CLINICAL CHARACTERISTICS ASSOCIATED WITH DECISION TO EXTRACT TEETH AMONG PATIENTS SEEKING ORTHODONTIC CARE AT MUHAS DENTAL CLINIC IN TANZANIA

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CLINICAL CHARACTERISTICS ASSOCIATED WITH DECISION TO EXTRACT TEETH AMONG ORTHODONTIC PATIENTS AT MUHAS DENTAL CLINIC IN TANZANIA

By

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A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Dentistry (Orthodontics) of

Muhimbili University of Health and Allied Sciences

October, 2024

CERTIFICATION

The undersigned certify that they have read and hereby recommend for Acceptances by Muhimbili University of Health and Allied Sciences a dissertation titled; **"Clinical characteristics associated with decision to extract teeth among orthodontic patients at MUHAS dental clinic in Tanzania",** in (partial) fulfilment of the requirements for the degree of Master of Dentistry in orthodontics of Muhimbili University of Health and Allied Sciences.

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Date: _____

DECLARATION AND COPYRIGHT

I, **Yonazi Mbonea Reuben**, declares that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for similar or any other degree award.

Signature…… **Date**……

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DEDICATION

This work is dedicated to my family;

My lovely wife Naelijwa and our son Jason.

Thanks for being there for me during this rewarding journey.

ABSTRACT

Background: The decision to extract or not during orthodontic treatment has been among clinicians' most debated subjects, with no common conclusion. However, orthodontic patients always present with clinical characteristics that serve as the basis of decision-making towards extraction or non-extraction of teeth, as part of orthodontic treatment.

Aim: This study assessed the clinical characteristics associated with the decision to extract teeth among orthodontic patients at MUHAS dental clinic in Tanzania.

Methodology: The study was an analytical cross-sectional design. Participants who were involved in the study were obtained by consecutive sampling techniques from amongst the patients presenting at the MUHAS dental clinic. A structured questionnnaire was used to collect both socidemographic and orthodontic tooth extraction data. Clinical characteristics among patients were obtained through clinical examination, use of orthopantomography, photography and study model analysis. Clinical findings were recorded in special forms, and the obtained information were used by three Orthodontists to decide on orthodontic tooth extraction. Data analysis was performed using Statistical Packages for Social Science (SPSS), Version 27.0. and the level of statistical significance was set at $p<0.05$, with 95% Confidence Interval (CI).

Results: The study involved 100 participants aged 13 years and above, with the majority being 13-22 years old. Of the participants, 40% required orthodontic tooth extraction for their treatment. First premolars were the most selected teeth for extraction, with the prevalence of 28%. Among the participants, 83% had Angle's Class I malocclusion and 17% had other Classes (Classes II and III). On patients' profile, 64% had straight and 36% had other facial profiles (convex and concave). Mild crowding of 1-3mm in both jaws was 44% in the maxilla and 52% in the mandible, while moderate to severe crowding of > 4mm was 20% in the maxilla and 17%in the mandible. Most participants had competent lips (94%), while only few (11%) had open bites. Increased overjet and overbite were in 26% and 19% of the participants, respectively.

In the adjusted Poisson regression, moderate to severe crowding in the mandible (OR=2.55, 95% Cl (1.13,5.74), *p=0.02*) and facial profiles (convex and concave) (OR=1.58, 95% Cl (1.01,2.47), *p=0.04*) were significantly related with the decision for orthodontic tooth extraction.

Conclusion: A considerable proportion (40%) of the participants were recommended to undergo tooth extraction during orthodontic treatment. The decision towards tooth extraction during orthodontic treatment, was related to the extent of crowding of the teeth in the mandible, and having a concave or a convex facial profile.

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ABBREVIATIONS

MUHAS	Muhimbili University of Health and Allied sciences
OPCD	Orthodontics Paedodontics and Community Dentistry
SPSS	Statistical Package for Social Sciences

DEFINITION OF KEY TERMS

Facial profile: the outline of the face as seen from the side (1).

Crowding: Dental crowding, or swarming, can be inconsistent between tooth size and arch dimension (2).

Dental Study Model: Study models are essential diagnostic aids when planning cosmetic dentistry, oral surgery, and orthodontics. The information given by a study model includes accurate replication of the teeth and the surrounding soft tissues (3).

Malocclusion: Dental malocclusion is the incorrect alignment of the upper and lower teeth, which can lead to other dental problems (4).

Competent lip: Refers to patients' lips that are in light contact at the clinical rest position (5).

Incompetent lip: Refers to patients' lips that cannot be contacted under unstrained conditions (6).

Open bite: A condition where there is a lack of contact between upper and lower teeth (7).

Overjet: Is a horizontal overlap between maxillary and mandibular teeth (8).

Overbite: Is a vertical overlap between maxillary and mandibular teeth (9).

Orthodontic tooth extraction: Is defined as the removal of one or more permanent teeth excluding the third molars in the course of corrective orthodontics (10).

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The decision to extract or not during orthodontic treatment has been among clinicians' most debated subject, with no common conclusion (11), because an orthodontist can opt for tooth extraction over non-extraction or vice versa to achieve the desired treatment outcome. The orthodontic extraction approach involves extracting one or more teeth to create a space to relieve teeth crowding and camouflage jaw irregularities. In contrast, a non-extraction approach uses orthodontic appliances to expand the jaw and gain the necessary space to correct malocclusion (12).

In the early 1900s, Edward Angle was convinced that the whole dental arch could be aligned by orthodontic force in association with growth, which made him practice more non-extraction orthodontic therapy. On the other hand, history records Tweed favouring orthodontic extraction, with a conclusion that carefully and consistently planned extractions allowed him to improve the patient's appearance and treatment stability (13). It is evident that history reveals an extended interplay between extraction and non-extraction; Profit conducted a forty-year study to assess the frequency of orthodontic extraction cases and found that the total extraction percentage was 30% in 1953, peaked at 76% in 1968 and went down again to 28% in 1993; in addition, the extraction of the four-bicuspids increased from 10% in 1953 to 50% in 1963, and between 35% to 45% until the early 1980s, then went back to the 10% level by 1993 (14).

