CONSEQUENCES OF TOOTH LOSS ON ORAL FUNCTION AND NEED FOR REPLACEMENT OF MISSING TEETH AMONG PATIENTS ATTENDING MUHIMBILI DENTAL CLINIC

By

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Dentistry (Restorative Dentistry) of Muhimbili University of Health and Allied Sciences

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance the dissertation entitled **"Consequences of tooth loss on oral function and need for replacement of missing teeth among patients attending Muhimbili dental clinic"** in fulfillment of the requirements for the degree of Master of Dentistry (Restorative Dentistry) of Muhimbili University of Health and Allied Sciences.

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DECLARATION

AND

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I, **Quaker Andrewleon S.** , declare that this **dissertation** entitled õ**Consequences of tooth loss on oral function and need for replacement of missing teeth among patients attending Muhimbili dental clinic**ö is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

Signatureí í í í í í í í í í í í í . Dateí í í í í ..

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ACRONYMS

IDA   Interrupted Dental Arch

MMO   Maximum Mouth Opening

MoHSW   Ministry of Health and Social Welfare

MUHAS   Muhimbili University of Health and Allied Sciences

POP   Posterior Occlusal Pairs

TMD   Temporomandibular Disorders

TMJ   Temporomandibular Joint

TWI   Tooth Wear Index

SDA   Shortened Dental Arch

ABSTRACT

Background: Tanzanian oral health services constitute mainly of tooth extractions. Consequently, individuals susceptible to dental caries and periodontal diseases will have a substantial number of missing teeth, which can affect oral function.

Objective: The main objective of this study was to determine the consequences of tooth loss on the oral function and need for replacement of lost teeth among patients seeking treatment at the School of Dentistry MUHAS.

Materials and methods: During a period of three months, patients seeking dental treatment at the School of Dentistry were recruited for the study. Criteria included age of 20 years and above with one or more missing teeth except for third molars. Participants were interviewed for demographic information, chewing ability, symptoms of temporomandibular disorder and perceived need for replacement of missing teeth. Afterwards the subjects were examined to asses: caries status, tooth mobility, occlusal tooth wear, over eruption of unopposed teeth, and signs of temporomandibular disorders. Data was analyzed using Statistical Package for Social Sciences SPSS 16. For comparison of proportions, chi-square analysis and t test were used. A linear regression analysis was performed, with the chewing ability score as the dependent variable and number of POP as the independent variable

Results: A total of 361 subjects with mean age of 40.2 years (s.d. = 14.2, range = 20-93 years) were recruited into the study. About half 175 (48.5%) of the subjects reported some difficulty with chewing. Generally the fewer the occluding pairs present the greater the difficulty in chewing observed. Subjects with more than 6 posterior occlusal pairs appeared to have little problem in chewing across the whole range of foods. The frequency of signs and symptoms of TMD and excessive tooth wear increased with decreasing number of posterior occluding pairs, being more evident in subjects with less than 3 posterior occlusal pairs remaining. Over a third of the participants had one or more teeth with severe overeruption but none reported impairment of oral function. More than half of the subjects needed replacement for missing teeth

Conclusions: From this study, it is concluded that tooth loss leading to a dentition of 5 to 6 occlusal pairs impairs chewing of hard foods but not soft foods. Extensive loss of teeth leading to less than 3 POP is associated with increased symptoms of TMD and excessive

tooth wear of occluding teeth. Need for replacement of missing teeth is high for both anterior and posterior regions with the cost of dentures being the main barrier to replacement of missing teeth.

Recommendations: Dental personnel should make an effort to identify individuals with risk of tooth loss in order to retain at least 6 well-distributed posterior occlusal pairs. Dental laboratory services need improvement in order to be able to provide quality replacement of missing teeth at affordable costs. Further long-term multicenter studies to evaluate the consequence of tooth loss and assist in giving a more accurate projection needs for dentures nationwide are required.

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1. INTRODUCTION AND LITERATURE REVIEW

Studies have shown that tooth loss can have a substantial influence on the oral function (Sheiham et al., 2001, Nowjack-Raymer and Sheiham, 2003). However, although many epidemiologic studies express oral functionality by numbers of teeth it is questioned whether just the number of teeth is adequate to describe the functional status of the dentitions. It has been claimed that the occluding pairs of natural teeth are strongly correlated with oral functional status (Locker and Slade, 1994). A recent systematic review provided circumstantial evidence that besides the number of teeth also teeth type, tooth location and number of occluding pairs determine the functionality (Gotfredsen and Walls, 2007).

1.1 PATTERN OF TOOTH LOSS

Epidemiological studies have shown that molars are the most affected tooth type by caries and periodontal diseases (Mumghamba and Fabian, 2005, Adeyemo et al., 2008). Besides, molars have the lowest bone height scores (Wagaiyu et al., 2005) and the lowest attachment levels (Baelum, 1987). Consequently, molars are the most frequently extracted teeth, followed by premolars and lower anteriors (Sarita et al., 2004, Kida et al., 2006).

In Tanzania, like in most other developing world countries, the main reason for people to seek for dental care is pain that has become intolerable after a long period of õwait-and-seeö (Kikwilu et al., 2008, Varenne et al., 2006). Because of the delay in seeking treatment, the patients present with extensively decayed teeth that can no longer be saved by the conventional restorative procedures. Furthermore, restorative and rehabilitative dental treatment is limited by finances, shortage of professionals as well as dental materials. It can therefore be assumed that the people who are at risk of caries and periodontal diseases will have a large number of missing teeth.

1.2 FUNCTIONAL CHANGES RELATED TO TOOTH LOSS

When a tooth is lost, the integrity of the dental arch is impaired. Loss of one or more teeth is known to disrupt the balance of the stomatognathic system and trigger several structural and functional changes. These include impaired chewing ability, changes in occlusal stability and occurrence of temporomandibular disorders (TMD).

1.2.1 TOOTH LOSS IN RELATION TO CHEWING ABILITY

It has been well established that chewing performance, as measured with chewing tests declines linearly with a decrease of number of posterior teeth, which constitute the chewing platform area (Käyser, 1981, Wayler and Chauncey, 1983, Luke and Lucas, 1985, Oosterhaven et al., 1988). Similarly, studies have reported that the individual's perceived ability to eat the foods they like correlated closely with number of remaining teeth. For example, Papas et al.(1998) reported that chewing ability of older people decreased with decreasing number of natural teeth, although a loss of up to seven teeth did not lead to an assessment of impaired chewing ability. Similarly Locker (2002), in a study to asses the impact of oral disorders on ability to eat found that chewing ability was correlated with the number and distribution of teeth, and one in five participants reported that the loss of teeth prevented them from eating the foods they like. In another study, Leake et al. (1990) reported that the most important factors which influenced the chewing ability were the number of opposing pairs of posterior teeth. Based on the above, the common dental teaching and practice has been to consider the replacement of all missing teeth on the assumption that a complete complement of teeth is necessary for adequate chewing ability.

However, hypothesis that tooth loss results in impairment of chewing ability has been questioned by several authors (Ramfjord, 1974, Käyser, 1981). They argued that the importance of chewing for food pulverization has declined due to availability of food industries and modern means of food preparation. This argument was supported by several studies in which many people reported to be satisfied with their chewing ability despite the loss of considerable number of teeth (Agerberg and Carlsson, 1981). However, these propositions may not be applicable to all societies because the studies were done in the industrialized countries where pre processed or refined foods are available and people have a broad variety of foods. In non-industrialized countries, diet is largely composed of agrarian products and methods of food preparations are limited. Therefore, pulverization of food might need more intense chewing in these countries than in the industrialized countries. A study on shortened dental arches in Tanzania reported that contrary to industrialized countries dental arches with 3-4 occluding premolars resulted in impairment of chewing ability. However, this study did not explore the chewing ability of people with interrupted dental arches who constitute the majority of people with reduced dentition.

1.2.2 TOOTH LOSS AND OCCLUSAL STABILITY

Various phenomena have been described to occur to the remaining dentition when a tooth is lost. These include excessive occlusal wear of the remaining dentition and overeruption of unopposed teeth.

Increased tooth wear

When teeth are lost from a dentition, fewer teeth are available for mastication and absorption of occlusal forces. It is therefore reasonable to assume that the remaining teeth will experience excessive occlusal wear compared to teeth in a complete dental arch. However, studies in Western countries have reported that people with missing molars, remaining only with premolar and anterior teeth did not experience excessive wear of their dentition compared to people with complete dental arch (Poynter and Wright, 1990, Johansson et al., 1993). It was suggested that the so-called ‑mutually protected occlusionø (meaning disocclusion of posterior teeth during excursions) which is most often seen in adult dentition prevented the occurrence of clinically relevant tooth wear (Witter et al., 2001). Moreover, the fact that modern Western diet does not require intensive mastication may have a masking effect on possible association of tooth loss and occlusal wear of the remaining dentition.

Data on occlusal tooth wear in developing countries is scarce. In a study in Tanzania, it was reported that a decrease of number of occluding teeth was associated with increased occlusal tooth wear especially in cases where all molars were missing (Sarita et al., 2003a). However, this study was limited to individuals with a specific type of dentition comprising intact anterior and premolar regions in absence of molars. There is no data about how tooth loss influences the occlusal wear of remaining dentitions in interrupted dental arches.

