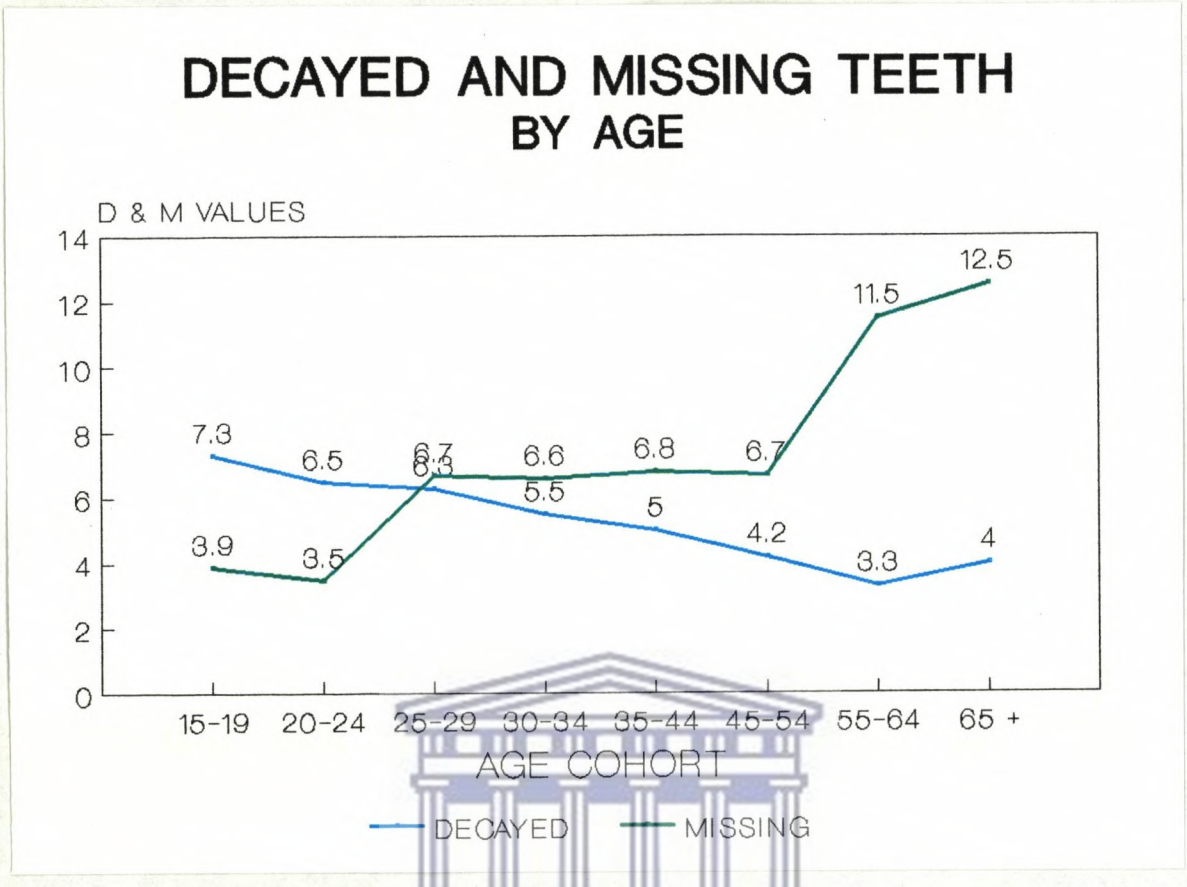


FIGURE 8.1.3

M CONFIDENCE LIMITS BY AGE

AGE -	MEAN M -	CL+ -	CL-
15-19	3.92	4.82	3.02
20-24	3.52	4.57	2.47
25-29	6.69	8.66	4.72
30-34	6.55	8.37	4.74
35-44	6.82	8.93	4.71
45-54	6.70	8.28	5.12
55-64	11.50	15.50	7.50
65 ++	4.83	17.28	7.63

TABLE 8.1.5

For the purposes of simpler graphic display and discussion, this component is omitted from analysis from here on since the prevalence was so very low. Overall the number of teeth present that were scored either 3 or 4 (Filled-decayed and Filled-sound), led to a prevalence of only 0.059% for the former and 0.359% for the latter. This compares with the prevalence of other components as follows: Decay-extract teeth 5.41%, Missing teeth 10.99% and Sound teeth 68.33%.

COMPONENTS OF THE DMFT - DECAY

Other than the M values compared above, there seem to be no other real differences in the sex-prevalence of DMF components. Although, in the 65+ age cohort a larger amount of decay was observed in females compared with males but this is subject to the previously expressed reservation about sample size (n = 11).

For the sample as a whole, the portion of the decayed component that requires extraction is close to half of the portion in need of restorative treatment. There is also a lower prevalence of the later in older age cohorts, a fact which may be related to the corresponding decrease in the number of teeth still present and exposed to the risk of caries. FIGURE 8.1.3 illustrates this trend.

Utilising the same methodology mentioned above, the Chi-square statistic reveals a significant difference in D values by age cohort both in the four column and collapsed two column frequency table. The table was again collapsed around the values of D≤10 and D>10. In this instance p values of .0002

(df=3), and .0495 (df=1) were obtained respectively, indicating that the number of decayed teeth is significantly lower in the older age cohorts of this sample.

COMPONENTS OF THE DMFT - MISSING TEETH

Tooth mortality can be employed as a crude indicator of the dental status of the community. Tooth loss can result from untreated dental caries and periodontal disease or it might be an iatrogenic problem. It is assumed for the purposes of this study, that most if not all missing teeth may be attributed to loss due to caries, but that in any case, the M value represents teeth missing for whatever reason, not only caries.

In this sample the numbers of Missing teeth (M), dominate the DMFT in every cohort (See TABLE 8.1.4 and FIGURE 8.1.2). It has been illustrated above that M is significantly different between the sexes.

The same analysis, illustrates a difference in M values between the age cohorts. The trend illustrated in FIGURE 8.1.3 is tested below.

This data suggests a significant difference between the mean M values of the 15-24 age cohorts and that of all cohorts over the age of 45. It also suggests a fairly significant difference in M between under-55 and over-55 age cohorts.

Results of the Chi-square test established that there is in fact a significantly larger M value in older age cohorts both when the test is done across four columns and for the collapsed table (M≤10 and M>10), giving p values of .00001 (df=3) and .003 (df=1) respectively.

This poses important questions about the association between tooth loss and the extractionist-dentist population.

TOOTH DECAY BY TOOTH TYPE

TABLE 8.1.6 describes the distribution of mean DMFT values, the mean numbers of Sound (SND), Decay-needing-conservation (DC), Decay-needing-extraction (DX), and Missing (MS) teeth by tooth type. The same data is graphically depicted in FIGURES 8.1.4 and 8.1.5.

Upper and lower molars are most often decayed (19-40%). First molars decay less frequently (19-26%) than second and third molars (30-40%). Canines experience least decay (2-4%) and extraction (M = 1-6%). Upper and lower anterior teeth have good survival rates (SND = 90-94% for lowers and 70-88% for uppers), with almost no decay in centrals and laterals although some may be missing (lowers: 5-8% and uppers 13-15%).

The distribution of decay and extraction across the upper and lower dental arches is very similar in total although subject to some variation by DMF component and tooth type. Both arches experience a similar prevalence of missing teeth (9.5%), and decayed teeth in need of extraction 2-3%, and

PREVALENCE OF DMFT BY TOOTH TYPE (%)

TOOTH	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
SOUND	26	38	50	69	74	88	71	70	70	75	88	71	66	49	34	26
D-CON	22	29	16	07	07	03	09	08	08	07	03	09	10	18	30	22
D-EXT	08	10	09	07	04	01	05	05	05	02	01	05	06	07	10	09
MISNG	41	21	22	14	12	06	13	15	15	14	06	13	16	23	24	41

TOOTH	38	37	36	35	34	33	32	31	41	42	43	44	45	46	47	48
SOUND	27	27	37	64	83	94	92	90	90	92	92	87	63	41	26	25
D-CON	23	21	14	14	07	03	01	00	00	01	02	03	14	12	23	17
D-EXT	08	10	12	05	02	00	00	00	00	00	00	01	05	07	09	13
MISNG	40	40	34	14	06	01	05	08	08	05	03	06	15	38	40	42

TABLE 8.1.6

PREVALENCE OF DMFT VALUES BY ARCH

	UPPER	LOWER	TOTAL
SOUND TEETH	30.2%	32.2%	62.4%
DECAY-FILL	6.5%	4.8%	11.3%
DECAY-EXTRACT	2.9%	2.3%	5.2%
MISSING TEETH	9.3%	9.5%	18.8%

TABLE 8.1.7

PREVALENCE OF DMFT VALUES BY TOOTH TYPE (ALL AGES)

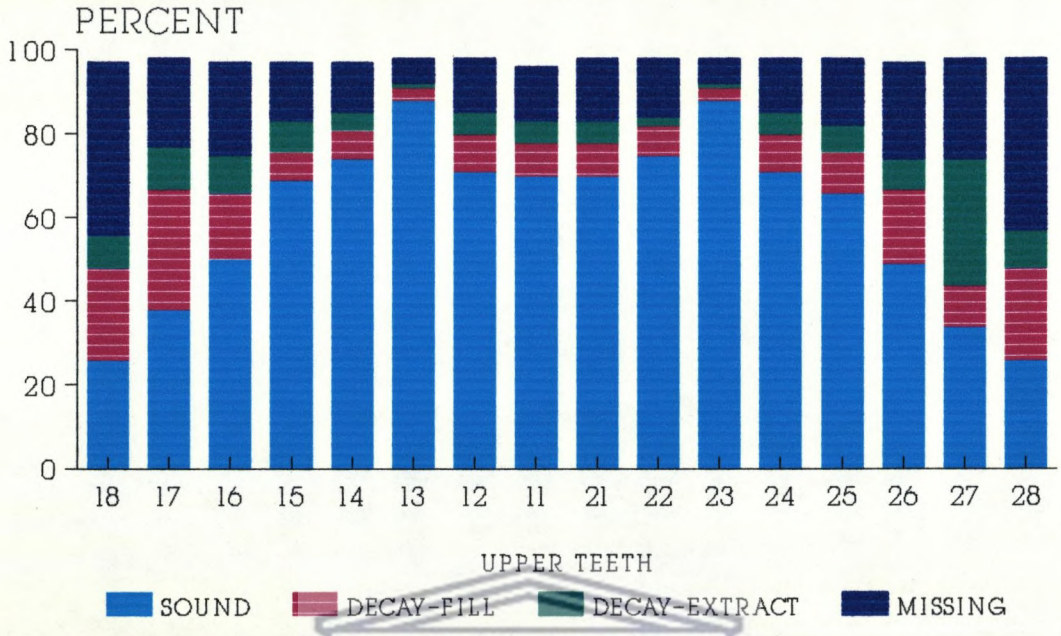


FIGURE 8.1.4

PREVALENCE OF DMFT VALUES BY TOOTH TYPE (ALL AGES)

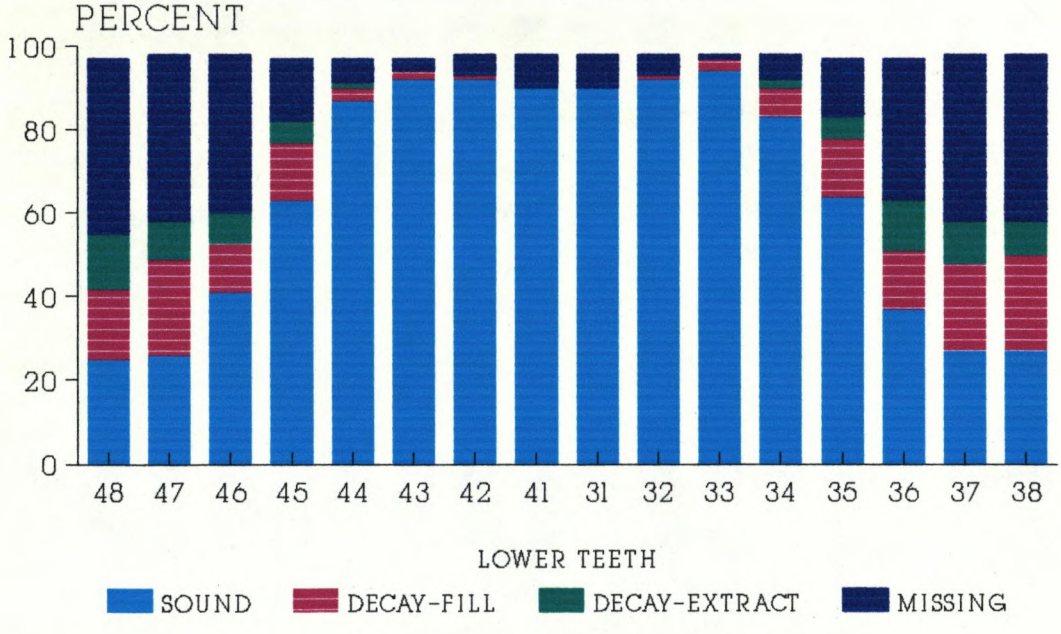
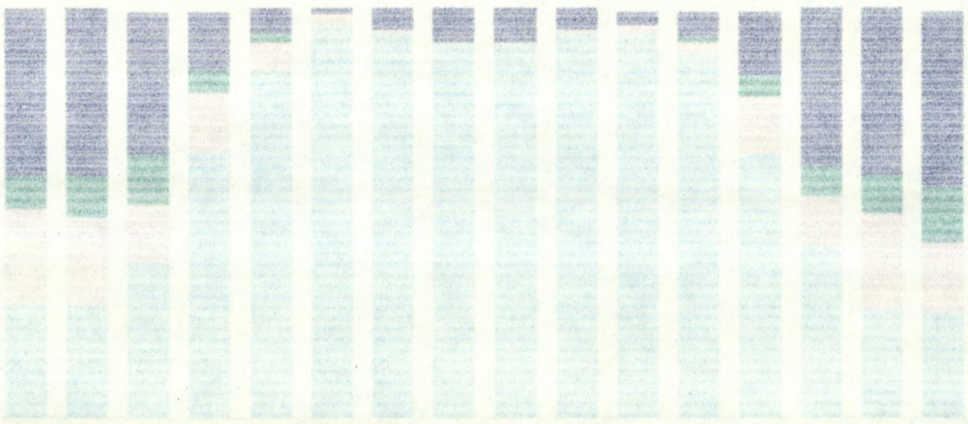


FIGURE 8.1.5



sound teeth 31% (TABLE 8.1.7). The upper arch has a slightly greater proportion of teeth in need of restoration, 6.5% compared with 4.8% in the lower arch.