To decide on the matter, the clinician looks for several features. These features include parameters of study models and cephalometric analysis together with the age of the patient (15). Specifically, characteristics such as crowding or spacing, overbite, overjet, temporomandibular dysfunction, occlusal stability, and facial esthetics, among others, play an important role (14). Justification of whether to extract or not comes after a thorough consideration of the characteristic features of an individual patient (15).

Various research has highlighted on the differences in dentoalveolar and craniofacial features among Arabic, Asian, African, African-Brazillian and African-American-American populations (16). Following Profitt's study of 1994, a similar study which was done at University of North Carolina concluded that there were significantly higher odds of extraction in the African American race (as compared to the Caucasian), as well as the characteristic features of crowding, overbite and overjet (17). Due to notable differences on dentoalveolar and craniofacial characteristics between African-Brazillian and caucasian, it led to a conclusion that Caucasian norms should not be used to African-Brazilian ones (16). Since it is evident that the differences in dentoalveolar and craniofacial characteristics exist among races and ethnicity, its prudent to do orthodontic treatment according to individual clinical characteristic.

Prior to this study, there was no retreavable data from Tanzania that have shown unique clinical characteristics of patients who required tooth extraction during orthodontic treatment. Knowing the patient-related characteristics might help clinicians to make informed orthodontic treatment decisions. Therefore, the current study aimed to provide this valuable information, by assessing the clinical characteristics of orthodontic patients attending the MUHAS Dental Clinic, and how they relate to a decision to perform tooth extraction during orthodontic treatment.

1.2 Problem Statement

Orthodontic treatment options can be influenced by the patient's craniofacial and dentoalveolar features and the presenting malocclusion (18). For example, one study showed that people with a convex profile with acute nasolabial angle, would benefit from orthodontic treatment involving tooth extraction; in order to provide a room for retraction of anterior teeth, thereby improving the facial profile (9). A former study has documented about the role of variations in craniofacial and dentoalveolar features among races and ethnic groups (16), which called for assessment of clinical characteristics of the Tanzanian patients which can affect orthodontic treatment options.

Currently, there is no retrievable data in Tanzania, that have assessed the patients' clinical characteristics and their relation to tooth extraction option during orthodontic treatment. Therefore, there was a need to assess the unique clinical features of orthodontic patients and how they can influence tooth extraction choice during orthodontic treatment.

1.3 Conceptual Framework

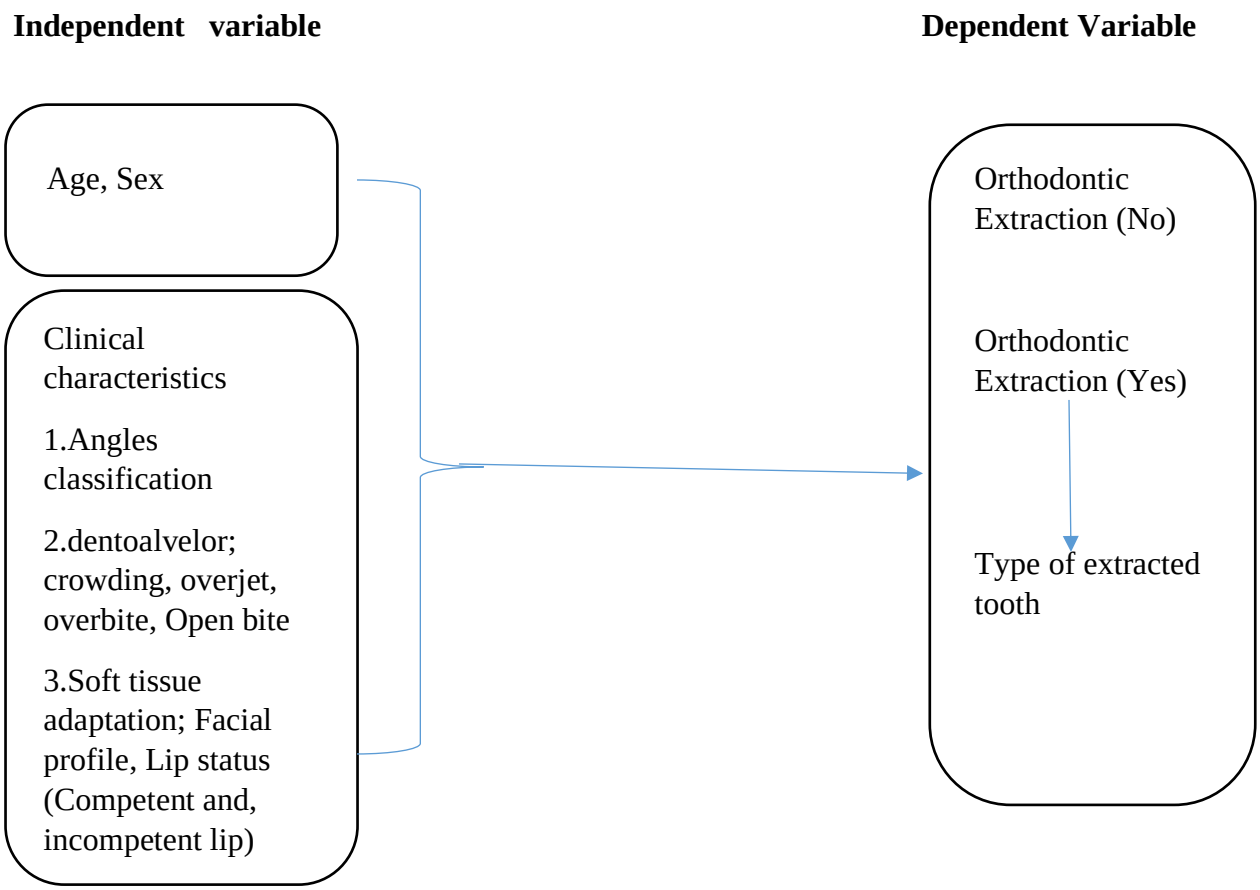


Figure 1: Conceptual Framework

Source: Yonazi, (2023).