Overeruption of unopposed teeth

It is widely accepted that teeth without antagonist overerupt progressively, causing occlusal instability and disharmony of the stomatognathic system (Daskalogiannakis, 2000). This concept has been incorporated in the dental education for a long period and it can be found in the textbooks of occlusion and prosthodontics (Ramfjord and Ash, 1983, Shillingburg et al., 1997, Posselt, 1968, Zarb, 1978). Therefore, many of the authors recommended prompt replacement of extracted teeth in order to avoid overeruption of unopposed teeth and other undesirable sequelae. However, current literature offers weak evidence of such adverse

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consequences (Shugars et al., 1998, Witter et al., 2001, Shugars et al., 2000). In one study, it was reported that only 24% of the patients with unopposed teeth for over 10 years showed moderate to severe overeruption (Kiliaridis et al., 2000). Furthermore, clinical observations have revealed certain patients who have had missing teeth for many years with little or no overeruption of the unopposed (Love and Adams, 1971, Kiliaridis et al., 2000). Until now, there has been no study carried out to determine the extent and effect of overeruption of unopposed teeth in people with interrupted dental arches (IDA) varied categories of reduced dentition in Tanzania.

1.2.3 TOOTH LOSS AND TEMPOROMANDIBULAR DISORDERS (TMD)

Loss of teeth, particularly loss of posterior teeth has long been considered an important predisposing factor for TMD. It was argued that firstly, the absence of posterior support results in overloading of the temporomandibular joint (TMJ) structures (Mohl et al., 1988). Secondly, it was assumed that the absence of posterior teeth would result in mandibular over-closure and as a consequence, the condyles would deviate from their normal centric position in the TMJ, causing dislocation in the joint (Luder, 2002, Tallents et al., 2002). The severity of the symptoms of TMD increases with decrease in the number of occluding teeth for most individuals. Some studies show a relation between unilateral chewing and signs and symptoms of TMD (Pullinger et al., 1993, Diernberger et al., 2008). Joint pain has also been reported more frequently on the side with most missing teeth and increased risk of joint disorders were found in subjects without any molar support (Pullinger et al., 1993, Wang et al., 2009). Furthermore, correlation between absence of posterior support and osteoarthritis of TMJ was reported in several studies (Hansson et al., 1983). For these reasons dentists often tend to recommend the replacement of missing teeth in order to prevent the occurrence of TMD.

On the other hand, however, several studies have concluded that tooth loss is of little relevance in the etiology of temporomandibular disorders (Ciancaglini et al., 1999, Tallents et al., 2002, Witter et al., 1994). The risk of osteoarthritis of the temporomandibular joint in people without posterior teeth was not different from those with complete dental arches. Furthermore no correlation could be found between the number of remaining teeth and severity of symptoms of temporomandibular disorders (De Boever et al., 2000). Similarly, Mejersjö and Carlsson (1984) found that neither the total number of occluding teeth nor the

number of occluding molars and premolars showed any correlation to signs and symptoms of dysfunction at the follow up. Even loss of a large number of teeth did not influence on the degree of pain and or dysfunction of the TMJ. Consequently, the replacement of absent teeth for the purpose of preventing the occurrence of temporomandibular disorders may not be necessary.

From the above it appears that data regarding the association of loss of teeth and health of temporomandibular joint is inconclusive. Besides, data about association of loss of teeth and signs and symptoms of TMD in Tanzania and other African countries is scarce.

1.3 SUBJECTIVE AND OBJECTIVE NEED FOR REPLACEMENT OF MISSING TEETH

In order to prevent or ameliorate the negative consequences of tooth loss, various forms of prosthodontic treatment (tooth replacement) have traditionally been recommended as the clinical standard of care. For a long time, it was stated in most text books of Prosthodontics and taught in most dental schools that, a full complement of teeth is a prerequisite for a healthy masticatory system and satisfactory function (Kanno and Carlsson, 2006). However, some researchers have challenged the traditional prosthodontic standard of care, in which all missing teeth (other than third molars) should be replaced. For example, some have argued that, in contemporary societies complete integrity of the dental arch is actually no longer necessary to fully chew modern diets. Ten occluding pairs of teeth, or a total of 20 properly distributed teeth, may be adequate for optimal chewing ability (Witter et al., 1999). In this view, prosthodontic replacement of missing teeth may not be necessary for every case. In deed it has been suggested that in some circumstances, prosthodontic replacement may even constitute overtreatment and inappropriate use of dental services (Pilot, 1986). It is because of the above reason perhaps that studies have shown that in many countries some types of dentures provided to the patients are often not worn (Meeuwissen et al., 1995, Cowan et al., 1991).

In recent years, increasing emphasis has been placed on the subjective dimension of oral health. In this approach, the subjective indicators and patientøs preferences are increasingly recognized as having a contribution in oral health care and policy decisions (Slade, 1997, Matthews et al., 1999). This is particularly relevant in decision making for prosthetic

replacement of missing teeth. In Tanzania, no studies have been done to determine needs for replacement of missing teeth from the patient's view.

2. STATEMENT OF THE PROBLEM

The traditional approach to restorative dentistry focuses on the preservation of complete dental arch in order to maintain chewing function and prevent occurrence of temporomandibular disorders and occlusal instability (Mohl et al., 1988). This concept is contained in many educational programs and the standard textbooks of prosthodontics and occlusion. It is also the prime objective of restorative care by many dental practitioners in Tanzania where, a great majority of the dentists provide acrylic removable partial dentures in an attempt to restore a complete dental arch (Sarita et al., 2003c). However, the aim to restore complete dental arches especially in high-risk groups (subjects with greater risk for caries and periodontal diseases) is beyond the economic resources of many subjects and health care systems even in the most developed countries with sophisticated dental care systems (Pilot, 1986).

On the other hand, evidence from several studies has indicated that loss of teeth is not always associated with impairment of function. The main argument is that the stomatognathic system has a substantial ability to adapt to changing situations. This implies that the number of teeth may be less than 28 or 32 and still satisfy the individual functional demands.

The result of one study in Tanzania suggests that there is sufficient masticatory ability when missing teeth are confined to the posterior region leaving an intact anterior and premolar region (Shortened Dental Ach). However, loss of teeth does not necessarily follow a sequence resulting in SDA. Indeed, for most individuals tooth loss is likely to result into interrupted dental arches rather than SDA.

It is necessary to investigate the state of oral function of people with different categories of tooth loss in order to determine the need for tooth replacements of absent teeth in Tanzania.

3. RATIONALE OF STUDY

There has been a deliberate effort by the government in the last few years to improve dental services countrywide. This includes refurbishment of dental clinics at district and regional levels, renovation of the University dental school, increased enrolment of students, and reinstatement of dental laboratory technology course. The main aim of these efforts is to prioritize restoration and replacement of missing teeth to meet functional demands, and ensure quality dental services for all citizens.

It has been observed that a large number of patients attend dental clinic for extractions while they have already lost one or more teeth resulting in an interrupted dentition (Interrupted Dental Arch). However, demand for replacement of the lost teeth is low. At present, there are few studies on the impact of tooth loss on oral functions in Tanzania. It would be interesting to know the minimum number of POP required for adequate chewing function. The ability to chew is not only an important dimension of oral health, but is increasingly recognized as being associated with general health status, because the ability to chew food may affect dietary choices and nutritional intake and may therefore have consequences for general health (Krall et al., 1998, Gilbert et al., 1998, Nowjack-Raymer and Sheiham, 2007). Furthermore as mentioned previously, the frequency of occurrence of symptoms and signs of TMD is thought to increase with the missing number of occlusal pairs, although this has not been verified. Other consequences of tooth loss in patients such as increased tooth wear and occlusal stability (mobility and overeruption) have not been profoundly investigated in Tanzania. It is expected that this investigation will shed light on the functional demand for replacement of teeth.

The information gained from this study will provide a deeper insight on the consequences of tooth loss and assist in tailoring the curriculum used in training of dental professionals in order to suit the needs of Tanzanian patients. It will also assist in planning of the prosthodontic services in terms of: materials, human resources and equipment.

4. OBJECTIVES

4.1 GENERAL OBJECTIVE

The main objective of this study was determine the consequences of tooth loss on the oral function and need for replacement of lost teeth among patients attending clinic at the School of Dentistry.

4.2 SPECIFIC OBJECTIVES

- To determine the association between number of teeth lost and chewing ability of the patients

- To determine the association between number of teeth lost and the frequency of signs and symptoms of TMD among patients

- To determine the association between the number of teeth lost and the occlusal stability of the patients

- To determine the need for tooth replacement for the space left by the tooth loss among patients

5   MATERIALS AND METHODS

Study Design,

Cross sectional study

Study Area

This study was conducted in the dental clinic at the School of Dentistry, Muhimbili University of Health and Allied Sciences (MUHAS) in the city of Dar es Salaam. The clinic serves patients attending Muhimbili National Hospital (MNH) the biggest referral hospital in Tanzania. The patients attending this clinic therefore are a mix of residents of Dar es Salaam city (direct patients) and referral patients from various parts of the country.

