PERIODONTAL DISEASES IN TANZANIA.

A STUDY ON SUSCEPTIBILITY AND PREVENTION PROGRAMMES

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A THESIS SUBMITTED FOR THE AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE UNIVERSITY OF DAR ES SALAAM

1994

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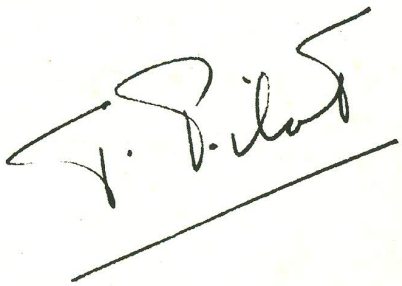
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ABSTRACT

The aim of this thesis was to study the epidemiology, susceptibility and prevention programmes with regard to periodontal diseases in Tanzania. Economic constraints to a large extent restrict the availability of both facilities and professional manpower. The level of periodontal disease destruction had been reported to be limited, although calculus and bleeding were frequently found. In an attempt to confirm the previous descriptions of the prevalence and severity of periodontal diseases in Tanzania, and to identify subjects for the study on susceptibility, a descriptive study was undertaken. 553 subjects from urban and rural Morogoro were examined for width of attached gingiva, calculus, gingival recession, gingival bleeding and probing pocket depth. In conformity to the previous studies, the results showed abundance of calculus and gingival bleeding. In spite of the poor oral hygiene, the destructive phases of periodontal diseases were not frequently present and these seem to be a problem for only a part of the population, mostly at older age.

The large variations between and within individuals that were seen, prompted the desirability of early identification of particularly susceptible subfractions of the population. In this context, clinical and microbiological examinations were performed. Bleeding/plaque ratio and

its association with periodontal destruction, as well as its potential to identify subjects with periodontal destruction, were studied in 26 subjects who exhibited at least three teeth with pocket depth of ≥5 mm (cases) and 28 subjects exhibiting no pockets deeper than 3 mm (controls). The cases had significantly higher gingival bleeding scores than the controls, but comparable plaque scores. The use of an extended scale of bleeding (0-2 points) was more discriminative between cases and controls than a compressed scale of bleeding (0-1 points).

Microscopic examination of spirochetes in plaque samples from pockets showed higher percentages of spirochetes than from non destructive sites, which corroborates with earlier findings. At non destructive sites, a significant higher percentage of spirochetes was found in cases than in controls, indicating a so far not described host effect. Despite the significant difference in percentage of spirochetes between cases and controls, spirochete counts did not provide a reliable measure to identify subjects with destructive diseases.

The impact of oral health education and the removal of calculus in the prevention / management of periodontal diseases were investigated in three groups (intensive oral health education, less intensive oral health education and control) of students over a period of 23 months. No effects of oral health education (OHE) in reducing bleeding and retarding calculus growth were

demonstrated at a level of clinical significance. The scaling effects on bleeding were small and of no clinical significance, whereas the overall clinical effects of scaling were very limited in this study.

It is concluded that the periodontal conditions are within the range previously reported for Tanzania and other East African countries. Individuals with destructive periodontal diseases could be identified on the basis of their bleeding score at the gingival margin and with the use of the modified bleeding/plaque ratio. Furthermore, the study challenges the essence of carrying out large scale oral health education programmes and scaling in the existing cultural, social and economical situation in Tanzania .

DECLARATION

I declare that this thesis has not been submitted for a diploma or degree in any other University

Date Nov, 1994

B.S. Lembariti

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CHAPTER 1

INTRODUCTION

1.1. THE PERIODONTIUM IN HEALTH AND DISEASE

The periodontium is defined as the tissues together forming the supporting and investing apparatus of the teeth: gingiva, alveolar bone, periodontal ligament and root cementum.

The teeth are firmly secured to the jaws by the collagen fibres of the periodontal ligament and the supra crestal connective tissue which insert into the cementum surface of the tooth and the associated alveolar bone. The gingiva protects these structures from the oral environment and is attached by collagen fibres to the alveolar bone and connected to the crown of the tooth by an epithelial attachment, called junctional epithelium. Apical to the epithelial attachment the gingiva is connected to the root cementum by collagen fibres (Fig. 1.1).

In health, the periodontal tissues are firm and intact, thus providing adequate support to the teeth during their function in the mouth. When oral hygiene is not practised adequately, microbial aggregations, called dental plaque, accumulate on the surfaces of the teeth, particularly on retention sites at the gingival margin. Consequently, the adjacent

periodontal tissues are affected with inflammation as a result.

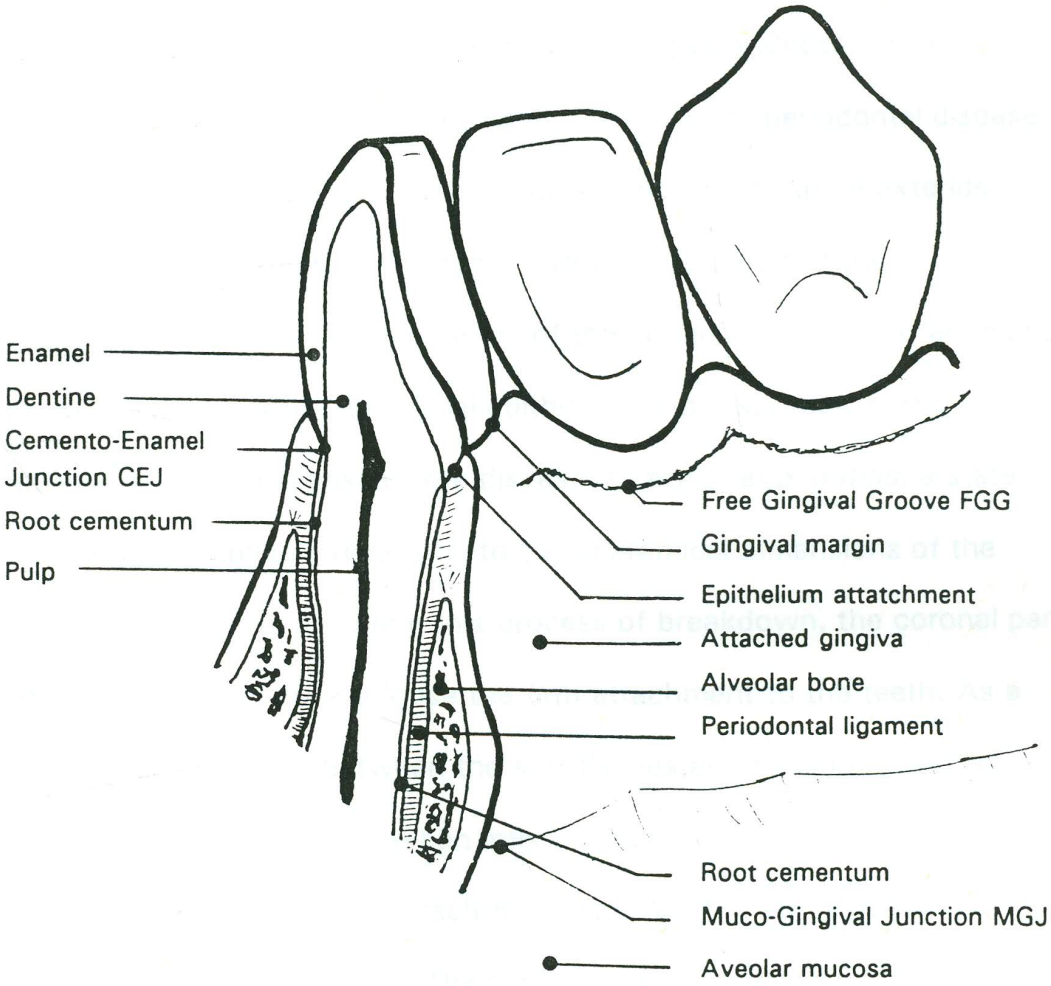


Figure 1.1. Anatomical features of the periodontium.

The persistance of inflammation in the periodontal tissues results in a disintegration of the anchoring collagen fibers. When the inflammatory

state continues, these desintegrated fibers become replaced by granulation tissue with chronic cellular infiltrate.

With the inflammation being limited to the gingiva, the disease is called *gingivitis* and is characterised clinically by gingival redness, oedema or enlargement, tenderness and bleeding. This state of periodontal disease is reversible to a healthy periodontium. As the inflammation extends deeper into the periodontal tissues, further destruction of the periodontium occurs i.e. breakdown of the connective tissue attachment, apical migration of the junctional epithelium and resorption of the alveolar bone. This phase of the disease is called *periodontitis*: a state that is not completely reversible to the anatomical dimensions of the healthy periodontium. During this process of breakdown, the coronal part of the periodontal tissues loose the firm attachment to the teeth. As a result, a space forms between the soft tissues and the tooth, the so-called periodontal pocket. When inflammation persists, the periodontal pocket continues to extend itself more apically, thereby spreading its contents, the dental plaque. The tooth will at the same time loose support and ultimately show increasing mobility. Also a gingival recession may appear - a more apical positioning of the gingival margin. When the periodontal disease proceeds over a long period of time, ultimately all support of the tooth may be lost. This leads to loss of teeth and ultimately to the loss of all teeth, thus making people edentulous.

Ideas and concepts about cause, onset and progression of periodontal diseases are developed and repeatedly adapted according to the results of ongoing scientific research. Since the middle of this century there is clear evidence that dental plaque is the cause of most, if not all types of periodontal diseases (Loesche 1987). Like other infections, the microbial - host interactions determine the nature of the resulting disease. The pathologic micro-organisms may cause disease indirectly, by producing microbial toxins, (Kahnberg et al. 1976) or directly, by invading the tissues (Listgarten 1965, Frank 1980, Saglie et al. 1981, Liakoni et al. 1987). The variations in the extent of the microbial attack as well as in the host response, account for a wide variety of disease patterns.

1.2. PERIODONTAL DISEASE ACTIVITY

Periodontitis by definition is an inflammation of the supporting tissues of the tooth - usually a progressive destructive change leading to loss of bone and periodontal ligament over a prolonged period of time. Periodontal disease activity, however, refers specifically to the active stage of the disease characterised by actual loss of supporting bone and connective tissue attachment. Three models have been described to explain the destruction of periodontal supporting tissues - the continuous model, the random burst model and the asynchronous multiple burst model (Socransky et al. 1984).

The *continuous model* implies slow, constant, and progressive destruction and is in line with data from cross sectional studies and older longitudinal studies. Cross sectional examinations and older longitudinal surveys in which data from different persons (and from different sites in the mouth) were pooled, have given the impression that destruction is continuous and slowly progressive over time.

The *random burst model* proposes short episodes of destruction followed by periods of no destruction, occurring randomly with respect to time and sites within an individual. Longitudinal monitoring of patients has revealed that specific sites within individuals lost millimeters of probing attachment (loss of periodontal attachment as examined by a periodontal probe) and substantial bone support within several months, while other sites in the same individual even gained periodontal attachment or remained static.

The *asynchronous multiple burst* model proposes that destruction occurred during a definite period of life and that the disease then went into remission. In this model, many sites would show bursts of activity over a limited period of time, followed by an indefinite period of inactivity. The major amount of periodontal destruction would probably occur during a period of a few years.

At present it is highly speculative to describe the exact pattern of progression of destructive periodontal disease since it is impossible to

identify small changes in attachment levels with a periodontal probe. In longitudinal studies, the problem exists that biological real but small changes in attachment loss (<2 mm) cannot be recognised whereas larger changes in attachment loss considered to be real changes could still be attributed to the measurement error (Janssen et al. 1988). Other, more accurate diagnostic methods are yet not available. Furthermore it should be understood that random bursts and remissions of tissue breakdown at given sites may occur, although the underlying disease progresses according to the continuous model (Manji & Nagelkerke, 1989).

It is proposed that it is no longer valid to talk of "periodontal disease" as a simple entity. It is better to use the term "periodontal diseases" for perhaps a group of diseases with similar clinical signs and symptoms, particularly so since periodontal diseases have been shown to be type, site, age, time, population and patient specific (Johnson et al. 1988).

The duration and frequency of the episodes in which the tissue is destroyed are unknown. Usually, the dental practitioner is only capable of documenting that an episode of disease in a patient has occurred, rather than determining the present state of disease activity.

The "gold standard" for determining the presence of active periodontal disease might, in theory, be represented by histologic and biochemical evidence of periodontal tissue destruction. Unfortunately, at present

there is no satisfactory "gold standard" for the clinical diagnosis of periodontal disease or periodontal health. Clinical markers, such as bleeding on probing and pocket depth remain poor predictors of disease progression (Haffajee et al. 1983). However, absence of bleeding on probing seems to be a reliable marker for a *stable* periodontium (Lang et al. 1990).

1.3. PERIODONTAL DISEASE PROGRESSION

Periodontal diseases progress at different rates in different patients at different times in different sites of the oral cavity. Different rates of disease progression have been reported in different age groups of untreated patients (Löe et al. 1986), treated patients (Lindhe & Nyman 1985), and patients on maintenance care (Axelsson & Lindhe 1978, 1981, 1991). Disease progression appears to occur at a much higher rate for patients and teeth having a history of periodontitis than without such a history (Papapanou et al. 1988, 1989). Since bleeding on probing is a poor predictor for disease progression (Lang et al. 1986) it has been suggested (Claffey et al. 1990, Badersten et al. 1990) that increasing probing depth in patients on maintenance care, may serve as a predictor of disease progression.

Findings from many cross sectional studies of different populations

suggest that periodontal diseases without treatment progress slowly with increasing age. The mean annual attachment loss has been calculated to be approximately 0.1 mm. (For review see Baelum 1985). These findings are in agreement with results from longitudinal studies in one group of Norwegian students and academicians and another group of tea labourers from Sri Lanka (Löe et al. 1978). In the Norwegian group, the annual attachment loss was less than 0.1 mm per tooth surface per year, while in the Sri Lankan group, attachment loss was considerably greater, and varied between 0.2 mm and 0.3 mm per tooth surface per year. In the Sri Lankan group, there was, in addition, a tendency for older individuals to loose more attachment per year than younger individuals. It was noted that a high rate of disease progression occurred at localised sites in the mouth and in a relatively small proportion of the Sri Lankan group.

In summary, the following conclusions can be drawn regarding the nature of periodontal disease:

a) the number of sites with destructive disease differs substantially between individuals;

b) different sites within the mouth exhibit different levels of destruction;

c) different sites and individuals may have varying rates of progression within a given time period.

With regard to the prediction of future periodontal destruction, it is concluded that:

d) the only predictor for a low risk of future periodontal destruction seems to be the absence of bleeding on probing;

e) the only predictor for a high risk of future periodontal destruction seems to be the already existing attachment loss (early in life) or, as it is sometimes described "attachment loss for age".

It is now recognised that several different forms of periodontal disease can be distinguished in humans. These distinct clinical entities have different bacterial profiles and furthermore they progress and respond differently to a given therapy.

According to the World Workshop on Clinical Periodontics (American Academy of Periodontology 1989) periodontal diseases have been classified in the following way :

Classification of periodontal diseases:

1. Gingivitis

1.1. Plaque-associated gingivitis

1.2. Acute necrotising ulcerative gingivitis

1.3. Steroid hormone-influenced gingivitis

1.4. Medication -influenced gingival overgrowth

1.5. Desquamative gingivitis

2. Periodontitis

2.1. Adult periodontitis

2.2. Early onset periodontitis

A. Prepubertal periodontitis

1. generalised

2. localised

B. Juvenile periodontitis

1. generalised

2. localised

C. Rapidly progressive periodontitis

3. Periodontitis associated with systemic diseases

4. Necrotising ulcerative periodontitis

5. Refractory periodontitis.

Among the different forms, the plaque-associated gingivitis and adult periodontitis are by far the most common of the periodontal diseases affecting large populations world wide.

Periodontitis related to HIV infection is a new type of periodontitis, that belongs to the group of periodontitis associated with systemic diseases. HIV related periodontitis is currently attracting professional attention (Kenrad et al. 1987, Reichart et al. 1987, Winkler & Murray 1987, Pindborg et al. 1988). Although periodontal diseases have been established as part of the spectrum of conditions associated with HIV infection, the links between them remain unclear (Robinson 1992). Different hypotheses have been proposed with regard to the etiology of periodontitis and gingivitis in HIV infected patients. A shift in the micro flora, changes in the host's defence mechanism as well as a direct effect of HIV have been postulated. Like the other groups of periodontitis associated with systemic diseases, these lesions are more painful and do not respond well to conventional periodontal therapy.

1.4. MANAGEMENT OF PERIODONTAL DISEASES

The purpose of periodontal treatment is to preserve the dentition. Therapy should resolve inflammation, arrest disease progression, maintain aesthetics, maximise patient comfort, regenerate lost periodontium, and create an environment that deters recurrent disease.

To accomplish these goals, both surgical and non-surgical procedures are employed. Plaque control has been a recognised means of achieving gingival and periodontal health since decades (Brandtzaeg & Jamison 1964, Löe et al. 1965). The control of plaque is considered to be an individual's responsibility which can be facilitated by appropriate oral health education. Oral health education programmes are geared to provide information, skills, involvement, support and reinforcements on tooth cleaning to achieve plaque control. Oral health education therefore, has been considered as the most important method for the prevention and control of plaque and hence periodontal diseases. Yet, there are very few public oral health education programmes in operation,whereby careful monitoring permits claims of success.

Education generally seems to have a paramount position in the promotional, preventive and therapeutic categories of solving oral health problems. Planned health education bears a number of goals. One of the goals is to reinforce and maintain existing positive behaviours or to change them to behaviours conducive to health. Another goal is to remove barriers that inhibit free choice, and to facilitate informed decision making. Health education therefore, is concerned with acquisition of knowledge and understanding, changes in beliefs and attitudes, and acquisition of skills (Tones 1987).

To achieve the goals, health education should not only take into account

forces within the individual that affect behaviour, e.g. beliefs, attitudes, interests, values, needs, motives, expectations, perceptions and biological factors. Also forces from outside, which interact with man's inner forces e.g. family, kinship, friendship, peer groups, economic conditions, medical facilities and services are important. Since these internal and external forces are in a constant state of dynamic interaction, the process of health education has to be fluid, flexible and continually tailored to changing situational and personal factors.