The conceptual framework illustrates the relationship between the patient's clinical characteristics and the orthodontic tooth extraction. Clinical characteristics such as underlying skeletal morphology, crowding, overjet, overbite, open bite, soft tissue adoption and facial profile, can influence an orthodontist's decision towards tooth extraction during orthodontic treatment, and the type of tooth to be extracted. Furthermore, information on the patient's age and sex plays a vital role, as it can modify the decision towards orthodontic teeth extraction.

1.4 Rationale of the Study

Orthodontic treatment involving tooth extraction is irreversible once executed. Hence, understanding the clinical characteristics that make extraction as an option over non-extraction among patients seeking orthodontic care is essential. Undertaking this study, provided information about the clinical characteristics of orthodontic clients attending the MUHAS Dental clinic, and how they relate to tooth extraction or non-extraction decisions during orthodontic treatment. Furthermore, this study showed the frequency of orthodontic tooth extraction, non-extraction, and the type of extracted teeth, respectively. In addition, this study is for partial fulfilment of the requirement of a Master of Dentistry degree in Orthodontics. Lastly, information obtained from this study, can be used as a reference for further studies.

1.5 Research Questions

Overall question: What are the patients' clinical characteristics leading to Orthodontic tooth extraction decision among patients seeking orthodontic care at the MUHAS Dental Clinic?

Specific questions:

1. What are the clinical characteristics of orthodontic patients attending MUHAS dental clinic?
2. What is the prevalence of orthodontic tooth extraction recommendation at the MUHAS dental clinic?
3. What is the prevalence of the type of teeth to be extracted from orthodontic patients attending the MUHAS dental clinic?
4. What is the association between clinical characteristics and orthodontic tooth extraction recommendation?

1.6 Objectives

1.6.1 Broad objective

To assess the patients' clinical characteristics associated with the decision to extract teeth among orthodontic patients attending the MUHAS dental clinic in Tanzania.

1.6.2 Specific objectives

1. To determine the clinical characteristics of orthodontic patients attending the MUHAS dental clinic?
2. To determine the prevalence of orthodontic tooth extraction recommendation at the MUHAS dental clinic?
3. To determine the prevalence of the type of teeth to be extracted from orthodontic patients attending the MUHAS dental clinic?
4. To assess the association between clinical characteristics and orthodontic tooth extraction recommendations?

CHAPTER TWO

2.0 LITERATURE REVIEW

Clinical characteristics of orthodontic patients

A spectrum of dental alveolar characteristics seen in patients with malocclusion include teeth crowding, open bite, increased overbite, cross bites and increased or reduced overjet, among others. Edward Angle created a classification that categorized malocclusion into three classes (19). In Class I malocclusion, there is a normal relationship between the upper and lower first molars with a compromised line of occlusion due to maligned teeth or crowding. Class II malocclusion, the lower first molar is distally positioned relative to the upper first molar. Class III malocclusion has a posterior occlusion of the mesiobuccal cusp of the maxillary first molar to the groove of the mandibular first molar. The line of occlusion in both Class II and III may or may not be compromised. Class II and III malocclusion can be either dental, skeletal, or both (20).

In a systematic and meta-analysis study on the prevalence of malocclusion in Africa, the distribution of malocclusion concerning Angle's Classification was Class I in 76.7% [50– 96%] of the populations, Class II in 9.7% [1.6–25.4%] and Class III in 4.0% [1–12%]. At the same time, deep overbite, open bite and crossbite were in 10.9%, 6.5%, and 9.8% of the populations, respectively (21). In a study which assessed the prevalence of classes of malocclusion among dental students at MOI University in Kenya, the study reported Class I malocclusion to be the most prevalent at 70%, followed by Class II division I at 7.5% and Class III and Class II division II at 2% and 5%, respectively, with normal occlusion standing at 12.5% of the participants (22). In a study which was done among schoolchildren in Tanzania, Class I malocclusion was recorded as the majority at 93.6%, followed by Class II and III at 4.4% and 2.0 %, respectively, with spacing of at least 2 mm recorded at (21.9%), and an open bite at (16.1 %) (23). Another earlier study from Tanzania, aiming at assessing the demand for orthodontic treatment among 9–18-year-olds seeking dental care in Dar-es-Salaam, reported Class I to be the commonest trait among children, occurring in 90% of the cases. Meanwhile, 41.2% had crowding and 28.4% had spacing in the incisor segments (24).

In Moshi, Tanzania, a study which examined the prevalence of malocclusion among 12-15-year-olds reported that Angle's Class II and III malocclusion occurred in 6.9% and 11% of the sample. Both jaws frequently encountered crowding, especially in the lower anterior segments. The anterior open bite occurred in 6.2% and a deep bite in 10.7% of the sample (25).

Regarding facial profiles, and soft tissue adaptation, these are crucial clinical characteristics. A cross-sectional study that assessed the epidemiology of facial profile, occlusal features and orthodontic treatment needs among adolescents, found the straight, convex, and concave facial profile measurements to be in 81.9%, 12.1% and 6.15% of sampled students, respectively (26).

In a study which was done in Saudi Arabia, it was reported that the most common facial profiles determined in the anteroposterior planes of their participants, were the straight facial profile (49.2%), convex (42.6%) and concave (8.2%) (27). A study from Pakistan was conducted in order to look at the ratio of extraction versus non-extraction decisions based on the profiles, the distribution of the facial profiles was 57% convex, 41.5% straight and 1.5% with concave profiles (28). Furthermore, a study in Nigeria which aimed at assessing the facial profile and occlusal characteristics in primary dentition of children, reported that straight profile was the commonest at 65.6%, followed by convex at 31.7% and concave at 2.7% (29). In Tanzania, a study was conducted to assess preferred facial profiles among Tanzanians, where it was reported that the female’s straight profile and the male’s Class I profile were the most preferred facial profiles (30).