Study Period

The study was conducted during the months of November 2010 through January 2011

Study population

The study population was derived from all adult patients who attended dental clinic at the School of Dentistry from November 2010 through January 2011

Sample Size

The minimum number of subjects was derived by a formula:

$$n = z^2 \frac{P(1-P)}{e^2}$$

Where :

    n = sample size

    p = prevalence of difficulty in chewing was estimated to be around 25% based

    on data from previous studies (Ow et al., 1997, Foerster et al., 1998, Nguyen et

    al., 2011, Kida et al., 2007)

    e = maximum error on p = 0.05

    z = 95% confidence interval = 1.96

$$n = \frac{1.96^2 \times 0.25(1- 0.25)}{0.05^2} = 288$$

Adding 20% to the above estimate, the minimum sample size was 346 subjects

Recruitment procedure

From November 2010 through January 2011, all adults seeking dental treatment at the School of Dentistry, MUHAS were informed about the study objectives and requested to participate. After consent, subjects were screened to select those who fulfilled the criteria for inclusion: i) 20 years old and over ii) incomplete dentitions (one or more missing teeth except for third molars). Those who fulfilled the criteria for inclusion were invited for a detailed interview and a clinical examination. Those not selected or refusing to participate were assisted to proceed with treatment accordingly (Figure 1).

Flowchart:
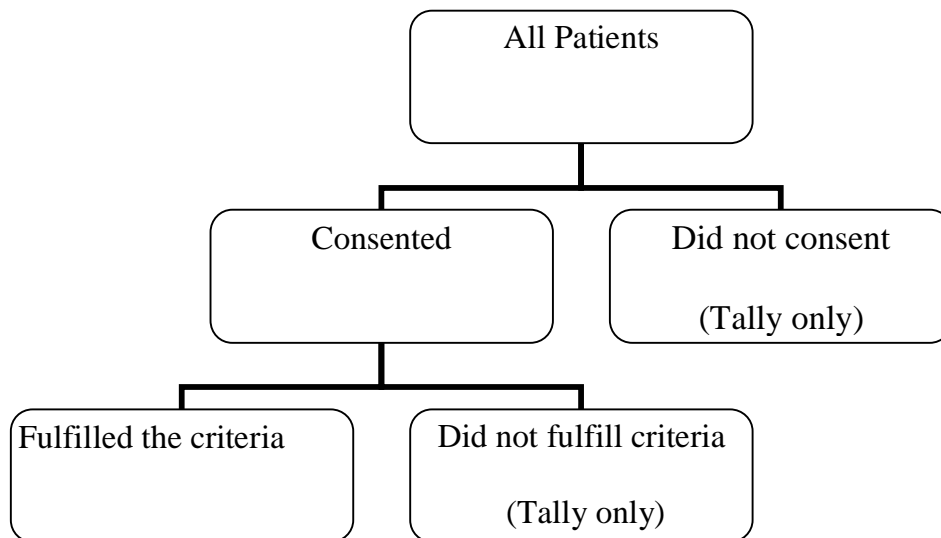
Figure 1: Flowchart of recruitment of subjects

Exclusion Criteria

Exclusion criteria were

i)   inability to communicate such as mental incapability

ii)   conditions which alter the dental arch and oral function such as oral tumors

iii)   severe dental pain

Ethical Issues

Ethical clearance for this study was obtained from the Ethical Clearance Committee of the Muhimbili University of Health and Allied Science and the protocol was approved by the administration of the Muhimbili National Hospital. In addition, every subject was informed of his or her right to refuse participation or to withdraw from the study at any moment and that such decision would not affect the rights for services at the hospital in any way.

Data Collection

Data was collected by personal interview and clinical examination.

Interview:

The interviews were carried out by one trained dentist using a pre-tested structured questionnaire. During the interview items about demography: age, sex, education, and occupation were enquired. Thereafter the subjects were interviewed about (1) chewing ability, (2) symptoms of temporomandibular disorder and (3) perceived need for replacement of missing teeth

1) Chewing ability:

Firstly, general complaints about chewing function were enquired by question: õDo you have any problems chewing food?ö i) No ii) Yes. If õYes,ö What problems do you encounter? The problems were categorized as 0 = no complaints; 1 = chewing takes too long; 2 = must swallow food coarsely; 3 = have to use special or specially prepared food; 4 = Avoids foods I would like to eat. Thereafter, subjects were asked to describe their perceived difficulties in chewing common Tanzanian foods: roasted meat, boiled meat, stiff porridge, pears, raw sweet potato, sugar cane, roasted maize, fresh apple, pawpaw / ripe banana, cooked bananas, cooked maize (makande), raw carrots, roasted cassava, cooked rice, ripe mangos, row cassava, chapati, raw mangos, roasted bananas. The questionnaire is similar to those used in other studies (Sarita et al., 2003d, Nguyen et al., 2011). Perceived difficulty for each food item was scored as: 0 = very easily; 1 = minor problems, adopted; 2 = minor problems, not adapted; 3 = difficult but not avoided; 4 = very difficult but not avoided; 5 = very difficult and avoided; 6 = never used that food (other than avoiding).

2) Symptoms of temporomandibular disorders

With regard to temporomandibular disorders, subjects were asked about:

    (i)   pain in or around the TMJ with differentiation between left and right side and the severity: none, occasional, light or frequent, heavy pain

    (ii)   sounds within the TMJ on movements (opening or closing of mouth) with differentiation to side (yes, no)

    (iii)   restricted mouth opening (yes, no)

Two other factors associated with TMD were also inquired:

    i)   Chewing side preferences (bilateral, unilateral, with front teeth)

    ii)   Clenching or grinding habits

3) Perceived need for replacement of missing teeth

Concerning perceived needs for replacing missing teeth, the subjects were asked:

    i)   Do you feel you need to replace the missing teeth i) no, i) yes. If õyesö What is the main reason for your need: i) aesthetics ii) chewing iii) speech iv) I donøt need replacement.

    ii)   What are the reasons for not replacing the missing teeth until now i) cost / financial reasons ii) services not available iii) not recommended by the dentist iv) negative experience/attitude v) other reasons

Clinical Examination

Clinical examinations were performed by one examiner with subjects seated in a dental chair with operating light using mouth mirrors and dental probe. The following parameters were assessed:

    i) Caries status

    ii) Tooth mobility

    iii) Occlusal tooth wear for occluding teeth

    iv) Over eruption of unopposed teeth

    v) Signs and symptoms of Temporomandibular Disorders

Caries status: The õDecayedö and õFilledö of DMFT were scored for each tooth as

0) Sound (no caries, no restoration),

1) Caries ó reparable,

2) Caries ó irreparable (require endodontic treatment e.g. Pulpitis)

3) Root remnants,

Tooth mobility was estimated for all teeth according to Ramfjordøs(1959) criteria and modifications suggested by Grace and Smales (1983).

  0 - Physiologic mobility, firm tooth

  1 - Slight increase mobility õslightly more than physiologicö (Grade I)

  2 - Definite to considerable increase in mobility but with no impairment of function (Grade II)

  3 - Extreme mobility: severe horizontal mobility combined with vertical displacement. A loose tooth that cannot be used for normal function (Grade III)

  8 - Missing

The overall status of the dentition was scored for each tooth as: 1) present 2) replaced with removable partial denture 3) replaced with fixed denture (bridge) 4) irreparable teeth recommended for extraction (with extensive caries or pulp symptoms that require complex restorations, mobility grade III, or root remnants)

Occlusal tooth wear for occluding teeth was assessed according to the Tooth Wear Index (TWI) proposed by Smith and Knight (1984). The scores were:

  0. No visible wear

  1. Wear in Enamel

  2. Dentine just exposed

  3. Substantial loss of dentine

  4. Wear into secondary pulp / dentine

In the analysis, average wear index for each subject was computed as the sum wear of all occluding teeth divided by the number of occluding teeth. Average tooth wear index was re categorized into two groups: 1) Low wear and 2) significant wear (exposure of dentine and beyond)

Over eruption of unopposed teeth over the occlusal plane was estimated and scored as

    1. None

    2. One to three millimeters

    4. More than 3 millimeters

Furthermore, subjects were asked whether the overerupted teeth impair oral function in any way.

Signs and symptoms of TMD

i) Assessment of clicking or crepitation in the temporomandibular joint

ii) Measurement of the maximum mouth opening (MMO**)**

Need for replacement of missing teeth

Objective assessment of need for replacement of missing teeth was based on the following criteria:

1. Missing anterior teeth and premolar (incisors, canine, or premolar)
2. Presence of cardinal signs of TMD (pain or maximum opening of the mouth less than 40mm)
3. occurrence of excessive occlusal tooth wear

Calibration

Before the study was launched, the investigator was calibrated against a renowned clinical expert familiar with the concepts of functional dentition. Agreements between investigator and expert were rechecked during the study. Cohenøs Kappa coefficient for presence of teeth was 1.0 at beginning and mid of the study caries 0.89 and 0.86, mobility 0.78 and 0.9, tooth wear 0.78 and 0.84 respectively.

Data analysis

Data was analyzed using Statistical Package for Social Sciences SPSS 16. For comparison of proportions chi-square analysis or t test were used. In addition, linear regression analysis was performed, with the chewing ability score as the dependent variable and number of POP as

the independent variable. Multiple regression analysis was used to adjust the results for confounding effects of age and sex for tooth wear and temporomandibular disorders.

