MALOCCLUSION AND ORTHODONTIC TREATMENT NEEDS IN 12-15-YEAR-OLD CHILDREN IN MOSHI, TANZANIA

A Thesis submitted in partial fulfilment of the requirements

for the Degree of Master of Dental Surgery (MDS) in Paediatric

Dentistry, University of Nairobi

Deogratias Stanslaus Rwakatema, DDS (Dar)
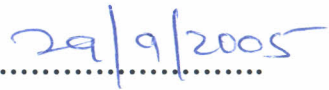
Nairobi,

August, 2005

DECLARATION

I, **Dr Deogratias Stanslaus Rwakatema,** declare that this Thesis is my own original work, which has not been presented anywhere and not intended to be presented to any other University for the award of a similar, or any other degree.

....29/9/2005......

Signature   Date

CERTIFICATION

The undersigned certify that this Thesis entitled *"MALOCCLUSION AND ORTHODONTIC TREATMENT NEED IN 12-15-YEAR-OLD CHILDREN IN MOSHI, TANZANIA"* is the original work of Dr. Deogratias Stanslaus Rwakatema (DDS) who conducted the study during his postgraduate training in Paediatric Dentistry between 2002-2005 at the University of Nairobi under our supervision.

Supervisors

Signature...................................... Date...14/10/05...

Prof. P.M. Ng'ang'a, BDS, MSD, PhD (Orthodontist)

Dept. of Paediatric Dentistry and Orthodontics, Faculty of Dental Sciences, University of Nairobi.

Signature...................................... Date...14/10/05...

DR. A.M. Kemoli, BDS, MSc (Paedodontist)

Dept. of Paediatric Dentistry and Orthodontics, Faculty of Dental Sciences, University of Nairobi.

DEDICATION

This Thesis is dedicated to my late father who died in 1996. My father, Stanslaus

Kiiza Rwakatema was born and lived in Kantare Kagongo - Bwanjai, Bukoba

rural District in Kagera region, Tanzania.

May God rest him in

eternal peace

Amen.

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DEFINITION OF TERMS

1. **Malocclusion**: A deviation from normal arrangement and interdigitation of teeth.

2. **Awareness and concern towards malocclusion**: Consciousness of ones dentofacial appearance.

3. **Primary school**: Institution in which subjects attended for formal learning.

4. **Pupil**: Any child attending primary school for purposes of formal learning.

5. **Subject**: An individual who constituted the study population.

ACRONYMS

1. ACO: Assistant Clinical Officer.

2. CL: Confidence level.

3. COHU: Central Oral Health Unit.

4. DAI: Dental Aesthetic Index.

5. DDS: Doctor of Dental Surgery.

6. df: Degree of freedom.

7. DSR: Deogratias Stanslaus Rwakatema.

8. Epi. Info. : Epidemiology Information.

9. FDI: Federation Dentaire Internationale.

10. IOTN: Index of Orthodontic Treatment Need.

11. MDS (Paed.): Master of Dental Surgery in Paediatric Dentistry.

12. NOHP: National Oral Health Programme.

13. PMN: Peter M. Ng'ang'a.

14. sd: Standard deviation.

15. SPSS: Statistical Package for Social Sciences.

16. WHO: World Health Organization.

ABSTRACT

Background

Malocclusion may cause psychosocial problems and predispose to dental ill-health. Activities to recognize, prevent and treat malocclusion are essential for comprehensive oral health care.

Objective:

To assess prevalence of malocclusion, awareness and concern about malocclusion and orthodontic treatment need in 12–15– year–olds in Moshi, Tanzania.

Design:

Descriptive cross-sectional study.

Setting:

Moshi Municipality in Kilimanjaro region, Tanzania.

Subjects and Methods:

A sample of 299 randomly selected public primary school children aged 12 - 15 years. Data was collected using questionnaires and clinical examinations. A total of 158 males and 140 females responded to questionnaire and 153 males and 136 females were examined for malocclusion. Data on registration of malocclusion were collected using modified Bjork criteria and DAI scores. Data were analyzed using SPSS, Microsoft excel and Epi. Info. packages.

Results:

The overall prevalence of malocclusion was 97.6%. Angle's Class I malocclusion (67.5%) prevailed. Angle's Class II and III malocclusion occurred in 6.9% and

11% of the sample respectively. Subdivions occurred in 5.9% of those with Class II malocclusion and 8.7% of those with Class III malocclusion. Anterior irregularities were high in maxilla (46%) and in mandible (51.6%) with significant gender difference (P<0.05) where females exhibited more irregularities than males in both jaws. However, males exhibited more crowding in incisor segments than females (P<0.05). Frontal open bite occurred in 6.2% and deep bite in 10.7% of the sample. Although there were significant correlations between awareness and concern about malocclusion in the subjects, this, however did not correlate significantly with severity of malocclusion. Subjective and objective orthodontic treatment needs were found in 69.1% and 35.3% of the subjects respectively. Mean DAI score was 24.6 and handicapping malocclusion 6.9%.

Conclusion:

Overall there was a high prevalence of malocclusion. There was no significant gender difference in most of the malocclusion traits. Significant correlations between awareness and concern about malocclusion were noted. Objective orthodontic treatment need was lower than subjective need. Mean standard DAI score was below the lower cut off-point of treatment need categories. A small proportion of the subjects exhibited handicapping malocclusion. These findings form a base line for future studies on prevalence of malocclusion as well as trends of awareness and concern towards malocclusion in this population.

Recommendation:

Information from this study will be useful in the planning of oral health services in Tanzania. Presence of unmet orthodontic treatment needs in Tanzanian children calls for training of orthodontists to provide treatment opportunity for the population.

CHAPTER ONE

1.   INTRODUCTION

1.1   Overview of National Oral Health in Tanzania

In many African countries, the advent of independence came with the creation of reserves of academic manpower for training, research and service provision. Indeed, in Tanzania, the first National Oral Health Programme (NOHP) was based on this objective. Oral health care experts who met in Brazzaville in 1978 had plans to start oral health services in the African continent. Their plan was based on two objectives: to increase the dentist to population ratio through two stages. Initial stage was aimed at 1 dentist per 80,000 people and the next stage at 1 dentist per 40,000 people concomitant with training of auxiliary personnel. The goal is still unmet in most of these countries.[1]

Due to the limited resources available to cover the dental needs of the entire population of Tanzania, the government opted for the preventive approach to manage the oral diseases rather than the curative approach. This was in line with professional based primary oral health care delivery with emphasis on prevention.

Training for the degree of Doctor of Dental Surgery (DDS) at the University of Dar es Salaam started in 1979. Currently the intake is 30 students per year. Yet the number of dentists serving the people countrywide in all sectors dropped from 95 in 1994 to 81 in 2001.[2] NOHP plans are to constantly fill the shortfall arising

from retirement, resignations and death.[3] With the initiation of the provision of emergency oral health care at all rural health centres and strategically located dispensaries, 202 service units have been established and are manned by Assistant Clinical Officers (ACO) trained in emergency oral health care. Currently there are 250 trained oral healthcare workers [Dental Officers (98), Assistant Dental Officers (76), Dental Therapists (52) and Dental Technicians (24)] and 114 support staff (Dental Auxiliary) providing oral health services in Tanzania. They are located in 67 out of the 129 districts. Since the training is carried out in only three districts, 52% of the entire trained workforce is concentrated in these three districts. This leaves a considerable number of people in the remaining districts without any trained oral health personnel.[2]

Oral health education is given to school-aged children as part of the general health education. A need to expand this education through the mass media has been considered by NOHP.[2]

In many areas of Tanzania the treatment offered to children, especially in the deciduous dentition is extraction and temporary fillings. "Simple" orthodontic services are occasionally offered at the regional dental clinics where there is a qualified dental surgeon and a dental laboratory technologist. Comprehensive paediatric dental care is only performed at the dental school at Muhimbili National Hospital. However, even at this hospital, not all children can be managed because of the inadequacy of facilities and specialists.

The second national plan for oral health care in Tanzania was launched in 1988. It was based on the yet to be realized World Health Organization goal - "health for all by the year 2000".[3] It has since been reviewed. The review came out with guidelines oriented at making the oral health services as effective as possible, attainment of the stated measurable improvements in oral health and coverage of as much of the population as possible with simple basic promotive and curative oral health care.[2] However, a quick review of the plan with regard to the goals touching on the children lacks the clear and precise stated goal in relation to malocclusion affecting the children.

1.2   Normal occlusion

At the age of 3 years the occlusion of the primary dentition is stable. It consistently shows interdental spaces, which are normal features that help in the development of a normal permanent dentition.[4] The relationship of the distal terminal planes of opposing second primary molar teeth can appear in three categories: distal, mesial and flush terminal planes. Features for future permanent molar relation are related to these primary terminal planes.[4, 5]

In the permanent dentition ideal dental arches show specific occlusal features that include the mesio-buccal cusp of the upper first permanent molar occluding in the mesio-buccal groove of the lower first permanent molar. The distal aspect of the upper first molar contacts the mesial aspect of the lower second molar. The anterior teeth, both upper and lower, show crown inclination, which is sufficient

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to prevent over-eruption of teeth and an increased incisor overbite. The posterior teeth of the upper jaw show lingual inclination which remains constant, while the lower posterior teeth have a lingual inclination which is more pronounced towards the back of the arch. The teeth exhibit mesio-distal angulations, with the crowns of the teeth more mesially positioned than their root. No rotated tooth, spacing or crowding is observed in the entire dentition. The occlusal plane is flat or with only a mild curve of Spee. All the above features provide a definition of the Class I occlusion,[6] which is also described as Andrews six keys to normal occlusion.[7]

1.3   Malocclusion

Malocclusion is a deviation from the normal arrangement of teeth. It arises mainly during the process of occlusal development. It is likely that we are all predisposed to some kind of malocclusion due to the primary and secondary factors, which influence the development of the dental arch and occlusion.[4, 5, 8]

There are racial differences in occlusion.[9-12] Alveolar prognathism is common in the incisor region of the Bantu, Black Americans and indigenous Australians. It is associated with a reduction in the degree of incisor crowding. Mandibular third molars are frequently absent in white races than among Black Americans. Supernumerary teeth are both hereditary and racial.[13] All these taken together signify that the prevalence of malocclusion traits vary between individuals and between ethnic groups.

1.4   Aetiology of malocclusion

Clinically, an acceptable developing occlusion can be affected by many factors. These factors are categorized into primary and secondary factors. Alveolar sizes in combination with tooth size are the primary factors and determine the form and arrangement of the teeth in the permanent dental arch. In addition alteration in skeletal and soft tissue pattern of the orofacial region can cause disharmony as is observed in skeletal Class II and III malocclusion.[5]

Secondary factors are environmental factors. These factors can cause detrimental effects on the total occlusion especially during the period of occlusal development. They include early loss of primary teeth, interproximal caries, bony pathology, ankylosis of primary teeth, oral habits, trauma, early eruption of the permanent second molar[5] and secular trends which are related to change of nutrition.[4, 14, 15]

1.5   Sequelae of malocclusion

Malocclusion may exert a negative influence on the general as well as oral health of an individual. Unfavorable consequences of malocclusion include poor facial appearance,[14] risk of caries,[14] predisposition to periodontal diseases,[14, 16] psychological disturbances,[17] risk of trauma on the upper incisors,[14, 18, 19] abnormalities of stomatognathic function and temporomandibular joint dysfunction.[14, 20]

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Prevalence of malocclusion

Worldwide reports indicate the problem of malocclusion to be universal. However, the prevalence of malocclusion and the distribution of malocclusion types vary among racial, national and ethnic groups.[9-12] Malocclusion is unique as compared to other conditions. It presents a group of often-unrelated traits, which, in psychosocial terms, may have considerable variability of individual adjustment. One such example is the maxillary diastema, which is generally considered a sign of beauty in some areas of Africa although there is no documented evidence so far. However, it is considered unsightly in the Western world[21]. In many instances, it is difficult to compare directly the prevalence of malocclusion between investigations. This is due to the different criteria adopted to record the conditions, level of severity of malocclusion, sampling differences in terms of age and gender, availability of study casts and radiographs and variability in the examiners accuracy.[14, 22]

Several indices have been developed for use in diagnostic classification, epidemiological data collection, recording of treatment need priority and assessment of the success of treatment.[23-29] According to Shaw [30] Angle's classification is best for diagnostic classification but is severely limited as an indicator for treatment need or standard. The Bjork *et al*. index[23] and the

Federation Dentaire Internationale (FDI) method[27] are good for epidemiological data collection especially for the prevalence of malocclusion or its traits.

A recent study in Bogotá; Colombia [31] on the prevalence of malocclusion and orthodontic treatment need in children and adolescents aged 5-17 years showed that 85% of the subjects had some type of anomaly, from mild to severe. Half of them recorded occlusal anomalies, one-third had space discrepancies and one-fifth had dental anomalies. No clear sex differences were noted except for the maxillary overjet, spacing, and tooth size, which were more frequent in boys and crowding was more frequent in girls. Urgent need for treatment was estimated to be 3% and comprised subjects with extreme post and pre-normal occlusion, impacted maxillary incisors or extensive aplasia.

Abu Affan *et al.* [32] studied the prevalence and severity of malocclusion in 12-year-old Sudanese children. The sample involved 318 girls and 317 boys who were clinically examined using Bjork *et al.*[23] criteria. Majority of the children had Angle's Class I malocclusion (77.7%) followed by Class II (11%) and Class III (3.1%). Sagittal, vertical and transverse occlusal anomalies were not common. The author suggested that public awareness and preventive orthodontics are important issues to consider in the future organization of orthodontic services in Sudan.

The prevalence of malocclusion and abnormal oral habits in North Indian rural children aged 6-15 years was studied by Guaba et al.[33] The results indicated that 29.2% of the children had malocclusion whereas 70.8% had normal occlusion. Angle's Class I malocclusion was found in 14.4% of the children while malocclusion with class II molar relationship was observed in 13.5% of the children and Class III molar relationship was seen in 1.3% of the children. Children with abnormal oral habits (predominantly tongue thrusting and thumb sucking) comprised 3% of the sample. The frequency distribution of abnormal oral habits in children with malocclusion was found to be 10.3%.[6]

Distribution, prevalence, severity of malocclusion and treatment need amongst Nigerian children aged 12-18 years was studied by Otuyemi et al.[34] The DAI criteria were used for registration of malocclusion. Most of the children (77.4%) did not need orthodontic treatment while 13% needed elective orthodontic treatment. Handicapping malocclusion was found in 9.2% of the population studied. No significant differences in the DAI score between gender, age group and social-economic backgrounds were found. The author concluded that Nigerian adolescents had better dental appearance and less orthodontic treatment need compared with the Caucasian and Oriental populations.