Reviews of the effectiveness of health education programmes that have been carried out in the industrialized countries, suggest that only a few programmes that included active participation of children and a high level of teacher cooperation and parent involvement, have been successful in changing oral health behaviour of school children (Lattal 1969, Evans et al. 1975, Albino 1978, Craft et al. 1981). The majority of the programmes in oral health however, have been shown to have serious limitations. They are usually ineffective in changing oral hygiene behaviour for an extended period, and to a degree which significantly affects periodontal health (Sheiham 1980, Sogaard & Holst 1988, Glavind 1990). Some of the shortcomings of the existing oral health education programmes are:

a) neglect of existing social - and cultural factors;

b) neglect of environmental factors and existing, or desired lifestyles;

c) neglect of peoples' interest;

d) too much disease oriented approaches;

e) fear arousal and victim blaming approaches;

f) neglect of integration into a broad health promotion strategy involving health as well as educational departments, agencies and individuals in the community groups.

The overwhelming majority of the experiences published so far, have been based on ideas and programmes that were carried out in the industrialized world. Not much is known about the effectiveness of oral health education programmes in the non-industrialized, developing countries, where experiences have shown, the prevailing conditions are quite different.

The other important aspect in the management of periodontal diseases is the removal of mineralised plaque or calculus. This procedure has been equivocally taken to be a prerequisite for periodontal health. Questions have been raised, however, to the traditional view of the importance of calculus in the periodontal disease process. It has been asked whether all calculus is as harmful as we have been let to believe. This is a crucial question which has important implications in terms of periodontal treatment and manpower resources, particularly when considering the delivery of periodontal care for communities. Scaling, which can only be delivered on a one-to-one basis, comprises the major

component of all periodontal treatment in terms of utilisation of manpower and resources. Manji and Sheiham (1986) have calculated that provision of scaling for every individual within a community, even on a once off basis, would be prohibitive in terms of manpower and resources in Kenya.

From recent conferences (Conference on clinical trials in periodontal diseases 1986, International conference on periodontal research 1987, Periodontology Today 1988) the consensus has emerged that if factors associated with successful treatment are abided (i.e. meticulous root debridement, compliance with personal and professional oral hygiene regimens), the potential for successful non-surgical care is greater than previously thought. Consequently, the non-surgical mode of treatment has been given increased considerations as a definitive model of therapy for patients with periodontal diseases. However, if signs of inflammation persist after non-surgical care, then surgical access may be necessary to achieve optimal healing and better possibilities for the patients to comply with the personal maintenance regime.

1.5. EPIDEMIOLOGY OF PERIODONTAL DISEASES

Since the early 1950's, indices have been created by combining one or more of the characteristic clinical symptoms of periodontal diseases into

one single connotation or figure (i.e. redness and swelling of the gingiva, probing pocket depth, loss of probing attachment, loss of alveolar bone, recession of the gingival margin, tooth mobility, tooth migration, tooth loss, etc.) to assess the prevalence and severity of periodontal diseases. Examples of such indices are Periodontal Index, PI, (Russell 1956), Periodontal Disease Index, PDI, (Ramfjord 1959), Extent and Severity Index, ESI, (Carlos et al. 1986).

In recent years, efforts have also been made to develop indices, that can assess the treatment needs of populations (e.g. Periodontal Treatment Needs Systems, PTNS, by Johansen et al. 1973; Periodontal Screening Index, PSE, by Oliver 1977, Community Periodontal Index of Treatment Needs, CPITN, by Ainamo et al. 1982). These indices allow fairly accurate assessments of the levels of periodontal conditions in populations for which specific interventions might be considered.

Results from different epidemiologic studies employing different methods of assessment have been interpreted to conclude that:

i) there is a strong association between improper oral hygiene and amounts of plaque, calculus and severity of periodontal diseases (Russel 1956, Scherp 1964, Ainamo 1989);

ii) in a given population, the severity of periodontal diseases increases with increasing age (Scherp 1964, Baelum 1985, Ainamo 1989).

Most studies revealed that periodontal diseases affect all populations and virtually all individuals worldwide. The distribution of those severely affected by the disease is however not even among the different populations. Some earlier studies for example have reported that Africans and Asians are more affected than other populations (Löe 1963, Waerhaug 1971).

1.6. PERIODONTAL DISEASES IN TANZANIA

The prevalence and severity of periodontal diseases in Tanzania has been studied since the early seventies. According to those studies carried out in Northern Tanzania (1973, 1976), in Dar es Salaam (1979) and in Mtwara (1982), Mosha and Normark (1983) reported a high prevalence of gingivitis, dental plaque and calculus, but a low prevalence of severe periodontal disease among Tanzanians of different age groups. The reported results are in agreement with data collected some years later (Gadegaard & Fejerskov 1983, Lembariti 1983, Baelum et al. 1986 a, b, 1987, Miyazaki et al. 1992). The latter studies reported a prevalence of severe periodontal diseases among adults in Tanzania which was less than 10%. The teeth most severely affected by loss of attachment in all age groups were the mandibular incisors and the first and second molars.

The data presented in most studies were collected by different investigators using various methods of sampling and examination.

Furthermore, the data generated from the studies have been presented in different ways; through averages or proportions affected and by either using the site in the mouth or the subject as unit of analysis. Because of different ways of data presentation, some studies cannot be compared, whereas differences in sampling and examination complicate the drawing of analogy. Hence, the drawing of conclusions on the basis of comparing surveys from different countries should be done with caution. One exception could be made regarding a survey in Kenya (Baelum et al. 1988a) and one in China (Baelum et al. 1988b) since both surveys had been executed by a group of investigators who had also carried out surveys in Tanzania (Baelum et al. 1986a, b, 1987). The investigators found a prevalence and a pattern of periodontal breakdown in Kenya and China which was identical to that existing in Tanzania. They reported that despite poor oral hygiene and large amounts of calculus few people experienced severe periodontal breakdown and tooth loss caused by periodontal diseases. A gradual recession of the margin of the inflamed gingiva appeared to be a notable characteristic of the loss of attachment.

Bearing in mind that every index has its limitations, the application of an index should be based on a rationale. It should meet the requirements assessed by the goal of the study. Although the CPITN has its limitations, the main advantage of using this index is its wide application in recent years and the large amount of studies now available for

comparison in the WHO Global Oral Data Bank, from which overviews are made yearly in Periodontal Profiles (Miyazaki et al.1992). For this reason, the prevalence and severity of periodontal diseases in Tanzania will be presented on the basis of CPITN data in Periodontal Profiles (Miyazaki et al. 1992) collected by Lembariti in 1982 and by Mosha in 1989 for adolescents and adults (Tables 1.1 and 1.2).

Table 1.1. Observed periodontal conditions measured by CPITN at age 15-19 years in Tanzania.

Year	Number of dentate persons	% of persons who have as highest score					Mean number of sextants with score				
		0	1	2	3	4	0	1+2+ 3+4	2+ 3+4	3+4	4
1982	137	2	5	30	62	1	1.5	4.5	3.8	1.6	0.0
1989	135	19	19	62	1	0	2.0	3.8	2.2	0.0	0.2

Table 1.1 with data for adolescents exhibits large variances in both the prevalence of periodontal conditions and in the average number of sextants affected. It is an illustration of the above discussion on difficulties of drawing comparisons between studies, even when the same index has been employed.

The prevalence of shallow pockets varied enormously between 1% (Mosha 1989) and 62% (Lembariti 1982). With regard to deep pockets, both studies indicate that deep pockets were very rare among adolescents. According to the overview of CPITN data in the WHO Global Oral Data Bank (Miyazaki et al. 1992), the Tanzanian findings are within the range of data obtained in most surveys from other countries in Africa. Comparisons with other countries of the world suggest similar situations. Only calculus seems to be more of a problem in the developing countries than in the industrialized part of the world. (See table with sequential order by mean number of sextants with calculus or higher score, WHO Global Oral Data Bank, 1 August 1992).

Table 1.2. Observed periodontal conditions measured by CPITN at age 35-44 years in Tanzania.

Year	Number of dentate persons	% of persons who have as highest score					Mean number of sextants with score					
		0	1	2	3	4	0	1+2+ 3+4	2+ 3+4	3+4	4	ex-cluded
1982	123	1	0	28	63	7	0.9	5.0	4.5	2.2	0.1	0.1
1989	197	6	3	81	9	1	1.2	4.5	3.9	0.3	0.0	0.3

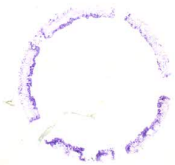
Estimated percentage of edentulous < 1

The periodontal condition of adults presented in Table 1.2 indicates again a large variance between the two studies. However, despite the large variances it is apparent that only few people experience complete

periodontal health. Oral hygiene, expressed as bleeding on probing was poor and calculus scores were high. The main increase in the prevalence of periodontal conditions between adolescents (Table 1.1) and adults seems to occur for shallow and deep pockets. However, the proportion of persons as well as the mean number of sextants per person, with deep pockets was small. This is even more striking when viewed in connection with the low mean number (0.1 and 0.3 respectively) of excluded sextants and the estimated national level of edentulousness of less than 1%. Tooth loss from periodontal diseases does not seem to be a frequent phenomenon in the 35-44 years age group in Tanzania.

The prevalence of deep pockets in this age group in Tanzania, is relatively low in comparison to other countries (see table with sequential order by % of persons having deep pockets, WHO Global Oral Data Bank, 1 August 1992). In general, countries of the industrialised world, seem to differ with respect to marked higher percentages of edentulousness (due most probably to the long term effect of dental caries and the treatment philosophies in the past). Contrary to the views of some fifteen years ago (WHO 1978) that periodontal diseases deprive many people of their teeth long before old age, data from the WHO Global Oral Data Bank (Miyazaki et al. 1992) have shown that few individuals actually experience severe periodontal diseases. The data also indicate that Africans and Asians are not more affected than Europeans.

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1.7. MICROBIAL INFECTION

It is well recognised that periodontal diseases are inflammatory processes induced by microbial plaque. Extensive research on the microbiological aspects has shown associations between certain microorganisms and different forms of periodontal diseases in the industrialized countries (Loesche 1987). However, little is known about the oral microbiota associated with periodontal breakdown in developing countries. A microbiological study of subgingival plaque in rural Kenya among 30-65 years old adults, revealed that those bacterial species commonly associated with deep periodontal pockets amongst North Americans (Tanner et al. 1979; Slots et al. 1980) and Scandinavians (Slots et al. 1986) were also found amongst these Kenyans (Dahlen et al. 1989). The prevalence per subject of Porphyromonas (P) gingivalis was 70%, of Prevotella (P) intermedius 100% and of A.actinomycetemcomitans 40%. The high prevalence of these microorganisms in adult Kenyans, was rather surprising in view of sporadic pathologic pocketing. Tanzanian children aged between 7 and 9 years have been reported to harbour small, medium and large spirochetes (Mikx et al. 1986). The mere presence of these organisms in the gingival crevice was not dependent upon the occurrence of gingival inflammation. However, gingivitis was found to be associated with increased proportions of spirochetes. Mikx et al. (1986) concluded that the early infection of spirochetes at non-bleeding sites in Tanzanian children shows that spirochetes were members of the normal

flora of pre-puberty children. A community in South Africa, with poor oral hygiene and persistent plaque deposits but no evidence of periodontal destruction, has been described by darkfield microscopy to have a percentage of spirochetes within the range found in patients with severe periodontitis (Africa et al. 1985).Furthermore it was found that in the presence of supra and subgingival calculus, a significant increase in the spirochete count occurred suggesting that calculus accumulations in the gingival sulcus could play an ecological role in the colonisation of spirochetes.

1.8. SUMMARY

The overall picture reveals that for the majority of people in most of the populations surveyed (both in Tanzania and elsewhere in the world), the progression of periodontal diseases is rather slow and seems to be compatible with the retention of a natural dentition until at least the age of 50, maybe 60 years. Furthermore, it appears that only subpopulations of the total population account for serious periodontal breakdown at an early age. This supports the risk concept that most periodontal conditions are fairly stable or only very slowly developing in most people. It is only a minority, on estimate 5-10% of the adult dentate population, that will suffer from serious periodontal breakdown. Even then, loss of teeth at an early age is not common. In these patients mostly single teeth are involved.

1.9. STATEMENT OF THE PROBLEM

On the basis of the foregoing, it can be concluded that the Tanzanian population has poor oral hygiene, much gingival inflammation and large amounts of calculus. Despite the poor oral hygiene and large amounts of calculus, the majority of the population has very little evidence of destructive periodontal disease. It is only a relatively small subfraction at older age that is responsible for most of the observed severe periodontal breakdown and tooth loss due to periodontal diseases.

For a developing country like Tanzania, the existing periodontal problems should be addressed in relation to the level of disease and within the existing constraints in resources and manpower. Of importance from an economical and public health point of view, would be to identify feasible modalities for the control and prevention of periodontal problems.

This thesis aims at addressing the areas of interest, namely:

a) to study more consicely the periodontal status of an adult Tanzanian population in order to determine the prevalence and severity of periodontal conditions and to compare the findings with previous data and to enable analysis of associations between different parameters of the periodontal conditions;

b) to study susceptibility of periodontal diseases and try to identify possible clinical and microbiological markers of periodontal

breakdown;

c) to study the feasibility of prevention oriented community periodontal programmes in the Tanzanian socio-economic and cultural setting.

Sub a)

A number of studies covering a wide range of populations and using various diagnostic criteria have assessed the periodontal status of Tanzanians. The recordings made and the presentations of these data vary considerably (discussed in section 1.6.). Sofar, the prevalence of periodontal conditions in a Tanzanian population according to the CPITN scoring system is yet uncertain. Furthermore, it is not known to which extent the hierarchical scoring system of CPITN overestimates the prevalence of gingival bleeding in a Tanzanian population since the prevalence of calculus seems to be high. Finally, detailed information regarding the prevalence of periodontal conditions that are not recorded by CPITN are needed to analyse additional clinical characteristics of the disease.

Sub b)

From the present treatment point of view, all patients with signs of gingival inflammation need to be treated in order to prevent loss of periodontal attachment. Obviously, this may lead to treatment of large

numbers of patients who might be relatively resistant to periodontal breakdown. It would therefore seem more reasonable to concentrate efforts on the proportion of individuals that are likely to develop periodontal breakdown to such extent that it causes major oral health problems.

The ability to detect in advance of overt disease, those at high and at low risk of developing disease, has many potential advantages for the patient, for the clinician and for public health planners. It allows for example, preventive efforts to be focused on those at risk in a more cost effective manner. At present, however, there is no reliable method to identify persons who will be at risk for severe destruction, leading to tooth loss.

Considerable effort is now applied to identify clinical and laboratory indicators of periodontal tissue destruction. The majority of these studies and their subsequent applications, involve substantial investments in terms of finances, equipment and manpower, which are scarce in the developing countries. In an attempt to explore more practical techniques of identifying indicators related to the susceptibility of periodontal diseases feasible in the Tanzanian context, this thesis studies some clinical and laboratory indicators.

1. Bleeding/plaque ratio as an indicator of severe periodontal diseases.

The onset and progression of gingival inflammation and periodontal breakdown can be considered to be a state of disturbed equilibrium between plaque and host response. The level of equilibrium between the amount of plaque and the host response determines the susceptibility for inflammation. It has been suggested by Van der Velden et al. (1985), that the ratio between bleeding and plaque may be a means of assessing susceptibility to periodontal diseases and may serve as a prognostic indicator for periodontal breakdown. The clinical measurements to assess the bleeding/plaque ratio are relatively easy to perform and most important, the assessment of the ratio does not require laboratory tests. Hence the utilization of such a ratio as an indicator for periodontal disease susceptibility would be an attractive and feasible measure in the Tanzanian context. The bleeding/plaque ratio has been studied by several authors (Abbas et al. 1986, Galgut 1988), but no conclusive recommendation to the efficacy of such an approach has been reached. All studies so far have determined the bleeding/plaque ratio according to Van der Velden's method. To our view however, the Van der Velden's method has some short-comings both in the clinical assessments as well as in the computation of the ratio, as will be described in more detail later on.

In the present study a modified bleeding/plaque ratio was assessed using a different method of scoring and computation:

a) The bleeding/plaque ratio is supposed to express an intimate

interaction between plaque and bleeding. Scoring of the bleeding tendency at the base of the gingival crevice or pocket according to Van der Velden's method, complicates the assessment of an intimate interaction since subgingival plaque cannot be quantitatively recorded. Therefore, bleeding was scored at the gingival margin (for the modified bleeding/plaque ratio) where supragingival plaque in direct contact to the gingival margin could be accurately quantified.

b) the bleeding was scored with an extended scale (0-2) in contrast to the compressed scale (0-1) used by Van der Velden and plaque was quantified by measuring the amount in millimeters from the gingival margin, instead of using the plaque index of Silness and Löe (1964).

c) the bleeding/plaque ratio computed according to Van der Velden's method, by dividing the sum of all bleeding scores by the total plaque score, ignores the site specific relationship between plaque and bleeding. Therefore, first the bleeding/plaque ratio of each site was calculated and subsequently the average of all sites was computed as the bleeding/plaque ratio of the subject.

2. Spirochete counts as an indicator of severe periodontal diseases. There is overwhelming evidence that micro-organisms and their products in dental plaque constitute the primary etiological agents of periodontal

diseases (for review see Slots 1979, Van Palenstein Helderman 1981). Several studies using either cultural techniques, for instance Slots and Genco (1984), and darkfield microscopy, for instance Listgarten and Hellden (1978) have attempted to identify the possible pathogens in periodontal destruction. Microscopic examination of subgingival samples seems to be a more practical procedure for screening purposes than the cultural techniques. In this respect it is of interest that proportions of spirochetes microscopically assessed in dental plaque have been associated with the degree of inflammation and destruction of the periodontium (Listgarten & Hellden 1978, Armitage et al. 1982, Loesche & Laughon 1982). However, so far no conclusive recommendation to the efficacy of spirochetes in dental plaque as an indicator for periodontal breakdown has been reached. The lack of distinction between subject dependent factors, site dependent factors as well as inflammation dependent and tissue destruction dependent factors in studies on the prevalence of spirochetes, may have masked the potential of spirochetes to be an indicator of periodontal tissue loss.