In the analysis, the number of occluding pairs was used as a functional unit of the dentition. This was defined as pairs of maxillary and mandibular teeth including bridge abutment and pontics that came into contact when the subjects closed in centric occlusion. Removable dentures and teeth indicated for extractions were excluded.

6. RESULTS

Altogether 797 patients (307 males and 490 women) aged 20 years and over reported to the dental clinics at the School of Dentistry (MUHAS) during the period of the study. Among them 421 (54 %) had complete dental arches, 354 (44 %) had one or more missing tooth (except last molars) and 7 (2%) were edentulous (Table 1). Of those who had one or more missing teeth 15 (2%) were not included in the study for various reasons: eleven did not consent, three had tumors of oral cavity, and one had debilitating medical conditions. Participation rate was therefore 98%.

Table 1: Distribution of subjects according to age and status of the dental arch (n=782)

Arch category	20 - 39		40 - 59		60 +	
	n	%	n	%	n	%
Complete dental arch	300	62	103	44	18	30
Missing anterior teeth only	7	1	3	1	0	0
Missing posteriors only	132	27	76	33	18	28
Missing anterior and posterior	49	10	49	21	20	33
Edentulous	0	0	2	1	5	8
Total	488	100	233	100	61	100

Of those with missing teeth, ten (3%) had missing teeth only in the anterior region, 225 (65%) had missing teeth only in the posterior region, while 119 (34%) had missing teeth in both anterior and posterior regions. The mandibular first molars were the most frequently missing teeth followed by mandibular second molar. The proportion of subjects with missing anterior teeth increased with age from 30 % in the 20 - 39 year olds, 41 % in the 40 - 59 year olds to 55% in those aged 60 years and over.

The demographic data of subjects with missing teeth is summarized in Table 2. The mean age was 40.2 years (s.d. = 14.2, range = 20 - 93 years). The majority were 20 - 39 years old, employed, with secondary level of education or more. About two thirds (60%) of those aged

20 - 39 and 40 - 59 were females while in contrast, 65% of those aged 60 years and over were males ($\chi^2 = 9.802$, df = 2, p = 0.007, CI 95%).

Table 2: Demographic data of participants

	N	(%)
Sex		
Male	155	43
Female	206	57
Age groups (yrs)		
20 - 39 Years	188	52
40 - 59 Years	130	36
60 + Years	43	12
Educational level		
None	18	5
Primary	129	36
Secondary	141	39
Tertiary	73	20
Occupation		
Unemployed	41	11
Self Employed	119	33
Employee	201	56

The proportion of subjects with 5 or more posterior occluding pairs decreased with increasing age: from 66% in the 20 - 39 year olds, 54 % in the 40 - 59 year olds to 28 % in the 60+ year olds ^{2} = 14.87, df = 1, p = 0.001). Conversely, 0 - 2 posterior occluding pairs were more frequent in the 60 + year olds (49%) compared to 20-39 year olds (13%) and 40 - 59 year olds (21%) (^{2} = 38.59, df = 1, p < 0.001).

Association between tooth loss and chewing ability

Table 3 shows the frequency distribution of subjectøs complaints about chewing function. Nearly all (98%) subjects with 0 - 2 posterior occluding pairs of teeth complained about chewing function: 57% avoid certain foods, 71% swallow food coarsely, 29% chew for long periods and 11% use special or specially prepared foods.

Table 3: Percentage distribution of complaints about chewing function

Occlusal pairs	n	% No complaints	% Avoids certain foods	% Swallows coarsely	% Chewing takes too long	% Requires Special Preparation
0	26	0	82	83	59	16
1 - 2	39	15	41	61	11	8
3 - 4	88	42	25	37	9	5
5 - 6	94	65	11	11	1	0
7+	114	98	1	2	0	0

Complaints about chewing decreased with increasing number of posterior occluding pairs. It was reported by (98%) of 0 - 2 occlusal pairs ; (68%) of subjects with 3 - 4 occlusal pairs, one third of those with 5 - 6 occlusal pairs and nearly none (2%) of those with 7 or more occlusal pairs. The most frequent complaint was that subjects swallow food coarsely because of loss of teeth.

Table 4 shows the percentage distribution of perceived difficulty for chewing common Tanzanian foods. Generally the fewer the occluding pairs the greater the difficulty in chewing. Subjects with more than 6 posterior occlusal pairs appeared to have little problem in chewing across the whole range of foods. All subjects with 0 occluding pairs and majority of the subjects with 1 - 2 occluding pairs had difficulties eating or could not eat at all the foods categorized as hard. About one quarter of the subjects with 1 - 2 posterior occluding pairs could not eat with ease the foods categorized as soft. Majority of subjects with 3 - 4 and 5-6 posterior occluding pairs could eat the soft foods with ease but not the hard foods.

Table 4: Distribution of subjects who reported they could eat only with difficulty or could not eat some or all types of foods in relation to posterior occlusal pairs (POP)

Type of food	% 0 POP n = 26	% 1 - 2 POP N = 39	% 3 - 4 POP n = 88	% 5 - 6 POP n = 94	% 7 + POP n = 114
Hard foods					
Roasted meat	100	92	56	46	11
Boiled meat	100	82	51	27	2
Sugarcane	100	100	82	52	15
Roasted bananas	96	64	42	19	5
Peanuts	100	87	53	23	6
Raw carrots	100	87	53	30	8
Pears	100	76	47	27	8
Raw mangos	100	94	55	31	11
Raw cassava	100	87	52	27	10
Raw sweet potatoes	100	82	56	29	10
Fresh apple	100	84	38	21	4
Roasted maize	100	94	81	44	13
Roasted cassava	100	87	49	23	5
Cooked maize (makande)	100	76	43	19	8
Soft foods					
Cooked bananas/potatoes	65	28	13	0	0
Stiff porridge	69	20	15	0	0
Chapati	96	56	32	4	1
Ripe pawpaw/bananas	61	25	5	0	0
Cooked rice	53	25	15	0	0
Ripe mangos,	100	53	16	11	0

As 10 pairs of opposing teeth were considered the cutting point for increased volume of chewing complaints, analysis was done to compare 0 - 9 with 10 + pairs of opposing teeth for each of the food items (Table 5). Overall patients with 0 to 9 occlusal pairs were up to 12 times more likely to have difficulty chewing than those with 10 to 15 pairs of opposing teeth.

Table 5: Percentage of participants who reported that they eat with difficulty or avoid some or all the foods for 0-9 and 10+ occluding pairs (** $p<0.001$)

Types of foods	% 0 - 9 pairs	% 10 + pairs	Odds Ratio
Hard foods	n =120	N =241	99% CI
Roasted meat	72	29	6.3 (3.38 - 11.77)**
Boiled meat	67	17	9.6 (5.02 - 18.55)**
Sugarcane	86	37	11.8 (5.51 - 25.03)**
Roasted bananas	57	15	7.8 (4.04 - 15.13)**
Peanuts	73	16	13.6 (6.89 - 26.80)**
Raw carrots	74	19	12.2 (6.26 - 23.82)**
Pears	67	18	9.4 (4.88 - 17.92)**
Raw mangos	74	24	9 (4.73 - 17.16)**
Raw cassava	71	20	9.3 (4.89 - 17.80)**
Raw sweet potatoes	72	21	9.8 (5.1 - 18.69)**
Fresh apple	63	14	10.8 (5.47 - 21.18)**
Roasted maize	83	34	9.4 (4.70 - 18.86)**
Roasted cassava	71	15	13.9 (7.05 - 27.70)**
Cooked maize (makande)	63	16	9.3 (4.83 - 18.05)**
Soft foods			
Cooked bananas/potatoes	16	10	21.5 (3.14 - 147.58)**
Stiff porridge	16	10	21.5 (3.38 - 11.77)**
Chapati	51	9	10.0 (4.79 - 20.91)**
Pawpaw/ bananas	15	1	40.9 (2.88 - 540.78)**
Cooked rice	13	1	11.3 (2.20 - 57.79)**
Ripe mangos	44	5	14.0 (5.79 - 33.93)**