Patients' lip posture plays a significant role in orthodontic treatment planning; there are two postural positions that the dentist can assess: relaxed lip and closed lip position. The relaxed position is when the lips are apart, relaxed, and hanging loosely, with no effort made at lip contraction. In contrast, closed lip position, there is minimal contraction in the effort to effect anterior closure. Patients' lip postures can be significantly affected by malocclusion (31). A study investigating the prevalence of lip competency in Nepal found that 89.6% of the participants had competent lips, and 10.4% had incompetent lips; out of these, more females than males had competent lips (32). A study was conducted among Syrian children, in the study it was found that the percentage of those presenting with competent lips comprised 72.6% (33).

On the other hand, in Tanzania, a study involving schoolchildren reported that 45% of the children had incompetent lips (34).

A number of studies in Tanzania have highlighted on the clinical characteristics among school children; however, limited studies have documented a variety of clinical characteristics among orthodontic patients, assessed together.

Prevalence of tooth extraction in orthodontic treatment

In orthodontic treatment, extraction or non-extraction approach is among the procedures selected as part of the treatment plan. A study which was done in Brazil found that the frequency of orthodontic treatment with extractions stands at 45.8% and without extraction was at 54.2% (35). Another study in North Carolina and India found an extraction prevalence of 25% and 59.80% respectively (17,36). In addition, a study which was done in Pakistan reported that 41.5% of their participants were treated with extraction protocol, while 58.5% were none extraction (28). In another study which investigated extraction trends for a period of 5-10 years, 73.8% of the dentists reported a decreased extraction cases in pursuing orthodontic treatment. Major reasons that influenced their decision were the considerations of the facial and smile aesthetics (reported by 97.5%), increased use of inter-proximal reduction (95%), and periodontal implications (86%) (37). Furthermore, another study from Italy reported extraction decision to reach 20% of evaluated cases. Reasons that influenced orthodontists' decisions were soft issue profile and amount of crowding (38). Additionally, a study from Nigeria reported a 53% extraction prevalence in orthodontics cases (10). However, in a study which was done in Tanzania, the percentage of tooth extraction due to orthodontics was 13% (39).

No studies in Tanzania have quantified the frequency of tooth extraction during orthodontic treatment, hence this study have provided data about the frequency of tooth extraction during orthodontic treatment in Tanzania

The prevalence of the type of extracted teeth from orthodontic patients

The first four premolars

In most of the extractions in the orthodontic treatment, the first four premolars are the most extracted teeth in the orthodontic treatment (36). A study which was done in India supports this fact where it was found that about 34.4% of participants had premolar extraction, of which the majority of the extraction included the four first premolars (40). Inconsistent with this, a study which was done in Brazil also found the four first premolars to be the mainly extracted teeth during orthodontic treatment (35). This was in line with what was found in a study that was done in Nigeria, which found 73% of all extracted teeth were the first four premolars (10).

Second premolars

The second premolars are other teeth mostly extracted in the orthodontic treatment. A study by Mahtani and Jain, reported 1.95% of cases whose second premolars were extracted, from 2003 to 2007 and increased to 2.9% in 2019-2020 (40). The degree of discrepancy, mild crowding, incisor position and facial profiles are some factors that made the orthodontist to extract the second premolars (40).

Malformed, severely rotated supernumeraries and periodontal compromised teeth

Other factors that lead to teeth extraction are malformed, severely rotated and compromised teeth, that cannot be aligned through orthodontic treatment. The primary reason for removing the malformed, rotated and compromised teeth is to allow other teeth to align during the orthodontic treatment (41). Due to the current technological advancements, orthodontists tend to use 3D- -modelling scans to help in determining the teeth that cannot be straightened with orthodontic therapy, without first undergoing extractions, for example, a tooth that is too large to fit in the mouth, a tooth that grows in the wrong direction, a tooth which is sore or painful, a discoloured tooth and a tooth that appears to be chipped, cracked or otherwise damaged (42).

Moreover, in a study by Al-Ani et al. (44), an emphasis is made that periodontal involvement, malformed crowns, length and health of the root of the teeth, prognosis of impacted teeth and supernumeraries, can enforce the decision for extractions. Mandibular incisors are not commonly extracted during orthodontic treatment. However, Zhylich et al. (45) highlighted that

their extractions are done in case of periodontal compromise, ectopic and supernumerary mandibular incisors.

There is no retrievable information from Tanzania that have shown the type of teeth that are often recommended for extraction during orthodontic treatment. Thus, this study has provided insight into which types of teeth are often opted for extraction during orthodontic treatment in a Tanzanian context.

The association between clinical characteristics and orthodontic tooth extraction

Soft tissue adaptation

Soft tissue aesthetics and harmony are among the major goals that orthodontic treatment aims to achieve. Patients seeking orthodontic care, expect the treatment's outcome to improve their dental and facial esthetics (46). During diagnosis, orthodontists should look for both unpleasant and pleasant facial features; unpleasant features should be corrected during orthodontic treatment, while preserving pleasant ones (47). Studies have shown orthodontic extraction may lead to a reduction in upper and lower lip prominence, a decrease in the interlabial gaps and an increase in the nasolabial angle (48). For example, in a study which was done by Hassan, which looked at dental and skeletal characteristics of participants with incompetent lips, orthodontic extraction was used to correct lip incompetence by allowing the retraction of incisors (49). Hence, it is suggestive that a patient's soft tissue adaptation and facial profile can influence extraction or none extraction therapy during orthodontic management (13); in a study that investigated how profile-based treatment planning could affect both extraction and none extraction in orthodontic, it was concluded that out of 41.5% of extraction cases, 67% of extraction decision were made based on patient facial profile (28).