In Kenya, a study was done in Nairobi on the prevalence of malocclusion in 13-15- year-old children by Ng'ang'a et al.[35] and involved 913 children. The registration method used was that described by Bjork et al.[23] The prevalence of

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malocclusion was reported to be 72%. The predominant anteroposterior relationship of the dental arches was neutral occlusion (93%). Specific malocclusion traits were highest for crowding (19%), rotation (19%), posterior cross bite (10%), maxillary over jet (10%) and frontal open bite (8%). No significant difference was observed in the overall prevalence of malocclusion between males and females but some occlusal traits were significantly higher in males.

In Tanzania, 9 studies on malocclusion in children were carried out between 1988 and 2004.[9, 10, 36, 37, 38, 44, 48, 49, 51] To the author's knowledge these are the only published studies on malocclusion carried out in that country on children so far. Kerosuo et al.[36] did a study on occlusion among a group of Tanzanian urban school children in Dar es Salaam. In this study, occlusion and its variations were studied in a group of 642 primary school children, aged 11-18 years. Most of the children (96%) had Angle's Class I occlusion. Distal and mesial bites were rare in the sample, representing 3% and 1% respectively. Crowding was found to be the most common dental anomaly (16%). No clear differences in occlusion were found between boys and girls. The results showed smaller occlusal variation compared with Caucasian children. Kerosuo et al.[10] confirmed the previous observation with regard to the comparison between Caucasian children and Tanzanian children where racial difference in terms of malocclusion were noted.[9] Tanzanian children exhibited significantly less occurrence of distal bite, crowding and lateral crossbite than Finnish children.

The occurrence of different occlusal anomalies was studied and compared in-groups of 642 Tanzanian and 458 Finnish school children by Kerosuo et al.[10] The Finnish children showed a significantly higher prevalence of distal occlusion, crowding and a lower prevalence of anterior open bite than Tanzanian children did. The proportion of subjects with no occlusal or space anomalies was considerably higher among the Tanzanians than among the Finns (55% and 12% respectively). The distinct differences found in the occlusion of Tanzanian and Finnish children in that study seemed to reflect the differences in hereditary or environmental factors, which are expressed as craniofacial or dentoalveolar differences between these two groups[13]. In another study, Kerosuo et al.[36] and Mugonzibwa[37] found 93% and 96% respectively, of Angle's Class I malocclusion among children in Dar es Salaam.

A study on malocclusion was carried out by Mugonzibwa et al.[38] in Bukoba and Moshi. Various occlusal characteristics were studied among 12-year-old children. The entire study sample of 353 twelve-year-olds consisted of 47% boys and 53% girls. Angle's and Foster's classifications were used in the study. Most of the children had Angle's Class I occlusions in both townships. No child had distal occlusion in Bukoba but 8% of the school children had Angle's Class III malocclusion compared to only 5% of the children in Moshi. The most prevalent occlusal anomalies in both populations were increased over jets and deep bites (>3.5 mm), the prevalence of which was significantly higher in Moshi. Openbite

occurred more often in Moshi girls than Bukoba girls. No child had scissors bite in Moshi. Median diastema was common in the whole sample. About one fifth of the whole sample had crowding. The results suggested that different occlusal and space characteristics were present in Bukoba and Moshi children.

Evaluating the pattern of the studies done on prevalence of malocclusion in Tanzania, it is obvious that most of the work has been carried out in Dar es Salaam.[9, 10, 36, 37] Little is known on the prevalence of malocclusion in children from the other parts of the country.[38]

2.2   Awareness and concern about malocclusion

In clinical practice many of the patients who are referred for orthodontic treatment appear to be unaware of the severity of their malocclusion. Others are unnecessarily concerned about minor irregularities. However, the clinician will often try to encourage more accurate awareness of malocclusion so as to achieve patient rapport during treatment.[39] While malocclusion refers to the impairment of the anatomical relation and functioning of the teeth and adjacent craniofacial structures, most of the individuals with these problems are primarily concerned about issues of appearance. This suggests that the impact of malocclusion is primarily psychosocial. It is important to understand how individuals perceive their occlusal features so as to ensure effective communication and provision of adequate advice on treatment needs.[40]

Espland et al.[41] studied the perception of malocclusion in 11-year-old Norwegian children by comparison between personnel and parental awareness. The results indicated that the individual's comprehension of the professional terms used may be unclear and that professionally defined cut-off points often do not coincide with norms existing within the actual family unit. Birkeland et al.[42] reported a higher proportion (90.8%) of parents putting equal importance for both girls and boys in relation to dental aesthetics.

A study by Ng'ang'a et al.[43] among subjects aged 13-15 years in Nairobi children showed more females being dissatisfied with appearance of their teeth. In the same study more females thought their teeth looked better than those of their peer group. Similarly, more females than males wished their teeth to be straightened. Females appeared to have a higher awareness and concern about malocclusion in that study than males.

Recently, Mugonzibwa et al.[44] reported that parents and their children in Dar es Salaam perceived severe deviations such as space deficiency irregularities as the most unattractive compared to other occlusal traits like open bite. However, these findings were not truly representative of Dar-es Salaam parents and their children due to the incidental sampling method used in that study.

Clearly there is paucity in the data on awareness and concern about malocclusion in East Africa, which call for a need to carry out scientific researches on this issue.

2.3. Need for orthodontic treatment

Need for orthodontic treatment is perceived or felt by the patient or detected by the dental professional. In a given population, the following four categories of need may exist: First are individuals who perceive a need and are also deemed in need by the dental professionals. Second are those who do not perceive any need but whom the dental profession deems to be in need. The third category is those who do not perceive any need and dental professionals concur with them. Lastly are those who perceive to have a need but the dental professional determines there is no need.[45]

The need for orthodontic care can be derived from meticulous research to get the basic data, which include prevalence and severity of the problem and thorough assessment and analysis of service or treatment records.[46] Normative orthodontic needs are objectively and clinically determined by professional opinion while perceived or subjective needs are what patients or the public determine concerning their orthodontic care. Demand for orthodontic care or expressed need is the desire and attempt by individuals of the community to seek attention for their felt, perceived or subjective needs.[46, 47]

A search for data on malocclusion studies in East African children in connection with orthodontic awareness and treatment needs reveals very little information on the subjective and objective needs for orthodontic treatment among the children of these countries.[43, 48, 49] A previous study[49] indicates that 3-12% of Dar es Salaam children had "absolute need" for orthodontic treatment. Likewise majority of orthodontic treatment demand showed "absolute need" in Dar es Salaam children[48]. Objective and subjective orthodontic treatment need was 33% and 29% in Kenyan children respectively.[43] These studies are few and inconclusive. There is, therefore, a need for additional scientific research.

2.4   Statement of research problem

Malocclusion arises mainly during the process of occlusal development and has been shown to lead to psychosocial problems and to predispose to dental ill health.[17, 22, 50] Oral health research done in Tanzania has placed little emphasis on malocclusion[2, 3] and the likely concern and need for orthodontic treatment.

2.5   Justification of the study

The little work on malocclusion that has been done on children in Tanzania is mainly limited to Dar-es-Salaam, the capital city of the country.[9, 10, 36, 37] Awareness and concern about malocclusion and need for orthodontic treatment have similarly been subjected to very little evaluation in the country.[44, 48, 49, 51] Hence the extent of the problem in the general population remains unclear. The findings from this study would give additional and essential information on

malocclusion in Tanzania. The information would be useful in planning an orthodontic service and act as a basis for future related research activities.

2.6 Objectives

2.6.1 *Broad objective:*

To assess the prevalence of malocclusion, awareness and concern about malocclusion and orthodontic treatment need among 12-15-year-old primary school children in Moshi Municipality, Tanzania.

2.6.2 *Specific objectives:*

2.6.2.1 To assess the prevalence of malocclusion in primary school children aged 12 - 15 years by gender.

2.6.2.2 To assess awareness and concern about malocclusions in primary school children aged 12 - 15 years by gender.

2.6.2.3 To assess subjective and objective orthodontic treatment needs in primary school children aged 12 - 15 years by gender.

2.7 Null hypotheses

2.7.1 There was no gender difference in the prevalence, awareness and concern about malocclusion.

2.7.2 There was no orthodontic treatment need in 12-15 year children in Moshi, Tanzania.

2.8   Variables

Socio-demographic variables were age, schools and class levels. Independent variable studied was gender. Dependent variables were malocclusion features, awareness and concern about malocclusion and subjective and objective orthodontic treatment needs.

Uganda to the North, Burundi, Rwanda and the Democratic Republic of Congo to the West, Zambia, Malawi and Mozambique to the south and the Indian Ocean to the East **(Figure 1)**. It has a size of 942784 square kilometers. It has a population estimate at 37.6 million people based on the 2004-year projection[2, 52]. Population growth rate is at 2.8%. About 50% of the population earn below one United State of American Dollar (USD) per day. Its economic growth rate is 4%. The source of income for majority of the people who live in the rural areas (81%) is small-scale agriculture and livestock. Staple foods include maize, rice, bananas, sorghum and cassava. The literacy rate amongst people who live in the rural and urban areas aged 15-50 years is 65.6% for the males in the rural and 84.3% in the urban. The literacy rate for the females in the rural and urban areas at the age of 15-50 years is 50.1% and 75.3% respectively. Life expectancy is 47 years for males and 50 years for females based on National population census of 1988.[2, 52] There are 26 administrative regions and 129 districts.

3.2. Socio-demographic characteristics of Moshi Municipality.

Moshi Municipality is in Moshi district, which is in the Kilimanjaro region (Figure 2).
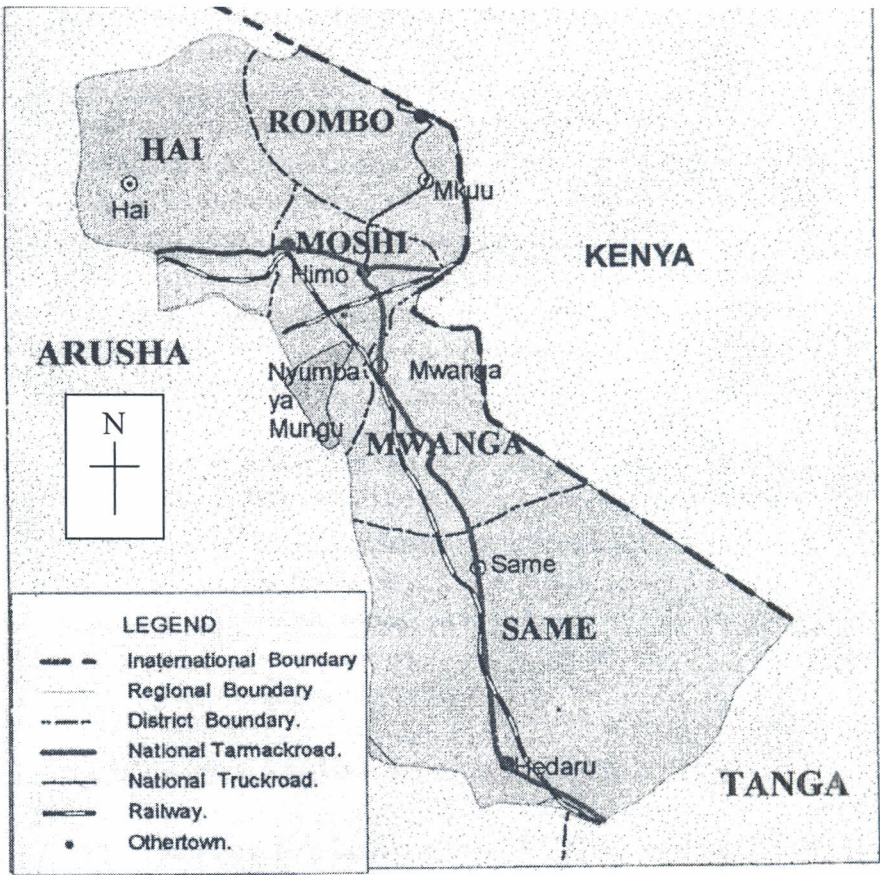
Figure 2. Administrative map of Kilimanjaro Region

The Municipality is located across the Dar es salaam-Arusha highway at the foot of Kilimanjaro mountain. Kilimanjaro Mountain has snow and ice capped summits of Kibo and Mawenzi, the only ice and snow on the equatorial belt of the world. Moshi district is bordered by Rombo district in the North and East,

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Mwanga district in the Southeast, Arusha region in the Southwest and Hai district in the West. According to the population projection of 2002, Moshi Municipality had a population of 201,334 people. Among these, 8136 (4%) were public primary school children aged 12-15 years.[52]

Administratively, Moshi Municipality has two divisions, East and West. These divisions are divided into locations. The East division has 8 locations and the West division has 7 locations. Social services in Moshi Municipality include 26 public primary schools, which are evenly distributed within the locations. There are about 60 health facilities including a regional hospital and Kilimanjaro Christian Medical Centre. This center is among the four zonal main referral hospitals in Tanzania. Also, this centre runs Faculty of Medicine and Allied Health Sciences with both undergraduate and postgraduate degree courses. There are two public and three private dental clinics, which at the moment deal mainly with provision of general dental services.[52]

Economic activities in the Municipality include wage employment in government, public services and private enterprises. Livestock farming include keeping of dairy cattle, piggery, sheep and goats in stalls. There are several small-scale industries operating under different capacities and producing various products. These products include metal works, woodworks, oil processing, and milling, saw mills, garages, printers, tailoring marts and many others.[52]

CHAPTER FOUR

4. MATERIALS AND METHODS

4.1 Ethical clearance

Ethical clearance was sought from the Ethics, Research and Standards Committee of the Kenyatta National Hospital and University of Nairobi in Kenya. Further ethical clearance was sought in Tanzania from Kilimanjaro Christian Medical Center Ethical Committee, the director of Moshi Municipality, Municipal Medical Officer, the Municipal Education Officer and the Head-teachers of the selected primary schools.

Written informed consent in Kiswahili language was obtained from the pupils' parents through the Head teachers **(Appendix C 1)**. Subjects were told the purpose of the study collectively as a group before giving self-administered questionnaires and individually before clinical examination **(Appendix C 2)**. A pupil was allowed to drop out of the study on his / her own wish or the parent's wish. The information obtained was held in strict confidence.

Pupils found with a need for treatment were given a referral note to attend to the nearby oral health care unit. Oral health education was given on individual basis where possible. It was not possible to deliver oral health education to all the pupils due to routine class sessions, which were on-going at the time of this study.

4.2   Study population

Public primary school children aged 12-15- years (4145 males and 3991 females) from Moshi Municipality, Tanzania.

4.3   Study design

It was a descriptive cross-sectional study which involved public primary school children.