Fig.1 represents the mode of the scores for the perceived difficulty of chewing twenty common foods for the posterior occluding pairs. Subjects with six or more posterior occluding pairs appeared to have little problem in chewing the 20 foods. Major increase in chewing difficulties occurred in subjects with five occluding pairs and a further increase in subjects with four or less occluding pairs.
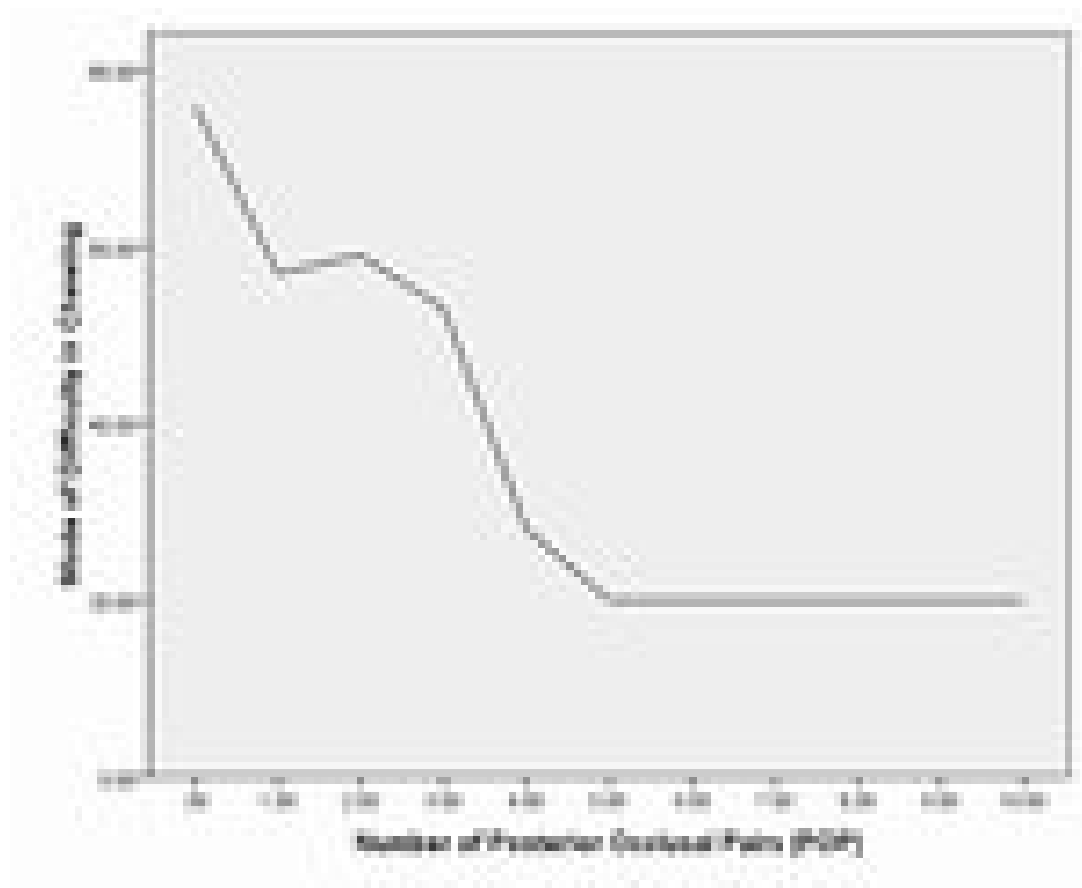
Figure 2: Mode of Difficulty in chewing in relation to the number of POP

Association proved to hold for linear regression. Stepwise regression gave a   of 0.4 for 6 to 10 occlusal pairs and 0.7 for 0 to 5 occlusal pairs. The difference of the mean(s) of chewing difficulty between those with 6 or more occlusal pairs and those having 5 and less pairs using t test was highly significant t (207) =14.3, p <0.001, CI 99%.

Association between tooth loss and the temporomandibular joint disorders (TMD's)

Table 6 presents the subjective symptoms of temporomandibular disorder for the categories of posterior occluding pairs. The frequency of joint pain increased with decreasing number of posterior occluding pairs: from 8% for 7+ occluding pairs to 25% for 3-4 occluding pairs and 46% for 1- 2 occluding pairs $(\chi^2 = 64.05, df=4, p < 0.001)$. However, pain was occasional or light and no subject reported severe pain. Joint sounds were reported more frequently by subjects with no posterior occlusal pairs than the others *(p < 0.001 Fisher exact test,)*. Few individuals reported restricted mouth opening and the frequency did not differ significantly between categories of posterior occlusal pairs.

Table 6: Subjective symptoms associated with temporomandibular disorders

Posterior occluding pairs	Number of subjects	Subjective symptoms					
		Pain		Joint Sound		Restricted mobility	
		n	%	n	%	n	%
0	26	18	69	11	42	2	8
1- 2	39	18	46	6	15	0	0
3 - 4	88	22	25	10	11	11	13
5 ó 6	94	13	14	11	12	13	14
7+	114	9	8	4	4	1	1
Total	361	80	22	42	11	27	8

Table 8 shows the distribution of clinically assessed signs of temporomandibular disorders for the categories of posterior occlusal pairs. The frequency of clinical signs increased with decrease of in number of posterior occluding pairs. Clicking and crepitation in the joint were significantly more frequent in subjects with two or fewer posterior occlusal pairs $(\chi^2 = 85.5, df =4, p < 0.001)$. For the whole sample, clicking and crepitation was found significantly more often in the older age group (37%) compared to the younger age group 12.2% $(\chi^2 = 30.2, df=1, p < 0.001)$.

Table 7: Clinical signs associated with temporomandibular disorders

Posterior occluding pairs	Number of subjects	Clinical signs			
		Clicking or crepitating		Max. mouth opening < 40 mm	
		n	%	n	%
0	26	19	73	9	35
1- 2	39	23	59	5	13
3 - 4	88	22	25	3	3
5 ó 6	94	18	19	12	13
7+	114	5	4	1	1
Total	361	73	20	23	6

Chewing side preference was strongly related to the location of the most occlusal pairs. No significant association was found between chewing side preference and occurrence of signs and symptoms of TMD. Twelve subjects, five women and seven men, reported they grind their teeth during sleep.

Tooth loss and tooth wear

Occlusal tooth wear tended to increase with decreasing number of posterior occluding pairs (Table 8). The mean scores for occlusal tooth wear were lowest in individuals with 7 or more posterior occluding pairs and highest for those with 2 or less occlusal pairs. For the younger age group occlusal tooth wear was mostly limited to õenamel wear and dentine just exposedö where as in the older group õwear into secondary dentine / pulpö increased significantly with decrease of posterior occluding pairs ($\chi^2=16.48$, $df= 2$, $p=0.001$).

Table 8: Means scores for occlusal tooth wear (sd in parentheses)

Posterior occluding pairs	Mean scores for occlusal tooth wear			
	Anterior region		Posterior region	
	20Öage < 40yrs	> 40 yrs	20Öage < 40yrs	> 40 yrs
0	1.9 (0.6)	2.5 (0.6)	0	0
1 - 2	1.5 (0.5)	2.1 (0.8)	1.8 (0.5)	2.0 (0.9)
3 - 4	0.9 (0.6)	1.9 (0.4)	1.5 (0.6)	2.2 (0.3)
5 ó 6	0.8 (0.6)	1.9 (0.6)	1.2 (0.2)	1.9 (0.4)
7+	0.6 (0.4)	1.9 (0.5)	0.9 (1.1)	2.0 (0.5)

After dichotomization õlow wearö (no visible wear / wear in enamel) was found more frequently among the young age group than in the old (^{2} = 10.5, df= 1 p < 0.002). For the younger age group õhigh wearö (dentine just exposed / wear into secondary dentine / pulp) was found more often in subjects with less than 3 posterior occlusal pairs than the others (p = 0.008, Fishers exact test). In the regression analysis, age (Beta = 0.019, p < .0.01) and number of posterior occluding pairs (Beta = -0.059, p = 0.01) were the only factors, which were significantly associated with increased wear.

Tooth loss and occlusal stability

Over eruption of unopposed teeth

Overall, 354 (96%) subjects had one or more unopposed tooth. Taking the maximum score per subject, the frequency of over eruption was none or mild (Ö3 mm) in 226 (63.8%), severe (> 3 mm) in 128 (36%). Over-eruption was more common in the maxilla than mandibular teeth and in posterior region than the anterior. None of the subjects reported that the over erupted teeth hindered function.

Tooth mobility

Increased tooth mobility was rare in the young age group. In this age group, only 19 (12.1%) individuals had one or more mobile teeth. For the older age group, however, the prevalence of tooth mobility was 18.1% in the anterior region and 24.7% for the posterior region. Also for the older age group, tooth mobility tended to increase with the reduction of posterior occluding teeth: from 33.3% for those with 7 or more occlusal pairs, to 44.4% for those with 0 occlusal pairs.

Table 9: Mean Mobility for occluding pairs only (N = 354)

Category of Occlusal pairs	20 Öage < 40yrs		> 40 yrs		Total
	n	Mean mobility (SD)	n	Mean mobility (SD)	n
0 Pairs	0	0	19	0.5 (0.38)	19
1to 2 pairs	16	0.35 (0.52)	23	0.27 (0.44)	39
3to 4 pairs	46	0.08 (0.17)	42	0.18 (0.3)	88
5 to 6 pairs	38	0.15 (0.29)	56	0.22 (0.3)	94
7 + pairs	87	0.06 (0.16)	27	0.11 (0.15)	114

Need for tooth replacement

From the interview, 181 (50.4%) subjects reported they needed replacement of missing teeth. More than two-thirds (66.7%) of subjects who had lost teeth only in the anterior region indicated they needed tooth replacement for appearance, 37(36.3%) of the subjects who had

lost teeth only in the posterior region needed tooth replacement for chewing. Of those who had lost teeth in both the anterior and posterior regions 94 (74.2%) needed tooth replacement for appearance and chewing.

Overall, the perceived and assessed need for replacement of lost teeth increased with increasing age and for each age group the subjective need for replacement of lost teeth was lower than the assessed needs (Fig 3).