Dental Crowding

According to Lestrel et al., dental crowding is a discrepancy between teeth and the jaw that causes malalignment (50). Crowding can be categorized into mild, moderate and severe; each category may call for a specific treatment approach. Severe crowding requires the extraction of one or more teeth. In contrast, moderate crowding might need proximal stripping of teeth (51, 52). A study conducted to investigate the morphological characteristics influencing tooth

extraction during treatment reported that the degree of crowding in the mandible was among the factors determining tooth extraction among participants (53). Another study assessed the reasons contributing to extractions in Class I malocclusion, and concluded that crowding in the upper and lower jaws was among the factors influencing the extraction decision (15).

Overjet and overbite

Several studies have shown how overjet and overbite are associated with extraction decisions during orthodontic treatment. Guo et al. reported that overjet and overbite discrepancies are the factors influencing extraction, where, increased overjet could result in extraction of upper premolars in situations where orthognathic surgery is unlikely to be undertaken, and overbite as a contributing factor in cases of Class II division I (53). Another study by Jackson et al., found extraction to increase as crowding and overjet increased, but also as overbite decreased (17). Rabie et al. and McIntyre highlighted about using tooth extraction in treating Class III borderline cases to correct malocclusion, including overjet correction (54,55).

Angle's classification

Angle's classification in classifying occlusion is widely used and well-accepted (55). Dardengo et al. investigated the frequency of tooth extraction in orthodontics as related to Angle's classification. They found that patients with Class I malocclusion had less extraction than those with Class II malocclusion (35). In contrast, a study which was done in India to assess extraction frequency in relation to age and Angle's classification, it was reported that among classes of Angle's classification, Class I had a high extraction frequency of 89% (36). Another study which was conducted in Nepal, reported that after analyzing the frequency of extraction and Angle classification, there was no significant differences, and extraction was high in Class II division I while low in Class I malocclusion (56).

There is no retrievable information from Tanzania on studies that have shown a correlation between the clinical characteristics of orthodontic patients and how they are associated with tooth extraction during orthodontic treatment, therefore, this study revealed the information.

Socio Demographic characteristics

The age and gender of the patients are among the vital information that an orthodontist asks from the patient; studies have associated the age and gender, among others, with the acquisition of orthodontic services and the treatment approach that can be opted. A retrospective study which was conducted in Nigeria to assess the prevalence of orthodontic tooth extraction reported a high percentage of extractions in female participants compared to males. Also, it reported that there was no statistically significant difference between the prevalence of tooth extraction and either of the gender (10). Similarly, in a study to assess extraction frequency at a college in India, females were the majority, and after comparing gender, females recorded a high frequency of tooth extraction (36). In a study which was conducted in Tanzania, which looked at the socio-demographic characteristics of orthodontic clients, it was reported that most of the clients were females with an average age of 14 years (57). Prior to this study, exhaustive information on socio-demographic influences was scarce in Tanzania.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was conducted at the Muhimbili University of Health and Allied Science (MUHAS), in the School of Dentistry's Dental Clinic, which is in the middle of the Dar es Salaam region/City in Tanzania.

MUHAS School of Dentistry Clinic is the largest dental facility in the country, and thus provides dental services to patients from various regions of Tanzania, with different socioeconomic backgrounds. Being the only institution of higher education that offers postgraduate training in Orthodontics, the School of Dentistry receives many Orthodontic patients from all the regions of Tanzania.

3.2 Study Design

The study used an analytical cross-sectional hospital-based design, whereby, participants were assessed at one-time point.

3.3 Study Population

All patients presented for consultations or orthodontic treatment at the MUHAS dental clinic at MUHAS School of Dentistry during the study period between March 2024 to May 2024, and who met the inclusion criteria and consented to participate in the study.

3.4 Sample Size Estimation

The sample size for this study was calculated from the following formula: The sample size, n= [(Z^2 ×P (1-P)/d^2)]; where n is the total number of the sample, d is the absolute precision (5%), confidence interval (CI= 95%), Z is a standard normal distribution (Z=1.96). P is the proportion of extraction cases due to orthodontic reasons in Muhimbili National Hospital Dental Clinic (39).

$$n = \frac{Z^2 \times \mathrm{P} \times (1 - \mathrm{P})}{d^2}$$

$n = \frac{1.96^2 \times 0.13 \times (1-0.13)}{0.05^2}$ = 173.79≈ 174 participants.

Therefore, the estimated sample size of study participants required is 174 orthodontic clients. However, it is worth mentioning that the number of participants obtained for this study was 100 due to the low number of participants who fit the inclusion criteria.

3.5 Sample Selection

All participants involved in the study were obtained by consecutive sampling technique from the patients presenting at the MUHAS Dental Clinic, Tanzania. All patients who fit the inclusion criteria were invited to participate in the study and recruited after consenting.

3.6 Inclusion Criteria

Orthodontic patients who have not undergone tooth extraction, with their records (Demographic details, casts, orthopantomogram radiograph) from 13-year-old and above (>13) who attended the MUHAS dental clinic for treatment between March 2024 to May 2024 were used. The candidate was recruited to participate in the study after a thorough verbal explanation of the aim of the study and after signing informed consent. The starting age of 13 years was chosen because, by the age of 13 years, participants are expected to have all the primary teeth shed off and have already passed the mixed dentition stage, as this study focused on clients with permanent dentition. An example is a study by Vaidya, which recruited participants starting from age 13 years (58).

3.7 Exclusion criteria

Patients whose casts and radiographs are distorted or have incomplete records. This is because distorted casts, radiographs, and incomplete records might not reflect the actual condition of the patient's teeth, bones, and history, respectively.

Patients who received previous orthodontic treatment were also excluded. This is because previous orthodontic treatment could significantly change the clinical characteristics that were assessed in this study.

Patients with orofacial deformities or syndromes receiving orthodontic treatment as part of a comprehensive rehabilitative treatment plan were excluded, since they might require specialized treatments that are not typical of the standard population being studied, leading to variability that could complicate analyses.

3.8 Study Variables

Independent variables

1. Patient age and sex

   Age: > 13 years' old

   Sex: 1= Male, 2= Female.