The present study was designed as a cross sectional case control study to assess whether spirochetes in subgingival plaque samples from sites without periodontal tissue destruction could serve as an indicator for the presence of tissue loss elsewhere in the oral cavity.

Sub c)

The efficacy of oral health education in the prevention and control of periodontal diseases has been demonstrated in patients attending dental clinics (Axelsson et al. 1991). The success of oral health education in large scale community programmes have shown various but mainly minor effects on oral health habits and oral health (Flanders 1987). To a large extent this is a result of the complexity of the whole issue of changing oral health habits of individuals who lack motivation. The largest and most important group that may be reached by health education is found in the school system. Children are not only fast learners and anxious to acquire new skills, they are also close to the teachers who may play the role of key persons in handing over the oral health message. Regardless of the equivocal nature of the evidence regarding the effectiveness of school dental health educational programmes it is important that they continue to be developed. Community oral health educational programmes have so far not been reported in non-industrialized countries. There is a need to investigate on the rationale and modes of oral health education appropriate and effective in populations of non-industrialized countries.

In the present study, the efficacy of oral health education programmes was assessed by comparing calculus and bleeding in three groups of children. Two groups received different oral health education programmes and a third group served as control.

Furthermore, the efficacy of calculus removal especially in large scale programmes was investigated. According to epidemiological data (CPITN), the provision of scaling for every individual in African communities is prohibitive in terms of manpower and resources.
In this study, the efficacy of calculus removal, in a population that has been reported to have abundance of calculus was investigated on bleeding tendency and reappearance of calculus. This was considered to be important since Tanzania has to decide whether or not to follow the traditional approaches of regular, professional removal of all hard and soft microbial deposits in all individuals as it is practised in the countries of the industrialized world.

In summary, the following questions were asked:

a. What is the pattern and distribution of periodontal diseases in an adult Tanzanian population? In addition, what are the associations between different characteristics of periodontal diseases?
   A *descriptive study* was designed to answer this.

b. Are there identifiable clinical and microbial parameters which can serve as indicators for periodontal breakdown in individuals and groups of the population?
   A *case control study* was designed to answer this question.

c. What is the impact of oral health education and instruction on periodontal health in the Tanzanian cultural and socio-economic situation? What mode of education is feasible and effective in the communities? A related question is the impact of professional removal of calculus on the condition of the periodontal tissues. An *intervention study* was conducted to answer this set of questions.

1.10. STUDY AIMS, OBJECTIVES AND HYPOTHESES

Study aim 1.

In a descriptive study, to describe the pattern and distribution of periodontal diseases in an adult Tanzanian population residing in Morogoro.

Objectives:

1. To determine the overall pattern and distribution of periodontal diseases in a Tanzanian population 20-65 years of age and to compare the results with previous data from Tanzania and other East African countries.
2. To investigate the associations between different characteristics of periodontal diseases.

Hypotheses: (Null hypotheses)

1. The prevalences of various periodontal disease conditions in the present sample are within the range of prevalences previously reported for Tanzania and East African countries.
2. The CPITN scores are hierarchical, that is: in patients and sextants with higher scores, also the conditions described by the lower CPITN scores are present.

Study aim 2.

In a case control study, to investigate clinical and microbial parameters related to destructive periodontal diseases.

Objectives:

1. To determine the efficacy of the bleeding/plaque ratio as an indicator of periodontal attachment loss.
2. To determine the efficacy of spirochete counts in plaque samples as an indicator of periodontal attachment loss.

Hypotheses: (Null hypotheses)

1. The bleeding/plaque ratio in healthy subjects and periodontally diseased subjects is not significantly different.
2. The proportion of spirochetes in subgingival plaque of healthy subjects and periodontally diseased subjects is not significantly different.

Study aim 3.

In an intervention study, to investigate the impacts of oral health education and the removal of calculus (scaling) on periodontal health in the Tanzanian cultural and socio-economic situation.

Objectives:

1. To determine the impact of health education on gingival health in the Tanzanian cultural and socio-economic context.
2. To determine the impact of calculus removal on gingival health in the Tanzanian population.
3. To determine the rate of calculus reappearance on scaled sites with time.

Hypotheses: (Null hypotheses)

1. Oral health education has no effect on gingival bleeding tendency.
2. Removal of calculus (scaling) has no effect on gingival bleeding tendency.
3. Calculus reappears at the same rate irrespective of the type of oral health education instituted.
4. The rate of calculus reappearance is proportional to time.
5. The variance of calculus reappearance is associated with baseline calculus scores.

CHAPTER 2

MATERIALS AND METHODS

This chapter gives a description of the experimental design, the selection of the subjects, the methods of examination and the statistical analyses for the three studies included in this work i.e., the descriptive study for the periodontal status in an adult population (see section 2.1.), the case control study on the susceptibility for periodontal diseases (see section 2.2.) and the intervention study (see section 2.3.).

2.1. THE DESCRIPTIVE STUDY

2.1.1. The design and sample

The study was designed as a cross sectional study involving both urban and rural adult populations. The sample was taken from the adult population, starting at age 20 and for practical reasons, the upper age limit was 65 years. This 20-65 year age group comprises of about 40% of the total population, living in urban and rural Morogoro, which is situated 200 km. west of Dar es Salaam.

The urban sample

From a list of factories in Morogoro municipality, one factory was

randomly selected. One, out of the three operating shifts in a day, of the selected factory (The Polytext), was randomly picked. All persons except a few (about 2%) of the staff working in this shift, together with the administrative staff in the factory, were examined. The non-participation was mostly due to illness or transfer during the execution of the study. Hence, none of the non-participation was caused by unwillingness to participate in the study.

The rural sample

Three out of the existing 60 villages in rural Morogoro were randomly selected. Out of the ten "ten cell" units in each village, five units were sampled. Except for a few members (3%) of the sampled "ten cell" units, all members, 30 to 65 years of age were examined. The 3%, though willing, could not participate due to their commitments outside the village during the period of examination. The age and sex distribution for the urban and rural sample is presented in Table 2.1.

Table 2.1. Age and sex distribution of the examined urban and rural population.

Group	Age	Male		Female		Total
		n	Mean Age	n	Mean Age	n
Urban	20-24	118	22	68	22	186
Urban	25-29	75	27	44	26	119
Urban	30-44	77	36	20	34	97
Rural	30-44	34	37	33	35	67
Rural	45-65	46	57	38	53	84
Total		350		203		553

2.1.2. The dentition of the studied sample

The number of teeth present in the sample are presented according to the region in the mouth, sex, age and residence in Table 2.2.

Table 2.2. The number of teeth present (mean ± standard deviation) according to region in the mouth; (posterior - post, anterior - ant of upper and lower jaw), sex (♂,♀), age and residence.

Age (yr)		Urban 20-24	Urban 25-29	Urban 30-44	Rural 30-44	Rural 45-64
Dentition	♂	27.5±0.9	27.4±0.9	26.8±1.9	26.6±1.7	22.9±5.1
	♀	27.4±1.1	27.0±1.8	26.8±1.8	25.7±2.2	20.8±6.3
Post upper	♂	7.9±0.3	7.8±0.4	7.7±0.7	7.5±0.9	5.9±2.2
	♀	7.9±0.3	7.8±0.9	7.3±1.3	7.3±0.9	5.1±2.3
Ant upper	♂	6.0±0.2	6.0±0.0	5.9±0.5	5.9±0.4	5.4±1.2
	♀	5.9±0.4	5.9±0.5	6.0±0.0	5.7±0.8	4.7±1.8
Post lower	♂	7.7±0.8	7.6±0.7	7.3±1.1	7.3±1.1	6.1±2.0
	♀	7.5±0.9	7.4±1.0	7.6±0.8	6.8±1.3	5.7±2.2
Ant lower	♂	6.0±0.1	6.0±0.1	5.9±0.5	6.0±0.2	5.6±1.0
	♀	6.0±0.0	6.0±0.0	5.9±0.2	5.9±0.2	5.4±1.2

With regard to the number of teeth no significant difference was found in the urban sample between males and females (ANOVA all p-values >0.10). Except for the anterior lower region, the ANOVA showed significant fewer teeth in females (despite their lower mean ages) than in males in the rural sample. The ANOVA also showed lower number of teeth in the older age groups. No significant difference was found between the urban and rural 30-44 year age groups (ANOVA all p-values >0.08).

2.1.3. Examinations

All subjects of the sampled urban and rural populations were examined inside a room while seated on a portable dental chair fitted with an artificial source of light, by one examiner (BSL). Using a graduated Williams Periodontal probe and a mirror, the following parameters were scored on six surfaces of each tooth (mesial vestibular, mid vestibular, distal vestibular, mesial oral, mid oral and distal oral) excluding the third molars.

Width of attached gingiva

The width in millimeters from the free gingival groove (FGG) to the mucogingival junction (MGJ) was recorded. Due to the lack of the mucogingival junction at the palatinal surface, the width of attached gingiva could not be assessed and therefore the upper oral surfaces were not scored.

Calculus

Using the same periodontal probe, calculus was recorded as 0: no calculus deposits; 1: calculus present; 2: abundance of calculus covering more than half of the anatomical crown.

Gingival recession

Recession was scored as the distance in millimeters from the exposed cemento-enamel junction (CEJ) to the gingival margin (GM).

Probing depth

The probing depth of the pockets was recorded in millimeters from the gingival margin (GM) to the base of the pocket.

In addition to the above examinations on six surfaces per tooth, bleeding on probing was only scored as being present or absent after searching examination on vestibular and oral surfaces at each sextant for the CPITN index (Ainamo et al. 1982).

After every examination of 10 subjects, one subject was randomly selected and re-examined two hours later for the assessment of the intra-examiner reliability.

2.1.4. Statistical analysis of the descriptive study

The analyses of the data collected in the descriptive study comprised of two different approaches. The first part deals with the description of the different periodontal conditions according to demographic and locational variations (within the mouth). In the second part, the periodontal conditions are displayed combined in one index: the "Community Periodontal Index of Treatment Needs (CPITN, Ainamo et al. 1982)".

2.1.4.1. Periodontal conditions: Variability in the sample

The examinations of the sample population (n = 553) included 28 teeth x 6 surfaces = 168 observations for calculus, pocket depth, recession and 126 observations for attached gingival width, totally amounting to maximal 630 recordings per person.

The analysis of the results involving such a big number of variables is complex and therefore a decision was made to aggregate the variables to a smaller set, taking into account the observed interrelations in the data.

Aggregation of data was achieved in the following way:

The first step in the procedure was to take the (individual) average of the values for comparable sites according to jaw (lower/upper), side (left/right), region (molar/premolar/ front), tooth site (mesial/central/distal) and surface (vestibular/oral).

In a second step, aggregation was performed using factor analysis. The most distinctive characteristic of factor analysis is it's data-reduction

capability. Given an array of variables, factor analytic techniques make it possible to see whether some underlying pattern of relationship exists so that the data may be rearranged or reduced to a smaller set that may be taken as source variables. This facilitates the construction of clusters that can be used as new variables in further analysis.

Factor analysis tries to explain a set of variables by a smaller set of so called "latent" variables. A latent-variable may be seen as an underlying variable that contains the common information of several measured ("manifest") variables. The latent variable cannot follow the measured variables exactly, due to measurement errors, random fluctuations (local deviations) and non-linearity. Therefore the variance explained by the latent-variables cannot be complete. On the average each of the K measured variables explains 100/K % of the variance. Factor analysis searches for latent variables explaining more than the average measured variable do. The mathematical term is that only factors are extracted with eigenvalue >1, as calculated from the correlation matrix. The extracted factors do not correlate with each other (orthogonal). In practice factors explaining only a little bit more than the average measured variable (e.g. eigenvalue up to 1.3) are often not well interpretable and not used in further analyses. In order to present a good and clear interpretation of the (new) latent variables, the original factors are often rotated along the directions of the measured variables. In this study the principle component way of extracting factors is used in

connection with varimax-rotation. Principle Components (PC) analysis was applied on the 15 variables as shown in Table 2.3 for each combination of jaw (upper/lower) and surface (vestibular/oral).
A pilot study showed that in most situations two factors were sufficient.

Table 2.3. The 15 measured variables entered in separate factor analysis (for jaw and for vestibular and oral surfaces).

Region	Side	Toothsite
Molars	Left	
Molars	Right	Mesial
Premolars	Left	Distal
Premolars	Right	Central
Front		
	5 x 3 = 15	

For the sake of uniformity each PC analysis was forced to produce two outcome factors (components). The outcome factors and their interpretations are presented in Table 2.4.

Table 2.4. Outcome factors and their percentage variance (explained by the two factors) as the result of PC analysis of the 15 measured variables.

Condition	Surface/jaw		Outcome factors		% Expl. Variance
Calculus	oral	lower	front + left	right	84
	oral	upper	front + left	right	83
	vest.	lower	front + right	left	78
	vest.	upper	front + prem	molar	78
Width of gingiva	oral	lower	front left	right	56
	oral	upper	not measured		
	vest.	lower	front + prem	molar	58
	vest.	upper	front + prem	molar	65
Pocket	oral	lower	front left	right	73
	oral	upper	front left	right	64
	vest.	lower	mesial + distal	central	66
	vest.	upper	mesial + distal	central	59
Recession	oral	lower	front + left	right	76
	oral	upper	front left	right	70
	vest.	lower	front + prem	molar	73
	vest.	upper	front + prem	molar	75

The percentage explained variance varied between 56 - 84%. This was an indication that in most cases the two outcome factors were sufficient. However, in oral surfaces in upper and lower jaw a clear distinction in two factors could often not be made, therefore three factors were chosen i.e. front region, left side and right side. The 15 measured variables of vestibular surfaces could be reduced by the PC analysis to mainly two outcome factors, front + premolar region and molar region. For the sake of uniformity and comparison all recordings on oral surfaces will also be further analysed according to front + premolar and molar region. In addition an analysis on the basis of approximal sites and central sites will be carried out for probing depths recordings. As a

result of the PC analysis, the original 630 variables were reduced to 51 outcome variables. Factor analysis offers the possibility to calculate the so called factor scores, i.e. a quantification for the "latent variable". In this situation where all 15 measured variables within each factor analysis had the same measurement unit (mm) except calculus, it was more forthcoming to work with sum scores to explain the latent variable. Further analysis was performed on the aggregated variables (sum scores) for the different periodontal conditions.

The periodontal conditions of different regions in the oral cavity according to sex, residence and age were analysed to determine the significance of differences:

a) Between males and females using a 2-way ANOVA with corrections for age and of residence.

b) Between the urban and rural groups of 30-44 years using 2-way ANOVA with correction for sex.

c) Between three age groups of the urban population using a 2-way ANOVA with correction for sex.

d) Between two age groups of the rural population using a 2-way ANOVA with correction for sex.

The residual standard deviation (Resid.s.d) following from the 2-way ANOVA using the five demographic groups and both sexes is presented as indication of the variability of the periodontal parameters within the

10 demographic groups. Further comparisons within the vestibular and oral surfaces were separately performed using the regions of the oral cavity that had emerged from the PC analysis as units for comparison (Table 2.5).

Table 2.5. Regions of the oral cavity as units for comparison using the paired t-test.

Vestibular surfaces	Oral surfaces
Upper versus lower jaw	upper versus lower jaw
Premolar + front versus molars	left versus right
	left versus front
	right versus front
Central versus proximal sites*	

* for probing depth only

2.1.4.2. Periodontal conditions according to the CPITN

The CPITN (Ainamo et al. 1982) which was originally designed to describe treatment needs in populations, has also been recommended for the assessment of the prevalence and severity of periodontal diseases. A description of the studied populations is given according to the CPITN method.

Differences with regard to sex, age and residence were tested using ANOVA applied on individual overall CPITN value. The underlying assumption of the CPITN is that it has a hierarchical structure, in the sense that calculus is always accompanied by bleeding and pockets

(probing depths > 3 mm) by calculus and bleeding. This assumption was checked in the present study.

2.2. THE CASE CONTROL STUDY

The aim of the case control study was to assess the efficacy of two potential markers of periodontal destruction: a) the bleeding/plaque ratio and b) microscopic spirochete counts in subgingival plaque.

2.2.1. The design and sample

The study design of the case control study was cross-sectional. The sample of the case control study was recruited from the population that was examined in the descriptive study (see 2.1.1.). Persons who experienced signs of destructive periodontal diseases (cases), and those who did not experience destructive periodontal diseases (controls) among the examined 553 individuals were selected. The selection of the study population was based on the following selection criteria:

cases : age 30 - 44 years
status $\geq$ 3 teeth with pocket depth of $\geq$ 5 mm

control : age 30 - 44 years
status $\leq$ 3 mm pocket depth overall.

On the basis of the above selection criteria, 32 controls and 30 cases comprised the sample for the case control study. Table 2.6 shows the distribution of the sample according to age and sex.

Table 2.6. Age and sex distribution of the cases and the controls.

Age (in years)		30-34	35-39	40-44	Total
Controls	♂	15	3	5	23
	♀	6	3	0	9
Cases	♂	6	11	5	22
	♀	1	3	4	8
Total		28	20	14	62

2.2.2. Examinations

While seated on a portable dental chair fitted with an artificial light, 26 cases and 28 controls were clinically examined for plaque, calculus, and gingival bleeding on probing. Four cases and four controls, though sampled, were not examined because of being away during the execution of the study. All teeth except the third molars were examined at the mid point of the oral surfaces i.e. palatinal for the maxilla and lingual for the mandible.

The selection of this site was based on the following:

1. Uniformity - one defined site for all examinations in a jaw.
2. Possible interferences from the conditions of the neighbouring teeth are minimum at this site.
3. Practicability and easiness in measuring the conditions at this site.