The normative need for replacement of missing teeth was higher than patientøs perceived need. Based on clinical examination it was judged that 11 (91%) of the subjects who had lost teeth only in the anterior region required tooth replacement for appearance. The need for replacement of teeth only in the posterior region was 141 (61.8%) whereas 39 (29.3%) needed replacement of the lost teeth in both anterior and posterior regions.
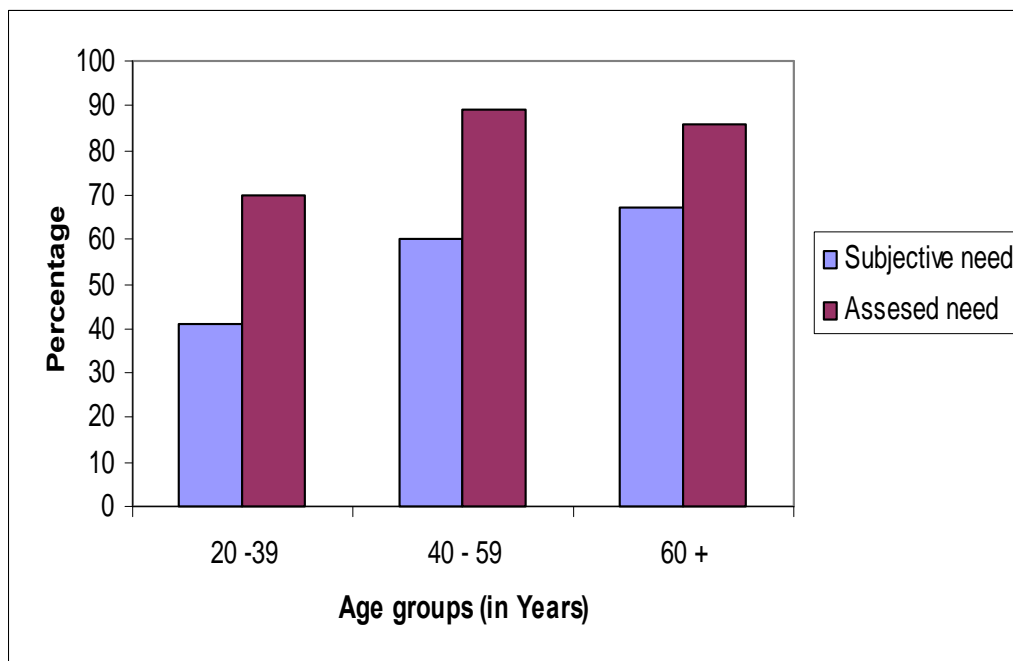
Figure 3: Subjective and assessed need for dentures of the study participants

Of the subjects who perceived the need to replace the missing teeth, only ten had dentures in the upper or lower jaw. The others indicated that they were without dentures mainly because they were unable to pay for dentures. Another reason for nonreplacement of missing teeth

was õServices not easily accessibleö availableö and õNegative experience/attitudeö Fig 3. No significant difference was found between the males and female subjectøs reasons for demanding dentures.
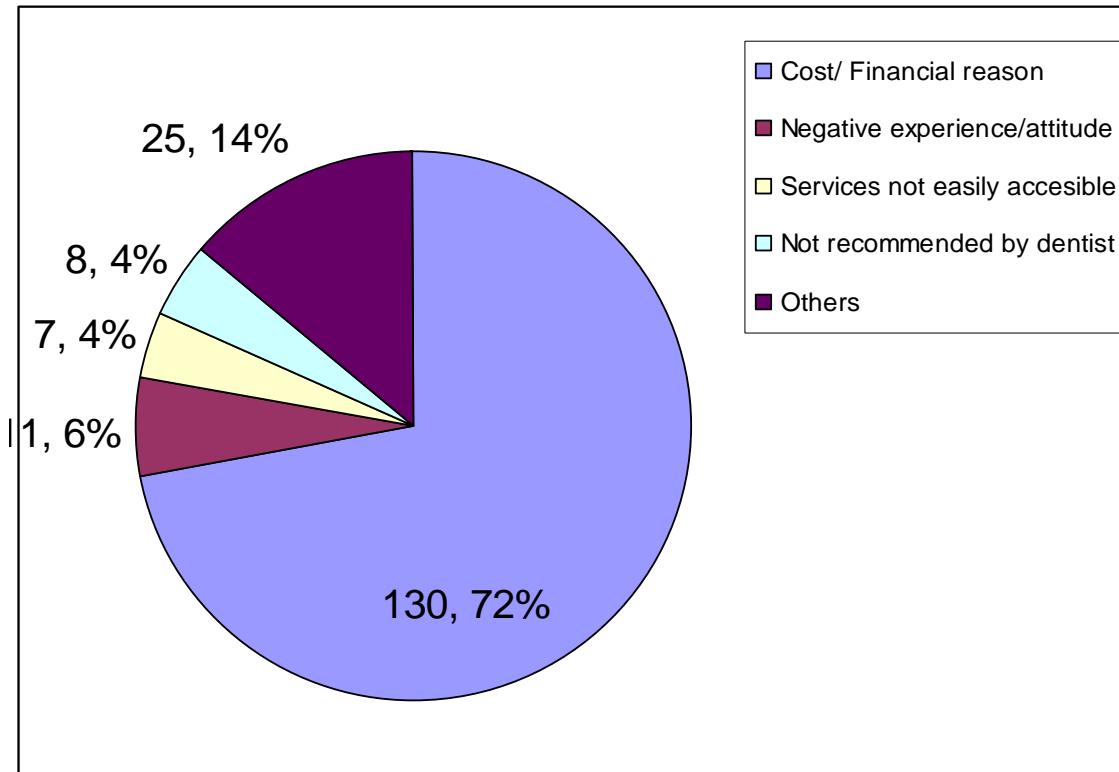
Figure 4: Reason for not having a denture among those subjects who perceived need for tooth replacement

7. DISCUSSION

In this study, the twenty food items used included the common agricultural products, which comprise the traditional staple foods in Tanzania. Foods differ in consistency depending on whether they are eaten pounded or milled before cooking. The foods considered soft such as cooked rice, stiff porridge, cooked potatoes and cooked bananas constitute the bulk of the main meals in the contemporary societies in Tanzania, where as foods considered hard such as roasted meat, sugarcane and roasted maize are usually eaten as accessories or light meals. Assessment of chewing function was based on answers to a structured interview. Objective evaluation using chewing tests might be preferred since they have proven to be good indicators of chewing function. For epidemiological studies, however, chewing tests are not suitable because they are time consuming, require special facilities, and conclusions are limited to the test foods used. Furthermore, it has been shown that the results obtained by questionnaire correlate with objective evaluation using a seaving method (Hirai et al., 1994).

It appears that loss of teeth has no impact on the chewing both the soft and hard foods if the remaining dentition has 7 posterior occluding pairs. When the loss of teeth is more extensive, leaving 5-6 posterior pairs of occluding teeth, the subjects experienced difficulties in chewing hard foods but not soft foods. This is in contrast with findings from a previous study in Tanzania which reported that a minimum of five occluding posterior occluding pairs located bilaterally were sufficient for chewing function (Sarita et al., 2003d). However, while most of the subjects of this study had interrupted dental arches, the corresponding subjects in the previous studies had shortened dental arches comprising intact anterior and premolar region and one pair of occluding molars. This may imply that compared to SDA, interrupted dentition has more negative implications to chewing function even though the number of posterior occluding pairs is the same

When the loss of teeth was extensive, leaving 0 - 2 posterior occluding pairs the persons experienced far more difficulties of chewing for both hard and soft foods (Table 4). Similar findings were reported among subjects with shortened dental arches comprising intact anterior region and 0 - 2 occluding pairs of premolars. Studies in industrialized countries also reported impaired chewing ability in persons with such dentitions (Sheiham et al., 1999, Agerberg and Carlsson, 1981) while similar results were also reported from adults in Brazilian (Elias and Sheiham, 1999). The overall effects of chewing difficulties on dietary intake could not be evaluated from this study but it can be speculated that a dentition with 0-2

posterior occluding pairs might lead to inadequate nutritional state, as individuals tend to exclude foods from their diets because they found them difficult to chew.

Frequency of subjective and objective symptoms of TMD increased with a decrease in number of posterior occlusal pairs. In particular joint pain as well as joint sounds increased significantly with decreasing number of posterior occluding pairs. For example, it was remarkable that more than 50% of the subjects with 0 - 2 posterior occluding pairs compared to only 8% percent of subjects with seven or more occluding pairs perceived pain in the TMJ (Table 6) . A similar trend was observed with regard to joint sounds and limitations of mouth opening. It is therefore reasonable to suggest that loss of teeth, particularly extensive loss of posterior occluding pairs is associated with increased symptoms of TMD. This is in agreement with findings of Seligman and Pullinger in (1989) and Mazengo and Kirveskari (1991). It has to be considered however, that the subjects of this study were dental patients who may have a higher risk of symptoms of TMD than the general population. Furthermore, the number of subjects for the categories of posterior occluding pairs was not large enough to support firm conclusions. Contrary to results from other studies that reported significantly higher frequencies of signs and symptoms in women than in men (Pullinger et al., 1988, Gesch et al., 2004) no such differences were found in the present study. Age also did not appear to be an important determinant of the prevalence of signs and symptoms of TMD as reported by Helkimo (1974)

It was observed that occlusal tooth wear tended to increase with decrease in number of posterior occluding pairs as suggested by Ekfelt et.al. (1990) Poynter and Wright (1990)and Johansson et, al(1993). Subjects with more than 4 posterior occluding pairs had a degree of wear, which was within accepted physiological limits for the both young and old age groups. However, excessive wear become evident in subjects with less than four posterior occluding pairs (Table 8). Such results could be due to excessive load on a reduced occlusal platform.