4.4   Sample size determination.

With the help of statistician this was done through a WHO recommended formula[53] as follows:

$$n = \frac{Z^2 P (1-P)}{E^2}$$

Where   n   =   Sample size

P   =   The expected prevalence was 72% based on regional study on the prevalence of malocclusion by Ng'ang'a *et al.*[35]

Z   =   1.96 (Standard normal deviate at 95% confidence level (CL))

E   =   Significance level (5%)

Therefore   n   = $\dfrac{1.96^2 \times 0.72\,(1 - 0.72)}{0.05^2}$

             =   310

There were 8136 Public primary school children aged 12-15 years in Moshi Municipality. This number was less than 10000 children for the above formula to be used alone. Therefore the calculated sample size was again subjected to the following formula to get the sample size.[53]

nf   = $\dfrac{n}{1 + \dfrac{n}{N}}$

Where   nf   =   The desired sample size for the population of less than 10000 people.

           n   =   Sample size.

           N   =   Study population.

Therefore, nf   = $\dfrac{310}{1 + \dfrac{310}{8136}}$

           nf   =   299

A minimum sample of 299 primary school children was set for examination of malocclusion and self-administered questionnaires pertaining to awareness and concern about malocclusion and subjective orthodontic treatment need. This sample formed 3.7% of all the public primary school children aged 12-15-years in Moshi Municipality.

4.5   Sampling procedure

The subjects were identified through a multi-stage sampling technique in two stages. A total of 26 public primary schools in Moshi Municipality were clustered in the two divisions. In the first stage, a random sample of two primary schools from each division was selected using a sampling frame on a table of random number. Moshi and Korongoni primary schools were selected from the Western division and Majengo and Pasua primary schools from the Eastern division.

In the second stage, each pupil-aged 12-15 years in the selected schools was identified through a register and assigned a number. Using a sampling frame, 78 pupils were randomly selected using a table of random number. The total number of pupils selected in each primary school constituted a representative sample for clinical examination and self-administered questionnaires.

4.6   Calibration

One supervisor, Peter M. Ng'ang'a (PMN) calibrated the investigator, Deogratias S. Rwakatema (DSR) in Nairobi, Kenya prior to data collection in Moshi.

Calibration involved registration of malocclusion using study models initially followed by registration of malocclusion on actual patients. This was kind of intensive training in registration of malocclusion traits before data collection. For quick reliability test in the field, clinical results of subjects were converted to nominal data in which malocclusion was accorded present or absent **(Appendix C: Keynote)**. According to kappa[54] test a 100% intra-examiner agreement was achieved before the study commenced. One of the supervisors (PMN) also came to the field in Moshi to ascertain that the project was being conducted according to the research protocol.

4.7 Data collection instruments and techniques

Data collection was in two parts: The first part was a questionnaire and the second part was a clinical assessment. The questionnaire was close-ended and self-administered. The questionnaire was adapted from a previous study[43] with a few additions **(Appendix A)**. Questions were aimed at determining subjective orthodontic treatment need and awareness and concern towards malocclusion. The questionnaires were administered on the same day in all the selected schools. This was deliberately done to avoid the possibility of pupils from the different schools discussing the questionnaires amongst themselves after school hours at home. The questionnaire was translated into Kiswahili language, which is easily understood by Tanzanian children in this age group **(Appendix A2).** It was self-administered prior to clinical evaluation of malocclusion. Together with trained personnel for recording data, we distributed and supervised filling - in of the questionnaire and its collection.

The clinical examinations were carried out under natural daylight. This was achieved by having the child sit on a chair next to a window **(Figure 3)**. Ordinary standardized plastic rulers and dividers were used for all linear measurements. Disposable examination gloves and sterile mouth mirrors were made available for each individual during the clinical examination. The investigator (DSR) carried out all the clinical examination of the subjects. One-trained dental personnel recorded the findings on pre-prepared forms **(Appendix B)**. The research team also included a nurse who was mainly involved in sterilizing and keeping the clinical examination instruments sterile and operational area safely in order.

Figure 3. Field clinical set up for examination of the subjects

The procedure for recording malocclusion used in the present study was adapted from Bjork *et al.*[23] criteria and Dental Aesthetic Index (DAI) criteria[55] (with some slight modifications on registering some of the malocclusion traits as specifically explained in **Appendix B**). The modifications were done to suite the design of this research and adherence to the ethical issues. Bjork *et al.*[23] criteria is an epidemiological index which registers malocclusion traits in a detailed way. It groups malocclusion into three: dentition anomalies, occlusal anomalies and space anomalies. It is based on the ideal occlusion. In this study it was modified for use to assess prevalence of malocclusion as explained in **Appendices B 1**. Dental Aesthetic Index (DAI) criteria[55] was specifically used to determine orthodontic treatment needs. It considers ten malocclusion components for determination of objective orthodontic treatment needs. **(Appendix B 2)**. It has been widely used and now adopted by WHO for these kind of studies.

4.8   **Reliability and validity of the results.**

Quality control of the data was strictly observed. Together with trained personnel for recording data, we distributed and supervised filling - in of the questionnaires by the children and its collection. Only the principal investigator (DSR) was *involved in carrying out clinical* examination of the subjects. In this way inter-examiner variability was eliminated. Data were collected and recorded in pre-prepared forms **(Appendix A and C)**. Re-examination of every 10th subject was done. Prior to the discharge of each subject, counter checking for the completion

of questionnaires was done. All records of the subjects were under the custody of one investigator (DSR) at the end of the day.

Using Kappa[54] test a 100% intra-examiner agreement for nominal variables was obtained for each of the 24 re-examined subjects.

A total of 24 subjects were re-examined for continuous variables. **Table 1** shows related t-test statistical results of intra-examiner variability on the means of continuous data of malocclusion traits. There was no significant difference ($p > 0.05$).

Table1. Mean score of numerical data for groups of malocclusion traits of 24 re-examined subjects.

Malocclusion trait	Mean score of the first examination	Mean score of the second examination
Dentition anomalies	2.0	2.0
Occlusal anomalies	3.38	3.29
Space anomalies	5.0	5.0
Other malocclusion traits	1.0	1.0
Total	11.38	11.29

$t = 0.3$, $N = 4$; $p > 0.05$ (no significant difference between the first and second examination).

4.9   Data processing and analysis

Data were fed in the computer for processing and analysis using Statistical Package for Social Sciences (SPSS) version 9.0.[56] A statistician was consulted for guidance in data analysis. Clinical data were separated accordingly into nominal and numerical variables **(Appendix C: Keynote)**. Nominal variables of malocclusion of the re-examined subjects were tested for agreement. Numerical variables of malocclusion traits were categorized into four groups as follows: dentition anomalies, occlusal anomalies, space anomalies and other malocclusion features. Mean values of intra-examiner observations for these groups were tested for reliability **(Table 1)**.

SPSS version 9.0[56] was used for calculating statistical parameters of the variables studied. These included prevalence of malocclusion, mean DAI score and cumulative frequency distribution of the DAI score. It was also used for paired t-test to test the reliability of the numerical variables of malocclusion, Spearman rank order correlation which tested correlation of awareness and concern about malocclusion and treatment need and Mann-Whitney U tests which tested the ordinal variables of treatment need categories. Epidemiology Information (Epi. Info.) version 6.04 b to c upgrade[57] was used for chi-squared test to look for gender differences and kappa test which tested reliability of nominal data of malocclusion traits.

A 5% statistical significant level was set for the nominal, numerical and ordinal variables studied. A p-value was determined by Fischer exact test on variables that had cells with less than 5 frequencies and Mantel Haenszel test in variables of cells with greater than 5 frequencies[57].

Each component of DAI scores is given a weight. Using a regression equation, total scores of an individual can be determined (Standard DAI score). Plotting a graph of population cumulative percent of DAI scores **(Figure 8)** gives a clue on the determination of the categories of orthodontic treatment need depending on the resource capabilities of the community at hand. To calculate standard DAI score, the following regression equation was used[55]: (Missing teeth mesial to first permanent molar of one quadrant to the other in the same jaw for both jaws x 6) + (crowding) + (spacing) + (diastema x 3) + (largest anterior maxillary irregularity) + (largest anterior mandibular irregularity) + (anterior maxillary over jet x 2) + (anterior mandibular overjet x 4) + (vertical anterior open bite x 4) + (antero-posterior molar relation x 3) +13. Total sum was equal to an individual standard DAI score. This determined an individual orthodontic treatment need according to the cut off points of treatment categories. Sample mean DAI score was the average of the subjects' DAI scores. Treatment categories used in this study according to DAI score were those recommended by WHO. These were DAI score of 25 which indicated "no or minor orthodontic treatment need" and 26 - 30 DAI scores which indicated "elective" orthodontic treatment need. DAI scores of 31 - 35 and ≥ 36 indicated "highly desirable" and "mandatory" orthodontic treatment need respectively.

Statistical gender differences were calculated for awareness and concern towards malocclusion and subjective orthodontic treatment need by combining levels of awareness and concern towards malocclusion. Those who responded by showing indifference and those who were not aware or concerned were excluded in finding the gender differences. Their occurrences and distribution are presented in **Tables 8, 9, 10, 11, 12 13, 14 and 15**. With Spearman rank-order correlation, subjects response alternative of questions were rank-ordered with individual DAI scores to look for association. Subjects' response alternatives of the following pairs of questions were rank ordered to look for association by using Spearman rank order correlation:

- First pair: "Do you generally observe that your teeth are not properly aligned in your mouth?" and "have you ever seen one among your age mate with malaligned teeth before?"

- Second pair: "Do you find your own teeth looking better or worse in your mouth, than those of most people of your age?" and "do your schoolmates tease you about the appearance of your teeth or jaws?"

- Third pair: "Are you satisfied with the way your teeth appear in your mouth now?" and "what is your view about staying with malaligned teeth throughout your life?"

- *Fourth pair: "Would you like to have your teeth straightened?"* and "would you accept any kind of manipulation in your mouth to straighten your malaligned teeth?"

CHAPTER FIVE

5. RESULTS

5.1 Distribution of subjects

A total of 299 subjects were randomly selected for the study. Among these, one pupil (0.3%) was not covered by questionnaires due to absenteeism on the day of self-administering questionnaire. A total of 10 pupils (3.3%) were not examined for malocclusion. Information from teachers showed that parents of those who were not examined for malocclusion thought that the present project was similar to a previous immunization programme that was associated with beliefs of inducing sterility. In total therefore, 298 children responded to questionnaire (158 males and 140 females) and 289 were examined for malocclusion (153 males and 136 females). Age was recorded to the nearest six months. It ranged from 12-15 years. Sample mean age for questionnaire respondents was 12.7 (sd 0.7) years. Sample mean age for examined subjects was 12.7 (sd 0.731) years. All the subjects were Tanzanians of African origin.

The distribution of respondents according to school and gender is shown in **Figure 4.** Children are shown to be evenly distributed gender wise and school wise.

Figure 4. Distribution of respondents according to school and gender (n = 298).
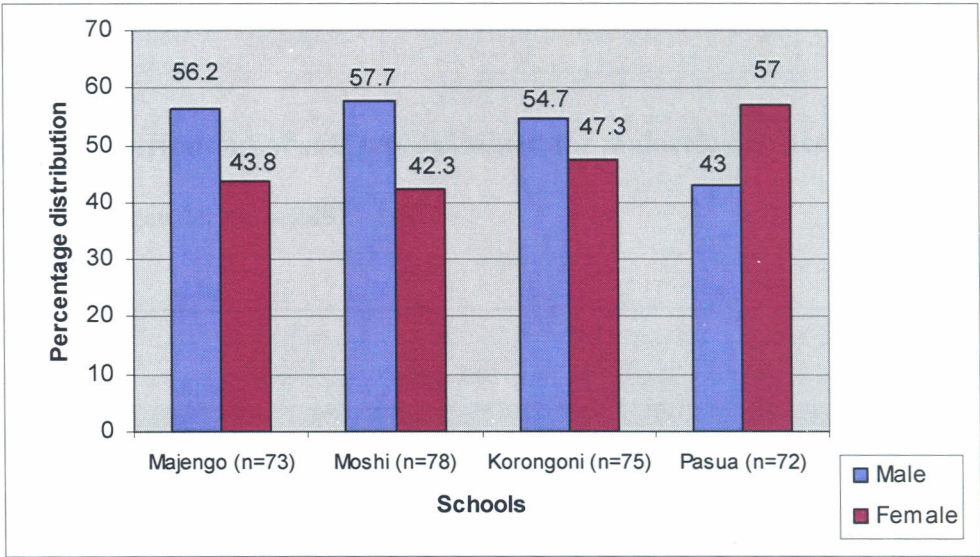
The distribution of respondents according to class level is shown in **Figure 5**. Most of the respondents were from Standard 6 and 5 and very few from Standard 3 and 4.

Figure 5. Distribution of respondents according to class levels (n = 298)
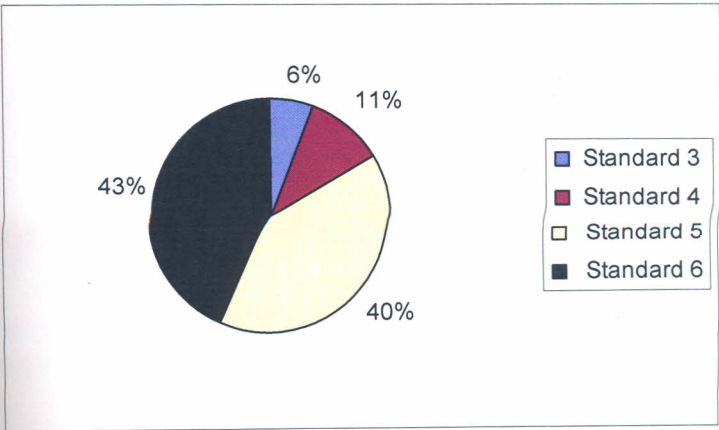
Distribution of examined subjects according to school and gender is shown in Figure 6 where the children are shown to be evenly distributed gender wise and school wise.

Figure 6. Distribution of subjects examined for malocclusion according to schools and gender (n = 289).
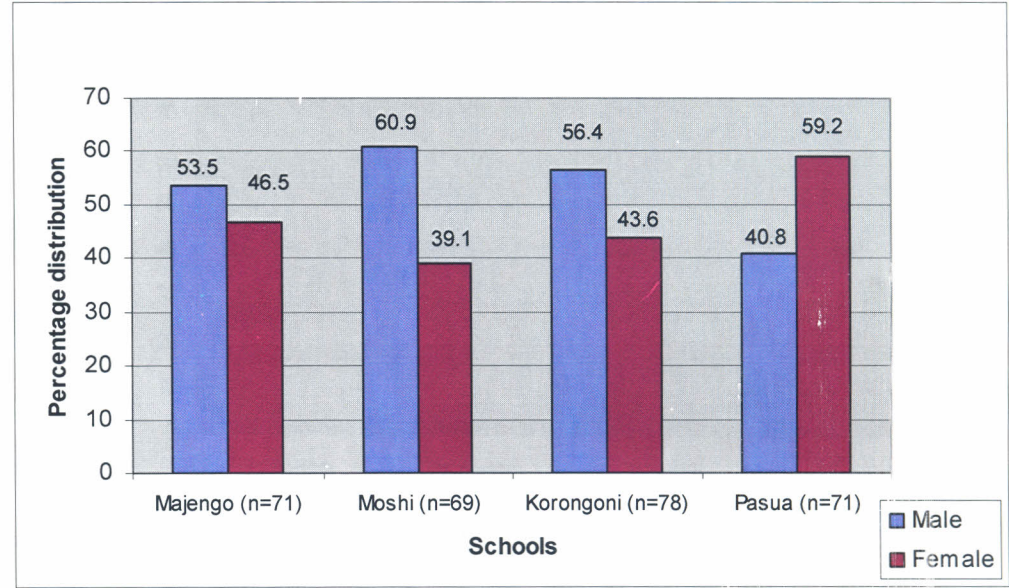
Distribution of examined subjects according to age and gender is shown in **Figure 7**   More males than females in the age of 14 and 15 years were examined for malocclusion.