Using a graduated Williams periodontal probe and a mirror, plaque was

scored after washing the site with a spray of water and drying with air, as follows: score 0: no plaque; score 0.5: plaque detected only after probing; score 1: visible plaque and 1 mm in height at the midpoint of the gingival margin of the respective surface. If the plaque deposits were more than 1 mm in height, then the thickness in millimeters was recorded as the score for that site.

Calculus was scored as either present or absent.

Bleeding was scored as score 0: no bleeding; score 1: bleeding after 10 seconds and score 2: spontaneous bleeding. Bleeding was scored at the gingival margin and in the gingival crevice.

Bleeding at the gingival margin (GB) was provoked by inserting a pressure sensitive probe (Van der Velden 1979, employing a constant probing force of 0.75 N) 1 millimeter deep into the gingival crevice at the midpoint. Then the probe was retracted horizontally (perpendicular to the tooth) with the same constant force.

Periodontal pocket bleeding (PPB) was assessed according to the method of Van der Velden (1979). The recording of pocket bleeding was done according to the criteria used in the gingival bleeding (GB).

The bleeding/plaque ratio was assessed according to the method of Van der Velden et al. (1985) with PPB index (0-1). The ratio was computed by dividing the total mouth bleeding score by the total plaque score.

The modified bleeding/plaque ratio was based on GB index (0-2). The ratio was computed by first calculating the bleeding/plaque ratio at each individual site. In case the plaque score was 0, a ratio at the individual site could not properly be calculated. Therefore each bleeding-plaque combination was transformed in a "ratio" score, which is presented in table 2.7. The average of all scores of individual sites represented the modified bleeding/plaque ratio of a subject.

Table 2.7. Index of gingival bleeding - plaque combinations at the individual site.

	Bleeding score at the marginal gingiva		
	0	1	2
Plaque score			
0	0	6	10
0.5	0	4	8
1.0	0	3	6
1.5	0	2	4
2.0	0	2	3
2.5	0	1	2
≥ 3	0	1	2

2.2.3. Plaque samples

From each subject, cases and controls, one subgingival sample was taken at the midpoint of the oral surface of one of the upper premolars which showed bleeding on probing but no periodontal pocket and no calculus. In addition, in subjects with destructive periodontal disease

(cases) one subgingival sample was collected from a periodontal pocket of > 5 mm showing bleeding at the marginal gingiva after probing. Because of the scarsity of sites with deep pockets, the choice of sampling site depended on the location of pockets. So, when pockets were non-existent at the midpoint of the oral surface of the upper premolars, then proximal or vestibular surfaces of premolars or surfaces of molars were taken as sites for the plaque sample.

Before the plaque samples were collected, the identified sites were washed and isolated with cotton rolls. The supragingival plaque and calculus were carefully removed with curettes. The plaque samples were then taken with a clean curette by inserting the curette to the bottom of the pocket, placing it in contact with the root surface and subsequently moving it in a coronal direction in a scaling stroke. The sample thus obtained was suspended in one mL 4% phosphate buffered formaldehyde and stored at room temperature before examination.

After transfer to the laboratory, the sample was homogenised by ultrasonic treatment for 10 seconds at 10% output power of the homogenizer (Kontes U.S.A.). An aliquot of 5 μL of the plaque suspension was spread on a multitest slide (Flow Laboratories, U.S.A.). After heat fixation and staining with cristal violet and iodine, the sample was evaluated by light microscopy at 1200X magnification. In random

selected microscopical fields all spirochetes and all other bacteria were counted to at least 200 units. Samples with a density of more than 100 units per microscopical field were five times diluted. In the group of spirochetes "Large" spirochetes were separately counted. The "Large" spirochetes were irregularly winded, dark blue stained and had a width of about 0.5 μm. In the dark field microscopy they resembled the Large spirochetes defined by Listgarten and Hellden (1978). The investigation was conducted on a double-blind basis. One investigator (BSL) performed all the clinical examinations and the collection of subgingival plaque samples, whereas another investigator performed the microscopic counts, without awareness of the origin of the coded samples.

2.2.4. Statistical analyses of the case control study. Clinical part

Case control studies being observational in origin, always involve a danger of confounding. Possible confounders in such studies include the well known demographic variables e.g. sex, age, residence, etc. In this study only sex and age were not evenly distributed over the cases and controls (Table 2.8).

Table 2.8. Distribution of sex, age and residence over cases and controls.

	Sex		Age		Residence	
	Male	Female	30-36	37-44	Urban	Rural
Case	22	4	11	15	15	11
Control	19	9	19	9	18	10

Since the residence could not act as a confounder (due to its even distribution over cases and controls) it was not entered in the analysis. Differences in clinical parameters e.g. plaque score, calculus score, gingival bleeding scores, GB and PPB, as well as the bleeding/plaque ratio (Van der Velden et al. 1985) and the present modified bleeding/plaque ratio between cases and controls were tested using the ANOVA with case/control, male/female and 30-36/37-44 years as entrances.

The potential of clinical parameters to be used as markers of periodontal destruction was analysed in 2 x 2 contingency table analysis with the median value of the clinical parameter as selection criterion and the presence of periodontal destruction as validation criterion. On this basis, sensitivity and specificity together with odds ratio values were obtained.

2.2.5. Statistical analyses of the case control study. Microbial part

The design of the study allowed two comparisons of the proportion of spirochetes in the plaque samples:

a) Comparison of cases and controls on sites with gingivitis. This comparison was done using the ANOVA while correcting for sex and age differences between cases and controls. Due to the skewness in the spirochete counts, the ANOVA was carried out after square root transformation.

b) Comparison of sites with gingivitis versus sites with periodontal destruction within the group of cases. A paired t-test was applied in this comparison.

Due to the skewness of the spirochete distribution, the median and interquartile ranges will be presented rather than means and standard deviations.

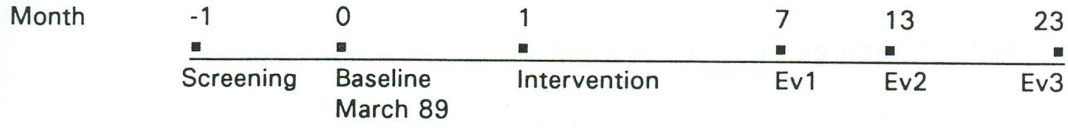
2.3. THE INTERVENTION STUDY

2.3.1. The design

The study was designed as a longitudinal follow-up study with a split mouth design component. Three groups of secondary school children participated in this study, two groups received oral health education (OHE) and one group served as control. All participating children including those of the control group underwent a scaling of the mouth according to a randomised split mouth design on contralateral quadrants.

The split mouth design enables an efficient comparison of scaled and non-scaled teeth, since biological variability between children is ruled out.

The design and time schedule for the study is shown in Figure 2.1.



Screening = selection of the study group.
Baseline = examination of calculus and bleeding.
Intervention = implementation of OHE and scaling.
Ev1, Ev2, Ev3 = examination of calculus and bleeding to evaluate the effect of the interventions.

Figure 2.1. Design and time schedule of the intervention study.

2.3.2. Selection of the target population

The study population was selected from students 14-18 years of age attending Form 1 in secondary schools in Morogoro. The rationale for selection of this group was:

1. Assurance of availability of students for the follow-up evaluations (captive group). Unless transfers are inevitable, most Form 1 students continue with their studies at the same school for a minimum of 4 years (until Form 4).
2. The young age group of Form 1 students is considered relevant

because the eruption of the permanent dentition (except the third molars) is complete in most individuals. Furthermore, this age group is approaching adulthood and is therefore involved in taking on own responsibility for matters of lifestyle, hygiene and health.

3. Calculus formation is assured. According to Baelum et al. (1988) and Lembariti et al. (1988) calculus formation starts early in life among Tanzanian and Kenyan populations. This has been further supported by a recent citation of Anerud et al. (1991), that the early formation possibly starts at or shortly after tooth eruption. Calculus has been reported to be seen first in the mandibular incisors and the maxillary first molars.
4. Teachers in the schools can fulfill the role of key-persons in the supervision of the OHE-programme.

Four co-education secondary schools in the Morogoro municipality were selected for the study. From each school, all Form 1 students (n = 718) were clinically screened for calculus deposits on the mesial and distal buccal surfaces of the 16 and 26 and on the mesial and distal lingual surfaces of the 34, 33, 32, 31, 41, 42, 43 and 44. The calculus was scored as: 0, no calculus deposits, 1, calculus present and 2, abundance of calculus.

On the basis of the amount of the deposits, the students most prone to calculus formation were identified as follows: The scores were added up

for each student (maximum score possible = 10x2x2=40). A threshold (score 18) was identified as the criterion for the first selection. 253 children exhibited a calculus score of $\geq$ 18. Students that had been exposed to dental treatment for the past five years were excluded (2%). The children who passed the first selection were divided into three groups according to the calculus score (scores 18-24; 25-30; $\geq$31). The sample in each school or combination of schools was stratified according to sex, age (14, 15, 16, 17, 18 years) and calculus scores (Table 2.9). A check on the quality of the stratification is described in Chapter 3.

The three groups were thereafter randomly assigned into OHE groups and a control group as follows:

Group 1 = no oral health education (Control 0)

Group 2 = less intensive oral health education (OHE 1)

Group 3 = intensive oral health education (OHE 2).

Table 2.9. Sex and age distribution of the stratified sample in the intervention study.

Group*	Sex	Age in years					Total
		14	15	16	17	18	
1	♂	1	6	14	10	5	36
	♀	3	7	5	2	0	17
2	♂	0	9	16	8	2	35
	♀	3	7	4	2	0	16
3	♂	2	7	15	8	3	35
	♀	2	7	5	1	0	15
Total		11	43	59	31	10	154

* 1 = Kigurunyembe Secondary School
* 2 = Morogoro Secondary School
* 3 = Jabal-Hira Secondary School and Forest Hill Secondary School.

2.3.3. Baseline examinations

The baseline examinations were carried out in a classroom in each school. The subjects were examined while seated on a portable dental chair fitted with an artificial light source. After thorough cleaning with a spray of water, cotton rolls and drying with air, calculus and bleeding were scored and recorded on prepared forms (see Appendix F). On each examination day 20% of the children were randomly selected for re-examination by the sole examiner (BSL). Each re-examination was perfomed after an interval of about 1 hour during which period 5 other subjects were examined. Reproducibility of the observations is presented in Chapter 3.

Calculus

Using a graduated Williams periodontal probe, calculus was scored on teeth presented in Figure 2.2 that are most prone to calculus formation (Sand 1949, Parfitt 1959).

17	16	15	14	13	12	11	21	22	23	24	25	26	27
---	B --- L	---	---	--- L	--- L	---- L	--- L	--- L	--- L	---	---	B --- L	---
47	46	45	44	43	42	41	31	32	33	34	35	36	37

B = buccal
L = lingual

Figure 2.2. Teeth and surfaces examined for calculus.

The scoring was done in half of millimeters according to Volpe and Manhold (1962), as the mesial diagonal, distal diagonal and midline calculus height (Figure 2.3).

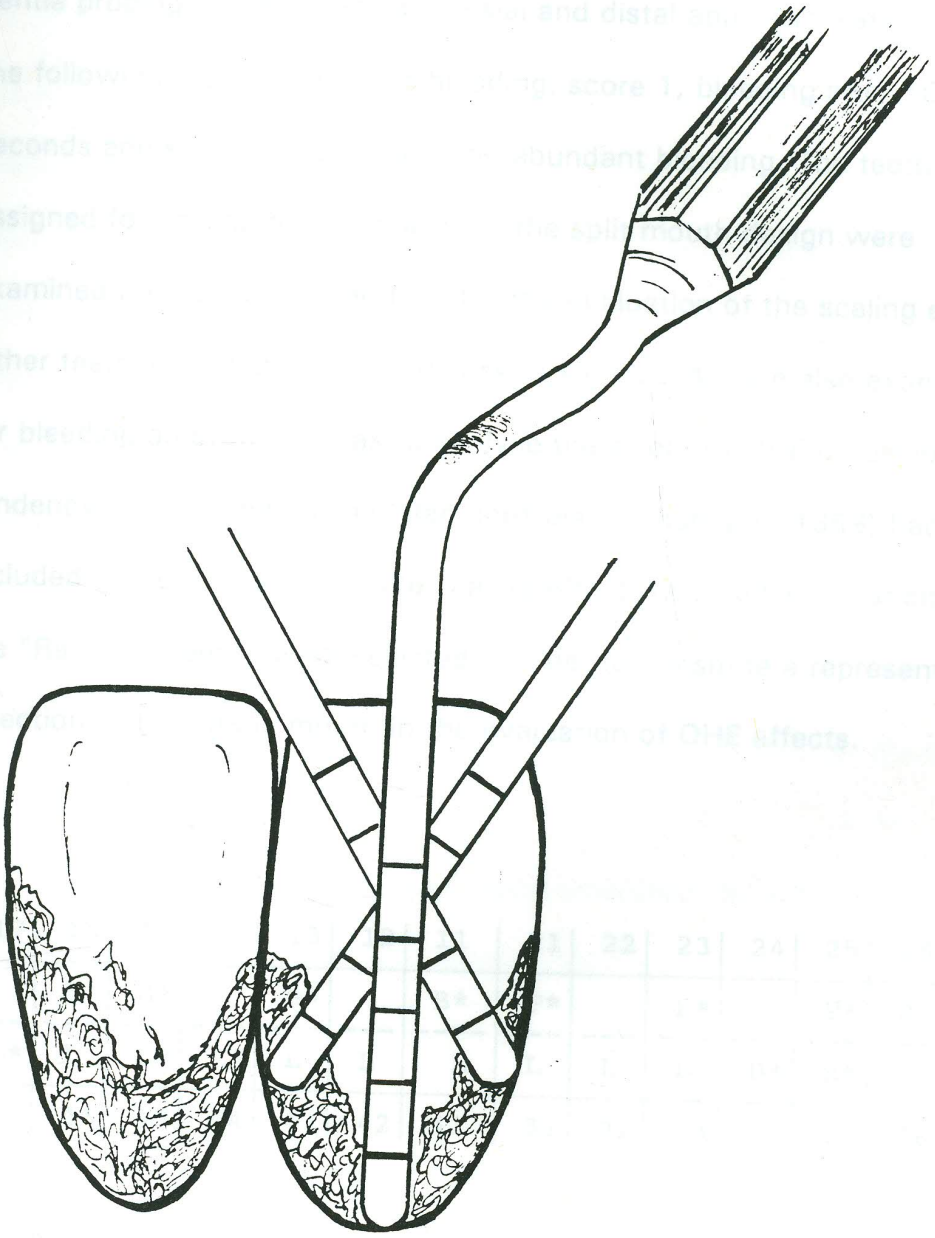


Figure 2.3. Calculus height measurements.

Gingival bleeding

Using a WHO TRS 621 periodontal probe, bleeding was scored after gentle probing in the pocket on mesial and distal approximal surfaces in the following way: score 0, no bleeding, score 1, bleeding after 10 seconds and score 2, immediate and abundant bleeding. The teeth assigned for scaling or non-scaling in the split mouth design were examined for bleeding on probing for the evaluation of the scaling effect. Other teeth indicated with an asterisk in Figure 2.4 were also examined for bleeding on probing so as to analyse the effect of OHE on bleeding tendency. Since some of the "Ramfjord teeth" (Ramfjord 1959) had been included in the evaluation of the scaling effect, teeth adjacent or close to the "Ramfjord teeth" were selected in order to consitute a representative selection of the whole mouth in the evaluation of OHE effects.

17	16	15	14	13	12	11	21	22	23	24	25	26	27
	B	B*		B*		B*	P*		P*		P*	B	
---	---	---	---	---	---	---	---	---	---	---	---	---	---
L*	L	L*	L*	L	L	L	L	L	L	B*	B*	L	B*
47	46	45	44	43	42	41	31	32	33	34	35	36	37

B = buccal
L = lingual
P = palatinal.
* Indicator teeth for evaluating OHE-effects on bleeding tendency.

Figure 2.4. Teeth and surfaces examined for bleeding.

In addition to the clinical examinations, the tool used for cleaning the oral cavity was asked from the subjects.

2.3.4. The intervention

Scaling

After the baseline examination, scaling and polishing of the teeth assigned for calculus examination (Figure 2.2) was performed according to the split mouth random method on contralateral quadrants. Selection of the contralateral quadrants i.e. upper right and lower left (UR + LL) or upper left and lower right (UL + LR) was done by the flip of the coin.

Oral health education programmes

The following regimens of health education were instituted for the three groups:

The control group received no oral health education. In practice this meant that they continued their habitual oral hygiene, without being exposed to any organised oral health educational programme.

OHE 1 (group education with one recall)- this group received oral hygiene instruction in groups. The children were asked to bring their own toothbrush for the instruction session. Almost all of them practised a horizontal stroke method of brushing. They were shown to apply these horizontal movements in shorter strokes and more on the marginal

gingival area than they used to do. A systematic method of brushing was instructed in order to promote brushing of all tooth surfaces. The children were asked to start to brush the upper right palatinal sites, then the upper front palatinal sites and the upper left palatinal sites. Subsequently the upper right buccal sites, upper front buccal sites and upper left buccal sites. Thereafter, in the same sequence, the mandibular teeth and finally the occlusal surfaces were brushed. This process of systematic brushing was guided step by step by the instructor during the instruction session. After one week the children were once recalled and their toothbrushing method checked and adjusted if needed. They were asked to apply this method of oral hygiene daily in the morning and evening.

OHE 2 (intensive group education with several recalls) - this group received the same oral hygiene instruction in small groups as the OHE-1 group. Instead of one recall, they practised systematic tooth brushing weekly in school under supervision of an instructed teacher. The dental team visited the two schools where this intervention programme was carried out regularly to ensure adequate execution. Supervised weekly brushing sessions were carried out during four months after baseline examination.

The whole intervention part of the study, i.e. identification of the sites for scaling, the actual scaling / polishing and the oral health education supervisions, were carried out without the knowledge and participation of the examiner (BSL). The exercise was conducted by a group that included a periodontist, an oral hygienist and a general dental practitioner. The examiner therefore was not aware which intervention programme had been executed, which school served as control and which sites had been scaled.