Increased tooth mobility was rare in the young age group but more common in the older age groups. Mean mobility of the occluding pairs for each category of posterior occlusal pairs was within the normal physiologic limit.

Most subjects with unopposed teeth had substantial overeruption. In spite of that, no subject complained of functional impairment due to overeruption of unopposed teeth. This is similar to what was reported by Sarita et al (2003b) in an epidemiological study.

More than half of the participants needed replacement of missing teeth. Despite the high subjective and objective needs, the number of subjects with dentures was very low. Majority of subjects indicated they remained partially edentulous because they were unable to afford dentures. Denture services are expensive and available mainly in the cities and some of the regional hospitals; therefore, they are difficult to access. Moreover, replacement of missing teeth is not included in the National Health Insurance scheme.

The sample for this study was drawn from patients attending dental clinic at the School of Dentistry in Tanzania and may not represent the population of individuals with missing teeth in the country.

Due to scarcity of records and the fact that most of the teeth are lost at long intervals, the time interval between losses of teeth and interview could not be determined.

In this study, the subjects were rather young. This was attributed to the fact that the sample was recruited from dental patients attending the clinic. The low proportion of elderly patients in the sample might be an underestimation. We speculate that people who are edentulous or near edentulous are old, unable to pay for treatment and therefore do not perceive the benefit of attending dental clinic.

About two thirds (68%) of the sample had missing teeth only in the posterior region while only ten subjects had missing teeth only in the anterior region. This supports the consideration that anterior teeth are natural survivors of decay while molars, particularly in the lower jaw have a high risk of decay leading to loss. As reported in previous studies (Hugoson et al., 1988, Johansson et al., 1993, Yun et al., 2007, Broadbent et al., 2006) this study also confirms that tooth loss increases with age.

8. CONCLUSIONS

Results indicate that, loss of teeth has no impact on the chewing if the remaining dentition has 7 or more posterior occluding pairs. However, when the loss of teeth is more extensive, leaving 5-6 posterior pairs of occluding teeth, the subjects experienced difficulties in chewing hard foods but not soft foods. Chewing ability decreases sharply when the number of posterior occluding pairs falls below 5.

Similarly, excessive tooth wear of occluding teeth and increased frequency of TMD symptoms and signs were more marked among subjects having less than 3 posterior occlusal pairs compared to those with more.

Despite a relative high, need for replacement of missing teeth for both anterior and posterior regions few subjects had such replacements. The cost of dentures was the main barrier to replacement of missing teeth.

From this study, it is concluded that: Chewing ability, occlusal stability are affected negatively by tooth loss with an accompanying increased risk of TMD signs and symptoms.

9. RECOMMENDATIONS

Based on the findings of the study the following recommendations are made:

1. Dental personnel should make an effort to identify individuals with risk of tooth loss in order to limit and prevent tooth loss
2. Improvement of dental laboratories to be able to provide quality replacement of missing teeth at affordable costs
3. Further long-term multicenter studies to evaluate the consequence of tooth loss and assist in giving a more accurate projection of the patients needs nationwide

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11. Appendix I: Informed Consent Form (English version)

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

DIRECTORATE OF RESEARCH AND PUBLICATIONS, MUHAS
INFORMED CONSENT FORM

ID-NO. ☐☐

Consent to Participate in a Study

Greetings! My name is Dr Quaker Andrewleon; I am working on this research with the objective of determining the consequences of tooth loss on oral function and the subjective and objective need for prosthodontic replacement among patients attending Muhimbili Dental clinics, Dar es Salaam.

Purpose of the study

The study is conducted in partial fulfillment of the requirements for the degree of Master of Dentistry in Restorative of MUHAS. This study is aiming to determine effects of tooth loss and the need for prosthodontic replacement among patients attending the restorative dental clinic of Muhimbili University College of Health Sciences. You are being asked to participate in this study because you have particular knowledge and experiences that may be important to the study. Kindly please be honest and true for betterment of the results that could lead to better intervention and recommendations for future.

What Participation Involves

If you agree to join the study, you will first be interviewed in order to answer a series of questions in the questionnaire prepared for the study.

Secondly, a dentist will perform a brief examination of your mouth. The examiner will provide you with a summary of the findings offer advice and refer for suitable treatment.

Confidentiality

I assure you that all the information collected from you will be kept confidential. Your name will not be written on any questionnaire or in any report/documents that might let someone identify you. Your name will not be linked with the research information in any way. All information collected on forms will be entered into computers with only the study identification number. Confidentiality will be observed and unauthorized persons will have no access to the data collected.

Risks

We do not expect that any harm will happen to you because of participating in this study. Some questions could potentially make you feel uncomfortable. You may refuse to answer any particular question and may stop the interview at anytime.

Right to Withdraw and Alternatives

Taking part in this study is voluntary. You can stop participating in this study at any time, even if you have already given your consent. Refusal to participate or withdrawal from the study will not involve penalty.

Benefits

The information you provide will help to determine the effect of tooth loss as well as the need of for prosthodontic replacement for teeth lost.

Whom to Contact

If you ever have questions about this study, you should contact the Principal Investigator, Dr Quaker Andrewleon S. of Muhimbili University of Health and Allied Sciences, P. O. Box 65001, Dar es Salaam.

If you ever have questions about your rights as a participant, you may call the Chairperson of the Senate Research and Publications Committee, P. O. Box 65001, Telephone: 255-22-2152489 Dar es Salaam and Dr. P.T.N. Sarita who is the Supervisor (Tel 0784-632228)

Do you agree?

Participant agrees í í í í í í í ...   Participant does NOT agree í í í í í í .

I í í í í í í í í í í í í í í í . have read the contents in this form. My questions have been answered. I agree to participate in this study.

Signature of participant í í í í í í í í í í í í í

Signature of Research Assistant í í í í í í í í   Date í í í í í í ..í í í í .

12. Appendix II: Informed Consent Form (Kiswahili version)

CHUO KIKUU CHA SAYANSI ZA AFYA MUHIMBILI

KURUGENZI YA TAFITI NA UCHAPISHAJI

FOMU YA RIDHAA

Namba ya utambulisho

Ridhaa ya kushiriki kwenye utafiti

Hujambo! Ninaitwa Dr Quaker Andrewleon, nashughulika kwenye utafiti huu wenye lengo la madhara ya kupoteza meno na mahitaji ya meno bandia kwa wagonjwa wanaohudhuria kliniki za meno hapa Muhimbili.

Utafiti huu unafanyika katika kutimiza sehemu ya matakwa ya shahada ya uzamili ya matibabu ya kurekebisha na kuziba meno ya Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili. Utafiti unalenga kuchunguza athari za kupoteza meno na mahitaji ya meno bandia kwa wagonjwa wanaohudhuria kliniki za meno hapa Muhimbili. Unaombwa kushiriki katika utafiti huu kutokana na upeo na ufahamu ulio nao ambavyo ni muhimu kwa utafiti huu. Tafadhali kuwa mkweli na muwazi kwa vile matokeo ya utafiti huu yanaweza yakatoa maamuzi na mapendekezo ya baadaye.

Jinsi ya kushiriki

Ukikubali kushiriki katika utafiti huu, kwanza utasailiwa ili kuweza kujibu maswali toka kwenye dodoso lililoandaliwa kwa ajili ya utafiti huu.

Pili mganga wa meno atafanya uchunguzi mfupi wa kinywa chako na mono ya bandia kama unayo kisha atakufahamisha kuhusu afya yako ya kinywa kukupatia ushauri wa kitaalam na kukuelekeza mahali sahihi pa kupatiwa matibabu.

Usiri

Taarifa zote zitakazokusanywa kupitia dodoso zitaingizwa kwenye ngamizi kwa kutumia namba za utambulisho.Kutakuwa na usiri na hakuna mtu yeyote asiyehusika atakayepata taarifa zilizokusanywa.

Hatari

Hatutegemei madhara yoyote kukutokea kwa kushiriki kwako kwenye utafiti huu.

Faida

Kama utakubali kushiriki kwenye utafiti huu taarifa utakazotoa zitatuwezesha kutupa mwanga zaidi juu ya athari za kupoteza meno na mahitaji ya meno bandia.

Athari na kukitokea madhara

Hutegemewi kupata madhara yoyote kutokana na ushiriki wako katika utafiti huu. Baadhi ya maswali yanaweza yasikupendeze, unaweza kukataa kujibu swali lolote la aina hiyo na unaweza kuamua kusimamisha udahili wakati wowote.

Uhuru wa kushiriki na haki ya kujitoa

Kushiriki kwenye utafiti huu ni hiari. Unaweza kujitoa kwenye utafiti huu wakati wowote hata kama umeshajaza fomu ya ridhaa ya kushiriki utafiti huu. Kukataa kushiriki au kujitoa kwenye utafiti huu hakutaambatana na masharti yoyote.