Figure 7. Distribution of subjects examined for malocclusion according to age and gender (n = 289).
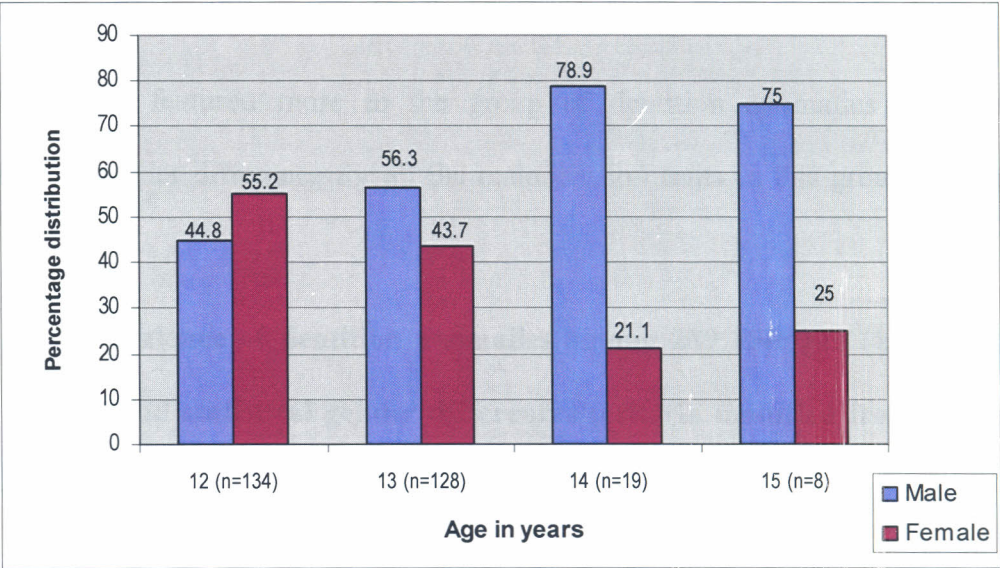
5.2   Prevalence of malocclusion

A total of 289 subjects (153 males and 136 females) were examined for malocclusion. Based on Bjork *et al.*[23] modified criteria **(Appendix BI)**, the overall prevalence of malocclusion was 97.6%. No significant gender difference for overall prevalence of malocclusion was noted **(Table 2)**.

Table 2. Overall distribution of malocclusion according to gender (n = 289).

Gender	Malocclusion		Normal		Total
	No.	(%)	No.	(%)	
Male					
	148	(96.7)	5	(3.3)	153
Female					
	134	(98.5)	2	(1.5)	136
Total	282	(97.6)	7	(2.4)	289

$(\chi^2 = 0.98$, df = 1; p= 0.45 (no significant gender difference).

Rotated teeth featured more in the group of dentition anomalies with no significant gender difference for all the malocclusion traits in this group **(Table 3)**.

Table 3. Prevalence of dentition anomalies among 289 children (153 male, 136 female) and statistical gender differences (criteria modified from Bjork et al.[23])

Dentition anomalies:	Gender				Total		p-value (chi-square)
	Male		Female				
	No.	(%)	No.	(%)	No.	(%)	
Inversion maxillary incisors (3 or <teeth)	8	(2.8)	5	(1.7)	13	(4.5)	0.53♦
Aplasia/Impacted (exclude last molars)	1	(0.3)	0	(0.0)	1	(0.3)	1.00♦
Transposition	2	(0.7)	0	(0.0)	2	(0.7)	0.50♦
Supernumerary	1	(0.3)	0	(0.0)	1	(0.3)	1.00♦
Rotated (estimated 15°)	38	(13.2)	33	(11.4)	71	(24.6)	0.91♦
Malformation	9	(3.1)	6	(2.1)	15	(5.2)	0.56♦

Key: ♦ p > 0.05 (no significant gender difference).

Occlusal anomalies which featured more than others were Angle Class I and III malocclusion and deepbite. However there was no significant gender difference in this group of malocclusion traits **(Table 4)**.

Table 4. Prevalence of occlusal anomalies among 289 children (153 male, 136 female) and statistical gender differences (criteria modified from Bjork *et al.*[23]**)**

| Occlusal anomalies | Gender | | Total | p-value (chi-square) |
| | Male | Female | | |
	No (%)	No (%)	No (%)	
Angle's class I (normal molar occlusion)	110 (38.1)	85 (29.4)	95 (67.5)	0.09♦
Angle's class II (≥½ cusp width)	10 (3.5)	10 (3.5)	20 (6.9)	0.79♦
Angle's class II subdivision (≥½ cusp width one side)	9 (3.1)	8 (2.8)	17 (5.9)	1.00♦
Angle's class III (≥½ cusp width)	13 (4.5)	19 (6.6)	32 (11.1)	0.14♦
Angle's class III subdivision (≥½ cusp width one side)	11 (3.8)	14 (4.8)	25 (8.7)	0.35♦
Maxillary overjet (≥ 6 mm)	14 (4.8)	6 (2.1)	20 (6.9)	0.1♦
Mandibular overjet (>0mm)	0 (0.0)	1 (0.3)	1 (0.3)	0.47♦
Deep bite (≥50% overlap)	20 (6.9)	11 (3.8)	31 (10.7)	0.17♦
Frontal open bite (>0mm)	8 (2.8)	10 (3.5)	18 (6.2)	0.56♦
Lateral open bite	10 (3.5)	7 (2.4)	17 (5.9)	0.62♦
Cross bite (posterior)	1 (0.3)	1 (0.3)	2 (0.7)	1.00♦
Scissor bite	5 (1.7)	2 (0.7)	7 (2.4)	0.45♦

Key: ♦ = p > 0.05 (no significant gender difference).

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Both crowding and spacing occurred frequently in all sextants examined. Crowding in the mandibular incisors was mostly noted than in other sextants. There was no significant gender difference in this group of malocclusion traits **(Table 5).**

Table 5. Prevalence of space anomalies among 289 children (153 male, 136 female) and statistical gender differences (criteria modified from Bjork *et al.*[23])

Space anomalies:	Gender		Total	p-value (chi-square)
	Male No. (%)	**Female** No. (%)	No. (%)	
Lack of space maxillary incisors (≥2mm)	37 (12.8)	38 (13.1)	75 (26.0)	0.47♦
Lack of space maxillary laterals (≥2mm)	21 (7.3)	10 (3.5)	31 (10.7)	0.08♦
Lack of space mandibular incisors (≥2mm)	63 (21.8)	60 (20.8)	123 (42.6)	0.61♦
Lack of space mandibular laterals (≥2mm)	40 (13.8)	30 (10.4)	70 (24.2)	0.42♦
Excess of space maxillary incisors (≥2mm)	50 (17.3)	42 (14.5)	92 (31.8)	0.74♦
Excess of space maxillary laterals (≥2mm)	11 (3.8)	19 (6.6)	30 (10.4)	0.06♦
Excess of space mandibular incisors (≥2mm)	27 (9.3)	32 (11.1)	59 (20.4)	0.22♦
Excess of space mandibular laterals (≥2mm)	27 (9.3)	22 (7.6)	49 (17.0)	0.74♦

Key: ♦ = p > 0.05 (no significant gender difference).

Midline displacement and maxillary median diastema occurred more frequent in the group of other malocclusion traits. There was no significant gender difference in this group of malocclusion traits **(Table 6)**.

Table 6. Prevalence of other malocclusion traits among 289 children (153 male, 136 female) and statistical gender differences (criteria modified from Bjork et al. [23])

| Other malocclusion traits: | Gender | | Total | p-value (chi-square) |
| | Male | Female | | |
	No (%)	No (%)	No (%)	
Maxillary median diastema (≥2mm)	14 (4.8)	14 (4.8)	28 (9.7)	0.74♦
Mandibular median diastema (≥2mm)	2 (0.7)	6 (2.1)	8 (2.8)	0.15♦
Abnormal maxillary labial frenum	0 (0.0)	2 (0.7)	2 (0.7)	0.22♦
Midline displacement (≥2mm)	38 (13.1)	27 (9.3)	65 (22.5)	0.31♦
Sagittal forced bite	0 (0.0)	0 (0.0)	0 (0.0)	-
Transverse (lateral) forced bite (≥2mm)	3 (1.0)	0 (0.0)	3 (1.0)	1.00♦

Key: ♦ = $p > 0.05$ (no significant gender difference).

The sample mean DAI score was 24.6 (6.49 sd). Both the median and mode were 23. The range was 13-62. The mean DAI score covered around 64 cumulative percent of the population **(Figure 8)**. According to gender, mean DAI scores were 24.5 (sd 6.167) and 24.9 (sd 6.847) for males and females respectively.

Figure 8. Cumulative percentage of subjects' DAI scores (n = 289).
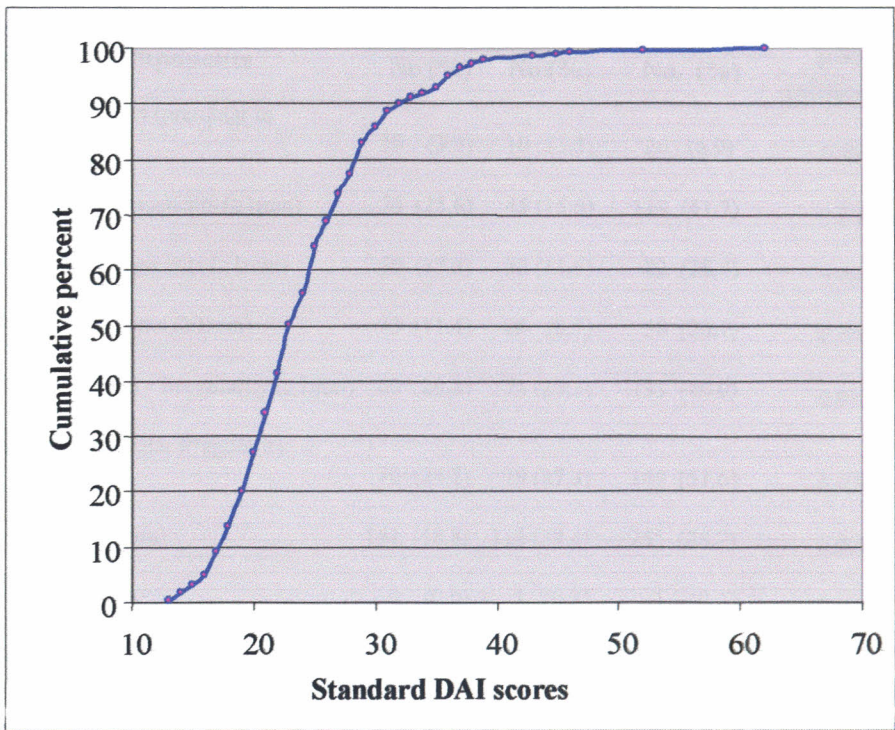
Table 7 shows the distribution of unweighted DAI components and gender differences. The results for reverse overjet and frontal open bites are the same as those generated by Bjork's criteria. Their inclusion in this table is for completion of DAI components. Significant gender differences occurred in some of the components.

Table 7. Distribution of unweighted DAI components (n=289) and statistical gender differences (153 male, 136 female).

Unweighted DAI components	Gender		Total	p-value (chi-square)
	Male No (%)	**Female** No (%)	**Total** No. (%)	
1. Missing teeth per subject (premolar to premolar in either jaw ≥1)	10 (3.5)	10 (3.5)	20 (6.9)	0.79♦
2. Crowding incisors 1-2 segments (≥1mm)	74 (25.6)	45 (15.6)	119 (41.2)	0.01◙
3. Spacing incisors 1-2 segments (≥1mm)	50 (17.3)	32 (11.6)	82 (28.4)	0.09♦
4. Maxillary median diastema (≥1mm)	33 (11.4)	25 (8.7)	58 (20.1)	0.50♦
5. Largest anterior maxillary irregularity (≥1mm)	60 (20.8)	73 (25.3)	133 (46.0)	0.01●
6. Largest anterior mandibular irregularity (≥1mm)	70 (24.2)	79 (27.3)	149 (51.6)	0.02●
7. Maxillary overjet (≥ 1 mm)	141 (48.8)	114 (39.4)	255 (88.2)	0.03◙
8. Reverse overjet (>0mm)	0 (0.0)	1 (0.3)	1 (0.3)	0.47♦
9. Frontal open bite (>0mm)	8 (2.8)	10 (3.5)	18 (6.2)	0.56♦
10. Antero-posterior molar relation (≥½ cusp width)	43 (14.9)	51 (17.6)	94 (32.5)	0.09♦

Key: ◙ = p < 0.05 (males more than females); ● = p < 0.05 (females more than males);

♦ = p > 0.05 (no significant gender difference).

Awareness and concern towards malocclusion

A 56.1% of respondents thought their teeth were properly aligned while 32.5% of

them thought their teeth were not properly aligned **(Table 8)**.

Table 8. Distribution of response alternatives (n = 298), gender difference on

responses (n = 264), correlation between responses and orthodontic

treatment needs (n = 277) on a question which asked "Do you generally

observe that your teeth are not properly aligned in your mouth?"

Question	Response alternatives	Male (158)		Female (140)		Total (298)	
		No	(%)	No	(%)	No	(%)
Do you generally observe	Yes, very much	13	(8.2)	9	(6.4)	22	(7.4)
that your teeth are not	Yes, somehow	82	(51.9)	63	(45.0)	145	(48.7)
properly aligned in your	No, not at all	49	(31.0)	48	(34.0)	97	(32.5)
mouth?	Do not know/do not care	14	(8.9)	20	(14.3)	34	(11.4)

◘ M: F: x^2 = 1.00, df = 1; p = 0.32 (no significant gender difference).

Correlation between responses and treatment indications: r = 0.054, p=0.368 (not significant)
(Statistics: chi-squared and Spearman rank order correlation tests).

Key note: ◘ = gender differences; those who responded by showing indifference or

those who said "do not know/do not care" were excluded in statistical calculation

for gender difference.