SOUND TEETH PRESENT BY TOOTH TYPE

The survival of various tooth types is clearly demonstrated in FIGURES 8.1.4 and 8.1.5. The persistence of upper canines and lower teeth 34-44 is evident. In fact this can be seen to have a prevalence of close to 100% in the sample. (N=290) The tapering off in the region of second pre-molars and molar regions is also evident. This simple pattern is only disrupted by the slightly lower survival rate of upper centrals and laterals, compared to their opposing lower counterparts and adjacent canines.

The teeth that seem to survive most frequently in all age cohorts, are in the lower first pre-molar to first pre-molar region. It seems rather strange that no evidence of decay is present in this section of the arch since extraction is clearly practiced in this section occasionally. Perhaps it suggests that extraction is not based on the presence of decay but upon some other factor.

However, it is encouraging that in general these aesthetically important teeth are among those most commonly retained, and also that it is a bimaxillary pattern, suggesting that the occlusal pairing necessary for reasonable masticatory and linguistic function, is fairly likely to be present.

CARIES AND PERIODONTAL DISEASE BY PLACE OF RESIDENCE

An attempt was made to analyse the DMFT and MNS values by home address of the subjects (See FIGURE 8.1.6). These values are given in TABLE 8.1.8, however, no significant association or difference of any kind was observed. This assessment was subject to the limitation of stratification, which was not performed on the basis of home address.

It should also be noted that the number of years of residence in Cape Town or other large city, which was recorded on the data sheet, was tested using non-parametric statistics and found not to have any association with any other variables.

STUDY SAMPLE BY HOME ADDRESS

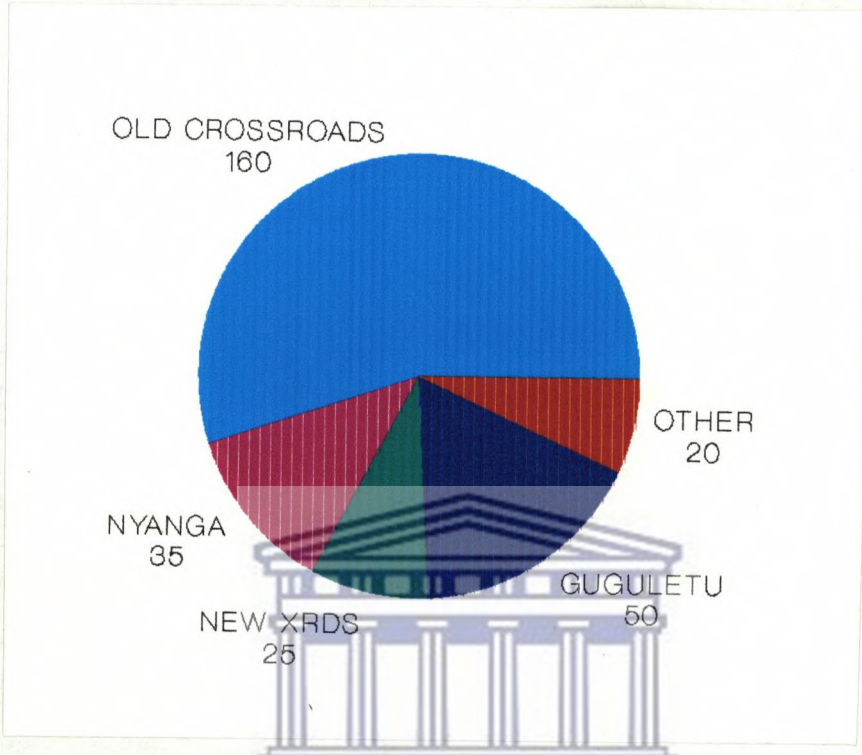


FIGURE 8.1.6

DMFT & CPITN (MNS) BY HOME ADDRESS

			CPITN CODES:					
	n	%	0	1	2	3	4	DMFT
CROSSROADS	162	55.9	.08	.38	3.23	1.37	.59	11.3
NYANGA	35	12.1	0	.43	3.14	1.46	.71	11.3
NEW CROSS.	24	8.3	.13	.21	3.25	1.08	.88	11.6
GUGULETU	47	16.2	.13	.36	2.66	1.64	.53	13.8
KHAYELITSHA	13	4.5	.15	1.23	2.46	1.46	.46	10.8
OTHER	9	3.1	0	0	3.44	1.22	.44	17.0

TABLE 8.1.8

8.2 PERIODONTAL DISEASE

TABLES 8.2.1-6 describe the periodontal status of subjects in terms of age cohort, individual and mean sextant scores.

The prevalence of persons with a completely healthy (in CPITN terms) periodontal status was zero, and very few subjects aged between 15 and 24 had gingivitis as the most severe sign of periodontal ill-health observed. As is evident from TABLE 8.2.1 and illustrated in FIGURE 8.2.1, pockets of moderate depth (Code 3) are the severest condition that is most prevalent in the sample as a whole, accounting for about 40% of the subjects. The presence of calculus as the most severe finding has a prevalence of 28% in the sample as a whole, with almost all of these subjects being below the age of 45 and most are under 30 years old.

The prevalence of deep pockets by age cohort, is illustrated in FIGURE 8.2.1 and 8.2.2. It is disturbing that even the younger cohorts below age 30, experience a Code 4 prevalence of between 12% and 14%. The cohorts are independent age groups, each located on a different time continuum. This means that one cannot suggest that subjects will experience a two-fold increase in the prevalence of deep pockets after age 45, however, the difference in prevalence of 29% and 58% in adjacent cohorts at this age, is a dramatic one which needs an explanation.

99% of the subjects are, in terms of the CPITN, classified as having periodontal ill-health and being in need of clinical treatment by a highly trained dental worker. The

question of whether this level of periodontal health or ill-health is acceptable or even normal must be seriously challenged.

MEAN NUMBER OF AFFECTED SEXTANTS (MNS)

The distribution of CPITN codes by number of affected sextants in each cohort provides an indication of how widespread the various levels of periodontal disease are in the subjects of each cohort (See TABLE 8.2.2 and FIGURE 8.2.2). The proportion of healthy sextants (Code 0) is very low for all ages. The widespread occurrence of gingivitis (Code 1) and calculus (Code 2) is described by very high MNS values, ranging from 4.6 to a high 5.8 for all age cohorts and displays little variability within this range.

Pockets of moderate depth (Code 3), though experienced at fairly high levels of prevalence even in the younger age groups, can be seen to be very much less widespread in these cohorts. Cohorts below age 30 experience a 3-6 mm pockets that are mostly limited to only two sextants, with the 25-29 year cohort recording the lowest MNS value for this code (.95). Subjects older than 45, have between 3 and 4 sextants with pockets of moderate depth, implying that 15-20 teeth are affected.

The occurrence of deep pockets (Code 4) in younger cohorts is very low (.14 to .17). Even in subjects aged 45 or older, not more than a mean one to two sextants are affected.

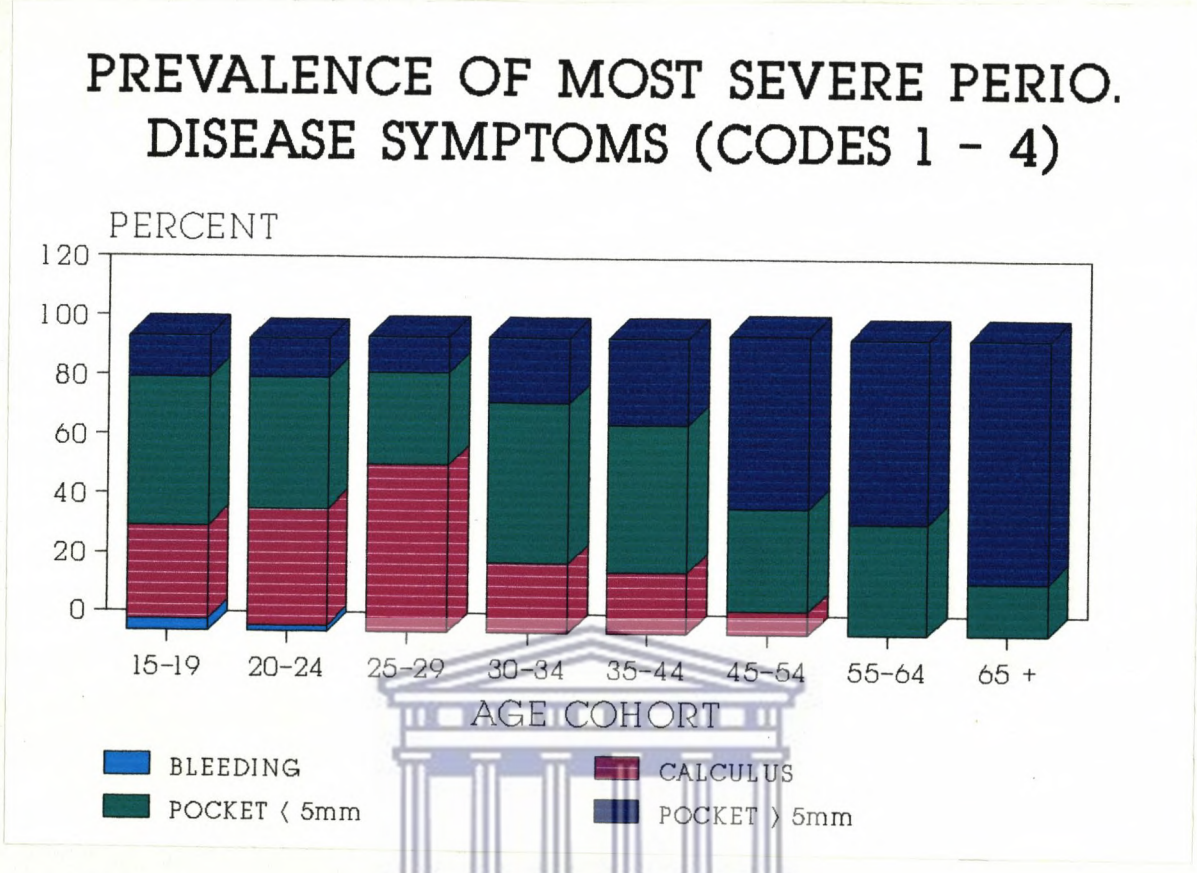


FIGURE 8.2.1

PREVALENCE OF PERSONS AFFECTED BY MOST SEVERE CPITN CODE: FREQUENCY (%) BY AGE

AGE	CODE 1	CODE 2	CODE 3	CODE 4
15-19	2 (4)	16 (32)	25 (50)	7 (14)
20-24	1 (2)	21 (40)	23 (44)	7 (13)
25-29	0 (0)	24 (57)	13 (31)	5 (12)
30-34	0 (0)	9 (24)	21 (54)	8 (22)
35-44	0 (0)	8 (21)	19 (50)	12 (29)
45-54	0 (0)	3 (8)	14 (35)	23 (58)
55-64	0 (0)	0 (0)	6 (38)	13 (62)
65 ++	0 (0)	0 (0)	2 (18)	9 (82)
TOTAL	3 (1)	81 (28)	123 (42)	84 (29)

TABLE 8.2.1

MEAN NUMBER OF SEXTANTS FOR ALL CPITN CODES

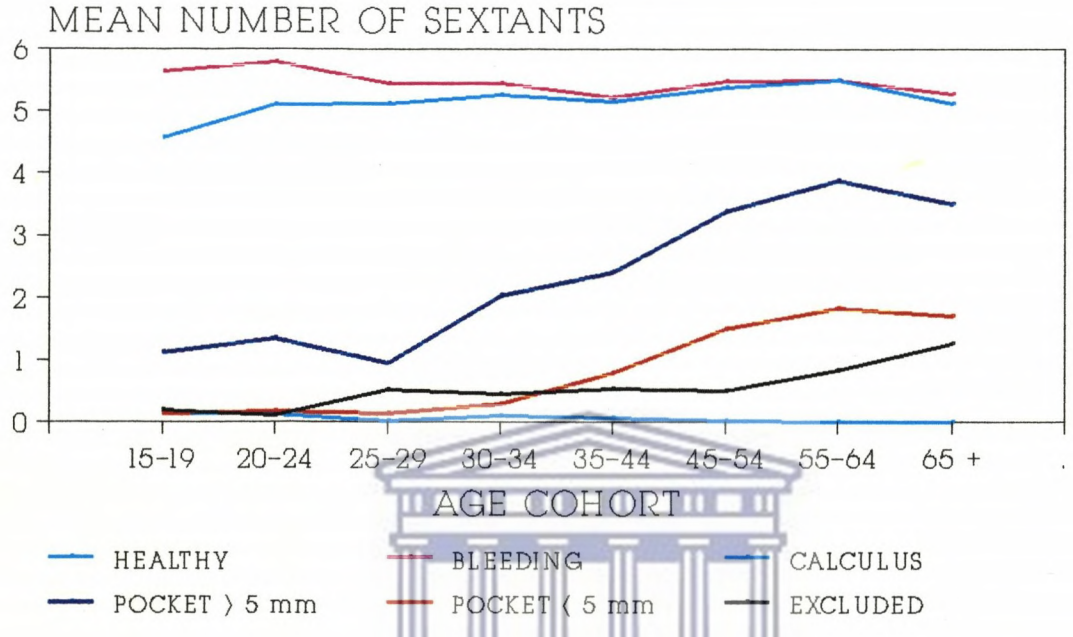


FIGURE 8.2.2

MEAN NUMBER OF SEXTANTS BY AGE

		CPITN CODES:					
AGE	n	0	1	2	3	4	X
15-19	50	.16	5.64	4.58	1.12	.14	.20
20-24	52	.12	5.79	5.10	1.35	.17	.10
25-29	42	.02	5.45	5.12	.95	.14	.10
30-34	38	.11	5.45	5.26	2.03	.29	.45
35-44	39	.08	5.23	5.15	2.41	.79	.54
45-54	40	.03	5.48	5.38	3.38	1.50	.50
55-64	19	0	5.50	5.50	3.89	1.83	.83
65 ++	11	.01	5.27	5.13	3.51	1.71	1.26
TOTAL	290	.11	5.61	5.19	2.06	.63	.44

TABLE 8.2.2

The mean number of excluded sextants (Code X) is very low in the youngest cohorts (.1 to .2) and is consistently low in most subjects under the age of 55 (.5). Older subjects have an average of one sextant excluded. This is supported by data discussed in the section dealing with Missing teeth.

MEAN NUMBER OF SEXTANTS BY AGE AND SEX

A breakdown of this data by age and sex for Codes 2-4 is presented in TABLE 8.2.3. The greatest divergence of CPITN values by sex is evident in the Code 4 category where differences in the MNS value of 1.7 and 1.3 for the 45-54 and 55-64 age cohorts respectively were recorded. FIGURE 8.2.3 illustrates this difference.