2. Crowding

   1-Mild crowding, 2- Moderate crowding, 3- Severe crowding, 4-Excess space

3. Angle's classification

   1-Angle's Class I 2-Angle's Class II 3-Angle's Class III

4. Lip status.

   1. Competent lip 2. Incompetent lip

5. Overjet

   1. Normal 2. Increased overjet 3. Negative overjet 4. Decreased overjet

6. Profile

   1. Straight 2. Convex 3. Concave

7. Overbite

   1. Normal overbite 2. Increased overbite 3. Decreased overbite 4. No overbite (open bite)

Dependent variables

1. Tooth extraction in orthodontic treatment

   1: Yes

   2: No

2. Type of extracted teeth due to orthodontic care

   1. First premolars 2. Second premolars 3. Canine 4. Incisors

3.9 Data Collection Methods

I. Questionnaires were administered to get information on demographics, orthodontic extraction, and the type of tooth to be extracted.

Demographic information was collected using structured questionnaires, which were responded to by the patients involved in the study.

Information on the orthodontic treatment approach (extraction or not), the number of teeth to be extracted from a patient, and the type of tooth to be extracted for orthodontic purposes were collected through a structured questionnaire which was responded to by three orthodontists who are working at MUHAS dental clinic.

II. Carey and arch perimeter methods to determine dental crowding

Arch length discrepancy measurements were collected from study model using a Brass wire and digital Vernier caliper, where the brass wire was used to measure arch length mesial to second molars. In contrast, a digital Vernier was used to measure the teeth' mesial-distal width, and a data sheet was provided to record the mesial-distal tooth widths of all teeth anterior to the first molar on both jaws. Arch length discrepancy was calculated by determining the available space and required space. Dental crowding was categorized as: mild (1–3 mm), moderate (4–6 mm) and severe (>7 mm).

III. Radiography

Orthopantomogram x-rays was taken by a radiology technician, a Pax –i3D smart imaging system OPG machine with PHT. 30LFO.Model, 74kvp, 12.0Ma and 13.6 seconds exposure time was used; the principal investigator attached the x ray images and presented to orthodontists together with other records.

IV. Clinical examination

The principal investigator conducted a clinical examination. Study participants were requested to sit upright on a dental chair with an LED light on for an intraoral examination. The molar relationship was examined by direct observation and from the study model, then classified according to Angle's classification. In addition, the open bite was assessed by direct observation and recorded accordingly. Information on soft tissue adaptation (lips status) was collected

through direct observation and using extra-oral photographs; participants were instructed to stay in a relaxed lips position to establish the presence or absence of lip seal, and competent lip was recorded to a participant whose upper and lower lip contact, at the same time, they are in a relaxed lips position while incompetence lips were recorded to a participant whose upper and lower lip cannot contact while they are in a relaxed lips position. Overjet was measured as the horizontal distance between the upper and lower incisors at the point of greatest severity and was categorized as: normal (1–2 mm), increased (>2 mm), decreased (<1 mm), Negative overjet (<0 mm). Overbite measured as the vertical overlap between the maxillary and mandibular incisors and categorized as: normal (1–2 mm), increased (>2 mm) and Decreased (<1 mm).

Participant's profile was taken by requesting the participant to sit in the chair and look straight into the mirror, which was 1 meter away, to attain a natural head position; then, a lateral view photograph was taken by the principal investigator. The profile was recorded according to the divergence of the line joining the forehead and the chin. A Nikon D5600 camera was used to take intraoral and extraoral photographs, and Quick cephalometric software was used during the analysis of the lateral view photograph, in addition, the profile was categorized according to the Arnett facial profile classification (59).

V. Orthodontists decision on orthodontic tooth extraction

Three orthodontists were supplied with soft copy records containing information obtained from clinical examination and study model analysis; furthermore, photographs, radiological images from orthopantomogram were also provided. Orthodontists used the information to respond to the structured questionnaire with specific questions on extraction decisions, the number of teeth to be extracted, and the type of extracted teeth.

3.10 Validity and Reliability

Validity

The clinical examination, clinical photographs and study model measurements were done by an experienced dentist (principal investigator). The principal investigator was trained by an experienced orthodontics in study model measurement. Moreover, the use of Angle's classification on assessing molar relationships and facial profile examination as documented by Arnett (59), is well documented in the literature, proving their validity in this study.

Reliability

Examination of the participants, measurement of study models and photograph taking was done by the same examiner, who is the principal investigator. Photograph analysis was done by an experienced dental specialist using quick cephalometric software. Furthermore, 10 study models were taken randomly from the study models that were already examined; second measurements were done, then compared with their previous measurements to assess intra-examiner reliability and an Intra-class Correlation Coefficient (ICC), found to be 0.85. Furthermore, interrater test was done among three orthodontists to assess consistency in extraction decision and the following Cohen's Kappa values were found. Orthodontist 1 versus 2 (Cohen's Kappa= 0.78), orthodontist 1 versus 3 (Cohen's Kappa= 0.58) and orthodontist 2 versus 3 (Cohen's Kappa=0.78).

3.11 Data Management and Analysis

Data for this study were analyzed using Statistical Packages for Social Science (SPSS) Version 27.0 for descriptive, bivariate and multivariate analyses. Data transformation to facilitate analysis and interpretation was done; i) Lip status was coded 1 = Competent and 2 = Incompetent. ii) Sex was coded 1 = Male and 2 = Female. iii) The orthodontic extraction decision was coded 1 = Yes and 0 = No. iv) The type of extracted teeth was coded 1=First Premolars 2=Second Premolars 3=Canines 4= Molars 5=Incisors 6=More than one type. **v)** Open bite was coded as 1= Yes 0= No. vi) Age was coded 0= 13-22years, 1=23-32years, 2= 33 years and above. The following categories of clinical characteristics were merged to facilitate data analysis; Angle classification [Class 1] was coded 1 = Class 1 and 2 = Other classes (class

II and III). Profile [straight] was coded 2 = Straight and 1= Others (convex and concave.). Overjet was coded 2 = Increased overjet 1=Others (Normal overjet, negative overjet and no overjet (Decreased overjet)) and overbite ware coded 2= Increased overbite 1= Others (Normal overbite, decreased overbite and no overbite (open bite)). Maxillary arch length discrepancy was coded 1=mild crowding, 2=moderate to severe crowding 4=excess space (No crowding). Mandibular arch length discrepancy was coded 1=mild crowding 2=moderate to severe crowding 4=excess space (No crowding).