2.3.5. Drop outs in the follow-up

Drop outs did not occur frequently. The number of subjects examined throughout in the study is presented in Table 2.10.

Table 2.10. Sample sizes in the intervention study.

	Number of subjects			
	Baseline	Evaluation 1	Evaluation 2	Evaluation 3
Control	52	51	47	46
OHE1	50	50	49	48
OHE2	48	46	43	42
Total	150	147	139	136

The initial sample (n = 154, see Table 2.9) resulted in 150 students entering the study. Four students were transferred to other schools before the baseline was conducted. Finally at the end of the study, 14

students had dropped out. An analyses on selectivity of drop-outs was performed in Chapter 3.

2.3.6. Statistical procedures

Statistical analyses were done for the scaling effect and the OHE-effect.

Outcome variables

The outcome variables were based on calculus scores and bleeding scores at baseline and at follow-up examinations and on increment values of calculus and bleeding scores for each interval period. This resulted in the analyses of mean bleeding and calculus scores of teeth assigned for the scaling intervention at baseline and at evaluation 1, 2 and 3:

Scaled teeth (S_0, S_1, S_2, S_3) and

Non-scaled teeth (N_0, N_1, N_2, N_3) and

Differences between scaled and non-scaled teeth (E_0, E_1, E_2, E_3) and in addition bleeding scores of the indicator teeth for OHE effects:

Indicator teeth (I_0, I_1, I_2, I_3).

It is important to note that the S0 and E0 are values observed *before* the actual scaling was done and therefore allow comparison of scores at baseline rather than indicating a scaling effect. Interval changes represented by increment values between the examinations are coded:

Scaled increments (S_{01}, S_{02}, S_{03}, S_{12}, S_{13}, S_{23})

Non-scaled increments (N_{01}, N_{02}, N_{03}, N_{12}, N_{13}, N_{23})

Bleeding increments of indicator teeth (I_{01}, I_{02}, I_{03}, I_{12}, I_{13}, I_{23})

Increments of differences between scaled and non-scaled teeth (E_{01}, E_{02}, E_{03}, E_{12}, E_{13}, E_{23}).

Comparability at baseline:

Although the OHE-programme was assigned randomly to the schools, the randomisation was not done on an individual basis. It was therefore necessary to check the initial comparability of the three different OHE-groups. For this purpose, the overall mean bleeding and calculus scores were compared for the three OHE-groups using the one-way ANOVA.

OHE-programme effects

Because of the split mouth scaling in the three OHE-groups, a simple one-way ANOVA to evaluate OHE-effects was not possible. Therefore a two-way ANOVA was used according to OHE-programme and contralateral quadrants of the split mouth. Possible area effects UL + LR versus UR + LL were not to be expected and were not really relevant for the research question. Therefore "area" and "interaction" were introduced in the analysis as nuisance parameters, and as such no results on the area will be reported.

The observations on calculus showed a skewed distribution, and to

approximate a "normal" distribution, the square root transformation was applied in testing the OHE-effects for the direct observations N_1, N_2, N_3, S_1, S_2, S_3 and for the increments N_{01}, N_{02}, N_{03}, N_{12}, N_{13}, N_{23}, S_{12}, S_{13}, S_{23}. The increments for scaled teeth from the baseline to the follow-up evaluations (S_{01}, S_{02}, S_{03}) did not reflect the OHE-influences and were therefore not analysed.

The observations on bleeding were reasonably normally distributed. The evaluation concerned the direct observations N_1, N_2, N_3, S_1, S_2, S_3, I_1, I_2, I_3 and the increments N_{02}, N_{02}, N_{03}, N_{12}, N_{13}, N_{23}; S_{01}, S_{02}, S_{03}, S_{12}, S_{13}, S_{23}; I_{01}, I_{02}, I_{03}, I_{12}, I_{13}, I_{23}.

The analysis at various time points (evaluation 1, 2 and 3) gave insight in the effects of different OHE-programmes whereas the analysis of the increments gave insight in OHE-influences on the ungoing process of both calculus formation and gingival inflammation.

Scaling effects

Differences between scaled and non-scaled sites at different evaluations E_1, E_2, E_3 and the increments with regard to the baseline examinations E_{01}, E_{02}, E_{03} (only for bleeding), as well as the increments during the follow-ups E_{12}, E_{13}, E_{23} were analysed for both calculus and bleeding using the paired t-test. The test on the increments of the scaling effects showed how the influence of scaling changes over time.

OHE-effects in combination with scaling effects

In order to find an optimal combination in education (OHE) and treatment (scaling), the influences of the OHE-programmes on the scaling effects were evaluated for both calculus and bleeding on E_1, E_2, E_3 and increments E_{01}, E_{02}, E_{03} (only for bleeding) and E_{12}, E_{13}, E_{23}. These analyses dealt with the question whether children who received OHE had more benefit of the scaling.

The analysis of different effects, corresponding outcome variables, and the statistical techniques are summarised in Table 2.11.

Table 4.13. Proportions of the combination of periodontal parameters per CPITN score according to sextants in 45-64 year olds in the rural sample.

CPITN score	combinations*			Upper jaw Right	Front	Left	Lower jaw Left	Front	Right
2	-P	+C	-B	3	4	8	2	0	0
	-P	+C	+B	97	96	92	98	100	100
Total n				30	25	24	45	48	39
3	+P1	-C	-B	0	0	0	0	0	0
	+P1	+C	-B	0	8	0	0	0	6
	+P1	-C	+B	0	4	0	0	0	6
	+P1	+C	+B	100	88	100	100	100	88
Total n				30	26	24	10	23	18
4	+P2	-C	-B	0	0	0	0	0	0
	+P2	+C	-B	0	0	0	0	0	0
	+P2	-C	+B	0	0	0	0	0	0
	+P2	+C	+B	100	100	100	100	100	100
Total n				3	15	8	1	7	3

* -P, +P1, +P2 = probing depth of 0-3 mm, 4-5 mm, ≥6mm respectively
-C = no calculus present
+C = calculus present
-B = no bleeding
+B = bleeding present

4.3. DISCUSSION AND CONCLUSIONS

4.3.1. Periodontal conditions

The periodontal status of the studied population as described in section 4.1 can be summarised as follows:

1. Calculus was abundant in virtually all individuals. The prevalence varied, with more calculus being found in males, among the rural inhabitants and in older age groups.

2. On average, scores for gingival recession were not that high, but

quite some variability was demonstrated. More recession was found in males and in older populations. Within the oral cavity, more recession was evidenced on the free surfaces accessible to tooth brushing (i.e. buccal and lingual surfaces) than on the approximal surfaces. Among the free surfaces, the extent of the observed recession was similar, suggesting that mechanisms other than the vigorous brushing on the buccal surfaces are involved. Similar observations have been reported from another Tanzanian population by Baelum et al. (1987). The pattern of gingival recession was to a large extent in conformity with that of calculus, suggesting possible associations between recession and continuous presence of calculus.

3. Variations in the width of the attached gingiva were more or less in conformity with the anatomical profiles. No variations as regards to the gender, age and area of domicile (urban/rural) were shown.
4. The pocket probing depth showed quite some variations between and within (tooth site) individuals. On average, higher probing depths were scored at approximal surfaces, in males, among the rural people and in older age groups. The pockets however, were generally shallow (4-5 mm). Only a few were 6 mm or more.

The above results clearly indicate considerable variations in extent and severity of periodontal breakdown between and within individuals in the studied sample from Morogoro, Tanzania.

These variations are also reported in other

epidemiological studies (Cutress et al. 1982, Hugoson & Jordan 1982, Anerud et al. 1983, Beck et al. 1984, Baelum et al. 1986). On average, the severity of periodontal destruction as expressed by recession and probing depth was rather low. Furthermore, although the male, rural sample and older age groups experienced more destruction, the actual clinical differences were not substantial.

The above description of the periodontal status from the comprehensive study (section 4.1) was confirmed in section 4.2.1 in the regular CPITN tables. The CPITN results though, tended to underestimate the severity and to overestimate the prevalence when compared to the comprehensive scorings reported in section 4.1. The lack of sensitivity in the CPITN scoring system has also been reported by Almas et al. (1991).

CPITN however, has shown to be a good guide for the assessment of the later stages of the disease (Code 4).

An obvious feature in the results was the dominance of calculus at all ages. The calculus prevalence of almost 100% (CPITN scores 2, 3 plus 4) affecting more than five sextants per person at age group 35-44 years, on average corroborates with earlier studies in Tanzania reported in overviews of CPITN data in the WHO Global Oral Data Bank (Miyazaki et al. 1992). The percentage of persons with pockets (CPITN scores 3 plus 4) of 81% at age 35-44 years affecting 2.2 sextants on average, are in accordance with results of a survey in 1982,

but differs sharply from the 10% prevalence and 0.3 sextants reported for a survey in 1989 in the same WHO overview (Miyazaki et al. 1992). Most probably the 1989 sample was a special one, or the differences are due to the different interpretations of the CPITN criteria by the different investigators. More importantly perhaps, the overall findings on periodontal conditions in this study are consistent with the results of other comprehensive studies done on East African populations by Baelum et al. (in Tanzania 1986, 1987; and in Kenya 1985). From a global perspective, the reported findings together place Tanzania in the worst 1/3 category (mean number of sextants with calculus) and middle 1/3 category (percentage of persons with deep pockets) in the sequential order of affected populations in the world (for review see Miyazaki et al. 1992).

The null hypothesis 1 of the study aim 1 is therefore confirmed since the study has shown the prevalence of the various periodontal conditions to be within the range of prevalences previously reported for Tanzania and East African countries.

4.3.2. The hierarchy in the CPITN scoring system

As shown in section 4.2.2, the hierarchical structure of the CPITN seems to work reasonably well in the studied sample. The agreement between periodontal parameters in relation to the CPITN scores was high, especially in the older age groups and when the advanced stages of the

disease (codes 3 and 4) were present. Overestimation of the prevalence of bleeding in score 2 as has been reported for a Japanese population (Takahashi et al. 1988) and also to a lesser extent for individuals in Hongkong (Holmgren & Corbet 1990) was very limited in the present Tanzanian sample. A possible explanation for the lack of conformity in the findings between this and the cited studies might be the method to assess bleeding. In Japan and Hongkong bleeding was assessed on index teeth, whereas in this study bleeding was determined on all teeth of a sextant and consequently the chance of scoring bleeding in the present study was higher. Large overestimations of calculus in score 3 and 4 as has been shown for the Norwegian population (Grytten et al. 1989) were not experienced in the present study. This is probably due to the abundance of calculus in the Tanzanian population. With regard to calculus the present sample seems to be comparable with the Hongkong sample (Holmgren & Corbet 1990) where overestimation of calculus in score 3 and 4 was also low. Recording of the worst finding in the sextant instead of on the index teeth may improve the hierarchical power of the CPITN index.

The results of the present study confirm that the CPITN hierarchical system is a good indicator of the actual presence of periodontal conditions. This confirms hypothesis 2 of study aim 1.

4.3.3. General conclusions and recommendations

The results of the present study have demonstrated that the subjects included showed abundance of calculus and much gingival bleeding. In spite of the poor oral hygiene, the destructive phases of periodontal diseases were not frequently present and seem to be a problem for only a small part of the population. The large variations between and within individuals of periodontal breakdown emphasises the desirability of early identification of particularly susceptible subfractions of populations. The high risk assessment points to a desirable way to attack the real problem in the management of periodontal problems. The real public health problem is the ultimum consequence of periodontal diseases, that is tooth loss and edentulousness. Consequently, those in danger of losing the natural dentition need to be identified and managed before the problem gets out of hand. Efforts should therefore be focused on developing markers and methods that will facilitate the identification of the susceptible subfractions of the populations. For the rest (the majority) of the population more effective and appropriate (in respect to the prevailing economical, social and cultural realities) methods of management of periodontal diseases need to be developed, tested and implemented.

CHAPTER 5

RESULTS OF THE CASE CONTROL STUDY

The case control study was designed to assess the efficacy of clinical and microbiological parameters as potential markers of periodontal destruction.

The clinical part of the case control study was directed on the bleeding/plaque ratio as a marker of destructive periodontal diseases. Since the results obtained in the present study indicated that the bleeding tendency, but not the amount of plaque, was associated with destructive periodontal diseases, an additional analysis on gingival bleeding tendency as a marker of periodontal destruction was included.

The microbiological part of the case control study was directed on microscopic spirochete counts in subgingival plaque as marker of periodontal destruction.

5.1. THE CLINICAL PARAMETER.

Bleeding on probing at the margin of the gingiva (GB) and the amount of plaque on each tooth for cases and controls are presented in cross tabulation (Table 5.1). A set-up of data analogical to Table 5.1 but now with the periodontal pocket bleeding (PPB) score in cross tabulation with

the plaque score is shown in Table 5.2.

Table 5.1. Distribution of teeth according to plaque score and bleeding score at the gingival margin (GB) in cases and controls.

	GB							
	Cases				Controls			
	0	1	2	Total	0	1	2	Total
Plaque score								
0	0	6	2	8	55	14	2	71
0.5	11	92	56	159	117	112	11	240
1.0	2	66	195	263	60	135	43	238
1.5	0	15	88	103	10	35	31	76
2.0	0	19	94	113	10	43	33	86
2.5	0	0	10	10	0	8	6	14
≥3.0	0	0	33	33	15	20	8	43
Total	13	198	478	689	267	367	134	768

Table 5.2. Distribution of teeth according to plaque score and pocket* bleeding (PPB) score in cases and controls.

	PPB							
	Cases				Controls			
	0	1	2	Total	0	1	2	Total
Plaque score								
0	0	7	1	8	36	34	1	71
0.5	0	65	94	159	91	128	21	240
1.0	0	44	219	263	29	143	66	238
1.5	0	10	93	103	3	39	34	76
2.0	0	14	99	113	4	40	42	86
2.5	0	0	10	10	0	6	8	14
≥3.0	0	1	32	33	10	22	11	43
Total	0	141	548	689	173	412	183	768

*pocket bleeding score is assessed by probing the bottom of the gingival crevice whether it is deepened to a pocket or not.

The data in Table 5.1 and 5.2 seem to indicate that plaque scores do not differ much between cases and controls in contrast to GB scores and PPB scores which appeared to differ substantially between cases and controls. The differences in clinical parameters between cases and controls were tested using ANOVA while correcting for age, sex and interactions. This was done for different regions in the mouth, namely the total mouth and upper and lower jaw. In addition, the calculus score was analysed.

Table 5.3. Significance levels (ANOVA) of differences in calculus, plaque, GB and PPB scores between cases and controls and the influence of confounding factors.

	Group Case vs Control	Sex ♂ vs ♀	Age 30-36 vs 37-44	Interactions Group Sex	Group Age	Sex Age
Calculus						
Total mouth	***	*	-	**	-	-
Upper jaw	***	-	-	*	-	-
Lower jaw	***	**	-	**	-	-
Plaque						
Total mouth	-	-	-	-	-	-
Upper jaw	-	-	-	-	*	-
Lower jaw	-	-	-	-	-	-
GB						
Total mouth	***	-	-	-	-	-
Upper jaw	***	-	-	-	-	-
Lower jaw	***	*	-	-	-	-
PPB						
Total mouth	***	-	-	-	-	-
Upper jaw	***	-	-	-	-	-
Lower jaw	***	*	-	*	-	-

- not significant, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

In Table 5.3 it is shown that GB and PPB scores and calculus scores were significantly different between cases and controls, while plaque was not. Age (within the small range 30-44 years), sex and interactions were not confounders for the total mouth score of GB, PPB and plaque. Table 5.4 presents the mean total mouth scores of these clinical parameters. Calculus was not included since the total mouth calculus score was biased by sex and interactions.

Table 5.4. Mean total mouth scores of plaque, GB and PPB in cases and controls.

	Cases	Controls
Plaque	1.23	1.11
GB	1.67	0.83
PPB	1.80	1.01

Although this study was carried out to investigate a bleeding/plaque ratio as marker of periodontal destruction, the present data on clinical parameters suggest that a single clinical parameter may be used for that purpose. PPB scores were induced in this study to enable comparison between the modified bleeding/plaque ratio and the bleeding/plaque ratio of Van der Velden et al. (1985), but PPB scores were not considered to be independent markers of periodontal destruction since the bleeding tendency at the bottom of a pocket may be influenced by tissue

The only remaining non biased clinical parameter considered to be a possible marker of periodontal destruction was GB. Its potential as marker of periodontal destruction will be analysed furtheron (Table 5.7). The differences in the modified bleeding/plaque ratio between cases and controls were tested by ANOVA while correcting for age, sex and interactions. Differences in the bleeding /plaque ratio according to Van der Velden et al. (1985) between cases and controls were also tested by ANOVA but after square root transformation since the data showed a skewed distribution. The analysis indicated a significant difference between cases and controls only for the modified bleeding/plaque ratio (Table 5.5). Since total mouth values have not been affected by confounding variables, they were used in further analysis.

Mean total mouth bleeding/plaque ratios for cases and controls are presented in Table 5.6. The mean modified bleeding/plaque ratio was significantly higher in cases than controls, whereas the bleeding/plaque ratio (Van der Velden) was not. This discrepancy can be explained since the bleeding/plaque ratio (van der Velden) was based on a compressed PPB index (score 0-1). The compressed PPB index resulted in a mean score of 1.00 for cases and 0.77 for controls, whereas the extended PPB index revealed a much larger difference between cases and controls (Table 5.4).

Table 5.5. Significance levels (ANOVA) of differences in modified bleeding/plaque ratio and bleeding/plaque ratio (Van der Velden) between cases and controls and the influence of confounding factors.

	Group Case vs Control	Sex ♂ vs ♀	Age 30-36 vs 37-44	Interactions Group Sex	Group Age	Sex Age
Modified bleeding/ plaque ratio						
Total mouth	***	-	-	-	-	-
Upper jaw	***	-	-	-	-	-
Lower jaw	***	-	-	-	**	-
Bleeding/plaque ratio (Van der Velden)						
Total mouth	-	-	-	-	-	-
Upper jaw	-	-	-	-	-	-
Lower jaw	-	-	-	-	-	-

- not significant, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 5.6. Mean total mouth modified bleeding/plaque ratio and mean total mouth bleeding/plaque ratio (Van der Velden) in cases and controls.