Significantly more males thought they had seen one among their age mate with malalighned teeth before (p = 0.03) **(Table 9)**.

Table 9. Distribution of response alternatives (n = 298), gender difference on responses (n = 196), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Have you ever seen one among your age mate with malaligned teeth before?"

Question	Response alternatives	Male (158)		Female (140)		Total (298)	
		No	(%)	No	(%)	No	(%)
Have you ever seen one	Yes	71	(44.9)	49	(35.0)	120	(40.3)
among your age mate	No	33	(20.9)	43	(30.7)	76	(25.5)
with malaligned teeth	Do not bother to look	54	(34.2)	48	(34.3)	102	(34.2)
before?							

□ M: F: $x^2 = 4.61$, df = 1; p = 0.03 (Males were significantly more than females)

Correlation between responses and treatment indications: r = -0.042, p=0.483 (not significant) **(Statistics: chi-squared and Spearman rank order correlation tests).**

Key note: □ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

A 51.3% of the respondents thought their teeth looked better than those of their age mates while 20.8% could not find a difference of their teeth with those of

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their age mate. Only 24.5% of respondent found their teeth to be worse than of their age mate **(Table 10)**.

Table 10. Distribution of response alternatives (n = 298), gender difference on responses (n = 288), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Do you find your own teeth looking better or worse in your mouth than those of most people of your age?"

Question	Response alternatives	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
Do you find your own	Much better	28 (17.7)	21 (15.0)	49 (16.4)
teeth looking better or	Somewhat better	50 (31.6)	54 (38.6)	104 (34.9)
worse in your mouth than	Like most of the others	34 (21.5)	28 (20.0)	62 (20.8)
those of most people of	Somewhat worse	33 (20.9)	28 (20.0)	61 (20.5)
your age?	Much worse	6 (3.8)	6 (4.3)	12 (4.0)
	Do not know/do not care	7 (4.4)	3 (2.1)	10 (3.4)

◘ M: F: $x^2 = 0.26$, df = 1; p = 0.61 (no significant gender difference)

Correlation between responses and treatment indications: $r = -0.091$, $p = 0.133$ (not significant)

(Statistics: chi-squared and Spearman rank order correlation tests).

Key note: ◘ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

Children who reported to have been teased due to their malalighned teeth at their schools were 25.8%. More respondents (70.5%) reported not to be teased before due to their malaligned teeth **(Table 11)**.

Table 11. Distribution of response alternatives (n = 298), gender difference on responses (n = 287), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Do your schoolmates tease you about the appearance of your teeth or jaws?"

Question	Response alternatives	Male (158)		Female (140)		Total (298)	
		No	(%)	No	(%)	No	(%)
Do your schoolmates tease	Yes, often	9	(5.7)	11	(7.9)	20	(6.7)
you about the appearance of	Yes, sometime	13	(8.2)	10	(7.1)	23	(7.7)
your teeth or jaws?	Yes rarely	22	(13.9)	12	(8.6)	34	(11.4)
	No, never	105	(66.5)	105	(75.0)	210	(70.5)
	Do not know/do not care	9	(5.7)	2	(1.4)	11	(3.7)

◘ M: F: x^2 = 1.15, df = 1; p = 0.28 (no significant gender difference)

*Correlation between responses and treatment indications: **r = 0.06, p = 0.317 (not significant)***
(Statistics: chi-squared and Spearman rank order correlation tests).

Key note: ◘ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

Children who were satisfied with the way their teeth appeared in the mouth were 68.2%. Only 29.1% of the respondents reported not to be satisfied with the way their teeth appeared in their mouth. The only significant correlation between response alternatives and treatment indications was on question which asked "are you satisfied with the way your teeth appear in your mouth now?" (r = -0.159, p= 0.008) **(Table 12)**.

Table 12. Distribution of response alternatives (n = 298), gender difference on responses (n = 290), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Are you satisfied with the way your teeth appear in your mouth now?"

Question	Response alternative	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
Are you satisfied with the way your teeth appear in your mouth now?	Very satisfied	50 (31.6)	36 (25.7)	86 (28.9)
	Rather satisfied	50 (31.6)	67 (47.9)	117 (39.3)
	Rather dissatisfied	31 (19.6)	21 (15.0)	52 (17.4)
	Very dissatisfied	21 (13.3)	14 (10.0)	35 (11.7)
	Do not know/do not care	6 (3.9)	2 (1.4)	8 (2.7)

◻ M: F: x^2 = 2.69, df = 1; p = 0.1 (no significant gender difference)

Correlation between responses and treatment indications: r = -0.159, p = 0.008 (significant correlation)

(Statistics: chi-squared and Spearman rank order correlation tests).

Key note: ◻ = gender differences; those who responded by showing indifference or those who said "do not to know/do not care" were excluded in statistical calculation for gender difference.

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Children who thought it is unpleasant to stay with malalighned teeth were 55.7% of the respondents **(Table 13)**.

Table 13. Distribution of response alternatives (n = 298), gender difference on responses (n = 255), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "What is your view about staying with maligned teeth through out your life?"

Question	Response alternative	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
What is your view about staying with maligned teeth through out your life?	Acceptable	50 (31.6)	39 (27.9)	89 (29.9)
	Unpleasant	86 (54.5)	80 (57.1)	166 (55.7)
	Do not know/do not care	22 (13.9)	21 (15.0)	43 (14.4)

◻ M: F: $x^2 = 0.44$, df = 1; p = 0.51 (no significant gender difference)

Correlation between responses and treatment indications: r = 0.029, p = 0.626 (not significant) **(Statistics: chi-squared and Spearman rank order correlation tests).**

Key note: ◻ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

Subjective orthodontic treatment need was observed in 69.1% of the respondents.

Only 13.8% thought they did not need orthodontic treatment and 17.1% were not

sure of the needs **(Table 14)**.

Table 14. Distribution of response alternatives (n = 298), gender difference on responses (n = 247), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Would you like to have your teeth straightened?"

Question	Response alternative	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
Would you like to have your teeth straightened?	Yes	114 (72.1)	92 (65.7)	206 (69.1)
	No	20 (12.7)	21 (15.0)	41 (13.8)
	Not sure	24 (15.2)	27 (19.3)	51 (17.1)

�‫ M: F: $x^2 = 0.59$, df = 1; p = 0.44 (no significant gender difference)

*Correlation between responses and treatment indications: **r = 0.061, p = 0.315 (not significant)*** **(Statistics: chi-squared and Spearman rank order correlation tests).**

Key note: ◘ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

Majority of the children (75%) were ready to accept orthodontic treatment need while only 10.4% were not ready **(Table 15)**.

Table 15. Distribution of response alternatives (n = 298), gender difference on responses (n = 255), correlation between responses and orthodontic treatment need (n = 277) on a question which asked "Would you accept any kind of manipulation in your mouth to straighten your malaligned teeth?"

Question	Response alternative	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
Would you accept any	Yes	120 (75.9)	104 (74.3)	224 (75.2)
kind of manipulation in your mouth to straighten	No	17 (10.8)	14 (10.0)	31 (10.4)
your malaligned teeth?	Not sure	21 (13.3)	22 (15.7)	43 (14.4)

□ M: F: $x^2 = 0.02$, df = 1; p = 0.9 (no significant gender difference)

Correlation between responses and treatment indications: r = 0.075, p = 0.214 (not significant)
(Statistical chi-squared and Spearman rank order correlation tests).

Key note: □ = gender differences; those who responded by showing indifference or those who said "do not know/do not care" were excluded in statistical calculation for gender difference.

There was significant correlation on response alternatives in all of the rank ordered paired questions except on a pair of questions which asked "Do you find your own teeth looking better or worse in your mouth, than those of most people of your age?" and "do your schoolmates tease you about the appearance of your teeth or jaws?" **(Table 16)**.

Table 16. Correlation between paired questions related to awareness and concern about malocclusion (n = 298).

	r	p-value
First pair: "Do you generally observe that your teeth are not properly aligned in your mouth?" *and* "have you ever seen one among your age mate with maligned teeth before?"	0.194	p = 0.001◙
Second pair: "Do you find your own teeth looking better or worse in your mouth, than those of most people of your age mates?" *and* "do your schoolmates tease you about the appearance of your teeth or jaws?"	-0.093	p = 0.108♦
Third pair: "Are you satisfied with the way your teeth appear in your mouth now?" *and* "what is your view about staying with malaligned teeth through out your life?"	-0.26	p = 0.000◙
Fourth pair: "Would you like to have your teeth straightened?" *and* "would you accept any kind of manipulation in your mouth to straighten your malaligned teeth?"	0.592	p = 0.000◙

Key: ◙ = p < 0.05, significant correlation; ♦ = p > 0.05, no significant correlation; statistics: Spearman rank order correlation test.

Subjective orthodontic treatment need.

Subjective orthodontic treatment need was assessed in 298 subjects (158 males and 140 females) who were present on the day of administering questionnaires **(Table 17)**. One subject was not present on the day of administering questionnaires. Therefore was not assessed for subjective orthodontic treatment need. Majority of children (69.1%) wanted their teeth to be straightened **(Table 14 and 17)**.

Table 17. Distribution of response alternatives on subjective orthodontic treatment need (n=298).

Question	Response alternative	Male (158) No (%)	Female (140) No (%)	Total (298) No (%)
◻ Would you like to have your teeth straightened?	Yes	114 (72.1)	92 (65.7)	206 (69.1)
	No	20 (12.7)	21 (15.0)	41 (13.8)
	Not sure	24 (15.2)	27 (19.3)	51 (17.1)

$X^2 = 0.59$, df $= 1$; p $= 0.44$ **(no significant gender difference).**

Keynote: ◻ = those who were not sure of their need for orthodontic treatment were excluded from determination of gender difference (n = 247).

A large proportion (72%) of those who were objectively judged to need orthodontic treatment had responded that they wished to be treated **(Figure 9)**. In the present study there was no significant gender difference (p = 0.44) among those who did not wish to be treated and those who wanted to be treated **(Table 17)**.

Figure 9. Subjective orthodontic treatment need among those who were identified objectively to need orthodontic treatment (n=93).
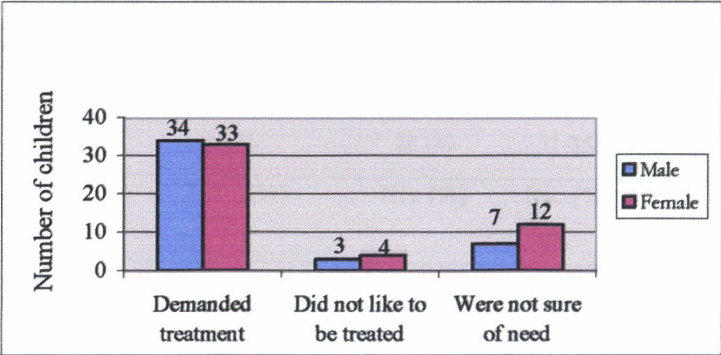
$\chi^2 = 1.21$, df = 2; p = 0.55 (no significant gender difference).

.5 **Objective orthodontic treatment need**

Objective orthodontic treatment need was assessed in 289 subjects who were examined for malocclusion **(Table 18)**. According to the DAI scores, the objective treatment indications were based on the severity of malocclusion. The results indicated that 64.7% of the subjects had either no need or had slight need for treatment whereas 35.3% were found with orthodontic treatment indications ranging from elective, highly desirable to mandatory **(Table 18)**.

Table 18. Objective orthodontic treatment need according to category of severity of malocclusion/treatment indications according to the Dental Aesthetic Index (DAI) (n = 289).

Severity of malocclusion:	No abnormality or minor malocclusion	Definite malocclusion	Severe malocclusion	Very severe or handicapping malocclusion	
Treatment indication:	No or slight need	Elective	Highly desirable	Mandatory	
Dental Aesthetic Index Score:	≤25	26 -30	31-35	≥36	**Total**
Gender:	No (%)	No. (%)	No. (%)	No. (%)	No. (%)
Male:	103 (67.3)	29 (19.0)	11 (7.2)	10 (6.5)	153 (100.0)
Female:	84 (61.8)	33 (24.3)	9 (6.6)	10 (7.3)	136 (100.0)
Combined:	187 (64.7)	62 (21.5)	20 (6.9)	20 (6.9)	289 (100.0)

$U = 9784.5$, $n_1 = 153$, $n_2 = 136$; $p = 0.38$ **(no significant gender difference)**

There were no significant gender differences on either the overall treatment need or the treatment indication categories **(Figure 10 and Table 18 respectively)**.

Figure 10. Gender distribution of orthodontic treatment need as per standard DAI score among those objectively found to have treatment need (n =102).
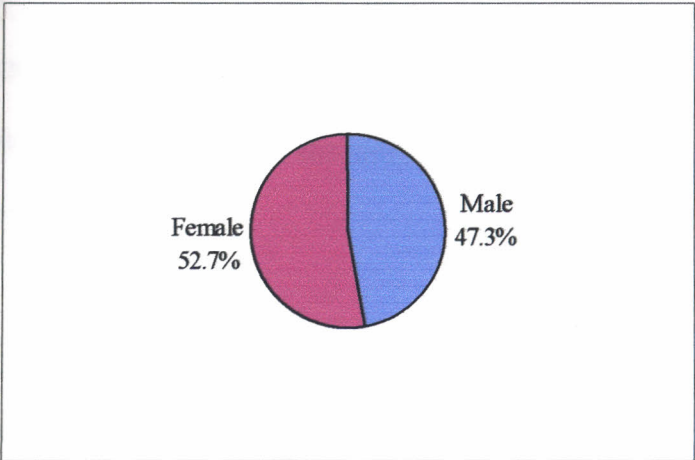
$\chi^2 = 1.74$, df = 1; p = 0.19 (no significant gender difference).

CHAPTER SIX

6.   DISCUSSION

The problem of malocclusion among children is universal; however, the prevalence of malocclusion and the distribution vary among racial, national and ethnic groups.[9-12] The aims of this study were firstly to assess the occurrence of malocclusion traits in 12-15 year-old public primary school children in Moshi, Tanzania. The second purpose was to assess the children's awareness and concern about malocclusion and the third was to determine their orthodontic treatment needs.

Representativeness of the study

Sampling

Clustering by divisions and by locations was applied in Moshi Municipality for multistage random sampling in order to get a representative sample of the study population.

Sample size

According to previous regional documentation, malocclusion in children is not a rare condition in East Africa.[35, 38] Hence a total of 289 out of the 8136 children in Moshi Municipality were studied for prevalence of malocclusion. This (3.6%) was above the 1% sample size recommended by WHO.[53] This ensured both increase in representativeness of the study population and statistical precision.

One pupil (0.3% of the sample size) was not covered by questionnaires and a total of 10 pupils (3.3% of the sample size) were not examined for malocclusion status. Parents of those who were not examined for malocclusion thought that the present project was similar to a previous immunization programme that was associated with beliefs of inducing sterility. Nonetheless, the sample size (298 children) that completed the questionnaires was adequate for the study. However, 289 subjects that were clinically examined were below the minimal sample size by 3.3%. This may have decreased statistical precision by 0.08%[57]. However this was much less to affect validity of the results.