Nani wa kuwasiliana naye

Kama una maswali kuhusiana na utafiti huu, wasiliana na Mtafiti: Dr Quaker Andrewleon wa Chuo Kikuu cha Afya na Sayansi ya Tiba Muhimbili, S. L. P. 65001, Dar es Salaam.

Kama una swali kuhusu stahili zako kama mshiriki unaweza kumpigia simu Mwenyekiti wa kamati ya Utafiti na Uchapishaji, S.L.P 65001, Simu: 255 22 2152489 Dar es Salaam au msimamizi wa utafiti huu Dr P.T.N Sarita (Simu: 0784-632228)

Je umekubali?

Mshiriki amekubali í í .... Mshiriki hajakubali í í í ....

Mimi .... nimesoma maelezo ya fomu hii.

Maswali yangu yamejibiwa.Nakubali kushiriki katika utafiti huu.

Sahihi ya mshirikií í í í í í í ....

Sahihi ya mtafiti msaidizií í í í í í í Tarehe ya idhini ya kushirikií ....í í í

13. Appendix III: English Questionnaire:

INTERVIEW QUESTIONAIRE ON CONSEQUENCE OF TOOTH LOSS
AND NEED FOR THEIR REPLACEMENT

1. Reg NO:

2. Age: í í .. 3. Gender: A. Male   B. Female   4.Occupation: í í í

5. Education: A. Primary education   B. Secondary   C. Higher education

6. Do you think you need to replace the missing tooth (teeth)?

   1. Yes   2.No   3.Do not know

7. If yes, replacement is needed for:

   1- Appearance / aesthetics

   2 - Chewing

   3 - Aesthetics and chewing

   4 ó Other_____

8. What are the reasons for not replacing the missing teeth (if lost for more than three months):

   1. does not need it

   2. cost / financial reasons

   3. services not accessible/available

   4. unsatisfactory previous experience

   5. was not recommended by dentist

   6. Other reason _____

9. Do you have any trouble chewing certain foods?

   1. No   2. Yes

10. If yes, which particular types of food give you problems what problem and how do you manage?í í

í í

Subjects to be asked whether they were able, at the time of interview, to chew or bite:

11. Roasted meat (Barbecued)		21. Cooked maize (makande)	
12. Boiled meat		22. Peanuts	
13. Stiff porridge		23. Raw carrots	
14. Pears		24. Roasted cassava	
15. Raw sweet potatoes		25. Cooked Rice	
16. Sugarcane		26. Ripe Mangos,	
17 Roasted maize		27. Raw cassava	
18. Fresh apple		38. Chapatti	
19. Pawpaw/ Bananas		39. Raw mangos	
20. Cooked bananas/Potatoes		30. Roasted bananas	

1. Good
2. Fairly good
3. Moderate
4. Poor

31. Which side of the mouth do you use for Chewing?
        1. Both   B Left   2. Right   3. Anterior teeth

32. Do you get pain around the TMJ?
        a. None   2. Sometimes

33. Do you hear any sound (Clicking popping or gritting) during the opening or closing of the TMJ?
        1. No   2. Yes, Left side   3.Yes, Right side   4. Yes, Both sides.

34. Do you have any problem opening or closing the mouth?
        1. No   2. Yes

35. Do you have any general joint disease?
        1. Yes   2. No

36. Do you have any clenching or grinding habits?

        1. Never   2. Sometimes   3. Often   4. I do not know

14. Appendix IV: Swahili Version Questionnaire

DODOSO KUHUSU ATHARI ZA KUPOTEZA MENO NA
MAHITAJI YA MENO BANDIA

1. Dod. Na: í ..

2. Umri: í í ..3. Jinsia: A. Mwanaume   B. Mwanamke   4. Kazi: í í í

5. Elimu ya :   A. Msingi   B. Sekondari   C. Chuo

6. Je wewe unahitaji meno (jino) la bandia   1. Ndiyo   2 Hapana   3. Sijui

7. **Kama ndiyo;** yanahitajika kwa ajili ya:

1. Mwonekano
2. Kutafuna
3. Kongea/Kutamka
4. Mengineyo í í í í í í í

8. **Kama Hapana**, Je; Ni sababu gani huna meno ya bandia (Kwa waliopoteza meno zaidi ya miezi mitatu iliyopita):

1. Uwezo mdogo wa fedha (ni ghali mno)
2. Hukuona haja ya kuwa nayo
3. Huduma ni ngumu kupata
4. Sijaridhika na huduma za awali
5. Sikushauriwa na mganga wa meno
6. Mengine í í í í í í í

9. Je huwa unapata shida kutafuna baadhi ya vyakula?

A. Ndiyo   B. Hapana

10. Kama ndiyo ni chakula gani na unafanyaje?

í í

í í

Washiriki waulizwe kuhusu uwezo wao wa kutafuna vyakula mbalimbali

11. Nyama ya kuchoma		21. Kande	
12. Nyama za kupikwa		22. Karanga	
13. Ugali		23. Caroti mbichi	
14. Pears		24. Mihogo ya kuchoma	
15. Viazi vitamu vibichi		25. Wali	
16. Miwa		26. Maembe mabivu,	
17. Mahindi ya kuchoma		27. Mihogo mibichi	
18. Apple (Maepo)		38. Chapati	
19. Papai /Ndizi mbivu		19. Maembe mabichi	
20. Ndizi /Viazi za kupika		30. Ndizi za kuchoma	

1. Vizuri
2. Vizuri kiasi
3. Wastani
4. Vibaya

31. Unatumia upande gani kutafunia?

    A. Pande zote   B Kushoto   C. Kulia   D. Meno ya mbele tu

32. Je unapata maumivu kwenye kiungo cha taya?

    1. Hapana   2. Ndiyo

33. Je huwa unasikia mlio wowote unapofungua na kufunga mdomo.

    1. Hapana   2. Kushoto   3. Kulia   4. Pande Zote

34. Unapata shida yoyote kufungua na kufunga mdomo?

    1. Hapana   2. Ndiyo

35. Una matatizo yoyote ya viungo?

    1. Hapana   2. Ndiyo

36. Je.Una tabia ya kusaga meno?

    1. Hapana   2. Wakati mwingine   3. Mara nyingi   4 Sijui

15. Appendix V: Examination form

37. Oral Hygiene

    1. Good no plaque   3. Moderate, also plaque on surfaces easy to clean

    2. Fair minor plaque   4. Poor almost every tooth has plaque

38. Temporomandibular Joint sounds/crepitus   1. Absent   2.Present

39. Maximum opening of mouth in mm _____

40. Pain around the mandibular joint: 1. Absent   2. Present

41 - 200. Map of dental arches Mark õlö over bridge abutment tooth; õXö over unreplaced missing tooth and õOö over recommended for extraction and õ□ö for denture replaced tooth. õAö For pontic of bridge

Overeruption																
Mobility																
Caries																
Tooth wear																
Tooth	18	17	16	15	14	13	12	11	21	22	23	24	25	26	27	28
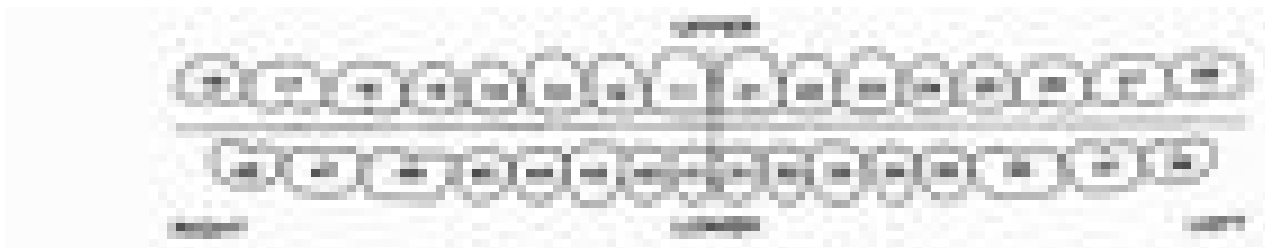
Tooth	48	47	46	45	44	43	42	41	31	32	33	34	35	36	37	38
Tooth wear																
Caries																
Mobility																
Overeruption																

201-202. Kennedyøs class;   201. Upperí í í .

    1. One;   2. Two   3.Three   4. Four   202. Lowerí í í

202. Number of Occluding units ………………

203 - 204. Prosthetic need "normative"

    0. No prosthesis needed

    1. For anterior teeth (incisors canines premolars);   203. Upper í í í

    2. For posterior teeth;   204. Lower í í í

    3. For both anterior and posterior

205 - 206. Type of Prosthesis needed

    0 - No prosthesis needed

    1 - Need for partial denture(s)   205. Upper í í ..

    2 - Need for full prosthesis (replacement of all teeth)   206. Lower í í ..

207-208. Type of denture patient is wearing: 207. Maxillary í í í í í í ..

     208. Mandibular í í í í í í .

209. Extra clinical notes:

16. Appendix VI: Tally sheet

All patients approached for the study to be tallied irrespective of participation. Reason for refusal of consent should be recorded if information cannot can be obtained space should be left blank. Taking part in the study is voluntary; subjects can stop participating in this study at any time even after consent has been obtained. Refusal to participate or withdrawal from the study will not involve penalty.

Information gained during solicitation to join the study						Screening Results		
S. No	Age	Sex	Education	Occupation	Consent	No of missing teeth	Kennedy class	Selected For Study