Cutress et al (1987) suggest a different method (with denominator = total number of sextants) for calculating the mean number of affected sextants for each individual. The values for Codes 3 and 4 calculated according to this method are depicted graphically by age and sex in FIGURE 8.2.4. It illustrates what appear to be significant differences between males and females for the age cohorts between 35 and 65 years.

TABLE 8.2.4. lists the MNS values for Code 4 by sex with 95% confidence levels. For age cohorts 45 to 64, the MNS value for Code 4 in males lies outside of the 95% confidence interval for the female MNS values. The males in these cohorts have a significantly higher number of sextants with deep pockets than females in the same cohorts.

MEAN NUMBER OF SEXTANTS WITH DEEP POCKETS BY AGE AND SEX

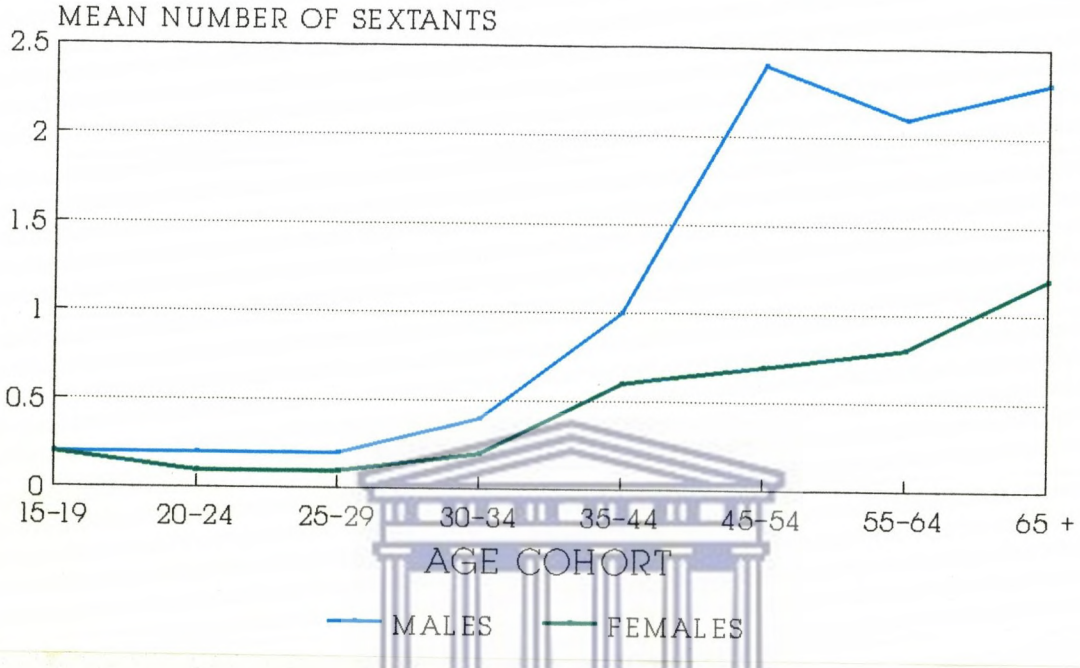


FIGURE 8.2.3

MNS BY AGE AND SEX: CODES 2-4

	CALCULUS:		- POCKETS⟨5mm:		- POCKETS⟩5mm:	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
15-19	3.8	3.0	1.2	0.9	0.2	0.2
20-24	3.9	3.6	1.3	1.0	0.2	0.1
25-29	4.7	3.7	0.7	0.9	0.2	0.1
30-34	3.3	3.4	1.9	1.3	0.4	0.2
35-44	2.4	3.4	2.3	1.1	1.0	0.6
45-54	1.4	2.6	1.9	1.9	2.4	0.7
55-64	1.4	1.9	1.7	2.4	2.1	0.8
65 ++	0.3	2.4	2.0	1.2	2.3	1.2

TABLE 8.2.3

MNS WITH CODES 3 AND 4 BY AGE AND SEX

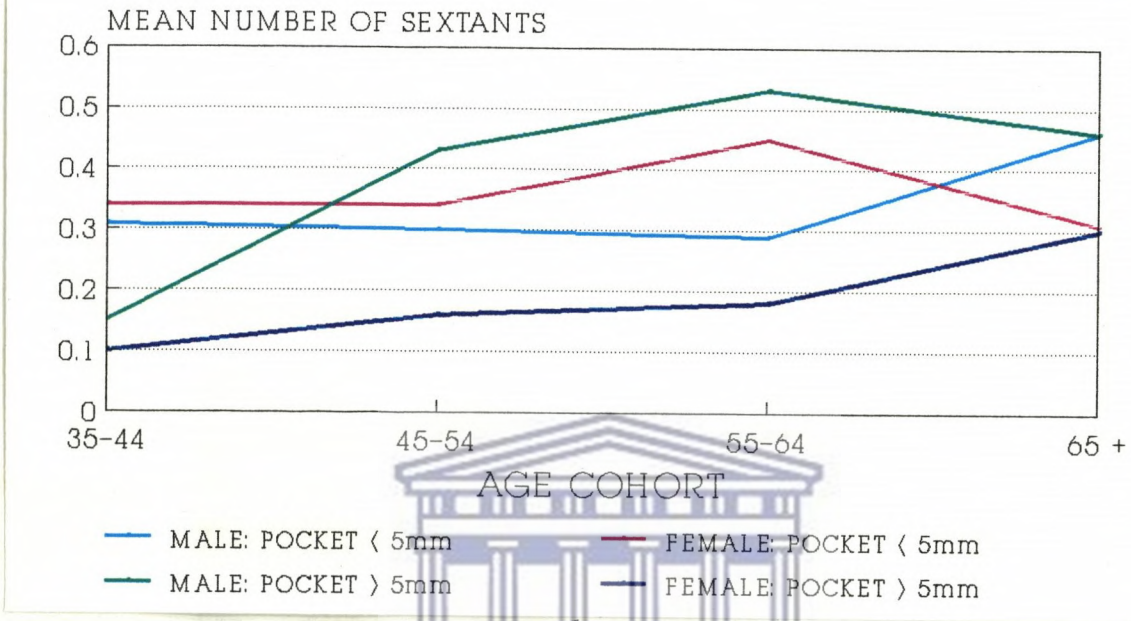


FIGURE 8.2.4

(METHOD USED BY CUTRESS ET AL (1987))

MNS: CODE 4 BY SEX (CUTRESS METHOD)

AGE	SEX	n	MNS	(SD)	CL+	CL-
35-44	M	20	.15	.28	.28	.02
35-44	F	19	.10	.20	.20	.00
45-54	M	20	.43	.32	.58	.28
45-54	F	20	.16	.26	.28	.04
55-64	M	11	.53	.41	.80	.26
55-64	F	8	.18	.19	.33	.03
65 ++	M	6	.46	.13	.59	.33
65 ++	F	5	.30	.27	.61	.00

TABLE 8.2.4

CPITN CODE BY SEXTANT

A frequency distribution of each code by sextant location was calculated The results are listed in TABLE 8.2.5 and illustrated in FIGURE 8.2.5.

The fairly prevalent location of calculus (Code 2) in lower sextants is evident. The largest number of sextants where gingivitis (Code 1)is recorded, is in the lower central region. Pockets in general (Codes 3 and 4) seem to occur most commonly in upper posterior sextants.

FREQUENCY DISTRIBUTION

A simple count of the frequency of each Code by the number of sextants affected in each individual, produced the tables included in Appendix 12.6 and summarised for the sample as a whole in TABLE 8.2.6.

This data shows very few sextants in the entire sample recorded as healthy (6%), and never in more than one or two sextants per subject. Gingivitis when present in individuals, generally affects only one sextant (13%), implying that most of the other sextants are affected by more severe signs of disease. Evidence from the Code 2 frequency distribution reveals the largest concentration of values. Only 12% of sextants in the sample are not affected with calculus. And when it is present, it is likely to be present in at least two (15%) and probably three or four (39%) sextants per individual.

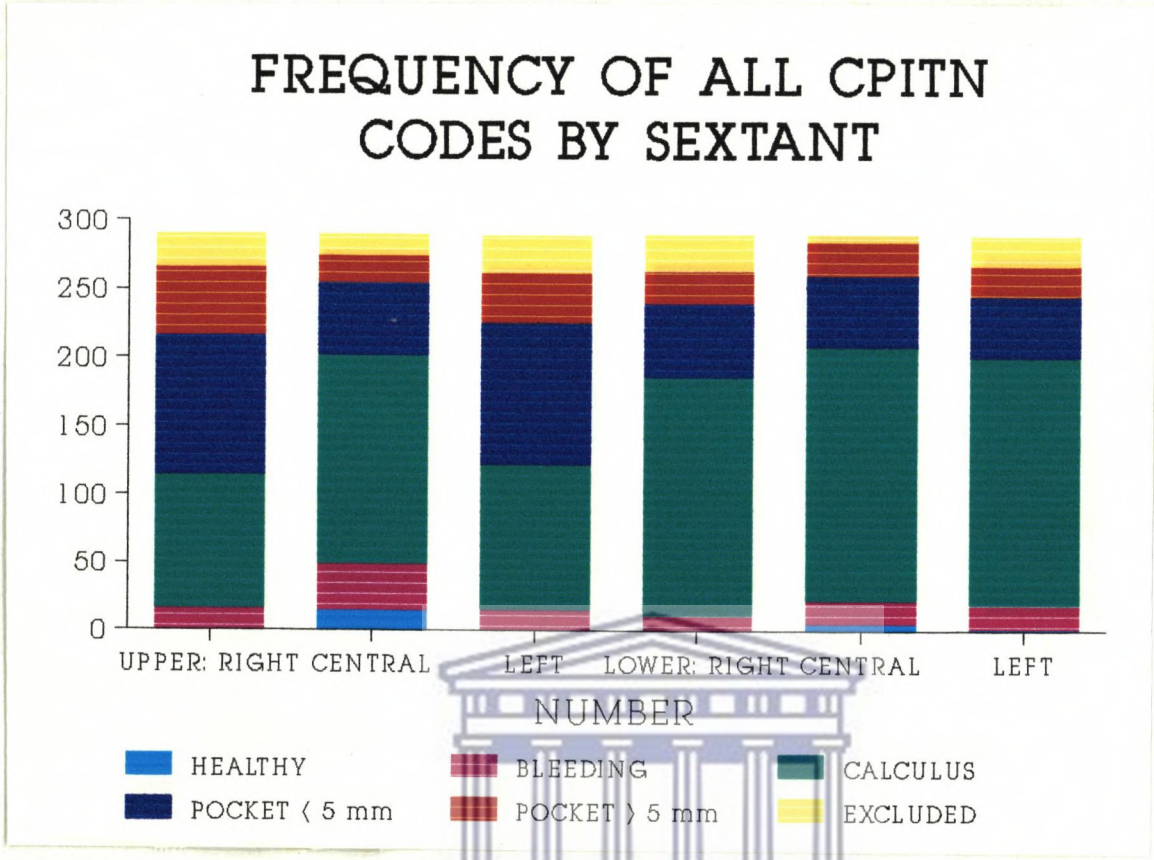


FIGURE 8.2.5

CPITN CODES BY SEXTANT

SEXTANT	UR	UC	UL	LL	LC	LR
CODE 0	0	15	0	2	6	1
CODE 1	17	35	16	18	17	11
CODE 2	98	153	107	181	186	175
CODE 3	102	52	103	45	52	53
CODE 4	49	20	36	22	24	24
CODE X	24	15	27	21	5	26

TABLE 8.2.5

CPITN FREQUENCY DISTRIBUTION (%)

NO. -	CODE0	CODE1	CODE2	CODE3	CODE4	CODEX
SEXT ANT 0	94.1	77.9	11.7	34.5	71.4	79.0
SEXT ANT 1	3.4	13.1	10.3	24.1	12.8	11.4
SEXT ANT 2	2.4	3.1	14.5	19.7	6.2	3.1
SEXT ANT 3	0	3.8	18.3	13.4	6.6	3.1
SEXT ANT 4	0	1.7	21.0	5.9	1.0	2.8
SEXT ANT 5	0	0.3	12.8	1.4	1.0	0.7
SEXT ANT 6	0	0	11.4	1.0	1.0	0

TABLE 8.2.6

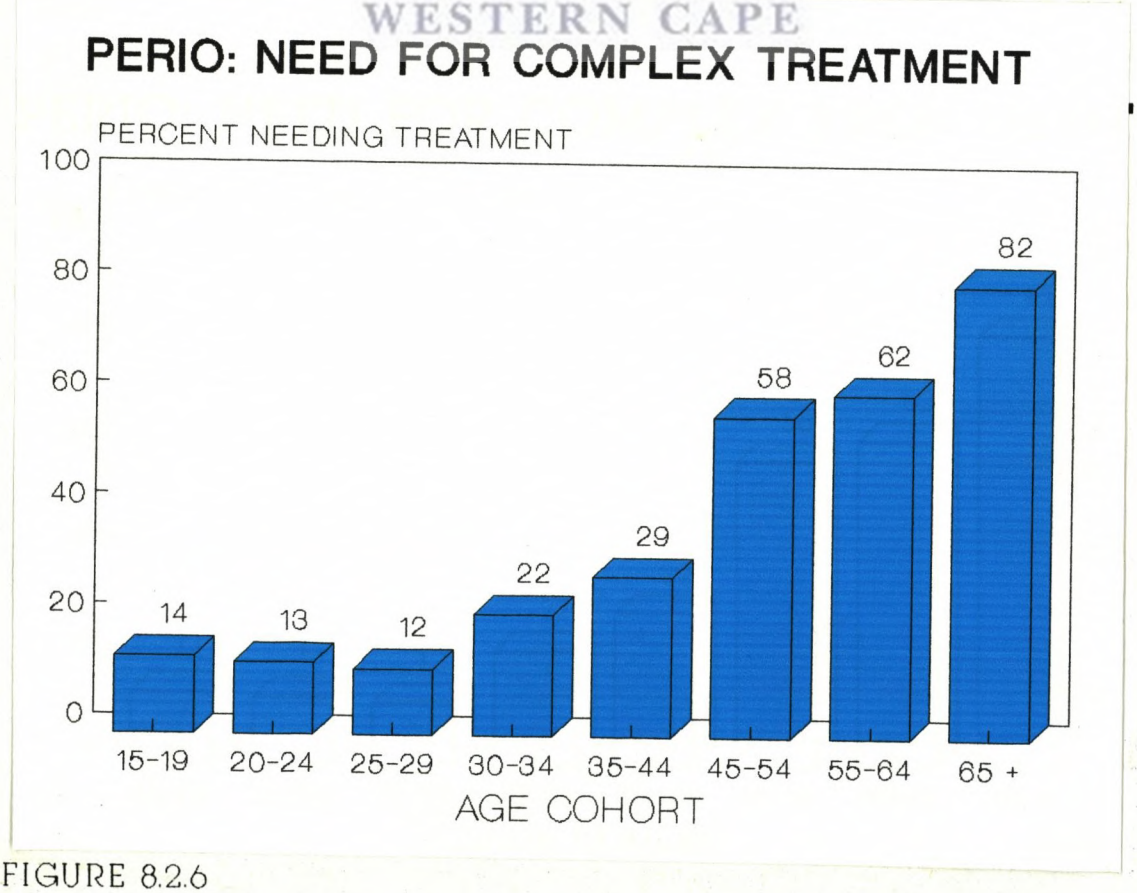


FIGURE 8.2.6

Moderate depth pockets (Code 3) when present occur most commonly in one (24%) or two (20%) and occasionally in three (13%) sextants. It is interesting to see that when Code 3 is present, it mostly occurs in no more than four sextants, representing 63% of all sextants coded worse than Code 2. Code 4 however, quite evidently only occurs in three or fewer sextants when present. The concept of a time continuum with progression of disease from Code 3 severity to Code 4 is clearly challenged. If such a time continuum exists, then there must be remission of Code 3 sextants.