Descriptive statistics were used to present the frequency distribution of the participants by extraction and the type of extracted teeth. Bivariate associations were done by using a Chi-square test. Those associations that were significant were entered into a multivariate analysis model. Below is the table showing each research question and the respective statistical analysis plan.

Research Question	Analysis plan
1. What are the clinical characteristics of orthodontic patients attending MUHAS Dental Clinic?	Frequency and percentage
2. What is the prevalence of recommended orthodontic extractions at the MUHAS dental clinic?	Frequency and Percentage
3. What is the prevalence of the type of teeth to be extracted from orthodontic patients attending MUHAS dental clinic?	Frequency and Percentage
4. What is the association between clinical characteristics and recommended orthodontic tooth extractions?	To associate clinical characteristics and tooth extraction or not, modified Poisson regression was used

3.12 Ethical Issues

The study was conducted with adherence to ethical standards outlined in the 1964 Declaration of Helsinki and its later amendments. In line with this, the Senate Research, Publications and Innovations of the Muhimbili University of Health and Allied Science was sought for ethical clearance to carry out the study.

The permission to conduct the study in the MUHAS Dental clinic was obtained from the School of Dentistry. A detailed verbal explanation of the nature and the study purpose was provided to both research participants and parents. Confidentiality was guaranteed to all parents and participants. Prospective participants were assured their right to refuse to participate at any stage of the study without any penalty.

A consent form was provided to be signed by participants and parents whose children agree to participate in the study. In addition, an assent form for children was provided.

3.13 Dissemination Plan

The findings of the study will be submitted, in a dissertation report and manuscript, to the Director of Postgraduate Studies, MUHAS, Director of Research and Publications, Dean of the School of Dentistry MUHAS, Head of Department, OPCD, MUHAS, as partial fulfilment of Masters of Dentistry in Orthodontics. A manuscript will also be submitted to a journal for publication.

CHAPTER FOUR

4.0 RESULTS

4.1 Sociodemographic characteristics

In figure 2, it was shown that the study involoved 100 participants, of which 54% were females. Half of the participants (50%) were between the ages of 13 and 22 years, as shown in Figure 3.

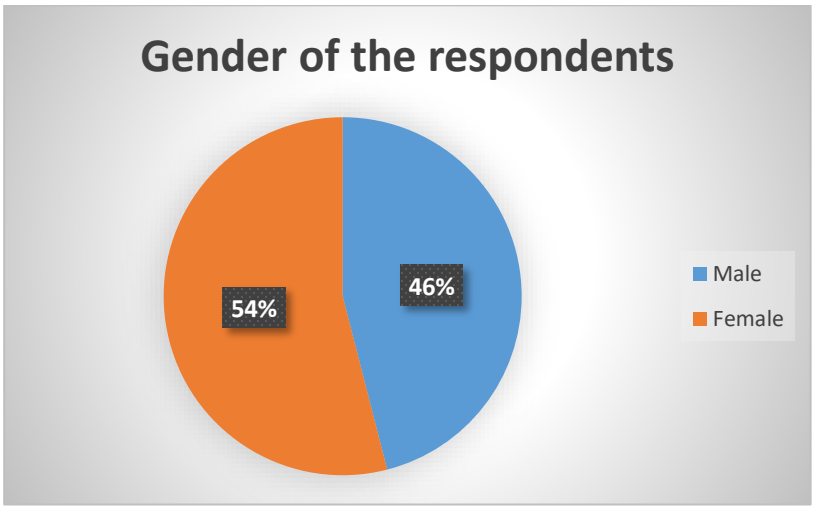


Figure 2: Frequency distribution of gender among study participants.

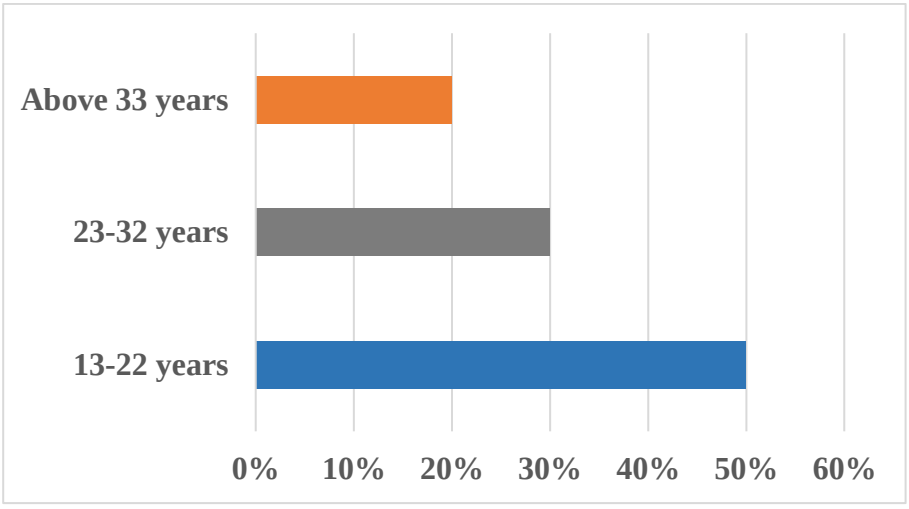


Figure 3: Frequency distribution of the age of participants.

4.2 Participant's Clinical Characteristics (Angle's Classification and facial profiles)

In Table 1, it was shown that majority of the participants, 83.8%, presented with Angle's Class I malocclusion. Moreover, 64 % of them had straight facial profiles (Figure 4).

Table 1: Frequency distribution of Angle's classification among the study participants.