Critique of the methodologies

Indices used for registration of malocclusion and determination of treatment need.

The ideal properties of an index are that it must meet the strict requirements of validity and reproducibility. Bjork *et al*. criteria[23] were modified for use in this study with this fact in mind **(Appendix B1)**. All individual malocclusion traits were mainly based on objective recording except for rotations and overbite in which estimations were used. A linear measurement (where indicated) was recorded to the nearest whole millimetre.

The Bjork *et al*.[23] criteria were selected for assessment of prevalence of malocclusion because of their sensitivity and reproducibility[30], and, -since they have previously been used by other authors,[32,35] for comparative purposes.

The DAI was selected among others for assessing orthodontic treatment need because it is based on socially defined aesthetic standards (multi-racial United States of America). It has been developed to be one of the realistic indices for assessing unmet need and screening for priority of orthodontic treatment need.[12, 55, 58] The unique aspect of the DAI is its linking of people's perception of aesthetics with anatomical trait measurements by regression analysis to produce a single score obviating the need as is the case in the IOTN, for two separate scores, which cannot be combined. DAI scores can be rank-ordered on a continuous scale. They differentiate cases within severity levels.[58]

No radiographs or study models were used in this study. This is likely to have introduced over-estimation or under-estimation of some of the malocclusion traits like aplasia/impacted teeth. Few children who had canines and premolars erupting were subjected to estimation of space anomalies and vertical dimensions.

Questionnaires

Close-ended questionnaire format which was considered appropriate at the cognitive level of the studied pupils was designed to assess any association between awareness and concern about malocclusion and orthodontic treatment need. The questionnaires have been tested and used before.[43] The use of Kiswahili language, which is easily understood by this group of subjects, produced appropriate response. However, self-administered questionnaires may have not

limited subjects from responding by presenting themselves in the best possible light.[59] Proper supervision and counterchecking ensured proper completion of questionnaires.

Prevalence of malocclusion

Based on the Bjork's *et al.*[23] criteria, 97.6% of the present population had some form of malocclusion **(Table 2)**. There is no documented evidence on the over all prevalence of malocclusion based on the Bjork's criteria in Tanzania for comparison. In Kenyan children, Ng'ang'a *et al.*[35] using Bjorks criteria, found 72% of the13-15- year-olds to have some form of malocclusion. In this study, no significant gender difference in the overall prevalence of malocclusion was observed. Bjork's criteria are very sensitive and detailed, hence even minor malocclusion traits were recorded. This may explain the high overall prevalence of malocclusion documented here. Another reason could be the sampling age. Some of the subjects were still in mixed dentition period although they had the required age for inclusion in this study.

Dentition anomalies

The commonest dentition anomalies were rotations **(Table 3)** and anterior irregularities **(Table 7)**. At least one missing permanent incisor, canine or premolar in either jaw according to the DAI score was observed in 6.9% of the children. This was higher in comparison to findings by Otuyemi *et al.*[34] in Nigerian children who found these anomalies in 3.7% of the sample. Exposure to

dental mutilation which is common in East Africa[3] may account for the disparities. Another explanation may be the fact that no radiological investigation was done to confirm the missing tooth. Furthermore, one cannot totally rely on the children's recall of the reasons for the missing tooth. Compared to Nigerian children,[34] this population exhibited more anterior irregularities in both jaws.

Occlusal anomalies

The results indicate that children (67.5%) had Angle's Class I, (6.9%) Angle's Class II and (11%) Angle's Class III malocclusion. Categorization of malocclusion into Angle's Class II and III subdivision traits observed have not been reported before in studies of malocclusion in East Africa. This can probably explain why Angle's Class I in this study was lower than the previous report by Mugonzibwa *et al.*[38] in the same population 14 years ago. Still, with exclusion of Angle's Class II and III subdivisions, occurrence of Angle's Class I malocclusion was higher in this study. This agrees with other African studies.[38, 35, 60] Distal molar occlusion of 6.9% was within the range of 1% - 14.7% reported in African children.[32, 35, 60-64]

Digit sucking predisposes to both Angle's Class II and posterior cross bite especially when the habit is prolonged.[65, 66, 17] However posterior crossbites were extremely rare in this study (0.7%) suggesting that other causes may be responsible for the findings rather than digit sucking. The occurrence of mesial molar occlusion was relatively higher compared to previous East African

findings.[35-38] However, from the literature, Africans are reported to exhibit higher Angle's Class III malocclusion than Caucasians[62, 63, 67, 68], a finding probably related to racial differences.

Occurrence of extreme maxillary overjet (≥6mm) (6.9%) was relatively lower than previous East Africa findings[35]. Mandibular overjet was very low **(Tables 4 and 7)**, agreeing with some earlier findings from East African studies. In this study, a cut-off point for registering maxillary overjet was ≥6mm. However, Mugonzibwa et al.[38] found an occurrence of 35% overjet in their sample at a lower cut-off point of >3.5 millimetres. The present findings, however, are similar to those of Otuyemi and Obidoye [64] on Nigerian children.

Scissors bites and frontal open bites occurred in 2.4% and 6.2% of children respectively. These were in line with those reported by Ng'ang'a et al.[35] in Nairobi children. Hassanali and Pokhariyal[69] reported differences in the occurrence of frontal open bite amongst different ethnic groups in Kenya. The discrepancies in some of the present findings in comparison with those reported before in East Africa therefore may be due to the ethnicity variation of this malocclusion trait. Lateral open bite in this study was relatively higher compared to previous East Africa findings.[35] The possible explanation of this is probably related to the differences in the sampled age. Subjects who had premolars and canines erupting in this study were subjected to estimation of the vertical occlusal relation.

A deep bite was found in 10.7% of the subjects. According to craniofacial growth and development[4], it is known that deep bite may improve as the age of the child advances due to the eruption of posterior teeth. Previous findings from East African studies are incomparable with findings in this study because they used linear measurements rather than the percentage of overlap to register overbite. There were no significant gender differences in this group of malocclusion according to Bjork's criteria **(Table 4)**. However, according to DAI criteria, maxillary overjet ($\geq$ 1mm) was significantly more in males than females **(Table7)**.

Space anomalies

Generally there was a high prevalence of spacing and crowding in this population compared to Ng'ang'a et al.[35] findings in Nairobi children in whom the same criteria were used. This can probably be explained by sampling difference in terms of age and ethnic differences. Mugonzibwa et al.[38] have reported similar results in Tanzanian children. Early extraction of deciduous teeth due to caries is very low [2] in this community to account for the space anomalies noted. Likewise aplasia / impacted teeth (0.3%) was very low to account for the space anomalies observed.

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Other findings

Except for sagittal forced bite, which was not encountered in this study, other traits (maxillary median diastema, abnormal maxillary labial frenulum, transverse forced bite and midline displacement) were in accordance with previous studies.[35] However, Kaimenyi [70] reported an occurrence of 35% for combined upper and lower midline diastema in Nairobi children aged 4-16 years as compared to the low findings in this study (9.7%). Strict comparison of the present data to previous findings in East Africa cannot be done because different criteria were used to register these traits. No significant gender difference was noted for this group of malocclusion traits.

Awareness and concern towards malocclusion

Assessing the way children react to malocclusion is a preliminary move towards establishing both subjective and objective treatment need. This is crucial before embarking on planning and organizing meaningful orthodontic services in a society. Part of this study was aimed at assessing in broad terms, the awareness of malocclusion in children in Moshi, Tanzania.

To be of any practical value, one has to assess an individual child's subjective responses to malocclusion and relate it to his/her objectively assessed malocclusion status that account for the subjective response.[41] This study was conducted along those lines. Of the studied pupils, only 17% were selected from standard 3 and 4 **(Figure 5)**. Although they had the required age for clinical

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assessment of malocclusion, their daily psychosocial interaction was with the majority of their classmates who were below the required age (most of standard 3 and 4 were below 12 years). This could have influenced their responses towards awareness and concern about malocclusion. The reason lies in the observation that there is an increasing awareness of malocclusion with increasing age in some of the child populations.[48, 71]

Children were assessed through questionnaires in regard to the way they reacted to malocclusion features in their normal lives. As inferred from **Table 8, 9, 10, 11, 12 13, 14 15 and 16**, the variables correlated may be causal, complementary, parallel, or of reciprocal association between two or more measured variables. A squared value of correlational coefficient explains only a portion of the variation between two variables. The rest of the percent variation is left unexplained unless there is perfect correlation ($r = -1$ or $+1$). Correlation estimates cannot prove one factor to be caused by another factor.[59] A positive correlation between a pair of the following questions: "do you generally observe that your teeth are not properly aligned in your mouth?" and "have you ever seen one among your age-mate with maligned teeth before?" **(Table 8)** may signify that children in this population had a strong common awareness and concern towards malocclusion. However, some defects of occlusion are not noticeable or else those who have them do not expect them to be noted by others.[72] Thus, group response to such malocclusion traits would be similar to those without. The present results

therefore on awareness and concern about malocclusion in relation to response alternative of this pair of questions need to be interpreted with caution.

Bullying or teasing is common among school children. Severe malocclusion leading to aesthetic impairment is one of the factors leading to teasing. Its effect can be devastating and long lasting.[71] Lack of significant correlation between response alternative of a pair of the following questions: "do you find your own teeth looking better or worse in your mouth, than those of most people of your age?" and "do your schoolmates tease you about the appearance of your teeth or jaws?" May partly be explained by what Shaw et al.[73] suggested that individual personality and or psychosocial variables are responsible for behavioral response to malocclusion. This was evidenced by the majority of the subjects who had awareness and concern to malocclusion being satisfied with their tooth arrangement. In Tanzania, primary school bullying or teasing is strictly prohibited at home and at school. This can partly explain the higher proportion of children who said they had never been teased before despite the high occurrence of anterior irregularities and awareness of having malaligned teeth. It is also probable that esthetic standards for this population are different from those used to design the indices for the registration of malocclusion in this study. Ng'ang'a et al.[43] observed the same in Nairobi children where 75% of children reported not having been teased before.

Dissatisfaction with own dental appearance is broadly related to the severity of the occlusal irregularities.[40, 74] Tanzanians' perceived need for oral health care is related to the relief of pain and discomfort[75, 76] Majority of subjects who had awareness about malocclusion were satisfied with their tooth arrangement in the mouth. The significant negative correlation was noted between response alternative of a pair of the following questions: "are you satisfied with the way your teeth appear in your mouth now?" and "what is your view about staying with malaligned teeth throughout your life?" might imply that high satisfaction caused no concern of unpleasantness of staying with malocclusion. They found it acceptable to stay with malaligned teeth as long as they were not the ones with the defects. Likewise when the dissatisfaction was high, they considered it uncomfortable to stay with malaligned teeth throughout their lives because they were the ones affected. Although this observation may add strong awareness and concern about malocclusion in these children, exposure to orthodontic treatment may change this observation.[77, 78]

Fewer children were dissatisfied with their own tooth arrangement in the mouth in comparison with the high overall prevalence of malocclusion observed in this study **(Table 12)**. This was also noted by Espeland *et al.*[41] and by Ng'ang'a *et al.*[43] in their studies. An explanation of this may be related to what Lindsay and Hodgking [39] suggested that the impact of malocclusion on perceived need and wish for orthodontic treatment does not always correlate with the severity of malocclusion. Both the largest maxillary and mandibular anterior irregularities

were significantly higher in girls than boys **(Table 7)** but there was no significant gender difference on satisfaction with own tooth arrangement. This was contrary to what was reported in 1997 in Nairobi children[43] where more females were dissatisfied with the arrangement of their teeth in the mouth. This may be due to the different socio-cultural beliefs and exposure (environment) in which these individuals have grown.

Subjects responses for awareness and concern towards malocclusion did not correlate significantly with the severity of malocclusion and treatment indications in all the questions asked except for satisfaction with their own tooth arrangement. This trend has previously been observed in Kenyan children.[43] Esa et al.[79] also noted satisfactions with dental appearance which correlated significantly with DAI scores among Malaysian schoolchildren of the same age group.

Subjective orthodontic treatment need

Perceived need and wish for orthodontic treatment does not always correlate to *the severity of malocclusion.*[39] Most of the individuals with malocclusion are primarily concerned about the issue of appearance. This suggests that the impact of malocclusion is primarily psychosocial, reflecting an attempt to cope with impairment of occlusion.[29, 50, 73] In Tanzania, orthodontic treatment demand seems to be influenced by professional advice.[48] Mugonzibwa et al.[48] found that 46% of their sample were advised by the dental clinician to seek orthodontic

treatment. Likewise 20.2% of the cases had a sibling undergoing orthodontic treatment. Gosney[80] has also observed that the dental practitioner tends to influence patient acceptance of orthodontic treatment.

The number of subjects who thought they needed orthodontic treatment (69.1%) was less than those who were ready to accept it (75.2%) **(Table 14 and 15)**. However, this was far higher compared to findings for Kenyan children (33%).[43] When rank-ordered response alternative of a pair of the following questions: "would you like to have your teeth straightened?" and "would you accept any kind of manipulation in your mouth to straighten your malaligned teeth?" a positive significant correlation was noted.

Orthodontic treatment services are hardly available in Moshi. None of the studied subject had undergone or was under orthodontic treatment at the time of data collection. It is unlikely that the findings in regard to the subjects who desired orthodontic treatment and were ready to accept it could be explained by what other researchers in the Western world have suggested. They have suggested that subjective demands for care are greatly influenced by availability, accessibility, acceptability, affordability and awareness of what is possible by the concerned individual or community.[77, 78] It is likely that the children wanted to have their teeth straightened so as to have a pleasing dental appearance like what they see in commercial advertisement.[43] Another possible explanation of this observation is that information about straightening of teeth could have prompted pupils to demand orthodontic treatment without knowing all the factors associated with it.

This calls for further studies in this community with regard to the psychosocial perception of malocclusion in relation to orthodontic treatment need.

Objective orthodontic treatment need

Prahl-Andersen [81] put forward three types of pieces of information to be obtained before evaluating orthodontic treatment needs which included objective signs determined by the dental professional, subjective symptoms determined by individual responses on the impact of malocclusion and lastly the social sufficiency determined by the society. To satisfy these three aims, the DAI has been developed and adopted by the WHO[55] to be one of the realistic indices for evaluating unmet orthodontic treatment need especially in children who are on subsidized public funds.[58] In a situation like that of Tanzania where little epidemiological studies on malocclusion have been done, it was imperative to use the DAI for assessment of objective orthodontic treatment need as well as for assessing the occurrence of malocclusion features. It is worth noting that, the indices in this study are based on the Western culture. However, experience shows that East Africans generally appear to attach great admiration to Western values and standards in their daily routine.[43] This notwithstanding however, it would be valuable to determine norms for dentofacial appearance in this population and subsequently design an appropriate index to evaluate orthodontic treatment need.