Most of the subjects affected with Code 4 have only one sextant (13%) and a few have either two or three (6%) sextants affected. This suggests that all the affected individuals require a limited amount of complex care i.e. in less than half their sextants. It also means that very few subjects have widespread periodontal disease at this level of severity.

TREATMENT NEEDS

A need for treatment, indicated by bleeding gums, calculus and shallow periodontal pockets (<5 mm), was evident in almost every subject. The ubiquitous presence of calculus in almost all subjects, makes this the baseline treatment -need consideration. According to the original intentions of the CPITN structure, Code 2 or Code 3 was to indicate a need for scaling and root planing of affected sextants. In this sample, all subjects require this level of treatment (TN2) in approximately five sextants (TABLE 8.2.7).

Although there is a presence of TN3 in younger age groups (12-14%), this is required for very few sextants per person (.1 to .3). The need for complex treatment in 1-2 sextants is only apparent after age 35. The prevalence of this treatment need rises from 30% at 40 to over 60% by age 60 (FIGURE 8.2.7). Overall, 29% of the subjects require complex treatment.

In addition to the clinical procedures required of TN2 and TN3, all subjects require improvements in oral hygiene to control the prevalence of gingivitis i.e. all should benefit from the provision of Oral Hygiene Education and practice.

The actual numbers of sextants requiring treatment are summated by age and treatment type in TABLE 8.2.8. For the purpose of this discussion, TN2 has been kept separated into its two main components as defined by Codes 2 (TN2) and 3 (TN2*) respectively. The Time Units (TU) have then been summated according to the method used by Gjermo et al (1983), with the total given in the first column. The average number of units required per subject are listed in the last column (TUx).

It can be seen from the totals, that most sextants require treatment of types TN1 and TN2. Far fewer sextants require treatment of moderate pockets and a very much smaller proportion TN3.

PERIODONTAL TREATMENT NEEDS

AGE	TN 1	TN 2 (MNS)		TN 3 (MNS)	
15-19	100%	96%	(4.6)	14%	(0.1)
20-24	100%	98%	(5.1)	13%	(0.2)
25-29	100%	100%	(5.1)	12%	(0.1)
30-34	100%	100%	(5.3)	22%	(0.3)
35-44	100%	100%	(5.2)	29%	(0.8)
45-54	100%	100%	(5.4)	58%	(1.5)
55-64	100%	100%	(5.5)	62%	(1.8)
65 ++	100%	100%	(5.1)	82%	(1.7)
ALL	100%	99%	(5.2)	29%	(0.6)

TN 1 ▪ ORAL HEALTH EDUCATION
TN 2 ▪ SCALING AND ROOT PLANING
TN 3 ▪ COMPLEX TREATMENT

TABLE 8.2.7

NO. OF SEXTANTS THAT NEED TREATMENT

AGE	n	TN0	TN1	TN2	TN2*	TN3	TU	TUx
15-19	50	8	282	229	56	7	1186	24
20-24	52	6	301	265	70	9	1369	26
25-29	42	1	229	215	40	6	1035	25
30-34	38	4	207	200	77	11	1115	29
35-44	39	3	204	201	94	31	1304	33
45-54	40	1	219	215	135	60	1690	42
55-64	19	0	105	105	74	35	883	46
65 ++	11	0	58	56	39	19	475	43
ALL	290	32	1627	1505	597	183	9213	32

TU ▪ TIME UNITS (TOTAL)
TUx ▪ TIME UNITS PER PERSON

TABLE 8.2.8

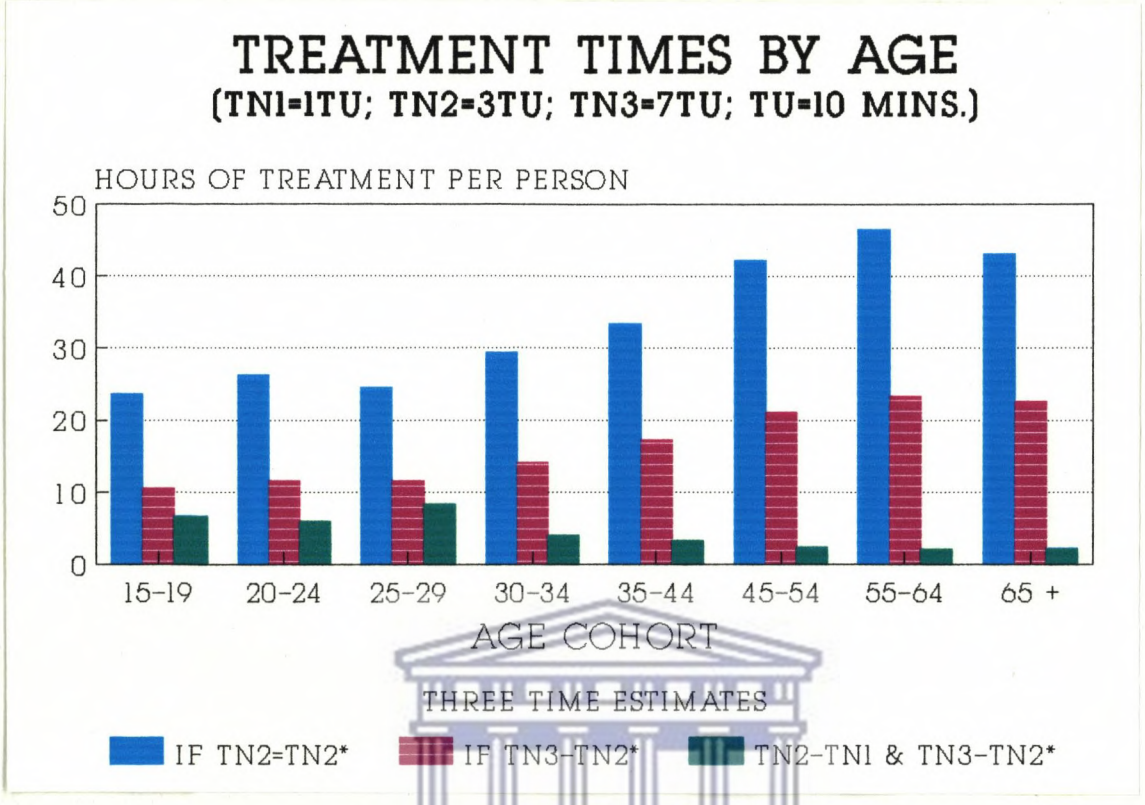


FIGURE 8.2.7

TN1=ONE; TN2 = SCALE CALCULUS;
TN2* = SCALE MODERATE POCKETS;
TN3 = COMPLEX TREATMENT.

3 TREATMENT TIME ESTIMATES (HOURS)

AGE	METHOD 1 - TOT.	AVG.	METHOD 2 - TOT.	AVG.	METHOD 3 - TOT.	AVG.
15-19	198	4.0	499	1.8	187	1.1
20-24	228	4.4	584	1.9	209	1.0
25-29	172	4.1	441	1.9	167	1.4
30-34	186	4.9	489	2.4	153	0.7
35-44	217	5.6	584	2.9	154	0.5
45-54	282	7.0	772	3.5	164	0.4
55-64	147	7.7	407	3.9	79	0.4
65 ++	79	7.2	218	3.8	43	0.4
ALL	1536	5.3	4064	2.5	1169	0.7

TU = 10 MINUTES
TOT. = COHORT TIME
AVG. = TIME PER PERSON

TABLE 8.2.9

TREATMENT TIME REQUIRED

The number of time units required per person is vast. For the sample as a whole, this is 32 TU per person in a range from about 25 TU below age 30 and rising to 46 TU in subjects aged 55 and older.

The calculation of real time requirements are subject to great local variation, with various authors describing a Time Units between 15 minutes and 45 minutes. An arbitrary 10 minute unit is used here to illustrate the sheer quantity of treatment need estimated by the CPITN system for this sample (Further tables are included in Appendix 12.7). TABLE 8.2.9 and FIGURE 8.2.7 illustrate three different formulations of this time estimate, using the 10 minute Time Unit, and presented as number of hours of treatment required per cohort (Tot.) and per subject (Mean).

The first pair of columns, is calculated in the conventional manner used by Gjermo et al (1983), and includes scaling of calculus (TN2) and moderate-depth pockets (TN2*) together as a single treatment type i.e. TN2 = TN2*. An massive 5.3 hours of treatment is required per subject according to this method, ranging from 4 hours at ages 15-19, to 7.7 hours after age 55.

The second pair of columns, uses a modification suggested by Gjermo et al (1983), that TN3 be included with the TN2 and TN2* categories of treatment need. This assumes that most pockets greater than 5mm, at least in younger subjects, can benefit from scaling and root planing and do not necessarily

require more complex treatment in most cases. The second estimation of time is based on this modification. For the sample in question this will mean every subject is assumed to require scaling and root planing in addition to Oral Hygiene Education. This formulation effectively reduces the treatment time by half to 2.5 hours per subject, and narrows the range considerably to 1.8 hours at age 15-19 to 3.9 hours at age 55.

The third formulation makes an even more radical assumption. It is based on the assertion that presence of calculus does not necessarily indicate either periodontal disease or therefore a need for treatment of the TN2 type. This means that scaling and root planing is only assumed to be required by subjects who have pockets identified by Codes 3 and 4. This formulation also makes the assumption suggested by Gjermo et al. This means, in summary, that all subjects require TN1 and those with Codes 3 or 4 will receive scaling and root planing. The time required to provide this formulation of interventions, is an average 0.7 hours per subject, with a range of 0.4 to 1.4 hours across the age cohorts.

The difficulty of the choice presented to a health planner by these different formulations is formidable. Given that the sample reflects general population proportions by age and sex, the magnitude of the population treatment time required, may be obtained by multiplying cohort totals by 2/3 * 1000. The treatment time calculated on this basis is staggering.

9 DISCUSSION

THE STUDY

The composition of the sample by age and sex in the same proportions as they exist in the wider Xhosa-speaking population of greater Cape Town (Figure 6.1.1), provides strong motivation for the generalisation of the data to this population. This is constrained by the fact that this was a clinic-attending sample, self-selected with variables which were not determined in this study. A further limitation is the exclusion of edentulous subjects and probably some caries-free individuals from the sample. However, it seems likely from the literature that the recorded prevalence of periodontal disease is unlikely to differ greatly due to this factor, although caries levels are more likely to have been over-estimated in younger age groups due to the exclusion of caries-free individuals and under-estimated in older age groups due to the exclusion of edentulous subjects.

The size of the sample and age/sex stratified sub-samples, except in the over-65 year age group, proved more than adequate to measure the levels of caries and periodontal disease prevalence recorded in this community.

The CPITN and DMFT indices both proved to be simple to use in the form described. The intra-examiner variability measured both with percentage (95% DMFT; 84% CPITN) and Kappa (k) methods (.87 DMFT; .68 CPITN), generated agreement levels

comparable with studies elsewhere. Manji et al (1989) calculated kappa (DMFT) of .89 to .95 for intra-examiner agreement and Hartshorne et al (1987) found k = 0.62 (CPITN).

The use of kappa raised a number of important methodological issues around the measurement of examiner agreement in dental surveys, and these need to receive further attention in future. Most important of these is the low frequency in individual cells of the contingency tables from which kappa is calculated. The choice of sampling unit and the resultant size of the re-examined sub-sample are the determinants of this pitfall that need to be dealt with.

DENTAL CARIES

The DMFT values recorded in this study are consistently higher than the levels reported in most other African studies for all age cohorts (See TABLE 9.1.1). These values are approximately double those recorded for a rural Kenyan sample by Manji et al (1989). Significant differences between urban and rural values are depicted in the literature (e.g. Songpaisen and Davies 1989a, Barnard et al 1979, Sheiham et al 1970), but the results from this study more closely resemble those of the urban populations. The results of this study compare more closely with the DMFT measured for South African Whites by Theron et al (1984) and Retief et al (1975), which ranged between 8 and 12. Louw (1979) also obtained a mean DMFT for his sample of 12 in a Cape Town Coloured population. He recorded a much wider range in DMFT, with a low DMFT of 6.5 in the 13-19 year cohort, compared with 11.2 in this study. However, an extremely high DMFT (21) measured by Louw,

CARIES STUDIES IN AFRICA

AUTHOR	YEAR	PLACE	AGE (YRS)		DMF	CARIES-FREE
RITCHIE	1979	RHODESIA	18-25	(M)	0.7	69%
			18-25	(F)	2.0	40%
GORACCI	1980	SOMALI	18-30		LOW	V.HIGH
ARAIN	1983	LAGOS	15-17	(U)	2.5	58%
MARSEILLE	1984	ZAIRE	35-44	(R)	1.2	
KOWALSKI	1983	ZAIRE	)21	(U)	3.9	
			(21	(U)	5.6	
MANJI	1989	KENYA	15-24	(R)	1.3	51%
			25-34	(R)	4.0	18%
			35-44	(R)	5.8	13%
			45-54	(R)	5.9	16%
			55-64	(R)	9.2	7%
OLSSON	1989	MOZAMBIQUE	25-43	(U)	8.1	7%
			25-34	(R)	3.7	31%
			45-54	(R)	7.9	6%

TABLE 9.1.1

CARIES STUDIES: SOUTHERN AFRICA

AUTHOR	YEAR	PLACE	AGE (YRS)		DMF	CARIES-FREE
RETIEF	1975	SA BLACK	16-17	(R)	1.2	60%
		SA BLACK	16-17	(U)	2.1	34%
		SA WHITE	16-17	(U)	11.6	4%
CLEATON-J	1979	XHOSA	16-30	(M)	2.5	32%
HARRIS	1978	SA BLACK	ADULT	(R)	3.2	11-25%
CLEATON-J	1980	SA BLACK	17	(R)	1.3	51%
			17	(U)	2.1	34%
THERON	1984	SA WHITE	16-18	(U)	8-11	1%
DU PLESSIS	1986	BUSHMEN	4-60	(R)	1.3	56%
CLEATON-J	1983	KWAZULU	16-18	(R)	3.1	26%
			16-18	(U)	4.9	7%
GILBERT	1988	TRANSKEI	ADULT		10.7	0.7%
RUDOLPH	1989	TRANSKEI	ADULT		5.7	17%
LOUW	1979	SA COLOURED	13-19	(U)	6.5	12%
			35-44	(U)	21	

TABLE 9.1.2

attributed to massive and rapid tooth loss over time, was recorded for the 35-44 age cohort. It is a disturbing possibility that this could be a trend determined by factors characteristic of the Cape Town area.