	Cases	Controls
Modified bleeding/plaque ratio	4.43	2.40
Bleeding/plaque ratio (Van der Velden)	0.90	0.88

Next step in the analysis was to verify whether the modified bleeding/plaque ratio, the bleeding/plaque ratio (Van der Velden) and the GB score of the subjects could serve as diagnostic tools to identify those subjects with periodontal destruction. For that purpose the score and ratios were dichotomised at the median level which was used as a screening criterion to identify individuals with periodontal destruction (cases). The results of this procedure are presented in Table 5.7 and they show that both the modified bleeding/plaque ratio and the GB score had a high sensitivity, specificity and odds ratio, in contrast to the bleeding/plaque ratio (Van der Velden).

5.2. THE MICROBIOLOGICAL PARAMETER

Spirochetes were microscopically counted on slides with subgingival plaque samples from subjects in the case control study. One case subject was excluded since the subgingival plaque sample was missing. Gingivitis sites without periodontal destruction in case subjects exhibited a statistically significant higher percentage of spirochetes than in control subjects (Table 5.8). Sites with pockets, only present in case subjects, showed significant higher percentages of spirochetes than the gingivitis sites without pockets. These significant differences were not observed for the large spirochetes.

Table 5.7. Decision matrices and resulting ratios based on median modified bleeding/plaque ratio, median bleeding/plaque ratio (Van der Velden) and median GB score as screening criteria and presence of periodontal destruction (cases) as validation criterion.

		Screening criterion					
		Median (3.90) modified bleeding/plaque ratio		Median (0.76) bleeding/plaque ratio (Van der Velden)		Median (1.33) GB score	
		—	+	—	+	—	+
Validation criterion							
Controls	—	27	1	15	13	25	3
Cases	+	5	21	13	13	2	24
Sensitivity			0.81		0.50		0.92
Specificity			0.96		0.54		0.89
Odds ratio			113		1.1		100
Confidence interval 95%			12-1045		0.4-3.4		15-652

The probability of encountering a subject with destructive periodontal disease on the basis of spirochete percentages was low but reached a significant value, odds ratio 3.2. at a screening level of >6% of spirochetes (Table 5.9). The sensitivity and specificity of the screening for destructive periodontal disease on the basis of spirochete percentages varied between 0.48 and 0.82 (Figure 5.1).

Table 5.8. Median and interquartiles range of the percentages of total and large spirochetes in subgingival plaque samples from pockets and gingivitis sites in subjects with periodontal destruction (cases) and from gingivitis sites in subjects without periodontal destruction (controls).

	Cases (n = 25)		Controls (n = 28)
	Pocket	Gingivitis	Gingivitis
Total spirochetes			
Median	12.4	7.5	2.7
Interquartiles range	6.9 — 28.7	2.1 — 14.0	1.4 — 9.6
P value	0.04 (paired t-test)		0.04 (ANOVA)
Large spirochetes			
Median	6.6	2.7	2.3
Interquartiles range	1.7 — 14.6	1.4 — 9.6	1.0 — 6.3
P value	0.20 (paired t-test)		0.07 (ANOVA)

Table 5.9. Decision matrices and odds ratios based on different screening values and presence of destructive periodontal disease (cases) as validation criterion.

	Screening criterion, percentage of spirochetes from sites without tissue destruction											
	> 3%		> 4%		> 5%		> 6%		> 7%		> 8%	
	—	+	—	+	—	+	—	+	—	+	—	+
Validation criterion												
controls (no destruction)	14	14	16	12	17	11	20	8	22	6	23	5
cases (with destruction)	9	16	11	14	11	14	11	14	12	13	13	12
Odds ratio	1.8		1.7		2.0		3.2		4.0		4.2	
Confidence bounds 95 %	0.6—5.3		0.6—5.0		0.7—5.9		1.0—9.9		1.2—13.1		1.2—14.5	

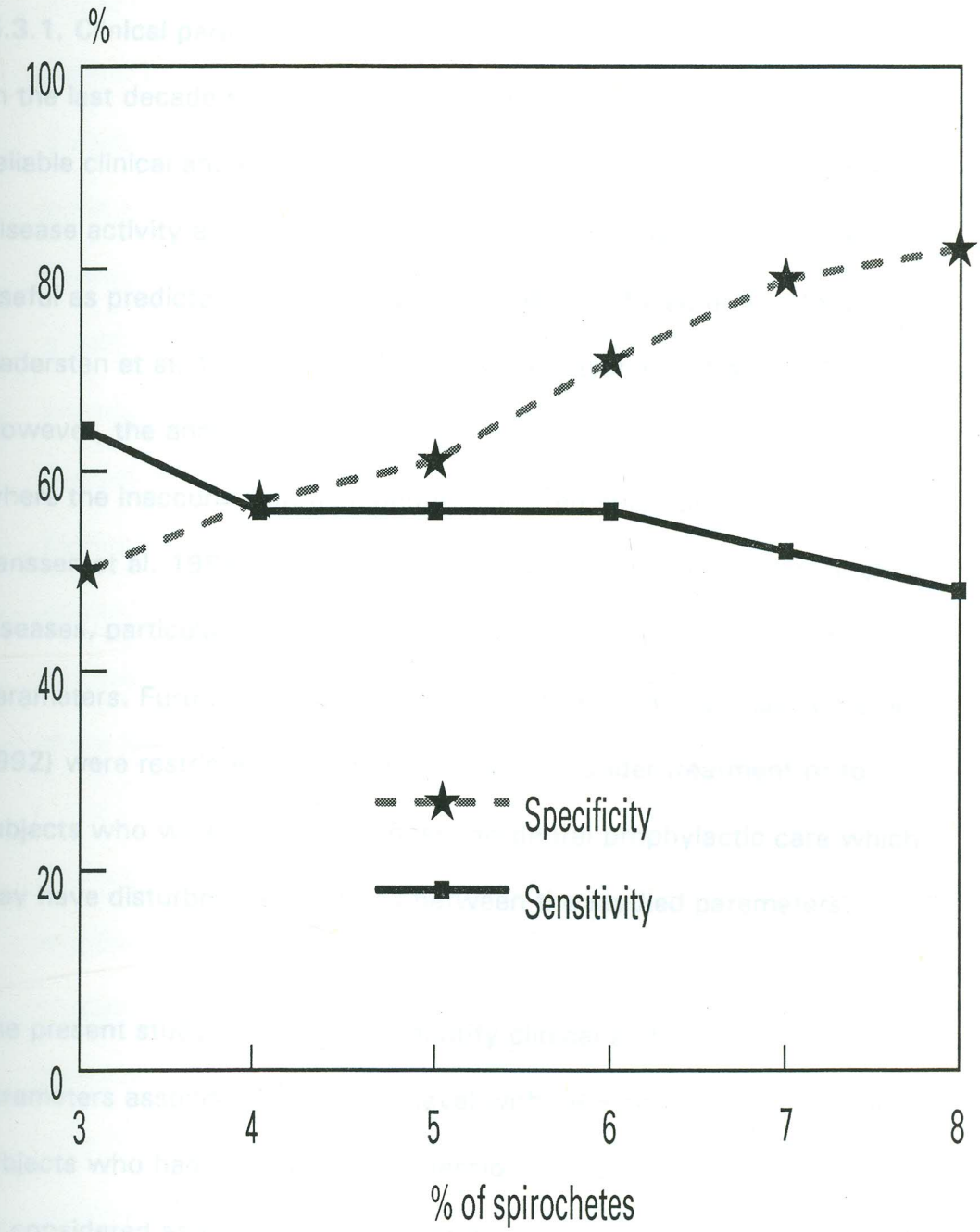


Figure 5.1 Sensitivity and specificity on the basis of percentage of spirochetes for the detection of periodontal destruction.

5.3. DISCUSSION AND CONCLUSIONS

5.3.1. Clinical parameters

In the last decade several studies have been conducted to evaluate reliable clinical and microbiological parameters to predict periodontal disease activity and progression, but none of the parameters were found useful as predictor (Listgarten & Levin 1981, Haffajee et al. 1983, Badersten et al. 1985, Lang et al. 1986, Halazonetis et al. 1989). However, the analyses were executed on the basis of individual sites where the inaccurate probing depth measurements (large type II error, Janssen et al. 1988) as validation of activity or progress of periodontal diseases, particularly impaired the sensitivity value of the predictive parameters. Furthermore, all studies except one in Kenya (Dahlen et al. 1992) were restricted to periodontal patients under treatment or to subjects who were regularly exposed to dental prophylactic care which may have disturbed associations between the studied parameters.

The present study attempted to identify clinical and microbiological parameters associated at subject level with periodontal destruction in subjects who had not received professional prophylaxis and who would be considered as subjects with a natural periodontal condition. The rationale was that if the parameters appeared not to be associated with destructive periodontal diseases, they might not likely be useful predictors of future periodontal destruction. On the other hand if the

parameters were strongly associated with periodontal destruction they might be useful predictors, which then had to be explored through further longitudinal studies.

Subjects with periodontal destruction (cases) and those without periodontal destruction (controls) exhibited comparable amounts of supragingival plaque. Despite a similar plaque score, the cases had significantly higher bleeding scores than the controls. This finding corroborates with the results of a Kenyan study with a comparable sample of subjects where those with periodontal destruction showed higher bleeding scores but comparable plaque scores as compared to controls (Dahlen et al. 1992). The strong association at subject level between bleeding scores and the presence of periodontal destruction in these East African samples has yet not been recorded elsewhere.

The modified bleeding/plaque ratio applied in this study showed a significant difference between cases and controls, whereas the bleeding/plaque ratio (Van der Velden) did not. The modified bleeding/plaque ratio differs in several aspects from the bleeding/plaque ratio (Van der Velden). Since the bleeding/plaque ratio is supposed to express an intimate interaction between plaque and bleeding and since only supragingival plaque can easily be scored clinically, the bleeding tendency of the adjacent tissue, that is the marginal gingiva, was scored for the modified bleeding/plaque ratio. For the bleeding/plaque ratio

(Van der Velden) the bleeding tendency at the bottom of the gingival crevice or pocket was scored. The bleeding/plaque ratio (Van der Velden) is calculated by dividing the sum of all bleeding scores in the mouth by the total plaque score. This way of computation does not take into account the site specific relationship between the amount of plaque and the concomitant bleeding tendency. To meet this imperfection first the bleeding/plaque ratio of each individual site was assessed before the bleeding/plaque ratio of the subject was calculated as the average of all sites. The index used for the bleeding score was extended with score 2 for the present modified bleeding/plaque ratio. Considering these differences between the two ratios, the discrepancy in their association with periodontal destruction seems to be largely caused by differences in the scale of the bleeding score and the way of computation.

On the basis of the modified bleeding/plaque ratio, subjects with periodontal destruction could be identified with high accuracy (Table 5.7). The same applied for the gingival bleeding score which also showed to be an accurate marker of periodontal destruction. In a recent study in the USA on subjects with and without periodontal destruction, gingival bleeding scores exhibited low to moderate diagnostic values in the identification of subjects with periodontal destruction (Machtei et al. 1993). That finding is in striking contrast with the present results.

However, they applied a compressed PPB index with score O and 1. It has been shown in this study that a PPB index (0-1) did not sufficiently distinguish between subjects with and without periodontal destruction. An additional explanation for the discrepancy in results could be the difference in exposure to dental care procedures between the USA and the Tanzanian populations.

The bleeding/plaque ratio as well as the gingival bleeding score seem to be susceptible for any dental care interference and that constitutes a weakness of these parameters to be used as diagnostic tools. For instance, periodontal treatment can change the bleeding/plaque ratio either to higher or to lower post treatment ratios dependent on the individual (Galgut 1988). It has been reported that 15-80% of sites converted to a new status regarding gingival bleeding between 2 examinations over time in patients in a supervised maintenance phase after periodontal treatment (Kalkwarf et al. 1989), indicating the extreme variability of the bleeding tendency under such conditions. It is therefore doubtful if these parameters could be useful epidemiological screening tools of susceptibility for destructive periodontal diseases in countries where most individuals are exposed to regular dental prophylaxis. Their application in those countries seems to be restricted to clinical trials where conditions are well controlled.

5.3.2. Microbiological parameter

A significant difference in percentage of spirochetes at sites with comparable clinical conditions between subjects with and without periodontal destruction was found, indicating a so far not described host effect. The character of this host factor is unknown. Host defence mechanisms, components of the gingival crevice fluid or components of the indigenous microflora such as *Porphyromonas gingivalis* (Simonson et al. 1992) might account for this effect. The microscopic data do not allow any speculation on differences in spirochete species between subjects or sites.

The present finding of higher percentages of spirochetes in pockets as compared to sites without pockets is in agreement with earlier findings (Listgarten & Hellden 1978, Lindhe et al. 1980, Armitage et al. 1982, Singletary et al. 1982, Savit & Socransky 1984, Greenwell & Bissada 1984). The differences in percentages of spirochetes at gingivitis sites (bleeding upon probing) without pockets between case and control subjects in this study shows analogy with the percentages of *P. gingivalis* found in a Kenyan study, the only study with a similar study design regarding sample sites and subjects (Dahlen et al. 1992).

Since samples were obtained from gingivitis sites with similar clinical conditions, inflammation, calculus and pocket dependent factors could

be controlled which otherwise may have biased differences in spirochete percentages between subjects. The finding by the present study design, that at gingivitis sites subjects with destructive periodontitis harbour higher percentages of spirochetes than subjects without destructive periodontal disease prompted an analysis on the feasibility to use microscopic spirochete counts as a screening method for destructive periodontal diseases. The diagnostic value of the spirochete screening method was too low to justify its application.

5.3.3. General conclusions and recommendations

The null hypothesis that the bleeding/plaque ratio is not significantly different between cases and controls is confirmed when the bleeding/plaque ratio of Van der Velden is used but the null hypothesis is rejected when the modified ratio is applied. The null hypotheses that the proportion of spirochetes in subgingival plaque is not significantly different between cases and controls is rejected. Both the modified bleeding/plaque ratio and the proportion of spirochetes were significantly higher in cases than controls. Furthermore it was found that the bleeding score of the marginal gingiva as a single clinical parameter was strongly associated with periodontal destruction. An additional analysis was conducted to determine whether the bleeding/plaque ratio, the gingival bleeding score and the proportions of spirochetes could be used as screening criterion to identify subjects with periodontal destruction.

Only the modified bleeding/plaque ratio and the gingival bleeding score showed high diagnostic values, whereas the proportion of spirochetes did not. Whether the gingival bleeding score and the modified bleeding/plaque ratio could serve as predictors of periodontal destruction has to be explored through further longitudinal studies.

CHAPTER 6

RESULTS OF THE INTERVENTION STUDY

This chapter presents the results of the Intervention Study as follows:

Section 6.1. presents the effects of Oral Health Education on the calculus and bleeding scores.

Section 6.2. presents the effects of scaling on the calculus and bleeding scores.

Section 6.3. presents the results of an explorative analysis of prognostic factors related to calculus and bleeding.

6.1. ORAL HEALTH EDUCATION (OHE) EFFECTS ON CALCULUS AND BLEEDING

Table 6.1 presents the calculus scores on scaled and non-scaled sites in the three groups at different examinations. At baseline, before the intervention, the three groups did not differ significantly regarding their calculus scores (see Chapter 3). After OHE had been implemented, the group that received the intensive OHE (OHE 2) exhibited on the scaled sites less calculus than the control group and the group that received less intensive OHE (OHE 1). Although the observed differences were

small they appeared to be significant at evaluations 1 and 2. No such differences were found on the non-scaled sites between the three groups. The differences between the scaled and non-scaled sites (split mouth design) did not show any meaningful trend between the three groups and hence one significant value for differences in scaling effect at evaluation 2 (Table 6.1) has no particular meaning.

Table 6.1. Calculus scores (mean ± SE in 0.1 mm) on scaled and non-scaled sites and the differences between scaled and non-scaled sites in the three groups at baseline and at following evaluations.

	n	Scaled	p*	Non-scaled	p*	Difference	p*
Baseline							
Control	51	11.6±0.7		12.1±0.7		0.5±0.4	
OHE 1	50	11.3±0.7		10.6±0.8		-0.7±0.6	
OHE 2	50	10.5±0.7		11.5±0.8		1.0±0.6	
Evaluation 1							
Control	51	1.7±0.3		11.8±0.8		10.1±0.8	
OHE 1	49	1.6±0.3	**.05**	9.5±0.8	.10	7.9±0.8	.10
OHE 2	46	0.9±0.2		11.0±0.9		10.1±0.9	
Evaluation 2							
Control	47	3.9±0.4		12.5±0.8		8.5±0.7	
OHE 1	49	3.4±0.5	**.03**	10.9±0.9	.10	7.5±0.9	**.02**
OHE 2	43	2.3±0.4		13.1±0.9		10.8±0.8	
Evaluation 3							
Control	46	6.4±0.5		14.2±0.8		7.8±0.7	
OHE 1	48	5.5±0.5	.13	12.2±0.8	.14	6.7±0.6	.11
OHE 2	42	4.8±0.6		13.6±0.9		8.8±0.8	

* p values obtained by ANOVA

Table 6.2 depicts the increments of calculus in scaled and non-scaled sites in the three groups over different evaluation intervals. The

increments of calculus over time intervals did not exhibit any particular direction between the three groups and consequently, also the differences between increments of calculus between scaled and non-scaled sites did not show any particular trend.

Figure 6.1 summarizes Table 6.1 and 6.2 in a graphical way.