Appearance of the face and dentition is recognized as a major factor in the human psychosocial health.[50] Experience shows that consciousness and concern of tooth-appearance in the mouth is mostly noticeable when children are about to complete their primary schooling or when they join secondary schools[50]. The present sample therefore was suitable for assessment of orthodontic treatment need in Tanzanian children.

Effective plans for orthodontic services require some knowledge of potential treatment load. Luffingham and Campbell[82] defined this as the number of subjects assessed to need treatment, minus those whose general condition is inadequate for treatment and those who do not wish to receive treatment. A health system research is concerned with organizing and applying solutions to the identified problems. If we are to achieve oral health for all, it can be said that orthodontic care is unduly delayed for Tanzanian children. For example, 6.9% of the handicapping malocclusions registered in this study call for mandatory treatment according to DAI criteria. However, in Tanzania, there is no organized system of early identification and management of such unfortunate children.

Factors influencing the objective demands for orthodontic treatment include the skills, current treatment policy, pressure of work, presence of auxiliary support, materials, equipment, education of the professional, and the system of remuneration.[77, 83, 84, 85, 86] Comparing orthodontic care in East Africa, there is a relatively more organized orthodontic service both in the public and private

sectors in Kenya than in other East African countries. The explanation for this may be found in the factors influencing objective and subjective demands for orthodontic care. In Kenya, there are already several specialists in paediatric dentistry and orthodontics.

Objective orthodontic treatment need in this study was found in 35.3% of the examined subjects. Results for mean DAI scores and objective orthodontic treatment need are presented in **Table 18**. Compared to Kenyan children's objective orthodontic treatment need (29%)[43] and Zambian children (17%) reported by Gabrial et al.[87] it is clear that Moshi children exhibit a higher objective orthodontic treatment need (35.3%). Probably those in very greatest need already had sought orthodontic treatment by the time of those studies as compared to Moshi where orthodontic services are unavailable.

Otuyemi et al.[34] found 13.4% severe, 5.5% definite and 3.72% handicapping malocclusion in Nigerian children using DAI criteria. No subject had history of orthodontic treatment. These findings are low compared to findings in this study basing on comparable unavailability of help for unmet orthodontic treatment needs. Yasuhiro et al.[12] have reported a mean DAI score of 30.1 for Japanese and 26.5 for white Americans which are relatively higher compared to findings in the present study. This may be due to racial differences. Handicapping malocclusion (DAI score of $\geq$ 36) in the present study was at the 93rd percentile **(Figure 8)** compared to the 86th percentile recommended by DAI criteria in predicting

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handicapping malocclusion.[88] Above this level handicapping malocclusion is considered present. This demonstrated that few pupils in this study had handicapping malocclusion compared to other population studies. However considerable unmet orthodontic treatment need is present.

Among the pupils who were objectively found to need orthodontic treatment majority thought they needed it. This signifies that these children were aware and concerned by their malocclusion and they desired to eliminate it.

Challenges during the study:

1. School children registration in Tanzania is based on birth certificate. It was therefore assumed that selected subjects had correct entry of their birth date in the school registrar as it was not possible to get birth certificates of the sample frame. Incorrect entry of subjects' age in the registrar could have caused over estimation or under estimation of their age in this study.

2. Subjects were examined for malocclusion under the natural right while seated on a chair. Examination of subjects on a dental chair under artificial right could have provided better illumination and positioning of subjects for examination of malocclusion traits in the posterior segments.

3. The number of children studied for the broad objective was below the minimum calculated sample size by 3.3% in this study. This may have decreased statistical precision by 0.08%.

4. Lack of study model and x-rays may have contributed to low precision on registration of malocclusion and overestimation or underestimation of aplasia/impacted teeth respectively.

Conclusion

► There was a high overall prevalence of malocclusion with no significant gender difference.

► The DAI criteria produced a mean DAI score of 24.6, with a very small proportion of subjects exhibiting handicapping malocclusion.

► There were significant correlations between awareness and concern about malocclusion. However both factors did not correlate significantly with objective treatment indications in the sample.

► Objective orthodontic treatment need was low compared to subjective orthodontic treatment need.

Recommendations

► The information from this study should form a basis for planning orthodontic care in this community because unmet subjective and objective orthodontic treatment needs are present.

► Specialists in orthodontics should be trained and necessary infrastructure created to handle orthodontic problems in this community.

► Further research should be undertaken to address the issues of children's concern on dentofacial appearance and psychosocial implications of malocclusion.

7. REFERENCES

1. **Luukkonnen P, Luanga C.** Oral Health Services. In: Lankinen KS, Bergstrom S, Makela PH, Peltomaa M (eds.). Health and Diseases in Developing Countries. London: The Macmillian Press Ltd, 1994, pp 523-529.

2. **Central Oral Health Unit**. Policy guidelines for Oral Health Care in Tanzania. 1st edn. Dar es Salaam: Ministry of Health, Tanzania, 2002, pp 1-18.

3. **Central Oral Health Unit**. The National Plan for Oral Health 1988-2002. First revision. Dar es Salaam: Ministry of Health, Tanzania, 1994, pp 1-61.

4. **Gordon PH.** Craniofacial growth and development. In: Richard R. Welbury (eds.). Paediatric Dentistry. New York: Oxford University Press, 1997, pp 1-15.

5. **Ferguson DJ.** Growth of the face and dental arches. In: McDonald RE, Avery DR (eds.). Dentistry for the Child and Adolescent. India: Mosby, Inc, A Harcourt Health Sciences Company, 2001, pp 626-647.

6. **Bhalajhi SI.** Orthodontics: The art and science. 2nd edn. New Delhi: Arya (medi) Publishing house, 2003, pp 77-120.

7. **Andrews LF.** The six keys to normal occlusion. Am J Orthod 1972; 62:296-309.

8. **Tandon S.** Development of Occlusion. In: S. Tandon (eds.). Texbook of Pedodontics. India: Paras Medical Publisher, 2003, pp 108-120.

9. **Kerosuo H.** Occlusion in the primary and early mixed dentitions in a group of Tanzanian and Finnish children. ASDC J Dent child 1990; 57:293-298.

19. **Cortes MI, Marcenes W, Sheiham A.** Prevalence and correlates of traumatic injuries to the permanent teeth of schoolchildren aged 9-14 years in Belo Holizonte, Brazil. Dent Traumatol 2001; 17:22-26.

20. **Sonnese L, Bakke M, Solow B.** Malocclusion traits and symptoms and signs of temporomandibular disorders in children with severe malocclusion. Eur J Orthod 1998; 20:543-559.

21. **Kerosuo H, Hausen H, Laine T, Shaw WC.** The influence of incisor malocclusion on the social attractiveness of young adults in Finland. Eur J Orthod 1995; 17:505-512.

22. **Shaw WC.** Dentofacial irregularities. In: Pine CM (eds.). Community Oral Health. Great Britain: Wright, 2000, pp 104-110.

23. **Bjork A, Krebs AA, Solow B.** A method of epidemiological registration of malocclusion. Acta Odont Scand 1964; 22: 27-41.

24. **Graiger RM.** Orthodontics treatment priority index. Public Health Service publication No. 1000, Series 2, No. 25. Washington DC: US Government Printing Office, 1967.

25. **Salzman JA.** Handicapping malocclusion assessment to establish treatment priority. Am J Orthod 1968; 54:749-765.

26. **Summers CJ.** A System for identifying and scoring occlusal disorders. Am J Orthod 1971; 59:552-567.

8.   APPENDICES

8.1   Appendix A: Questionnaires

8.1.1   Appendix A1: English version.

Questionnaire No. ☐☐☐   Date of interview ☐☐☐☐☐☐

1. Primary school No.   ☐

2. Class.   ☐

                                                          M   F

3. Gender.   ☐☐

4. Age (to the nearest six months) ……………………….   ☐☐

5. Race: 1. African   ☐

                2. Asian   ☐

                3. Caucasian   ☐

                4. Any other? (Mention)………………….

6. Do you generally observe that your teeth are not properly aligned in your mouth?

        1. Yes, very much   ☐

        2. Yes, somehow   ☐

        3. No, not at all   ☐

        4. Do not know / do not care.   ☐

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7.   Have you ever seen one among your age mate with malaligned teeth before?

1. Yes

2. No

3. Do not bother to look.

8.   Do you find your own teeth looking better or worse in your mouth, than those of

most people of your age?

1. Much better

2. Somewhat better

3. Like most of the others

4. Somewhat worse

5. Much worse

6. Do not know/do not care.

9.   Do your schoolmates tease you about the appearance of your teeth or jaws?

1. Yes, often

2. Yes, sometime

3. Yes, rarely

4. No, never.

5. Do not know/do not care.

10. Are you satisfied with the way your teeth appear in your mouth now?

1. Very satisfied ☐

2. Rather satisfied ☐

3. Rather dissatisfied ☐

4. Very dissatisfied ☐

5. Do not know/do not care. ☐

11. What is your view about staying with malaligned teeth through out your life?

1. Acceptable ☐

2. Unpleasant ☐

3. Do not know / do not care. ☐

12. Would you like to have your teeth straightened?

1. Yes ☐

2. No ☐

3. Not sure ☐

3. Would you accept any kind of manipulation in your mouth to straighten your malaligned teeth?

1. Yes ☐

2. No ☐

4. Not sure. ☐

Thank you for answering these questions.

8.1.2 Appendix A2: Kiswahili version.

Namba ya swali [ ][ ][ ]   Tarehe ya kuulizwa [ ][ ][ ][ ][ ][ ]

1. Nambari ya shule. [ ][ ]

2. Darasa. [ ]

                                                   Ke Me

3. Jinsia. [ ][ ]

4. Umri (Kadirio la miezi sita ya karibu). [ ][ ]

5. Nasaba yako ni   1. Mwafrika [ ]

                       2. Mhindi/Mwarabu [ ]

                       3. Mzungu [ ]

                       4. Mwingine? (Taja) …………………………………

6.   Unafikiri meno yako yamepangana vibaya kwenye kinywa chako?

    1. Ndiyo, vibaya sana [ ]

    2. Ndiyo, kwa kiasi fulani [ ]

    3. Hapana kabisa [ ]

    4. Sijui/sijali. [ ]

7. Ulishawahi kumuona mtu wa rika like mwenye meno yaliyopangana vibaya kinywani?

   1. Ndiyo

   2. Hapana

   3. Sijachunguza wenzangu.

8. Unafikiri meno yako yanaonekana mazuri au mabaya kuliko ya wengine
   wa rika lako?

   1. Mazuri sana

   2. Kidogo yaonekana mazuri

   3. Ni Kama ya wengine

   4. Kiasi yanaonekana vibaya

   5. Yanaonekana vibaya sana

   6. Sijui/sijali.

9. Je shuleni wenzako wanakutania kwa sababu ya taya au meno yako yasiyo
   pangana vizuri mdomoni?

   1. Ndiyo, mara nyingi

   2. Ndiyo, wakati mwingine

   3. Ndiyo, marachache

   4. Hapana, hawajawahi

   5. Sijui / sijali.

10. Unaridhika au uridhiki na jinsi meno yako yalivyo pangana na yanavyoonekana kinywani mwako?

1. Naridhika sana

2. Naridhika kiasi

3. Kiasi, siridhiki

4. Siridhiki kabisa

5. Sijui /sijali.

11. Toa maoni yako kuhusu wewe kuishi na meno yasiyonyooka au kupangana vizuri kinywani maisha yako yote?

1. Inakubalika tu

2. Haileti faraja

3. Sijui ningejisikiaje/sijali.

12. Ungependa kurekebisha au kunyooshwa meno yako yaliyopangana vibaya?

1. Ndiyo

2. Hapana

3. Sina uhakika.

13. Je uko tayari kukubali kushughulikiwa mdomoni kwa njia yoyote ile ili mradi meno yako yanyooshwe au yapangwe vizuri?

1. Ndiyo

2. Hapana

3. Sina uhakika.

Ahsante kwa kujibu maswali haya.

8.2 Appendix B: Criteria used for recording malocclusion

8.2.1 Appendix B1:

Procedure for recording malocclusion according to Bjork *et al.*[23]

with description of modifications in sections where it was applied for this study.

DENTITIONAL ANOMALIES:

1. Inversion of maxillary incisors (anterior cross bite):

   It is recorded if three or fewer maxillary incisors are occluding lingual to the mandibular incisors. It was recorded in the same manner in this study.

2. Impacted teeth/Aplasia:

   Aplasia is recorded after radiographic check.

   According to modification a tooth was considered impacted or aplastic if there was no history of extraction for the missing tooth and if both child's dental and chronological age required the tooth to be in the mouth. Late tooth developers were also considered. Bjork *et al.*[23] criteria advised to take X-ray in such cases but it was not done in this study due technical problems and the design of the study.

3. Transposition:

   Transposition is recorded considering incisors, canine and premolars. It is recorded if there is an interchange of position for a tooth having a lower number. It was recorded in the same manner in this study.

4. Supernumerary:

A tooth is recorded as supernumerary if there is an extra tooth irrespective of its shape and size. It is recorded according to the corresponding tooth. No modification was done to record this trait.

5. Rotation:

Rotation of a tooth is recorded for a fully erupted tooth when it exhibits more or equal to 15° of rotation. Direction of rotation as mesial or distal is also recorded. In this study, registration of rotation was through estimation. Direction of rotation was not recorded.

6. Malformation:

Abnormal shape or size is registered and the type of anomaly recorded. However in this study, malformation was recorded if a tooth exhibited obvious abnormal shape or size with exclusion of post eruption fluorotic deformities, caries and fractures.

OCCLUSAL ANOMALIES:

1. Antero-posterior molar relation:

According to Bjork *et al.*[23] criteria, antero-posterior molar relation is considered in terms of Angle's classification. Angle's Class I malocclusion is registered when there is bilateral normal molar relation. Each of Angle's Class II and III malocclusion is categorized into two grades. Grade 1 is registered when there is a deviation of *normal relation from one-half to one cusp width* bilaterally and Grade 2 is when the discrepancy is one cusp width and over. However, in this study, registration was done from grade 1 and over. In that

way, Angle's Class II malocclusion was registered when there was bilateral ≥ to half-cusp width distal to normal molar relation. Like wise Angle Class III was registered when there was bilateral ≥ to half-cusp width mesial to normal molar relation.

Angle's Class II sub division malocclusion was recorded when there was unilateral normal molar relation with Angle's class II features on the other side as it is described above. Angle's class III subdivision malocclusion was registered when there was unilateral normal molar relation with Angle's class III features on the other side as it has been described above.

2. Extreme maxillary overjet:

According to the criteria, it is measured with registration instrument level with the occlusal plane of the maxilla and classified as follows: Grade 1: 6 to 9 millimetres and Grade 2: 9 millimetres and over. However in this study the cut off point was set at greater than or equal to 6 millimetres. The horizontal relations of incisors were made with teeth in centric occlusion. Maxillary overjet was measured to the nearest whole millimetre.