Three other studies specifically describe Xhosa adults. Cleaton-Jones (1979) examined only male subjects apparently drawn directly from the homeland migrant labour recruitment programme and probably rural in origin. A low DMFT of 2.5 was measured, similar to the results of other studies on rural Black subjects in South Africa (Harris 1978; Cleaton-Jones et al 1980, 1983; Retief et al 1975) and Du Plessis' study on Bushmen in Botswana (1986). Gilbert et al (1988) recorded a DMFT of 10.7 for a somewhat mixed sample of Transkeian adults, a value which closely resembles the data in this study. Unfortunately the Transkei sample composition limits any meaningful comparison that might be made. The other Transkei study reported by Rudolph et al (1989), has a lower DMFT of 6.7 and seems to share a similar ambiguity in character, lying somewhere between the urban DMFT of this study and the rural DMFT of the authors referred to above.

Most of the African studies describe noticeable increases in DMFT with age, although not many record the statistical significance of this observation. The same trend is visible from youngest to oldest cohorts in this study, and the lack of statistically significant differences in DMFT by age may be addressed on two levels. The DMFT is a composite index made up of entirely separate categorical variables, and though the components may be very different with age, its composite nature obscures these differences. For both the D and M

components for example, statistically significant differences at the 95% level were in fact obtained. In addition, it is important to remember that the subjects of different ages come from entirely different cohorts, and since they do not share the same continuum across time, should not necessarily be expected to exhibit such age-related differences in DMFT. They should in fact be treated as separate samples.

The trend in dental caries reported by numerous sources in the literature, is described as declining in most affluent countries and rising in under-developed countries (FDI 1985). The high DMFT values recorded here seem to support this assertion, if one assumes that South Africa is a developing nation rather than an affluent one. Since this study described different age cohorts, the high DMFT recorded in the 25-29 year age group (13 ± 6.8) is reason for concern but is similar to the finding of Kaimenyi et al in Kenya (1988). It may be an indication that younger cohorts are currently experiencing or entering a phase of rapid caries destruction. By the time these cohorts have aged another decade, they may have reached DMFT levels far exceeding that currently experienced by their elders. The finding of Manji et al (1989) and Olsson et al (1989) that caries continued to affect the dentition of even the older subjects, illustrates the potential for very severe destruction in these young people even if there is merely the continued existence of current caries levels without any increase in rate. Olsson et al (1989) identify the degree of exposure to markets as an important determinant of caries in their Mozambique sample, a suggestion that could well be supported by the results of this study. It also raises serious questions about the state of

preventive and promotive strategies, the availability of extraction versus restorative services, utilization of existing services, the existence of a real diet-related rise in decay, oral hygiene and other factors.

In common with trends reported elsewhere (Ritchie 1979, Harris 1978, Linden 1988), females experience higher DMFT values, and where measured, they also have a lower prevalence of caries-free subjects. These findings are supported in this study, a trend which is found to be dependent upon the M component. This high female DMFT is also responsible for the high DMFT found in the 25-29 year cohort. This suggests that females in this age group either are experiencing higher levels of decay, or for some other reason, attend extraction clinics more frequently than their male peers. Some enquiry into attitudes toward extraction in this group is justified.

Also similar to most African survey findings, an obvious characteristic in this study is the almost complete absence of restorative treatment experience. This contrasts sharply with the amount of extraction experience observed. Clearly treatment of the "extractionist-sort" is available and utilised by a large proportion of subjects in this sample. However, the same centres providing this clinical service, are not, cannot or will not for some or other reason, provide restorative and/or preventive forms of treatment. Although an awareness of the treatment/prevention options available may be limited, it certainly suggests that there are serious deficiencies in the delivery of appropriate clinical services

to this community. It underlines the role of socio-economic factors as well as dental service availability factors in determining the community's dental health status.

The proportion of teeth affected by decay (±20%) is double the proportion found to be missing (±10%), indicating that large numbers of teeth could be treated if the inclination and/or the resources to provide the treatment were available. While the exact number of man-hours required to restore or extract these teeth was not calculated, it is evident that the treatment need may be considered to be massive. It is very unlikely that the resources necessary to transform such levels of unmet caries treatment need into functional teeth will ever become available. This makes it that much more urgent to plan a systematic prevention policy for this community. Various strategies were discussed in the section dealing with prevention, but perhaps most critical of all will be the extent to which oral health measures are integrated into an overriding Primary Health Care approach to community health.

The findings of Du Plessis (1987) and Shakenovsky et al (1986) place the loss due to caries from 67 to 72%, and loss due to periodontal disease at only 19 to 20%. The findings of this study suggest that with such large amounts of tooth loss occurring in young cohorts, the teeth that could potentially have developed periodontal disease leading to tooth loss, are no longer present to do so. The effect of this would be to both reduce the prevalence of severe periodontal disease, and to reduce this as a cause of tooth loss.

Although this study did not attempt to ascertain the reasons for tooth loss, a number of environmental factors mentioned by Norheim (1979) as leading to tooth loss, may be found in this community, including low income and socio-economic class. The relationship between availability and accessibility of dental care and the pattern of tooth loss suggested by Bouma et al (1986) appears to be supported.

Where large numbers of missing teeth are recorded in younger cohorts, as in this study, there is reason to seriously challenge the extraction-preference of those providing the dental care, an assertion put forward by Ainamo (1984), Tuominen et al (1984) and Barmes (1978) although certain other cultural factors may also affect patient demand for extractions, as illustrated by Louw (1982).

The proportion that missing teeth contribute to the DMFT is large, and similar to that found by Manji et al (1989) in Kenya. They found M contributed about 50% to the DMFT in those aged 25-34 and up to 85% after age 45. Differences in the DMFT components of South African groups sharing the same total DMFT are particularly revealing. The white group examined by Cleaton Jones and Walker (1982), had a similar DMFT (10), but the M value contributed only 1.3, the D value 1.7 and the F value 7.1. The results of this study contrast sharply with this data. Important environmental factors and their impact on dental health, are called into question. Tuominen et al (1984) cite the scarcity of appropriate services as a crucial factor in preventing people from preserving their natural dentition. This community has had little chance to benefit in this way.

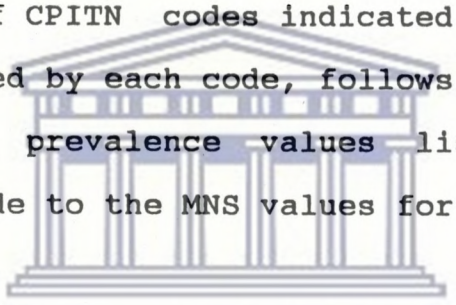
Similar to Ahlqwist et al (1986), Mohlin et al (1979) Anagnou-Varelzides et al (1986), the most commonly extracted teeth are the third molars, followed by upper first and second molars. The mean number of sound teeth in the 35-44 age cohort and up to age 55, is around 20, suggesting that this particular WHO goal for the year 2000 (In Infirri 1984) has been achieved. This compares with Manji et al (1989) who found 90% of subjects up to age 65 had at least 16 functional teeth. However it is not certain that all 20 of these teeth are in fact functional, though the decay by tooth type patterns illustrate that most of these teeth are located in the anterior segments. This suggests that the number of occluding pairs in each subject is high, a characteristic advised by Kayser (1984) and one which contributes to the retention of aesthetics and function even in old age.

PERIODONTAL DISEASE

Most CPITN studies in African 15-19 year olds share in common a very high prevalence of gingivitis (TN1) and almost no subjects completely healthy in terms of periodontal status. (See TABLE 9.1.3)(Pilot et al 1987). With the exception of Zimbabwe and Malawi, where TN2 is the severest CPITN code encountered, the results of this study closely resembles those of the other studies. The data from this study differs only in the prevalence of subjects with Code 3 (TN3). Rossouw (1986) also records a low prevalence of TN3 (4%) but with a much lower MNS value (.04). The prevalence of TN2 is similar in all samples excepting the Zimbabwe group and it seems all these nations will have to plan efficient ways of bringing secondary periodontal care to their communities.

In African adult groups aged 35-44, the index cohort for which most survey data has been reported, a very similar pattern is present (See TABLE 9.1.4)(Pilot 1987). The data from this study once more bares a strong resemblance to other African data, this time with the exception of Zimbabwe and Zaire which both experience TN2 as the most severe code in about 95% of subjects. Only two of the samples listed have a similar high prevalence of TN3, Kenya (14%) and Central Africa (32%). The data from this study lies between these two values in both the TN2 (50%) and TN3 (29%) categories.

The distribution of CPITN codes indicated by the Mean Number of Sextants affected by each code, follows the same pattern in this study as the prevalence values listed, and are also similar in magnitude to the MNS values for these studies.



The ubiquitous presence of gingivitis in younger age groups and calculus in all groups locally and elsewhere in Africa must surely challenge the concept of disease these variables are assumed to reflect. The additional evidence that only low prevalences of severe periodontal disease, reflected as TN3, were observed seem to support the assertion that periodontal disease progression from gingivitis and calculus to deep pocketing cannot be assumed. However the observation that pocketing in 15-19 year olds is only found when the mean number of sextants affected by calculus exceeds 3 (Barmes and Leous 1986) is borne out in the frequency distribution data for this study.

CPITN STUDIES IN AFRICA: 15-19 YRS

PLACE - YEAR -	TN0	TN1	TN2	(MNS)	TN2*	(MNS)	TN3	(MNS)
TANZANIA 1982	2	5	30	(3.8)	62	(1.6)	1	(.0)
MALAWI 1983	61	3	36	(1.4)	0	(0)	0	(0)
KENYA 1984	1	52	40	(1.2)	6	(0.2)	2	(.0)
VENDA 1984	0	0	28	(5.7)	69	(1.8)	3	(.0)
ZIMBABWE 1986	31	0	68	(0.9)	0	(0)	0	(0)
ZIMBABWE 1986	20	0	80	(1.3)	0	(0)	0	(0)
BUSHMEN 1986	0	2	33	(3.1)	62	(1.4)	4	(.04)
X ROADS 1985	0	4	32	(4.6)	50	(1.1)	14	(.14)

TABLE 9.1.3 (FROM PILOT ET AL 1987)

CPITN STUDIES IN AFRICA: 35-44 YRS

PLACE - YEAR -	TN0	TN1	TN2	(MNS)	TN2*	(MNS)	TN3	(MNS)
TANZANIA 1982	1	0	28	(4.5)	63	(2.2)	7	(0)
LIBYA 82/82	0	0	13	(5.6)	53	(2.5)	34	(.6)
KENYA 1984	1	4	31	(5.1)	49	(2.5)	32	(.8)
ZAIRE 1985	1	1	93	(5.0)	4	(0.1)	0	(0)
NIGERIA 1985	4	5	52	(4.7)	35	(1.2)	3	(.1)
NIGERIA 1986	1	2	53	(3.2)	26	(0.8)	0	(0)
C.AFRICA 1986	1	1	14	(5.1)	52	(3.1)	32	(.8)
ZIMBABWE 1986	10	0	87	(1.5)	3	(0.1)	1	(0)
X ROADS 1985	0	0	21	(5.2)	50	(2.4)	29	(.8)

TABLE 9.1.4 (FROM PILOT 1987)

Differences in distribution of CPITN codes by age and sex were only evident in the Code 3 and 4 categories, which may be construed as supporting the argument for progression from minor levels of disease to this level of severity. However, the concept of cohort-separateness must be invoked again, together with the fact that current research into periodontal disease, provides substantial evidence that this progression is not inevitable. The difference in sex however, may possibly reflect to some extent the patterns of tooth mortality discussed earlier. The suggestion is that since males in this sample have retained teeth to a much older age, the potential for developing periodontal disease has been retained. Conversely, the female group has in general experienced much greater amounts of tooth loss by the same age, and simply has fewer teeth still vulnerable to periodontal disease.

For the sample as a whole, for which the index 35-44 age cohort offers a fairly representative profile, the progression of periodontal disease has been slow, a finding in line with the observations of Pilot et al (1986) and Barmes and Leous (1986). And at this stage, it seems to be compatible with the retention of the dentition beyond age 50. The amount of tooth loss due to caries is of course independent of this but unfortunately seems to accelerate in the age cohorts older than 45.

TREATMENT NEEDS

The main objective in designing the CPITN was to provide guidelines and measurable goals related to the provision of periodontal care for populations. To this end the treatable-disease categories TN0-3 were defined. The various assumptions underlying this system have been discussed elsewhere. Only the implications of the results calculated by this system will be dealt with here.

In common with Manji and Sheiham (1986), Louw et al (1989) and Srivastava et al (1986), the calculation of treatment times by individual, cohort and community estimated massive amounts of time. In some studies the number of time units required to provide treatment have been converted into exact numbers of man-hours and personnel quotas. Using a time unit of 10 minutes, and multiplying this to population level, yield the enormous periods of between 7.8 and 209 * 10E5 hours. Even if the modification suggested by Gjermo et al (1983) is used, excluding TN3 and the need for dentists to do the work and allowing the exclusive use of auxiliaries to provide TN1 and TN2 levels of treatment, the number of working years is a massive 640 to 1693, depending upon which formulation of treatment need is used.

Clearly such estimates can have no direct use in reality. The figures may be modified by planning to employ large numbers of dental workers, by choosing to ignore the complex treatment category or be extending the time period during which such treatment must be provided, but a massive load of treatment still remains. Even the smallest estimate here, would be a

large burden to a developing economy. It seems that only by redefining the treatment need itself, can a more realistic solution be reached.

The smallest estimate is based upon an assumption that calculus does not necessarily cause a progression of periodontal disease to a severe state, and therefore does not necessarily need to be removed. The scaling of pockets up to about 6mm in depth can enjoy a substantial chance of remission (Takahashi et al 1989), so TN2* and TN3 subjects could receive this treatment, with the former given priority. The rest of the community would receive TN1. Special attention will be required for high risk subjects identified on the basis of medical history, young adults found on the basis of pocketing, attachment loss or other indicators.