Table 6.2. Calculus increment scores (mean ± SE in 0.1 mm) on scaled and non-scaled sites and the differences between scaled and non-scaled sites in the three groups at different evaluation periods.

	n	Scaled	p*	Non-scaled	p*	Difference	p*
Period 0-1							
Control	51			0.3 ± 0.5			
OHE 1	49		- -	0.9 ± 0.5	.39	-	-
OHE 2	46			0.6 ± 0.4			
Period 0-2							
Control	47			0.4 ± 0.4			
OHE 1	49		- -	0.3 ± 0.6	.11	-	-
OHE 2	43			1.6 ± 0.5			
Period 0-3							
Control	46			2.1 ± 0.5			
OHE 1	48		- -	1.5 ± 0.6	.48	-	-
OHE 2	42			2.1 ± 0.4			
Period 1-2							
Control	47	2.3 ± 0.3		0.7 ± 0.4		-1.6 ± 0.5	
OHE 1	48	1.9 ± 0.3	.57	1.4 ± 0.4	.21	-0.5 ± 0.4	**0.01**
OHE 2	41	1.5 ± 0.3		2.1 ± 0.4		0.6 ± 0.4	
Period 1-3							
Control	46	4.7 ± 0.5		2.4 ± 0.4		-2.3 ± 0.5	
OHE 1	47	3.9 ± 0.5	.23	2.7 ± 0.5	.53	-1.2 ± 0.6	.77
OHE 2	40	3.9 ± 0.5		2.6 ± 0.5		-1.3 ± 0.4	
Period 2-3							
Control	46	2.5 ± 0.5		1.7 ± 0.3		-0.8 ± 0.5	
OHE 1	48	2.1 ± 0.4	.24	1.3 ± 0.4	**.03**	-0.8 ± 0.5	**.05**
OHE 2	41	2.5 ± 0.4		0.5 ± 0.3		-2.0 ± 0.4	

* p values by ANOVA

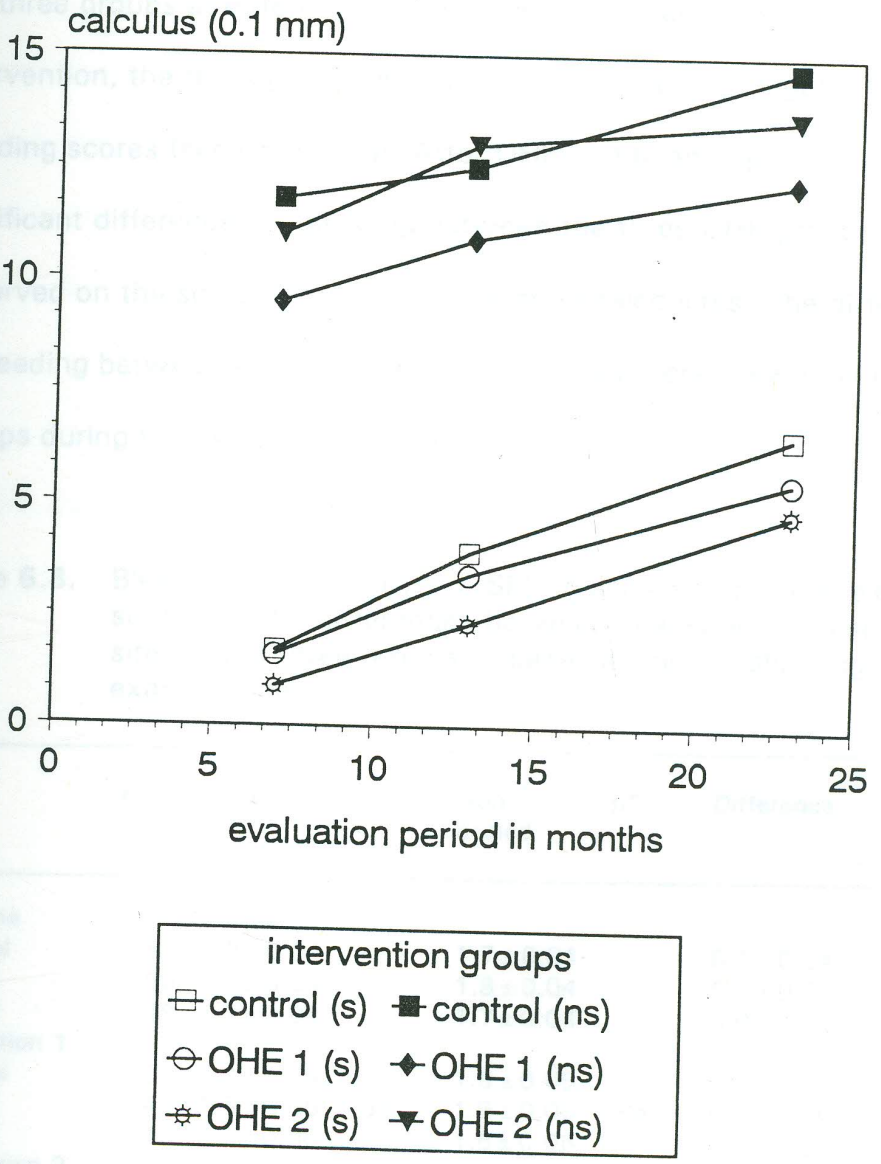


Figure 6.1. Mean calculus scores on scaled (S) and non-scaled (NS) sites of the control group, the OHE 1 group and the OHE 2 group during the study period.

Table 6.3 shows the bleeding scores on scaled and non-scaled sites in the three groups at different examinations. At baseline, before the intervention, the three groups did not differ significantly regarding their bleeding scores (see Chapter 3). After OHE had been implemented no significant differences in bleeding between the three OHE groups were observed on the scaled sites nor on the non-scaled sites. The differences in bleeding between scaled and non-scaled sites were alike in all three groups during the period of the study.

Table 6.3. Bleeding scores (mean ± SE) on scaled and non-scaled sites, and the differences between scaled and non-scaled sites in the three groups at baseline and at following examinations.

	n	Scaled	p*	Non-scaled	p*	Difference	p*
Baseline							
Control	51	1.8 ± 0.04		1.7 ± 0.04		-0.1 ± 0.04	
OHE 1	50	1.8 ± 0.04		1.8 ± 0.04		0.0 ± 0.03	
OHE 2	48	1.7 ± 0.04		1.7 ± 0.04		0.0 ± 0.03	
Evaluation 1							
Control	51	1.3 ± 0.05		1.6 ± 0.05		0.3 ± 0.05	
OHE 1	49	1.3 ± 0.06	.34	1.6 ± 0.05	.64	0.3 ± 0.06	.10
OHE 2	46	1.2 ± 0.06		1.6 ± 0.06		0.4 ± 0.06	
Evaluation 2							
Control	47	1.4 ± 0.06		1.7 ± 0.04		0.3 ± 0.05	
OHE 1	49	1.3 ± 0.06	.38	1.5 ± 0.05	.10	0.2 ± 0.05	.26
OHE 2	43	1.3 ± 0.06		1.6 ± 0.06		0.3 ± 0.07	
Evaluation 3							
Control	46	1.3 ± 0.07		1.6 ± 0.06		0.3 ± 0.05	
OHE 1	48	1.2 ± 0.06	.41	1.5 ± 0.07	.21	0.3 ± 0.06	.90
OHE 2	42	1.2 ± 0.08		1.4 ± 0.07		0.2 ± 0.08	

* p values by ANOVA

Table 6.4 presents the increments of bleeding on scaled and non-scaled sites in the three groups over different evaluation intervals. No consistent trend in any particular direction between the three groups was found regarding bleeding increments nor any real differences were detected between the three groups regarding bleeding differences for scaled and non-scaled sites.

Figure 6.2 summarizes Tables 6.3 and 6.4 in a graphical way.

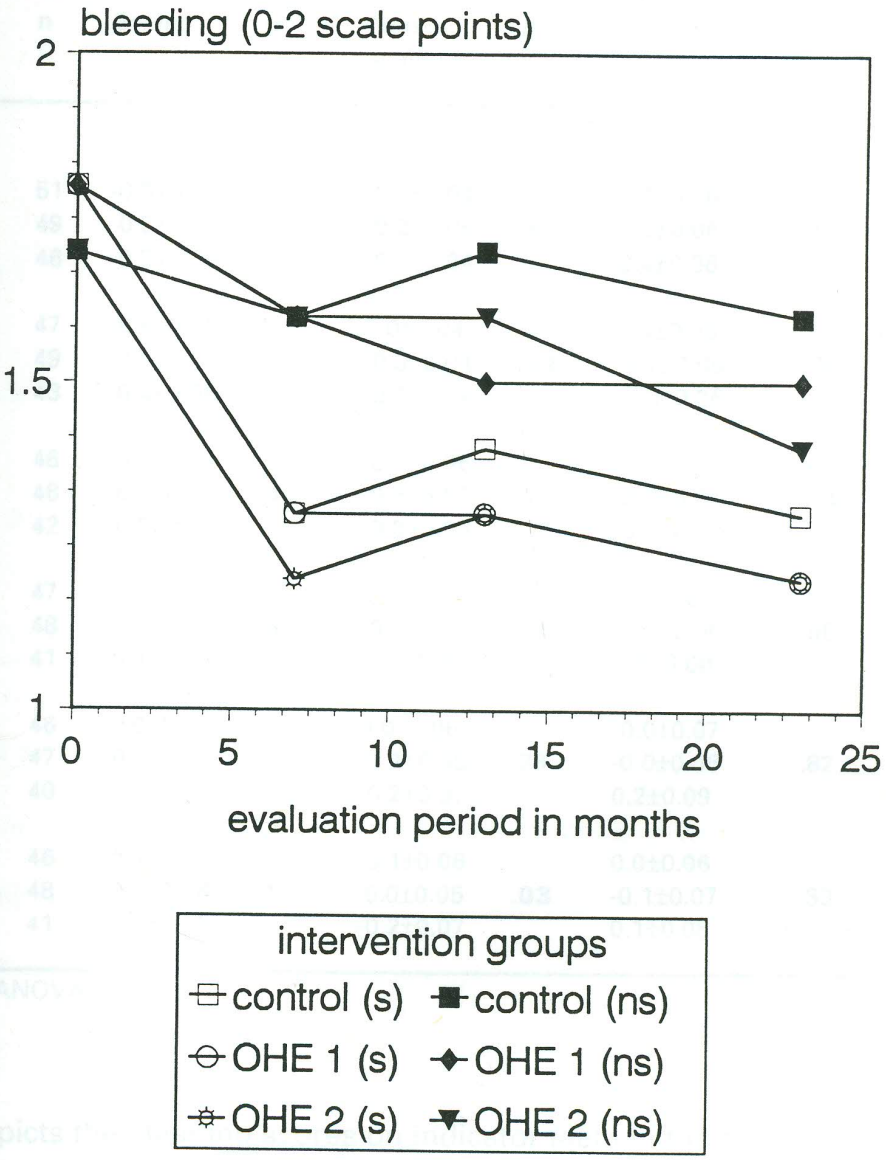


Figure 6.2. Mean bleeding scores on scaled (S) and non-scaled (NS) sites of the control group, the OHE 1 group and the OHE 2 group during the study period.

Table 6.4. Bleeding increment scores (mean ± SE) on scaled and non-scaled sites and the differences between scaled and non-scaled sites in the three groups at different evaluation periods.

	n	Scaled	p*	Non-scaled	p*	Difference	p*
Period 0-1							
Control	51	-0.5±0.04		-0.1±0.04		0.4±0.06	
OHE 1	49	-0.5±0.04	.94	-0.2±0.05	.82	0.3±0.06	.93
OHE 2	46	-0.5±0.05		-0.1±0.04		0.4±0.06	
Period 0-2							
Control	47	-0.4±0.06		0.0±0.04		0.4±0.06	
OHE 1	49	-0.5±0.05	.17	-0.3±0.04	**.01**	0.2±0.05	.58
OHE 2	43	-0.4±0.06		-0.1±0.04		0.3±0.06	
Period 0-3							
Control	46	-0.5±0.07		-0.1±0.06		0.4±0.07	
OHE 1	48	-0.6±0.07	.44	-0.3±0.06	.10	0.3±0.07	.74
OHE 2	42	-0.5±0.07		-0.3±0.06		0.2±0.08	
Period 1-2							
Control	47	0.1±0.05		0.1±0.05		0.0±0.07	
OHE 1	48	0.0±0.05	.31	-0.1±0.05	.14	-0.1±0.06	.96
OHE 2	41	0.1±0.06		0.0±0.05		0.1±0.08	
Period 1-3							
Control	46	0.0±0.06		0.0±0.06		-0.0±0.07	
OHE 1	47	-0.1±0.05	.78	-0.1±0.05	.28	-0.0±0.06	.82
OHE 2	40	0.0±0.08		-0.2±0.07		0.2±0.09	
Period 2-3							
Control	46	-0.1±0.06		-0.1±0.06		0.0±0.06	
OHE 1	48	-0.1±0.06	.72	0.0±0.05	**.03**	-0.1±0.07	.33
OHE 2	41	-0.1±0.07		-0.2±0.07		0.1±0.08	

* p values by ANOVA

Table 6.5 depicts the bleeding scores on indicator teeth in the three groups at different examinations. No convincing differences were found between the three groups, except at evaluation 3 where the group OHE 2 showed less bleeding than the other two groups. However, the differences were small and, in fact, of no clinical importance.

Table 6.5. Bleeding scores (mean ± SE) on indicator teeth in the three groups at baseline and at following examinations.

	n	Indicator teeth	p-value ANOVA
Baseline			
Control	52	1.3 ± 0.05	
OHE 1	50	1.3 ± 0.05	0.1
OHE 2	50	1.2 ± 0.04	
Evaluation 1			
Control	51	1.2 ± 0.05	
OHE 1	49	1.2 ± 0.05	0.2
OHE 2	46	1.1 ± 0.06	
Evaluation 2			
Control	47	1.2 ± 0.05	
OHE 1	49	1.1 ± 0.05	0.1
OHE 2	43	1.1 ± 0.05	
Evaluation 3			
Control	46	1.2 ± 0.05	
OHE 1	48	1.1 ± 0.05	**0.02**
OHE 2	42	1.0 ± 0.05	

Table 6.6 shows the increments of bleeding on indicator teeth in the three groups over different evaluation intervals. No significant differences nor any particular trend were observed in the bleeding increment scores between the three groups.

Table 6.6. Bleeding increment scores (mean ± SE) on indicator teeth in the three groups at different evaluation periods.

	n	Indicator teeth	p-value ANOVA
Period 0-1			
Control	51	-0.10 ± 0.05	
OHE 1	49	-0.08 ± 0.04	0.92
OHE 2	46	-0.10 ± 0.04	
Period 0-2			
Control	47	-0.13 ± 0.05	
OHE 1	49	-0.18 ± 0.05	0.54
OHE 2	43	-0.10 ± 0.04	
Period 0-3			
Control	46	-0.14 ± 0.06	
OHE 1	48	-0.21 ± 0.05	0.57
OHE 2	42	-0.21 ± 0.05	
Period 1-2			
Control	47	-0.04 ± 0.04	
OHE 1	48	-0.09 ± 0.04	0.25
OHE 2	41	-0.01 ± 0.04	
Period 1-3			
Control	46	-0.06 ± 0.05	
OHE 1	47	-0.11 ± 0.04	0.73
OHE 2	40	-0.09 ± 0.05	
Period 2-3			
Control	46	-0.02 ± 0.04	
OHE 1	48	-0.03 ± 0.04	0.30
OHE 2	41	-0.11 ± 0.05	

6.2. SCALING EFFECTS ON CALCULUS AND BLEEDING

Table 6.7 depicts the calculus scores and calculus increment scores for all subjects on scaled and non-scaled sites during the study period. At baseline the calculus scores on sites assigned for scaling or assigned for non-scaling did not vary (Chapter 3).

Table 6.7. Calculus scores and calculus increment scores (mean ± SE in 0.1 mm) for all subjects on scaled and non-scaled sites, and the differences between scaled and non-scaled sites at different examinations and at different evaluation periods.

	n	Scaled	Non-scaled	Scaling effect	Paired t-test
Baseline	151	11.1±0.4	11.1±0.5	0.0±0.3	ns
Evaluation 1	146	1.4±0.1	10.8±0.5	9.4±0.5	**0.001**
Evaluation 2	139	3.2±0.3	12.1±0.5	8.9±0.5	**0.001**
Evaluation 3	136	5.6±0.3	13.3±0.5	7.7±0.4	**0.001**
Period 1-2	136	1.9±0.2	1.3±0.2	-0.6±0.3	**0.01**
Period 1-3	133	4.3±0.3	2.7±0.2	-1.6±0.3	**0.001**
Period 2-3	135	2.4±0.2	1.1±0.2	-1.3±0.3	**0.001**

The scaled sites exhibited statistically significant less calculus than the non-scaled sites at the subsequent evaluations. The increments in calculus appeared to be significantly higher on scaled sites than on non-scaled sites in each evaluation period. The effects of scaling on the amount of calculus is also shown in Figure 6.1.

Table 6.8 shows the bleeding scores and bleeding increment scores for all subjects on scaled and non-scaled sites during the study period. At baseline, bleeding scores on sites allocated for scaling or allocated for non scaling did not differ (Chapter 3).

The scaled sites exhibited statistically less bleeding than the non-scaled sites at the subsequent evaluations. The increment values show that significant decreases in bleeding occurred at scaled sites as compared to

non-scaled sites in the period directly after scaling (period 0-1). The effect continued during the whole period of the study. No additional increment values in bleeding, positive or negative, was noted between scaled and non-scaled sites in the periods after the first follow up examination. The effects of scaling on the bleeding tendency is also shown in Figure 6.2.