3. Mandibular overjet:

It is measured by registration instrument and classified as follows: Grade 1: 0 to 2 millimetres and Grade 2: 2 millimetres and over. In this study, it was recorded if overjet was greater than zero millimetre.

4. Deep bite:

It is measured with registration instrument and classified as Grade 1: 5 to 7 millimetres and Grade 2: 7 millimetres and over. However, in this study, frontal deep bite was registered by estimating the percentage of overlap of upper "longest" central incisor on lower "longest" central incisor in which, 50% overlap and above was considered abnormal and was recorded.

5. Frontal open bite:

It is measured at the central incisors with the registration instrument and classed as follows: Grade 1: 0 to 2 millimetres and Grade 2: 2 millimetres and over.

In this study it was registered if there was a lack of vertical overlap between any of the opposing pairs of incisors. The largest open bite was registered if it was equal to or greater than 2 millimetres for inclusion.

6. Lateral open bite (posterior open bite):

It is recorded for the canine and premolar and for the molar section on each side. When a single tooth is involved, the whole section is recorded. In this study it was recorded for canine to molar section on either side of the mouth. It was recorded present when a single tooth or more teeth were involved.

7. Posterior cross bite

It is recorded for each side for the canine and premolar section and for the molar section. It is recorded if the buccal cusp of the upper tooth occluded lingual to the buccal cusp of the corresponding lower tooth. It is recorded

when the cusps have just passed one another. In this study it was recorded in the same way but considered combined canine to molar segments.

8. Scissor bite:

   Scissor bite is registered for the canine and premolar section to molar section if the lingual cusp of the upper tooth occludes buccal to the buccal cusp of the corresponding lower tooth. It is recorded just when the cusps have passed one another. In this study it was registered the same way but considered combined canine to molar segments.

SPACE ANOMALIES:

1. Lack of space in the incisors segments (crowding):

   Incisor section is demarcated by the distal contact points of the two lateral incisors when the lateral incisors do not deviate labially or lingually in relation to the midline of the alveolar process. Crowding per segment is considered present if there is more than or equal to two-millimetre lack of space. Recording was done in the same way in this study but to the nearest whole millimetre.

2. Lack of space in the lateral segments:

   Lateral segments in each jaw are taken as space limited by distal contact of lateral incisor with canine and mesial contact with first permanent molar. A point is used on the midline of the alveolar process between the two contact points when the lateral incisor and canine deviate. According to the criteria the crowding per segment is considered present if there is more than or equal

to 2 millimetres lack of space. Recording was done in the same way in this study but to the nearest whole millimetre.

3. Excess of space in the incisor and lateral segment.

Excess of space in the incisor and lateral segment is recorded if there is more than or equal to 2 millimetres of space in the segment. Recording in this study was done in the same way to the nearest whole millimetre.

OTHER MALOCCLUSION FEATURES:

1. Maxillary median diastema:

It is recorded if there is a diastema of at least 2 millimetres between the upper central incisors. The registration instrument is used. It was measure in the same way to the nearest whole millimetre.

2. Mandibular median diastema:

Mandibular median diastema was measured as well to the nearest whole millimetre but it was considered for inclusion in the spacing analysis of anterior lower segment.

3. Abnormal maxillary labial frenulum:

It is recorded when the maxillary labial frenulum is inserted low in the incisor papilla in which the papilla became anaemic on stretching the upper lip. It was recorded in the same way in this study.

4. Midline displacement:

It is recorded if in occlusion, mandibular dental arch midline is displaced to 2 millimeters or more in relation to the midline of the upper dental arch. Direction of the displacement is also recorded. Registration in this study was done in the same way but direction of the deviation was not recorded.

5. Sagittal forced bite:

Sagittal forced bite occurs when there is anterior discrepancy on occlusion in such way that patient tends to move the mandible either anteriorly or posteriorly to avoid the discrepancy. It was recorded as either present or absent.

6. Transverse forced bite:

It is a condition in which there is a premature contact on occlusion in such away the patient deviate the mandible on either side to clear away from the pre-contact so as to attain a satisfactory occlusion. It is recorded if there is more than or equal to 2 millimetres of mandibular deviation to either side at the incisor region.

8.2.2 Appendix B2.

Registration of malocclusion according to DAI criteria as per WHO[55] recommendation. It was used concomitantly with modified Bjork et al.[23] criteria as follows:

1. Missing incisor, canine and premolar teeth:

   Missing teeth from second premolar of one quadrant to the other in each jaw are registered. Missing tooth is not recorded in this point if space for the missing tooth is closed or if primary tooth is still in place and successor is not yet erupted or if missing teeth are replaced by prosthesis. Extractions of the anteriors for aesthetic reasons are considered, in that missing tooth due to extraction for aesthetic reason is not recorded.

2. Lack of space in the incisors segments (crowding):

   Both upper and lower incisor segments are examined for crowding. Crowding in the incisor segments is the condition in which the available space between the left and right canine teeth is not enough to accommodate all four incisors in a normal alignment. Crowding is not recorded if a canine or both are displaced but the incisors are in proper alignment. In this situation teeth may be rotated or displaced out of alignment in the arch. It is recorded as:

   0 = No crowding.

   1 = One segment crowded.

   2 = Two segment crowded.

   Lower score is given if in doubt.

3. Excess of space in the incisor segments:

   Spacing in the incisor segment is a condition in which the amount of space available between the right and left canine teeth is greater than the required to accommodate all four incisors in a normal alignment. If one or more incisor teeth have proximal surfaces without any interdental contact, the segment is considered as having space. Space for recently exfoliated primary tooth is not recorded if there is a sign that the permanent is going to erupt soon. Incisor segment spacing is recorded as follows:

   0 = No spacing.

   1 = One segment spaced.

   2 = Two segment spaced.

4. Maxillary median diastema:

   Defined as a space in millimetre between two permanent maxillary incisors when the teeth are at the normal position of contact points. It is measured with instrument at any level between the mesial surfaces of the central incisors to the nearest whole millimetre.

5. Largest anterior maxillary irregularity:

   It is registered if there is either rotation out of, or displacement from normal alignment of the anterior maxillary teeth. Greatest irregularity is recorded in one of the four maxillary incisors with instrument. The irregularity length is measured in a nearly whole millimetre. Irregularity of lateral incisors on its distal sides is also considered.

6. Largest anterior mandibular irregularity:

It is registered if there is either rotation out of, or displacement from normal alignment of the anterior mandibular teeth. Greatest irregularity is recorded in one of the four mandibular incisors with instrument. The irregularity length is measured in a nearly whole millimetre. Irregularity of lateral incisors on its distal sides is also considered.

7. Maxillary overjet:

The distance from the labio-incisor edge of the most prominent upper incisor to the labial surface of the corresponding lower incisor is measured with instrument. No recording if all maxilla incisors are missing or in lingual crossbite. If the incisors occlude edge to edge, the score is zero.

8. Mandibular overjet

Mandibular overjet is recorded with instrument in the same way as for anterior maxillary overjet; that is from labio-incisor edge of the most mandibular prominent incisor to the labial surface of the maxillary incisors. It is considered present when the length is greater than zero millimetres. It is not recorded if a lower incisor is rotated so that one part of its edge is in cross bite

9. Vertical anterior open bite:

The largest open bite is recorded with an instrument to the nearest whole millimetre.

10. Antero-posterior molar relation:

Antero-posterior molar occlusion was registered according to the relation of the permanent upper and lower first molars. The right and left sides were assessed with the teeth in occlusion. Largest deviation was recorded as follows:

0 = Normal.

1 = half cusp: The lower first molar is half cusp mesial or distal to its normal

relation.

2 = full cusp: Lower first molar is one cusp or more, mesial or distal to normal

relation.

8.3 Appendix C: Examination form for registration of malocclusion (Bjork *et al.*[23] modified criteria and DAI[55] criteria).

ID No. ☐☐☐ Date of examination ☐☐☐☐☐ Number of Primary School ☐☐☐

Class ☐   Gender: M F ☐☐

Dentition anomalies:

●Anterior crossbite (three or fewer incisors)………………………..... ☐☐

●Impacted / Aplasia except last molars……………………………… ☐☐

●Transposition……………………………………………………... ☐☐

●Supernumerary…………………………………………………….. ☐☐

●Rotation (Estimated 15º)…………………………………………... ☐☐

●ж Missing teeth P_2 to P_2……………………………………… U ☐☐ L

♦Largest anterior maxillary irregularity (≥ 1 mm)…...(…mm)………… ☐☐

♦Largest anterior mandibular irregularity…(≥ 1 mm) (…mm)………… ☐☐

Occlusal anomalies:

● ► Distal molar occlusion (≥ half cusp width) …………(**N, ½, F**)… ☐

● ► Mesial molar occlusion (≥ half cusp width) ……….(**N, ½, F**)…. ☐

♦ Extreme maxillary over jet (≥6mm)……………(….mm)………….. ☐

♦ Mandibular over jet (>0mm)……………………...(…mm)………….. ☐

♦ Deep bite (≥50%). ……………………….…..(…%)……………. ☐

♦ Frontal open bite (>0mm)……………………(...mm)………….. ☐

● Lateral open bite (posterior open bite)…………………………... ☐

● Posterior cross bite……………………………………………….. ☐

● Scissor bite…………………………………………………………. ☐

Space anomalies:

♦ Lack of space (maxilla ≥2mm) incisors………..(…mm)………….. ☐

♦ Lack of space (maxilla ≥2mm) lateral …………..(….mm)………….. ☐

♦ Lack of space (mandible ≥mm) incisors ………(….mm)………….. ☐

♦ Lack of space (mandible ≥mm) lateral……… (….mm)………….. ☐

♦ Excess of space (maxilla ≥2mm) incisors…… ..(…mm)………….. ☐

♦ Excess of space (maxilla ≥2mm) lateral……… (…mm)…………... ☐

♦ Excess of space (maxilla ≥2mm) incisors……..(…mm)………….. ☐

♦ Excess of space (maxilla ≥ 2mm) lateral …… (…mm)…………… ☐

Others malocclusion traits:

♦Maxillary median diastema (≥2mm)………..(….mm)…………….. ▭

♦Mandibular median diastema (≥2mm)………(....mm)…………….. ▭

●Abnormal maxillary labial frenum………………………………….. ▭

♦Midline displacement (≥2mm)………………(…mm)…………….. ▭

●Sagittal forced bite ………………………………………………… ▭

♦Transverse (lateral) forced bite (≥2mm)…….(...mm)…………….. ▭

Keynote:

> **0** = Not measured
>
> **1** = Presence of malocclusion trait
>
> **2** = Absence of malocclusion trait
>
> **ж** = Missing teeth (P2 = Second premolar)
>
> **U** = Upper jaw
>
> **L** = Lower jaw
>
> **►** = First molar relationship
>
> **N** = Normal First molar relationship
>
> **½** = Half cusp first molar relationship
>
> **F** = Full cusp first molar relationship
>
> **●** = Nominal variable
>
> **♦** = Numerical (continuous) variable

8.4 Appendix D: Consent form

8.4.1 Appendix D1: Parents' written consent form

Dear parent/guardian of (pupil's full name)...

Your child has been selected to participate in the study on malaligned teeth in Primary school children here in Moshi Municipality. We will ask your child some questions about malaligned teeth. We will also examine your child's mouth and teeth. We will not give your child anything parenterally or orally except for measuring teeth with plastic rulers. We will record all the information obtained from your child. This information will be kept as a confidential. Your child will be allowed to drop out of the study on his/her own wishes or your wishes without giving explanation.

We will help to advice accordingly if oral health problem is found in your child mouth.

Please sign accordingly below.

I agree to have my child to participate in the study.

Name ....

     Signature................................

I do not agree my child to participate in the study

Name ....

     Signature................................

8.4.2 *Appendix D 2: Subjects' oral consent form:*

Dear pupils,

You have been selected to participate in the study on malaligned teeth in Primary school children in Moshi Municipality. We will give you a questionnaire form to answer some questions related to the way you perceive malaligned teeth. We will also examine your mouth and teeth. We will not give anything to you parenterally or orally except for measuring your teeth with plastic rulers. Information obtained from you will be strictly kept as a confidential. You will be allowed to drop out of the study without giving explanation; on your own or your parent's / guardian wishes.

We will help to advice accordingly if oral health problem is found in your mouth.

Do you agree to participate in this study?

YES...................................   NO...............................

If you have any question pertaining to this study please ask at any time.

8.5 Appendix E: Ethical approval

8.5.1 Appendix E 1: Ethical approval in Kenya:

KENYATTA NATIONAL HOSPITAL
Hospital Rd. along, Ngong Rd.
P.O. Box 20723, Nairobi.

Tel: 726300-9
Fax: 725272
Telegrams: "MEDSUP", Nairobi.
Email: **KNHplan@Ken.Healthnet.org**

Ref: KNH-ERC/01/1910   **Date: 29 July 2003**

Dr. Deogratias S Rwakatema
Dept. of Paediatric Dentistry and Orthodontics
Faculty of Dental Sciences
University of Nairobi

Dear Dr. Rwakatema,

RESEARCH PROTOCOL "MALOCCLUSION AND ORTHODONTIC TREATMENT NEED AMONG 12 TO 15 YEAR-OLD CHILDREN IN MOSHI, TANZANIA"   (P65/6/2003)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** your above cited research proposal.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely,

DR. D MBORI-NGACHA
For: SECRETARY, KNH-ERC

Cc   Prof. K Bhatt, Chairperson, KNH-ERC
       The Deputy Director (C/S), KNH
       The Dean, Faculty of Medicine, UON
       The Dean, Faculty of Dental Sciences, UON
       The Chairman, Dept. of Paediatric Dentistry and Orthodontics
       CMRO
       Supervisors: Dr. P M Ng'ang'a, Dept of Paediatric Dentistry and Orthodontics, UON
                     Dr. A M Kemoli, Dept of Paediatric Dentistry and Orthodontics, UON

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8.5.2   *Appendix E 2: Ethical approval in Tanzania:*

TUMAINI UNIVERSITY
KILIMANJARO CHRISTIAN MEDICAL COLLEGE
P. O. Box 2240, MOSHI, Tanzania

ETHICAL CLEARANCE CERTIFICATE

No. *039*

For Research Proposal No. *066*

Title: *Malocclusion and orthodontic treatment need among 12*
to 15 year - old children in Moshi, Tanzania.

KCMC Investigator/~~Counterparts~~ *Dr. D. S. Rwakatema*

Sponsor *Ministry of Health*

Extension *September 2003 - August 2004*

Proposal Extension Approved by
KCMC Ethics Committee on *16 September 2003*

Dr. F. W. Mosha
SECRETARY

Mrs. J. P. Chugulu
CHAIRPERSON