However, this is all argued from a public health policy perspective, assuming that resources are limited and that demand is low in relation to need. The inevitability of 12-15% of a population eventually being affected by severe periodontal disease is assumed (Loe & Anerud 1978). The cost of intervention on a secondary level, it is assumed, would far exceed the likely benefits that may accrue from intervention.

The probability that TN2 level treatment on demand will have to be provided for a certain proportion of the population, is a fact that will have to be taken into account. Planning of services will therefore need to include the provision of clinical care to high risk patients and those demanding TN2 for example, for calculus-related halitosis, and a major Oral Health Education strategy to reach the community at large.

Despite these shortcomings of the CPITN, it has succeeded as a tool for drawing up a synopsis of periodontal disease status. Cutress (1986) noted that the CPITN had assisted in effectively describing the prevalence of gingivitis, and revealed a higher prevalence of calculus associated with gingivitis in young people than previously reported. In this study and the others reported, the CPITN has highlighted the very real dilemma of what should be considered normal or acceptable levels of periodontal disease, and what should be considered unacceptable and in need of further care. And even Manji and Sheiham (1986), conclude that the CPITN still appears to be an appropriate tool for planning dental services, but it is clearly essential to consider the limitations of resources actually available.

Although the results of this study have been found to have limited use in planning the specific manpower, time and other resources needed to effectively abolish periodontal disease in the community, they have highlighted a number of the problems. They have given a better idea of what would be encountered in setting up a community based strategy for secondary prevention. They have given a new perspective on the priorities in this area of oral health care and certainly emphasise the futility of treatment in the absence of systematic prevention programmes to limit the magnitude of periodontal conditions in subsequent cohorts. And the very presence of such vast amounts of periodontal ill-health, even if the "normal" should be redefined slightly, illustrates the importance of addressing the issue of periodontal disease at a

community level, where there seems to be a great deal of ignorance and certainly no ongoing intervention programme.

10 CONCLUSIONS

There is a shortage of information on the oral health of the Xhosa community in the Western Cape.

Caries prevalence rates are already high in young adults.

The large amounts of untreated decay may be considered an indictment of the authorities responsible for providing dental care to this community.

The existence of small amounts of severe periodontal disease in young adults is of concern.

The high prevalence of mild (and preventable) periodontal disease, reflects a low awareness of the condition and/or a lack of resources to control it.

A high tooth mortality rate and an absence of fillings, suggests that extraction is the only form of treatment made available to this community.

The absence of appropriate prevention strategies such as community oral health education and water fluoridation is reflected in these results. This should be addressed as a priority.

The CPITN index provides a helpful description of community periodontal disease status but leads to the calculation of unrealistically high estimates of resources to meet treatment needs.

The serious redefinition of what are acceptable levels of periodontal disease is a matter in urgent need of attention.

It is no coincidence that such poor oral health was observed in this, a poor, peri-urban squatter community. This study, serves as a sad reminder of the maldistribution of oral health and socio-economic resources in South Africa, something that will need to be rectified before any of the other proposed measures can enjoy a chance of success.

Various aspects of prevention and Primary Health Care have been discussed in the text. It seems certain that if oral health is to improve in this neglected community, then it is crucial for these oral health measures to be addressed in an integrated PHC approach. A concerted effort to bring health to the community in South Africa must surely be firmly based on the five PHC principles, including equity.

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12 APPENDICES

12.1 HISTORICAL BACKGROUND OF CROSSROADS

A decade of turbulent squatter history recently (June 1986) played itself out on a triangle of land just out of sight near the Cape Town airport. News headlines that echoed the struggle of this dispossessed and threatened people. Indeed the headlines refused to let it vanish silently beneath state bulldozers, and now render their own silent archival record of another apartheid victory.

The "squatter problem" has been a long standing thorn in the flesh for Cape Town's city fathers. Stemming from the growth of international capitalist links and the economic growth stimulated by mining developments in South Africa, a specific form of labour control and regulation evolved. The characteristics of migrant labour with its extensive legislation, had a profound effect on the development of the black working class.

By 1900, Cape Town was home for about 10 000 Africans. In 1901 the first removal of a black spot took place with the assistance of armed soldiers and trucks. Continued raiding and harassment attempted to keep these people in the designated squatter areas with limited success. Until 1950 it was the local municipalities who had the responsibility to provide housing but here as elsewhere little was done. In 1923 the Urban Areas Act formalized residential separation allowing "Natives" into urban areas only if their labour was required. The only black township built at this

time (1927) was Langa so the majority still lived in squatter camps on the periphery of the city. The economy grew at a rate of 9,8% p.a. between 1936 and 1946 swelling the migrant labour population even further. By 1948 the local squatter population had reached 150 000.

The arrival of a Nationalist government brought with it a relentless battle between squatters and a state which was determined to gain political and social control over every aspect of their lives. The tale of the "dompas" needs no retelling. The creation of controlled squatter camps was considered a short term solution to the "housing problem" in the Cape Peninsula. Women were "endorsed out" of the city in their thousands.

By 1962-63 repressive state action, low wages, unprecedented growth in manufacturing output and a number of other factors led to marginalisation of the workforce and introduction of the Coloured Labour Preference Policy in the Cape. This coupled with a freeze on family housing for Africans and limitation of residence rights somewhat later created a vast "illegal" black population in Cape Town. The number of contract workers continued to rise and whereas profit margins remained high the wages were able to be kept low. The housing shortage grew more critical by the year and by the mid-1970's, there were 37 squatter settlements in the Cape Peninsula. And as the state moved to destroy these settlements they met resistance for the first time in the Western Cape since the early 1960's. A resistance rooted in the bitter struggles of those years. However only Crossroads survived into the 1980's.

Beginning life as a "transit camp" set up by "white" local authorities who wished to reduce the size of Cape Town's fringe population, Crossroads began to take in the survivors of all the other demolition activities in the Peninsula. The intention was to sift and repatriate "illegals" to Ciskei or Transkei homelands. And from surveys done at the time, we learn that 50% of the men were employed. The other 50% of the men and 90% of the women were there without legal rights. Most had been living in Cape Town for over ten years !

Cole (1986) describes three phases in the first decade of the settlement's history. The first includes the active processes involved in community formation, building and defence during the years 1975 to 1978. The intervention of Dr Koornhof and the reform initiatives which alternately bloomed and withered from 1979 to 1983 make up the second phase together with struggles for political control both at the level of the state and internally. The third period, from 1983 to 1985 sees Crossroads interacting in a broader context with the political and social forces that produced the crisis South Africa is in the 80's.

During the first period, in 1976, the Divisional Council submitted an application to the Supreme Court to have Crossroads demolished on the grounds that it was a health hazard. The population stood at 10 000 and services provided were considered to be inadequate. A successful court action by the community gave the settlement legal status as an Emergency Camp and the Divisional Council as

landowner was obliged to provide basic services such as tap water, sewage and refuse removal. In spite of this they were to cry "Health Hazard" to the newspapers once again in 1984 (Argus 23/5/84) and suggest forced removal to Khayelitsha as the appropriate solution. As a reflection of how health authorities viewed this community, DIVCO's response is pertinent (MOH Dr L Tibbit: Argus 23/5/84). It is clear that as long as people had no legal right to be present in the area, planning of health services would take place as if their community did not exist. Political ideology preceded all other considerations.

Following the Supreme Court judgement, a period of "relative peace" ensued. Internally the community worked together to provide themselves with two schools, set up committees and other social control structures and built on established links with liberal outside organizations. Unlike other townships this area had the atmosphere of a liberated zone and whites were welcome and free to enter. The establishment of women's committees were a notable departure from the otherwise fairly traditional structuring of the community although this much later led to friction from the men who felt threatened by the effective and sometimes very prominent role played by the women. This period saw a growing involvement for the business sector represented by the Urban Foundation who attempted to assist with housing on condition the government granted an acceptable form of land tenure. This was not forthcoming until after the next two attempts at massive forced removal in early 1985. Through

out this time pass raids continued relentlessly, but the overall effect was to strengthen social cohesion and to promote unity and strength within the settlement.

The arrival of Dr Koornhof in late 1978 prevented an imminent attempt by Administration Board officials, SADF and police, to demolish Crossroads and evict its residents. He also brought with him a reformist approach that through negotiation and a series of broken promises, led to fragmentation of the existing community and the building of only part one in a projected three phase housing programme. No options of upgrading the existing settlement were entertained and only a fraction of the population were able to be included. Temporary permits to remain in Cape Town legally were a continual source of conflict and uncertainty. On expiry no renewal of permits took place and real uncertainty in this regard was only finally removed with the abolition of influx control laws in mid-1986.

The struggle to defend Crossroads now became transformed into resolving how to deal with the new housing on offer and other local issues. It was clear that Koornhof was dealing with Crossroads as "a problem in itself", that is, in isolation from the root of the whole problem in apartheid legislation.

One other important development during these years was the rise to power of Johnson Ngxobongwana as chairman of the "Crossroads Executive". With a hierarchy of headmen, his

ability to manipulate committees and to ruthlessly exclude any opposition, his stranglehold of control grew rapidly along with his personal bank balance.

Until 1983 the struggle in Crossroads related mainly to matters of local importance, to the survival and cohesion of the community. With the growth of extra-parliamentary opposition groupings and the intensification of political activity in South Africa as a whole, Crossroads finally began to be drawn in. In addition, the issue of forced removals became more universally challenged. The drought, economic recession and the partial moratorium on pass raids led to massive growth at the periphery of Crossroads. Frantic demolition by Development Board officials led to sometimes violent resistance by the community. Despite attempts at deportation to Transkei and Ciskei the attempts were appearing more and more hopeless. Worldwide publicity threw the spotlight back into this arena and a Nationalist minister stated publicly that Crossroads was a symbol of provocation and would be cleared at all costs. By this time the population had grown astronomically and by mid-1985 stood at 150 000 - 200 000 by Urban Foundation estimates. Influx control had clearly failed.

One final attempt at relocating the entire black population of Cape Town out in Khayelitsha was barely prevented in February 1985 leading to violent conflict and leaving 19 dead. Later in the year confrontation with the state reached another climax on broader political issues as the state of emergency began to take its toll in the Western Cape.

The conflict between more progressive groupings and the fascist Ngxobongwana hierarchy became more prominent in 1985 culminating in the banishment of all progressive organizations from Crossroads in May 1986 and finally the terrible "Witdoek" rampage that left many dead and thousands more homeless. A complete turnaround of opposition and conflict with the State and its agents the SAP became one of ghastly and efficient collaboration.

Health problems with widespread importance included TB, malnutrition, family planning, household accidents, childhood infections such as measles, and other infectious diseases. At certain times there was no doubt that demolition and exposure to winter rain and cold were the most severe threats to health. At other times police "riot control" methods were one's greatest threat to health!

In general the sociological circumstances described in this brief history were the determinants of health or ill-health in this community. Matters such as poverty, lack of employment, absence of land tenure, continual insecurity under influx control laws, inadequate housing, overcrowding, unhygienic surroundings.....these were the real issues that needed to be addressed if good health for all was to become a reality. The "Health Authorities" at no stage took positive steps to resolve such issues. It was left to a private group such as SACLA to provide some form of curative medical service from 1980 to 1986 and the Philani/SHAWCO nutrition group to assist in that area.

As far as dental facilities are concerned, only the efforts of students and staff of the UWC Dental Faculty have enabled any service to be rendered at all. It is also clear however, that this resides low down in the order of health priorities. There is no comparison between the importance of seeking dental treatment and the need to deal with some of the more life-threatening conditions listed above.

The life and crises of the Crossroads squatter community between 1975 and 1985 have been well documented in the press and a number of articles and books. This account is extensively derived from personal experience and the account by J.Cole in her thesis entitled "Crossroads 1975 - 1985: From squatter Community to Mini Bantustan". (Cole J. 1986)

12.2 DATA COLLECTION FORM

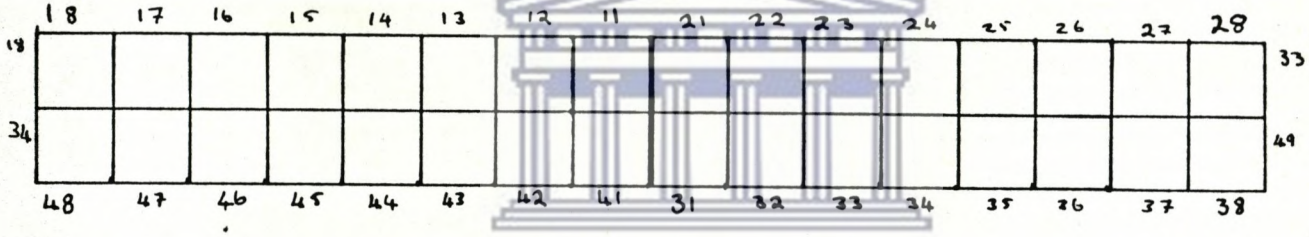
DATE [1][ ][ ][ ][ ][ ][6] (YEAR / MONTH / DAY) REG.No. [7][ ][ ][ ][ ][10] EXAM.No. [11][ ]

PERSONAL AND DEMOGRAPHIC INFORMATION.

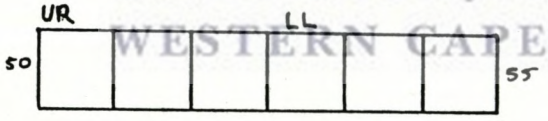
NAME ..... AGE [12][ ][ ][13] SEX [14][ ]

ADDRESS ..... [15][ ] PERIOD of TIME IN CITY(S) [16][ ][ ][17]

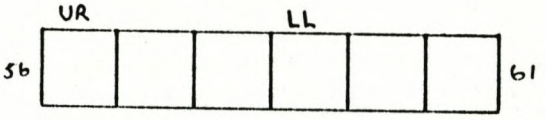
DMFT



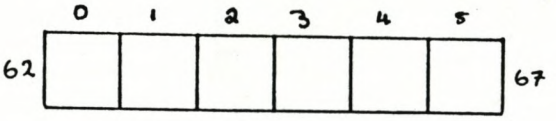
Clinical CPITN



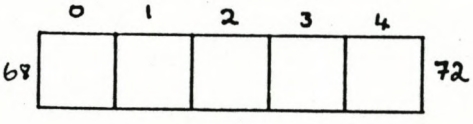
X-Ray CPITN



DMFT breakdown



CPITN breakdown



12.3 INTRA-EXAMINER VARIABILITY: PERCENTAGE METHOD

DMF(T) RESULTS WITH THE PERCENTAGE METHOD

1) 31 subjects out of a total 290 were re-examined.

2) 45 discrepancies occurred on the 992 teeth examined.
This represents agreement on 95.5% of the data.