Table 6.8. Bleeding scores and bleeding increment scores for all subjects on scaled and non-scaled sites, and the differences between scaled and non-scaled sites at different examinations and at different evaluation periods.

	n	Scaled	Non-scaled	Scaling effect	Paired t-test
Baseline	151	1.7 ± 0.02	1.7 ± 0.02	0.0 ± 0.02	ns
Evaluation 1	146	1.3 ± 0.03	1.6 ± 0.03	0.3 ± 0.03	**0.001**
Evaluation 2	139	1.3 ± 0.04	1.6 ± 0.03	0.3 ± 0.03	**0.001**
Evaluation 3	136	1.2 ± 0.04	1.5 ± 0.04	0.3 ± 0.04	**0.001**
Period 0-1	146	-0.5 ± 0.03	-0.1 ± 0.03	0.4 ± 0.03	**0.001**
Period 0-2	139	-0.5 ± 0.03	-0.1 ± 0.03	0.4 ± 0.03	**0.001**
Period 0-3	136	-0.5 ± 0.04	-0.2 ± 0.04	0.3 ± 0.04	**0.001**
Period 1-2	136	0.0 ± 0.03	0.0 ± 0.03	0.0 ± 0.05	ns
Period 1-3	133	0.0 ± 0.04	-0.1 ± 0.03	0.1 ± 0.04	ns
Period 2-3	135	0.0 ± 0.04	-0.1 ± 0.03	0.1 ± 0.04	ns

6.3. EXPLORATIVE ANALYSIS OF PROGNOSTIC FACTORS RELATED TO CALCULUS AND BLEEDING

Possible prognostic factors related to calculus and bleeding were tested using multiple regression analysis on scaled and non-scaled sites for calculus (after square root transformation) at evaluation 3, and on teeth which are representative for the mouth (indicator teeth) for bleeding, also at evaluation 3. The variables for the analysis included brushing aid, age, sex, calculus scores at baseline and bleeding scores at baseline (of indicator teeth). The results of the tests are presented in Table 6.9.

Table 6.9. P-values of multiple regression analysis for prognostic factors related to calculus and bleeding at 3rd evaluation.

Prognostic variables	p - values		
	Calculus		Bleeding
	Scaled	Non - scaled	Indicator teeth
Brushing aid	0.43	0.09	0.42
Age	0.18	0.17	0.82
Baseline calculus	0.00	0.00	0.18
Baseline bleeding	0.00	0.17	0.00
Multiple R	0.52	0.74	0.49

For calculus, significant prognostic values were evident with respect to the variables calculus and bleeding scores at baseline (p-values 0.00). For bleeding, only the bleeding scores at baseline (p values 0.00) depicted significant prognostic values. Moreover, a tendency to

significance (p-value 0.09) was shown for the variable brushing aid in relation to calculus on non-scaled sites. To elaborate further on this tendency, some additional analysis of the variable brushing aid were done (see Table 6.12).

The inclusion of the baseline values of calculus and bleeding in the multiple regression analysis can possibly lead to over-correction of the influence of the other variables values. To exclude possible masking influences of the baseline calculus and bleeding scores, these variables were either partially or totally excluded in additional analysis. Analyses were therefore done for the variables brushing aid, age, sex only and then together with either bleeding (for the calculus prognosis) or calculus (for the bleeding prognosis) alone. The results of the tests are presented in the Tables 6.10 and 6.11.

Table 6.10. P-values (multiple regression) for the prognostic factors brushing aid, age and sex as related to calculus and bleeding at 3rd evaluation.

Prognostic variables	p-values		
	Calculus		Bleeding
	Scaled	Non - scaled	Indicator teeth
Brushing aid	0.97	0.03	0.27
Age	0.10	0.10	0.46
Sex	0.67	0.32	0.12
Multiple R	0.18	0.29	0.16

The only variable that showed some prognostic potential was brushing aid, for calculus scores on non-scaled sites (Table 6.10). However, the low multiple R values implied that not only were the variables insignificant, but they were also irrelevant as prognostic factors for calculus and bleeding.

Table 6.11. P-values (multiple regression) for the prognostic factors brushing aid, sex, age and bleeding or brushing aid, sex, age and calculus as related to calculus and bleeding respectively.

Prognostic variables	p-value Calculus		Prognostic variables	p-value Bleeding
	Scaled	Non-scaled		Indicator teeth
Brushing aid	0.83	0.03	Brushing aid	0.40
Age	0.13	0.14	Age	0.56
Sex	0.45	0.23	Sex	0.10
Baseline Bleeding	0.00	0.02	Baseline Calculus	0.03
Multiple R	0.35	0.35	Multiple R	0.24

The variable initial bleeding showed prognostic potential for calculus on both scaled and non-scaled sites, while the variable calculus at baseline showed prognostic potential for bleeding (Table 6.11). Furthermore, the variable brushing aid showed again prognostic potential for calculus on non-scaled sites.

The effect of toothbrush or chewing stick on calculus and bleeding was analysed by testing the differences of calculus and bleeding scores with the use of the t-test.

Table 6.12. P-values (t-test) of differences in calculus and bleeding scores between toothbrush and chewing stick users at different evaluations.

	p-values		
	Calculus		Bleeding
	Scaled	Non-scaled	Indicator teeth
Baseline	0.39	0.17	0.66
Evaluation 1	0.49	0.13	0.20
Evaluation 2	0.69	0.12	0.49
Evaluation 3	0.85	0.03	0.41

Significant more calculus at non-scaled sites at 3rd evaluation was found in habitual chewing stick users, than toothbrush users (Table 6.12). This significance however, does not convincingly confirm the prognostic value of the brushing aid.

6.4. DISCUSSION AND CONCLUSIONS

6.4.1. Oral health education and scaling

The primary objective of any health education programme for an individual or for groups of individuals in a community, is to facilitate voluntary adaptation of behaviour which is conducive to health (Flanders

1987). It is apparent that different educational methods are needed for different groups of people living under different cultural and socio-economic conditions. In this study, the oral health education programmes were designed taking into account the existing Tanzanian realities: e.g. low awareness of oral diseases; limited availability of treatment; difficulties to provide reinforcement through literature (pamphlets, posters, charts), mass media (television, movies, radio programmes), lectures, open discussions, etc.; lack of professional manpower and resources to intensively supervise implementation of the programmes; lack of experience in health education programmes, etc. The target group in the present study was school children who did not receive a dental treatment programme. The school system provides an important group of subjects that can be reached and retained for long periods of time, thus facilitating long term instructions and evaluations of health education programmes. Children are not only fast learners and anxious to acquire new skills, but are potentially at risk of developing oral health problems at present or in a distant future. In the school system, teachers can act as key persons in carrying out and guiding the programmes.

The lack of impact of OHE on the clinical parameters calculus and bleeding is striking. Only 3 out of 15 tests done on the direct observations were significant (Tables 6.1, 6.3, 6.5). The lack of consistency in the trends in mean values of these clinical parameters,

testified the ineffectiveness of the oral health education programmes in influencing oral cleanliness in the studied population. This lack in effect could be due to either an ineffective programme or due to lack of power of the study. In the present study, the most important outcome variable is bleeding. On the basis of the mean bleeding increment scores (expressed in Table 6.6 from the initial status at baseline to the status at the end of the study) of the representative (indicator) teeth (i.e. control group, -0.14 standard error of the mean (SEM) 0.06 and intensive oral health education group, -0.21 SEM 0.05), the overall OHE-effects can be estimated as 0.07 SEM 0.08. This leads to a 95% confidence interval for the OHE-effects of -0.09 up to 0.23 on a scale of 0-2 points. An oral health education programme effect of 0.23 on a scale of 0-2 points, and scores around 1.2-1.6 to be obtained in the most favourable circumstances, is certainly not clinically impressive. So the power of the study is good enough, but the results obtained are clinically irrelevant. The results therefore confirm hypothesis 1 of study aim 3, that is: oral health education has no effect on gingival bleeding tendency.

The scaling effects on calculus, as could have been expected, were very substantial (Table 6.7). However, these effects were not long lasting, since calculus reappeared rather fast on the clean (scaled) sites. With increasing amounts of calculus deposits, the growth rate tended to slow down, suggesting that a potential "saturation point" was reached for

the non scaled sites (Figure 6.1).

Extrapolation of the curve of reappearance of calculus, results in estimates of 4-5 years before the amount of calculus reaches its baseline amount. This fast reappearance suggests that frequent repetitions of the scaling have to be done if the aim is to ensure clean surfaces devoid of calculus.

Scaling had also positive effects on bleeding tendencies especially soon after the cleaning (Table 6.8). Later on, the effects remained without showing additional improvements in the reduction of the bleeding. In this study, the overall influence of scaling on the bleeding tendencies was calculated to be in the order of 0.3 on a scale of 0-2 points and scores of around 1.2 - 1.6. An effect of such a magnitude cannot be considered to be clinically relevant, especially when considering the implications of the study in a large scale programme of removing calculus on a population basis. The present study rejects hypothesis 2 of study aim 3, that is removal of calculus has no effect on gingival bleeding tendency.

Intensive OHE may weakly have retarded the initial (period 0-1) reappearance of calculus on scaled sites (Table 6.1). However

subsequent increment scores in following periods (Table 6.2) and the parallel lines for calculus scores on scaled sites in Figure 6.1 lead to the conclusion that calculus reappears at the same rate irrespective of the type of OHE instituted. Thus hypothesis 3 of study aim 3 is confirmed. Calculus reappearance in the first 23 months after scaling seems to be proportional to time (Figure 6.1). Thus hypothesis 4 of study aim 3 is confirmed. It may take 4-6 years before calculus may reach the original amounts before scaling.

The combination of scaling and oral health education did also not reveal additional significant effects in reducing bleeding and retarding calculus growth.

The results in section 6.3 suggest a prognostic potential of the initial conditions of bleeding and calculus for the future status of the periodontal conditions with respect to bleeding and calculus. The tool used in the cleaning of the mouth (in this population tooth brush or tooth stick) did not show potential importance in the prognosis of the conditions. These results confirm hypothesis 5 of the study aim 3, that is: the variance of calculus reappearance is associated with the baseline calculus scores.

The main result of the intervention study is the lack of clear effects of OHE-programmes on bleeding and calculus. This result might most

probably be accounted for by the improvements in all three (i.e. intensive, less intensive and control) groups. This may have contributed, to some extent, to the underscoring of the modest effects of the intensive oral health education programme (which afterall was not all that intensive as the term may imply, but probably as intensive as possible in the Tanzanian cultural-socio-economical context).

The improvements experienced by the control group may have resulted from the well known "reactive testing effect" (Moser & Kalton 1972) i.e. behavioural changes are seen when a group gets any kind of attention, e.g. the examinations they were exposed to. This phenomenon is well documented in the health education literature (Podshadley & Shannon 1970; Evans et al. 1975; Greenberg 1977; Melcher & Feldman 1979). The fact that the three groups were age-mates living in the same municipal town (and therefore most probably close friends), may also have contributed to the improvements in the control group through "spilling-over" effects. Furthermore, in contrast to experiences in the industrialised countries, the people in this part of the world are still not aware of oral health problems and consequently, regard oral disease as being less serious, as recent studies confirmed (van Palenstein Helderman & Nathoo 1990; Mosha & Scheutz 1993; Sarita & Tuominen 1993). As a result, it is difficult for most people to perceive the associations between daily actions and their consequences for oral health. The rather slow progression of oral diseases complicates even

further this handicap. Regardless of the efforts made by the OHE-instructors, the parents generally do not supplement and/or assist the children in practising the learnt information. This may also have contributed to the observed minor effects of the health education programmes.

In general, benefits of OHE-programmes aimed at large groups with a substantial prevention component are difficult to substantiate (Burt & Roder 1978; Dunning 1979). Only a few studies (Emler et al. 1980; Huntley 1979) have reported improved oral health of participants following educational programmes. The majority of studies however, show limited effects of oral health education programmes (Clark et al. 1973; Graves 1975; Smith et al. 1975; Anaise & Zilkah 1976; Croft 1980). The findings of this study testify even further the lack of valid improvements (assessed by clinical parameters) in oral health following oral health education programmes.

These results showing no clinically visible effects in the mouth of the oral health education can easily demotivate the participants from continuing with such programmes. To avoid this, it is suggested that in future evaluation studies of OHE, objectives should not only concentrate on visible improvements in oral health, but should include other less ambitious, more modest and realistic effects which may be achieved, e.g. improvements in knowledge, change in habits etc.

The identification of the initial gingival conditions (baseline bleeding and calculus scores) as possible prognostic factors in this sample is in conformity to the observations of Sogaard et al. (1987).

6.4.2. General conclusions and recommendations

The lack of substantial effects of oral health education challenges the essence of organising large scale -prevention oriented- health education programmes for child populations in the existing cultural, social, and economical situation in Tanzania. This conclusion however, does not challenge effectiveness of oral health education in the *treatment* of periodontal patients. Since the scientific basis for oral health education in promoting oral health is unequivocal, it is important that large scale oral health education programmes continue to be developed. In the process, due considerations should be given to the creation of programmes that have concise objectives to be achieved, are well pretested before execution, reflect cognitive experiences, allow periodic reviews of the programme and have realistic objectives to assess the effects of the programme.

The clinically not relevant effects on bleeding and the fast reappearance of calculus as evidenced in this study, do not support the overall needs for scaling for populations at large. This conclusion, together with the recognised a) prohibitive material and manpower requirements in performing scaling to non-industrialised population at large (Manji &

Sheiham 1986); b) possible loss of attachment that may occur following repeated scaling and root planing of sites initially with shallow pockets (Knowles et al. 1980; Badersten et al. 1981; Pihlstrom et al. 1981; Lindhe et al. 1982); and c) observation in these populations that poor oral hygiene and high levels of gingivitis do not result in periodontal breakdown of a severity which causes major loss of teeth, except in a small subfraction of the populations (Baelum et al. 1986a,b; 1987; Lembariti 1983; WHO Global Oral Data Bank, Miyazaki 1992), indicate a need to reconsider the concepts upon which the current strategies for large scale scaling programmes are based.

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In scientific reports, the periodontal conditions of Tanzanians have been described as being characterised by overall poor oral hygiene and extensive gingival inflammation. Despite these conditions the majority of the population was reported to exhibit surprisingly little evidence of destructive periodontal disease. Only a relatively small part of the population, at older age, seemed to be responsible for most of the observed severe periodontal breakdown and tooth loss due to periodontal diseases. Such somewhat contradictory findings call for confirmation and more precision applied in a survey. It also raises issues on the feasibility and effectiveness of prevention oriented programmes, which traditionally are based on health education and removal of calculus. The topic of individual susceptibility for the destructive forms of periodontal diseases is an associated problem.

To confirm the reported assessment, and later on facilitate the identification of subjects for the susceptibility study, the descriptive study was carried out. The overall pattern and distribution of periodontal

diseases in the studied sample, 20-65 years old, were found to be within the ranges reported for Tanzania and East African countries. This confirmed the factual basis and hence the need to identify susceptible subpopulations that are in actual need for periodontal intervention.

The case control study attempted a search for possible markers to assist in the identification of those individuals at risk of experiencing destructive diseases. Bleeding/plaque ratio and its association with periodontal destruction, as well as its potential to identify subjects prone to periodontal destruction, were investigated in 26 subjects who exhibited at least 3 teeth with pocket depths ≥5 mm (cases) and 28 subjects exhibiting no pockets (controls). The use of an extended scale for bleeding was found to be more discriminative between cases and controls than a compressed scale. The bleeding/plaque ratio according to Van der Velden (1985) did not differ between cases and controls. However, the modified bleeding/plaque ratio differed significantly between cases and controls. Both the bleeding score at the marginal gingiva and the modified bleeding/plaque ratio exhibited their potential as markers of periodontal destruction. According to the results of the present study, these markers may be of use in the identification of susceptible individuals in populations of most non-industrialised countries

where the people are not exposed to regular removal of calculus (prophylaxis). In clinical trials where conditions are well controlled, these markers might also be utilised in countries where most people are exposed to regular dental prophylaxis.

Plaque samples from cases and controls were also examined microscopically to determine whether percentages of spirochetes could provide a reliable measure in the identification of subjects with destructive periodontal disease. Pockets generally contained higher percentages of spirochetes, a fact that corroborates with earlier findings. At non-destructive sites, a significant difference in percentage of spirochetes between cases and controls was found, indicating a so far not described "host effect". However, despite the significant difference in percentage of spirochetes between cases and controls, spirochete counts in this study did not provide a reliable measure to identify subjects with destructive periodontal disease.

The management of periodontal diseases, namely the feasibility of prevention oriented community periodontal programmes in the Tanzanian socio-economic and cultural setting was investigated in the intervention study. The impacts of oral health education and calculus removal were studied over a period of 23 months in a sample of secondary school students in Morogoro. The oral health education programmes failed to prove their effectiveness in reducing bleeding and retarding calculus

growth. Although significant effects on bleeding were observed immediately following scaling, the effects were too small to be considered of any clinical relevance.

According to the findings of the present study therefore, large scale prevention oriented health education and calculus removal programmes for child populations in the existing cultural, social and economic realities in Tanzania are not supported. In the Tanzanian context, this conclusion means a tremendous reduction of the burden that otherwise would have fallen on the few professionals and meager resources if the large scale programmes covering populations were implemented. This lack of impact of the oral health education and scaling programme might be due to the actual content, the length and energy spent on it, etc. However, it was considered the maximum what realistically could be applied observing the resources available in the country.

It should be noted though that this study does not challenge the importance of oral health education and calculus removal in the treatment of individual periodontal patients (as identified by the markers of destruction).

7.2. CONCLUSIONS

1. The periodontal conditions in Tanzania are within the range of prevalences previously reported for Tanzania and other East African countries.
2. The CPITN hierarchical system is a good indicator of the actual presence of periodontal conditions in the Tanzanian population.
3. Bleeding at the marginal gingiva and the modified bleeding/plaque ratio are accurate markers of periodontal destruction in populations not exposed to regular removal of calculus.
4. Spirochete counts are not reliable measures in identifying subjects with destructive periodontal diseases.
5. Large scale prevention oriented oral health education programmes for child populations are not effective in reducing bleeding and calculus growth to a level of clinical significance.
6. The overall positive effect of scaling on bleeding is too small to be of clinical significance.
7. The growth rate of calculus is proportional to time in the first 23 months after scaling.

7.3. RECOMMENDATIONS

1. There is a need to reconsider the concepts upon which the current strategies for large scale prevention oriented health education and calculus removal programmes are based. Research should be continued to find better, more effective and feasible ways to prevent tooth loss because of periodontal destruction.
2. Bleeding scores at the marginal gingiva and the modified bleeding/plaque ratio are good *markers* of periodontal destruction especially for populations not exposed to regular removal of calculus. Further longitudinal studies are suggested to explore whether bleeding at the gingival margin and the modified bleeding/plaque ratio can serve as *predictors* of periodontal destruction.

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