3) A closer look at the error breakdown;

score 0 instead of 1 - 15 errors
score 1 instead of 0 - 15 errors
score 1 instead of 2 - 3 errors
score 2 instead of 1 - 3 errors
score 2 instead of 0 - 1 error
score 0 instead of 2 - 1 error
score 0 instead of 5 - 3 errors
score 5 instead of 0 - 2 errors
score 5 instead of 1 - 2 errors

The "decision errors" evident in the first four rows are accountable for most of the discrepancy (80% of the total).

4) The difference in accumulated DMF Totals:

D1 = 16 versus 20
D2 = 4 versus 4
M = 4 versus 3
F = 0 versus 0
Totals = 24 and 27

This difference in DMFT of 3 in a group of 31 is small. It reflects a mean difference of 0.097 per subject between the DMFT for initial and duplicate examinations.

CPITN RESULTS WITH THE PERCENTAGE METHOD

1) 83.8% of the sextants examined had identical scoring in both examinations. A total of 32 errors out of 186 sextants examined.

2) A closer look at the error breakdown;

score 4 instead of 3 - 2 errors
score 3 instead of 4 - 4 errors
score 3 instead of 2 - 9 errors
score 2 instead of 3 - 10 errors
score 2 instead of 1 - 3 errors
score 2 instead of 0 - 1 error
score 2 instead of 4 - 1 error
score 4 instead of 2 - 1 error
score X instead of 4 - 1 error

The main area of error is in the allocation of scores 2 and 3 which accounts for 59% of the discrepancies and accounts for the variability in about 10 % of sextants in the duplicate sample. This will not seriously alter the assessment of treatment need since for that purpose, scores 2 and 3 are grouped together.

4) Comparison of number of sextants scored differently:

score 0 = 0 versus 1

score 1 = 0 versus 3

score 2 = 15 versus 10

score 3 = 13 versus 13

score 4 = 3 versus 5

score X = 1 versus 0

Scores range more widely on the second examination but the differences are still very slight.

12.4 INTRA-EXAMINER VARIABILITY: KAPPA METHOD

Independant scores obtained from each examination collected from data sheets were entered into a database as shown below, including record number, examination number (X=1or2) and tooth number (T) or sextant name (SXT) for the periodontal data.

Rec	X	T18	T17	...	T41	T42	T43	T44	T45	T46	T47	T48	UR	UC	UL	LL	LC	LR
12	1	1	5	...	0	0	0	0	0	1	2	5	2	1	2	1	1	2
19	2	1	5	...	0	0	0	1	5	0	5	1	4	4	4	2	3	3

Cross-tabulation to a second data base file followed, enabling the diagnostic criteria (for eg caries), numbered 0,1,2 and 5, to be recorded for each tooth and examination, in a seperate field (A.. etc where first figure is A's score and second figure B's score).

Rec	X	T48	A00	A10	A20	...	A22	A52	A05	A15	A25	A55
1	1	5	0	0	0	....	0	0	0	0	0	1
2	1	1	0	0	0	....	0	0	0	0	0	0

The score combinations were summated and tabulated as below.

EXAMINER "A"

T18	A0	A1	A2	A5	TOTAL	
B0	9	1	0	0	10	(TB0)
B1	0	5	0	1	6	(TB1)
B2	0	0	3	0	3	(TB2)
B5	0	0	0	12	12	(TB3)
TOTAL	9	6	3	13	31	(n)
	(TA0,TA1,TA2,TA3)					

Row and column totals were subtotalled in seperate fields to fascilitate further processing.

SXT	TA0	TA1	TA2	TA3	TA4	TB0	TB1	TB2	TB3	TB4	n
UR	0	0	10	12	7	0	1	12	8	8	29
UC	0	1	21	6	3	1	2	15	10	3	31

Calculation of proportion of agreement (PT) and subsequently Kappa, derived from observed agreement (PT) and expected agreement (PE) for the whole sample was performed next (See formula in appendices). Individual expected cell values were obtained by multiplying row total by column total and dividing by n. The sum of agreement cells (A00, A11, A22, A33, A44) was then expressed as a fraction of n in the same way as PT.

TT	PT	PE	Ka
18	.903	.299	.862
28	.935	.287	.909

By condensing the table shown earlier, to a 4X4 table to show presence or absence of each categorical variable, each cell's contents were defined in seperate fields as shown.

SXT	n	n11	n12	n10	n21	n22	n20	n01	n02
UR	29	0	0	0	0	29	29	0	29
UC	31	0	1	1	0	30	30	0	31

	EXAM A		
EXAM B	PRESENT	ABSENT	TOTAL
PRESENT	n11	n12	n1.0
ABSENT	n2.1	n22	n2.0
TOTAL	n0.1	n0.2	n

By redefining the contents of these fields, subsequently prefixed by s, b, c, p, and m, seperate Kappa values together with their attendant Standard Error (SEk) values for the presence or absence of each categorical variable were calculated. Formulae for each component (a, b, and c) are listed in the appendices. Below is an example of kappa for sound verses affected tooth number 18, the relevant a,b and c components of the Standard Error calculation and the Standard Error value for Kappa - sound teeth.

TT	Ks	as	bs	cs	SEks
18	.773	4.56E+5	4526.32	3.81E+5	.124
28	.817	5.02E+5	1754.44	4.49E+5	.123

Combination of the values calculated for each tooth, provided mean PT and PE values and their associated standard deviation, standard error, 95% confidence limits and enabled the construction of confidence intervals (CL-, CL+) for PT and Ka.

TT	PT	PE	Ka	Ks	SEks
18	.903	.299	.862	.773	.124
28	.935	.287	.909	.817	.123
*	*	*	*	*	*
*	*	*	*	*	ETC.
AVG	.954		.877	.866	.072
STD	.048		.187		
ERROR	.009		.033		
CONF	.017		.065		
CL-	.937		.813		
CL+	.970		.942		

By constructing a confidence level around the average Ka value, an assessment of where individual teeth lay in relation to this could be made. A formula was written to check whether a given tooth-specific Ka value plus or minus its confidence limit, overlapped with the mean Ka 95% confidence interval. The proportion of teeth lying in or out of these limits is recorded at the foot of each "above","in","below" column. It is also possible to note where specific tooth types are located.

TT	Ka	SEa	CONF	K+CL	K-CL	ABOVE	IN	BELOW
18	.862	.033	.065	.927	.797	0	1	0
28	.909	.033	.065	.974	.845	0	1	0
Ka	AVG	.877	CONF	.065	AVG	.38	.41	.22

A similar comparison of each diagnostic category, based on overlap of the confidence intervals constructed around their mean value, was performed.

CATEGORY	AVG	SE	CONF	K+CL	K-CL	ABOVE	IN	BELOW
Ks SOUND	.866	.072	.141	1.007	.725	0	1	0
Kb CARIES(MIN)	.791	.092	.180	.971	.611	0	1	0
Ka+CL : PERIO	.755	CARIES	.942	AVG:CARIES		.20	.80	0
Ka-CL : PERIO	.609	CARIES	.813	AVG:PERIO		.25	.75	0

A tooth by tooth comparison of Ka and PT was performed using confidence intervals individually constructed around the Kappa and PT values for each tooth and checking for overlap.

Tooth and sextant-specific Ka value compared with tooth/ sextant-specific PT confidence intervals:

TT	Ka	SEa	CONF	K+CL	K-CL	ABOVE	IN	BELOW
18	.862	.033	.065	.927	.797	0	1	0
28	.909	.033	.065	.974	.845	0	1	0
CARIES						0	.78	.22
UR	.745	.037	.065	.810	.680	0	1	0
UC	.677	.037	.065	.741	.612	0	0	1
PERIO						0	.17	.83

Tooth and sextant-specific PT value compared with tooth/ sextant-specific Ka confidence intervals:

TT	PT	SEpt	CONF	K+CL	K-CL	ABOVE	IN	BELOW
18	.903	.009	.018	.921	.886	0	1	0
28	.935	.009	.018	.953	.918	0	1	0
CARIES						.22	.78	0
UR	.828	.029	.057	.884	.771	0	1	0
UC	.806	.029	.057	.863	.750	1	0	0
PERIO						.83	.17	0

FORMULAE

Cohen's Kappa statistic: $k = \frac{Pt - Pe}{1 - Pe}$

where Pt is the proportion of agreement observed, Pe the proportion of agreement expected. The numerator therefore reflects agreement observed by chance and the denominator, the maximum agreement beyond chance that would have been possible given the marginal distributions of the disease condition.

P values were calculated as in the classic Chi- square test: row total times column total divided by grand total.

In the case of YES/NO or Presence/Absence judgements, a simplified formula is offered:

$$k = \frac{n(n11 + n22) - (n1.0*n0.1 + n2.0*n0.2)}{n^2 - (n1.0*n0.1 + n2.0*n0.2)}$$

Standard Error for kappa:

$$SEk = \frac{\sqrt{(a + b - c)}}{(n^2 - (n1.0*n0.1 + n2.0*n0.2))(\sqrt{n})}$$

where

$$a = n(n11[n - \{n1.0 + n0.1\}\{1 - k\}]^2 + n22[n - \{n2.0 + n0.2\}\{1 - k\}]^2)$$

$$b = n(1 - k)^2(n12(n0.1 + n2.0) + n21(n0.2 + n1.0)^2)$$

and $$c = (n^2k - (n1.0*n0.1 + n2.0*n0.2)(1 - k))^2$$

Standard Error for mean PT and Ka values was calculated as:

$$SE = \frac{Std.Dev.}{\sqrt{(n-1)}}$$

Confidence limits (95%) for kappa:

$$CL = 1.96 * SEk$$

The standard error may be used to set confidence limits about the underlying population value using the standard normal curve theory.

$k \pm 1.96 * SEk$ = an approximate 95% confidence interval for the underlying value

12.5 CPITN CALCULATION AND TABULATION

TABLE 8.2.1

The percentage of subjects, distributed according to each stage of the disease.

H Count number of persons with scores of 0 only

B Count number of persons with 1 as the highest code

C Count number of persons with 2 as the highest code

P1 Count number of persons with 3 as the highest code

P2 Count number of persons with 4 as the highest code

Divide all these counts by the total number of dentate subjects examined.and multiply by 100 to get percentages.

The same procedure is repeated for each age cohort.

TABLE 8.2.2

The mean number of sextants affected per person, for each stage of the disease

U (healthy) Count the number of sextants coded 0

V (bleeding +) Count the number of sextants coded 1,2,3,4

W (calculus +) Count the number of sextants coded 2,3,4

X (pockets) Count the number of sextants coded 3,4

Y (++pockets) Count the number of sextants coded 4

Z (no teeth) Count the number of sextants coded X

Calculate the Mean Number of Sextants affected (MNS).
Divide each count value by the number of dentate subjects.

TABLE 8.2.7

The treatment needs expressed as percentage of subjects, distributed according to the type of treatment required. For the second and third levels of treatment need, the mean number of sextants requiring treatment appears in brackets.

Values are drawn from Tables 8.2.1 and 8.2.2.

% TN1	=	%B + %C + %P1 + %P2	from Table 8.2.1
% TN2	=	%C + %P1 + %P2	from Table 8.2.1
		(MNS, calculus or worse	from Table 8.2.1
% TN3	=	%P2	from Table 8.2.1
		(MNS, deep pockets)	from Table 8.2.2

TABLE 8.2.6

The frequency distribution of the number of sextants per person scored with Codes 0-4 and X. The proportion of the sample with a given number of healthy sextants can be determined.

For each subject count the number of Code 0 sextants
the number of Code 1 sextants
the number of Code 2 sextants
the number of Code 3 sextants

the number of Code 4 sextants

the number of Code X sextants

For each of the above six categories, count the number of subjects with 0, 1, 2, 3, 4, 5, and 6 sextants.

This procedure was followed for individual age cohorts as well as for the sample as a whole.

CALCULATION OF PERIODONTAL TREATMENT TIMES

TABLES 8.2.8 and 8.2.9

The source of data for this set of calculations was drawn from Table 8.2.1 above, containing the mean number of sextants requiring treatment by age cohort and treatment category.

The MNS values were multiplied by the number of subjects in each cohort (n). This generates a total number of sextants requiring treatment by age cohort and treatment category.

These totals were then multiplied by the appropriate Time Unit value for each category, and summated into one total.

The mean was then determined for each age cohort and the sample as a whole.

12.6 CPITN FREQUENCY DISTRIBUTION TABLES

		CODE 0	CODE 1	CODE 2	CODE 3	CODE 4	CODE X
15-19	0	42	25	2	20	43	44
	1	5	12	2	16	5	3
	2	2	3	8	7	1	2
	3	0	5	13	3	0	0
	4	0	4	10	2	0	0
	5	0	0	11	1	0	0
	6	0	0	3	0	0	0
20-24	0	48	31	2	25	45	49
	1	2	12	4	8	5	2
	2	2	5	4	11	2	0
	3	0	3	8	4	0	1
	4	0	0	18	2	0	0
	5	0	1	9	1	0	0
	6	0	0	7	1	0	0
25-29	0	41	34	0	24	37	33
	1	1	5	2	6	4	3
	2	0	1	4	8	1	2
	3	0	1	9	4	0	2
	4	0	1	10	0	0	1
	5	0	0	4	0	0	1
	6	0	0	13	0	0	0

		CODE 0	CODE 1	CODE 2	CODE 3	CODE 4	CODE X
30-34	0	36	33	2	10	30	27
	1	0	4	4	14	5	8
	2	2	0	8	3	3	1
	3	0	1	5	5	0	1
	4	0	0	8	4	0	1
	5	0	0	6	1	0	0
	6	0	0	5	1	0	0
35-44	0	37	36	7	11	27	30
	1	1	3	4	8	5	4
	2	1	0	5	8	1	1
	3	0	0	8	8	4	2
	4	0	0	7	3	0	1
	5	0	0	3	0	1	1
	6	0	0	5	1	1	0
45-54	0	39	38	10	8	17	29
	1	1	1	7	6	7	7
	2	0	0	8	13	4	2
	3	0	1	8	9	6	0
	4	0	0	4	3	3	2
	5	0	0	3	1	1	0
	6	0	0	0	0	2	0
55-64	0	19	19	6	2	6	11
	1	0	0	4	6	4	4
	2	0	0	4	4	3	1
	3	0	0	2	4	5	2
	4	0	0	3	3	0	1
	5	0	0	0	0	1	0
	6	0	0	0	0	0	0

		CODE 0	CODE 1	CODE 2	CODE 3	CODE 4	CODE X
65 +	0	11	10	5	0	2	6
	1	0	1	3	6	2	2
	2	0	0	1	3	3	0
	3	0	0	0	2	4	1
	4	0	0	1	0	0	2
	5	0	0	1	0	0	0
	6	0	0	0	0	0	0
ALL(No.)	0	273	226	34	100	207	229
	1	10	38	30	70	37	33
	2	7	9	42	57	18	9
	3	0	11	53	39	19	9
	4	0	5	61	17	3	8
	5	0	1	37	4	3	2
	6	0	0	33	3	3	0
ALL(%)	0	94.1	77.9	11.7	34.5	71.4	79
	1	3.4	13.1	10.3	24.1	12.8	11.4
	2	2.4	3.1	14.5	19.7	6.2	3.1
	3	0	3.8	18.3	13.4	6.6	3.1
	4	0	1.7	21	5.9	1	2.8
	5	0	.3	12.8	1.4	1	.7
	6	0	0	11.4	1	1	0

12.7 CPITN TABLES OF TREATMENT TIME

TIME UNITS REQUIRED					TN2=TN2*		TN3→TN2*		TN2→TN1 TN3→TN2	
AGE	TU1	TU2	TU2*	TU3	Tot.	Mean	Tot.	Mean	Tot.	Mean
15-19	282	687	168	49	1186	23.7	2994	10.6	1119	6.7
20-24	301	796	211	62	1369	26.3	3505	11.6	1253	5.9
25-29	229	645	120	41	1035	24.6	2647	11.6	1000	8.4
30-34	207	600	231	77	1115	29.4	2932	14.2	921	4.0
35-44	204	603	282	216	1304	33.4	3505	17.2	924	3.3
45-54	219	646	406	420	1690	42.3	4633	21.1	985	2.4
55-64	105	314	222	243	883	46.5	2440	23.4	475	2.1
65+	58	169	116	132	475	43.2	1308	22.6	260	2.2
ALL	1627	4515	1792	1279	9213	31.8	24386	15.0	7012	3.9

TIME REQUIRED (TU=10 min)					TN2=TN2*		TN3→TN2*		TN2→TN1 TN3→TN2	
AGE	T1	T2	T2*	T3	Tot.	Mean	Tot.	Mean	Tot.	Mean
15-19	47	115	28	8	198	4.0	499	1.8	187	1.1
20-24	50	133	35	10	228	4.4	584	1.9	209	1.0
25-29	38	108	20	7	172	4.1	441	1.9	167	1.4
30-34	35	100	39	13	186	4.9	489	2.4	153	.7
35-44	34	100	47	36	217	5.6	584	2.9	154	.5
45-54	37	108	68	70	282	7.0	772	3.5	164	.4
55-64	17	52	37	41	147	7.7	407	3.9	79	.4
65+	10	28	19	22	79	7.2	218	3.8	43	.4
ALL	271	753	299	213	1536	5.3	4064	2.5	1169	.7

TIME REQUIRED (TU=5 mins)			TN2=TN2*		TN3→TN2*		TN2→TN1 TN3→TN2	
AGE	T1	T2	T2*	T3	Tot.	Mean	Tot.	Mean	Tot.	Mean
15-19	4	10	2	1	33	.7	83	.3	31	.2
20-24	4	11	3	1	38	.7	97	.3	35	.2
25-29	3	9	2	1	29	.7	74	.3	28	.2
30-34	3	8	3	1	31	.8	81	.4	26	.1
35-44	3	8	4	3	36	.9	97	.5	26	.1
45-54	3	9	6	6	47	1.2	129	.6	27	.1
55-64	1	4	3	3	25	1.3	68	.6	13	.1
65+	1	2	2	2	13	1.2	36	.6	7	.1
ALL	23	63	25	18	256	.9	677	.4	195	.1

12.8 MNS BY CPITN CODE, AGE AND SEX

USING WHO PREFERRED CALCULATION I.E. N=No. of subjects

BOTH	SND	BLD	CALC	PKT3	PKT4
15-19	.20	1	3.40	1	.20
20-24	.10	.70	3.80	1.20	.20
25-29	0	.30	4.20	.80	.10
30-34	.10	.20	3.30	1.60	.30
35-44	.10	.10	2.80	1.70	.80
45-54	.10	.10	2	1.90	1.60
55-64	0	0	1.60	2	1.50
65 +	0	.10	1.30	1.60	1.80
ALL	.10	.40	3.10	1.40	.60
MALE					
15-19	.10	.60	3.80	1.20	.20
20-24	0	.50	3.90	1.30	.20
25-29	.10	.30	4.70	.70	.20
30-34	0	.10	3.30	1.90	.40
35-44	0	0	2.40	2.30	1
45-54	0	0	1.40	1.90	2.40
55-64	0	0	1.40	1.70	2.10
65 +	0	0	.30	2	2.30
ALL	0	.20	3	1.60	.80

FEMALE	SND	BLD	CALC	PKT3	PKT4
15-19	.20	1.40	3	.90	.20
20-24	.20	.90	3.60	1	.10
25-29	0	.30	3.70	.90	.10
30-34	.20	.30	3.40	1.30	.20
35-44	.20	.20	3.40	1.10	.60
45-54	.10	.20	2.60	1.90	.70
55-64	0	0	1.90	2.40	.80
65 +	0	.20	2.40	1.20	1.20
ALL	.10	.60	3.20	1.20	.40

METHOD OF CUTRESS ET AL (1987) I.E. N=No.of sextants

CODE 3/AGE	n	MNS	SD	t(95%)	CI	CL+	CL-
15	49	.18	.21	2.030	.061	.24	.12
20	52	.21	.25	2.030	.070	.28	.14
25	42	.14	.18	2.030	.056	.20	.08
30	38	.29	.28	2.030	.092	.38	.20
35	39	.33	.30	2.030	.098	.43	.23
45	40	.32	.23	2.030	.074	.39	.25
55	19	.36	.32	2.093	.154	.51	.21
65	11	.39	.16	2.201	.106	.50	.28

CODE 3/SEX	n	MNS	SD	t(95%)	CI	CL+	CL-
35 MALE	20	.31	.27	2.093	.126	.44	.18
35 FEMALE	19	.34	.33	2.093	.158	.50	.18
45 MALE	20	.30	.23	2.086	.107	.41	.19
45 FEMALE	20	.34	.22	2.086	.103	.44	.24
55 MALE	11	.29	.21	2.201	.139	.43	.15
55 FEMALE	8	.45	.21	2.306	.171	.62	.28
65 MALE	6	.46	.13	2.447	.130	.59	.33
65 FEMALE	5	.31	.18	2.571	.207	.52	.10

CODE 4/AGE	n	MNS	SD	t(95%)	CI	CL+	CL-
15	49	.02	.07	2.030	.020	.04	-.00
20	52	.03	.07	2.030	.020	.05	.01
25	42	.02	.07	2.030	.022	.04	-.00
30	38	.04	.10	2.030	.033	.07	.01
35	39	.13	.24	2.030	.078	.21	.05
45	40	.29	.32	2.030	.103	.39	.19
55	19	.38	.37	2.093	.178	.56	.20
65	11	.38	.21	2.201	.139	.52	.24

CODE 4/SEX	n	MNS	SD	t(95%)	CI	CL+	CL-
35 MALE	20	.15	.28	2.093	.131	.28	.02
35 FEMALE	19	.10	.20	2.093	.096	.20	.00
45 MALE	20	.43	.32	2.086	.149	.58	.28
45 FEMALE	20	.16	.26	2.086	.121	.28	.04
55 MALE	11	.53	.41	2.201	.272	.80	.26
55 FEMALE	8	.18	.19	2.306	.155	.33	.03
65 MALE	6	.46	.13	2.447	.130	.59	.33
65 FEMALE	5	.30	.27	2.571	.310	.61	-.01

12.9 DMFT DATA BY AGE AND SEX

CONFIDENCE LIMITS FOR DMFT DATA - SELECTED AGE COHORTS

AGE	SEX	n	DMFT	SE	t(95%)	CL	CL+	CL-
15-19	BOTH	50	11.300	.705	2.010	1.417	12.72	9.88
25-29	BOTH	42	13.024	1.059	2.021	2.140	15.16	10.88
35-44	BOTH	39	11.821	1.065	2.021	2.152	13.97	9.67
55-64	BOTH	18	14.833	1.870	2.101	3.929	18.76	10.90
25-29	MALE	19	9.842	1.224	2.093	2.562	12.40	7.28
25-29	FEMALE	23	15.652	1.452	2.069	3.004	18.66	12.65
55-64	MALE	10	11.700	2.565	2.228	5.715	17.41	5.99
55-64	FEMALE	8	16.455	2.006	2.306	4.626	21.08	11.83

MISSING TEETH BY AGE

AGE	n	MEAN-M	SE	t(95%)	CL	CL+	CL-
15-19	50	3.92	.449	2.010	.902	4.82	3.02
20-24	52	3.52	.523	2.010	1.051	4.57	2.47
25-29	42	6.69	.976	2.021	1.972	8.66	4.72
30-34	38	6.55	.899	2.021	1.817	8.37	4.74
35-44	39	6.82	1.044	2.021	2.110	8.93	4.71
45-54	40	6.70	.781	2.021	1.578	8.28	5.12
55-64	18	11.50	1.905	2.101	4.002	15.50	7.50
65 +	11	12.46	2.192	2.201	4.825	17.28	7.63

MISSING TEETH BY SEX

AGE	SEX	n	MEAN-M	SE	t(95%)	CL	CL+	CL-
15-19	MALE	25	3.120	.393	2.060	.810	3.93	2.31
15-19	FEMALE	25	4.720	.784	2.060	1.615	6.34	3.10
25-29	MALE	19	3.842	.799	1.224	.978	4.82	2.86
25-29	FEMALE	23	9.043	1.502	1.452	2.181	11.22	6.86
35-44	MALE	20	5.800	1.695	2.086	3.536	9.34	2.26
35-44	FEMALE	19	7.895	1.184	2.093	2.478	10.37	5.42
55-64	MALE	10	9.000	2.620	2.565	6.720	15.72	2.28
55-64	FEMALE	8	14.625	2.507	2.006	5.029	19.65	9.60

CERTAIN DMFT DATA BY AGE AND SEX

15-19	BOTH	SD	MALE	FEMALE
DMFT	11.3	5	10.3	12.3
SOUND	20.7	4.8	21.7	19.7
DC	5.3	2.6	5.1	5.4
DX	2	1.8	2	2
MISSING	3.9	3.2	3.1	4.7

20-24	BOTH	SD	MALE	FEMALE
DMFT	10.1	4.5	10.3	10
SOUND	21.9	4.5	21.7	22
DC	4.8	2.5	4.5	5
DX	1.7	1.4	1.5	2
MISSING	3.5	3.7	3.9	3

25-29	BOTH	SD	MALE	FEMALE
DMFT	13	6.8	9.8	15.7
SOUND	19	6.8	22.1	16.3
DC	4.1	2.4	4.3	4
DX	2.2	2.1	1.7	2.6
MISSING	6.7	6.3	3.8	9

30-34	BOTH	SD	MALE	FEMALE
DMFT	12.1	6.4	12.8	11.3
SOUND	19.9	6.4	19.2	20.7
DC	3.6	2.2	3.3	3.8
DX	1.9	1.6	2.1	1.7
MISSING	6.6	5.5	7.3	5.7

35-44	BOTH	SD	MALE	FEMALE
DMFT	11.8	6.6	10	12.9
SOUND	20.2	6.6	21.2	19.1
DC	3.2	2.7	2.9	3.5
DX	1.8	1.9	2.1	1.5
MISSING	6.8	6.5	5.8	7.9

45-54	BOTH	SD	MALE	FEMALE
DMFT	11	6	9.2	12.8
SOUND	21	6	22.8	19.3
DC	2.4	1.7	2	2.7
DX	1.8	2	1.5	2.2
MISSING	6.7	4.9	5.6	7.8

55-64	BOTH	SD	MALE	FEMALE
DMFT	14.8	7.9	11.7	18.8
SOUND	17.2	7.9	20.3	13.3
DC	2.3	1.7	2.1	2.6
DX	1	1.2	.6	1.5
MISSING	11.5	8.1	9	14.6

65 +	BOTH	SD	MALE	FEMALE
DMFT	16.5	6.7	13.7	19.8
SOUND	15.5	6.7	18.3	12.2
DC	1.8	1.9	.5	3.4
DX	2.2	2.8	.5	4.2
MISSING	12.5	7.3	12.7	12.2

ALL	BOTH	SD	MALE	FEMALE
DMFT	11.8	6.2	10.7	13.1
SOUND	20.1	6.2	21.3	18.9
DC	3.8	2.6	3.5	4.1
DX	1.9	1.8	1.7	2
MISSING	6.2	5.8	5.4	6.9

12.10 CHI-SQUARE TESTS: DMFT, D, M BY AGE AND SEX

SUMMARY FOR CORRECTED SIGNIFICANT VALUES:

DMF BY SEX	df = 3	p = .03
M BY SEX	df = 1	p = .02
M BY AGE	df = 3	p = .00001
M BY AGE	df = 1	p = .003
D BY AGE	df = 3	p = .0002
D BY AGE	df = 1	p = .0495

DMF BY SEX	0-6	7-12	13-16	17+	TOTAL	0-12	13+
MALE	30	68	28	22	148	98	50
FEMALE	16	65	23	38	142	81	61
TOTAL	46	133	51	60	290	179	111
CHI-SQUARE					8.965		2.208
p					.0298		.1370
ODDS RATIO							1.476
CL+							2.444
CL-							.892

DMF BY AGE							
15-24	14	59	16	12	101	73	28
35-64	17	40	19	22	98	57	41
TOTAL	31	99	35	34	199	130	69
CHI-SQUARE					7.090		3.770
p					.0690		.0520
ODDS RATIO							1.875
CL+							3.544
CL-							.995

M BY SEX	0-5	6-10	11-15	16+	TOTAL	0-10	11+
MALE	96	34	8	10	148	130	18
FEMALE	74	34	17	17	142	108	34
TOTAL	170	68	25	27	290	238	52
CHI-SQUARE					7.780		6.058
p					.0507		.0138
ODDS RATIO							2.274
CL+							4.460
CL-							1.166

M BY AGE							
15-24	80	15	5	1	101	95	6
35-64	46	31	8	13	98	77	21
TOTAL	126	46	13	14	199	172	27
CHI-SQUARE					25.678		8.896
p					.00001		.00286
ODDS RATIO							4.318
CL+							12.639
CL-							1.549

D BY SEX	0-5	6-10	11-15	16+	TOTAL	0-10	11+
MALE	87	49	12	0	148	136	12
FEMALE	65	66	10	1	142	131	11
TOTAL	152	115	22	1	290	267	23
CHI-SQUARE					6.758		.011
p					.0800		.9176
ODDS RATIO							.917
CL+							2.405
CL-							.372

D BY AGE	0-5	6-10	11-15	16+	TOTAL	0-10	11+
15-24	37	51	12	1	101	88	13
35-64	66	28	4	0	98	94	4
TOTAL	103	79	16	1	199	182	17
CHI-SQUARE					19.821		3.858
p					.00019		.0495
ODDS RATIO							.288
CL+							.998
CL-							.083

12.11 LIST OF FIGURES AND TABLES