Class	Frequency	Percent
Class I	83	83.0
Others (Class II, III)	17	17.0
Total	**100**	**100.0**

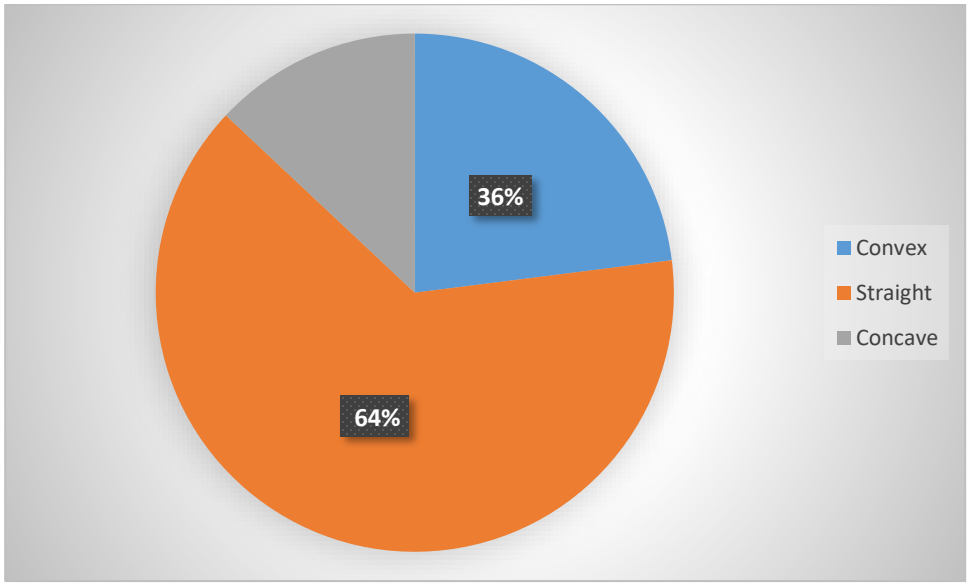


Figure 4: Frequency distribution of participants' facial profiles.

4.3 Participant's clinical characteristics (overjet, overbite, lips status maxillary, and mandibular arch length discrepancy)

In Table 2, the participants who presented with increased overjet and overbite were 26% and 19%, respectively. A vast majority of the participants had competent lips (94%). Regarding crowding of teeth, in the maxilla it was mild in 44%, and it was moderate to severe in 20% of the participants. While in the mandible, 52% had mild crowding, and 17% had moderate to severe crowding. In addition, 36% of the participants had excess space in the maxilla, and 31% in the mandible.

Table 2: Frequency distribution of clinical characteristics (overjet, overbite, maxillary, and mandibular arch length discrepancy) of the participants.

Description	Frequency	Percent
Overjet		
Increased Overjet	26	26.0
Others	74	74.0
Total	100	100.0
Overbite		
Increased overbite	19	19.0
Others	81	81.0
Total	100	100.0
Lip status		
Competent	94	94.0
Incompetent	6	6.0
Total	100	100.0
Maxillary arch length discrepancy		
Mild Crowding	44	44.0
Moderate to severe Crowding	20	20.0
Excess Space	36	36.0
Total	100	100.0
Mandibular arch length discrepancy		
Mild Crowding	52	52.0
Moderate to severe Crowding	17	17.0
Excess Space	31	31.0
Total	100	100.0

4.4 Prevalence of recommended orthodontic tooth extraction and Type of teeth to be extracted

As shown in Figure 5, tooth extraction was recommended in 40% of the participants. Teeth which were mostly recommended for extraction were the first premolars (in 28% of the patients), incisors and canines were the least recommended teeth, both were recommended in 1% only (Figure 6).

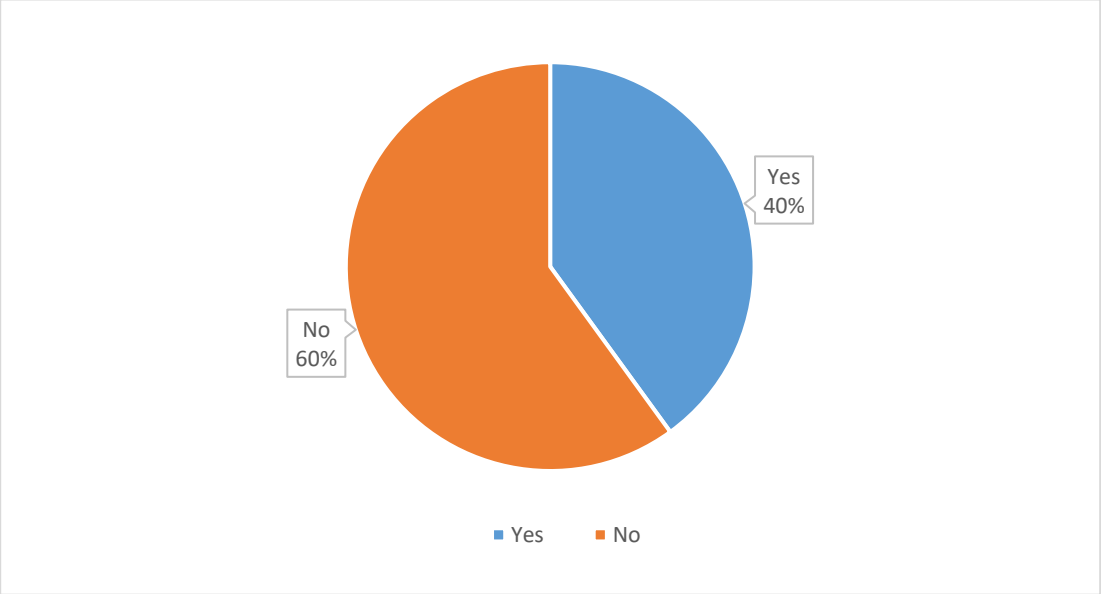


Figure 5: Frequency distribution of orthodontic tooth extraction or non- extraction decision.

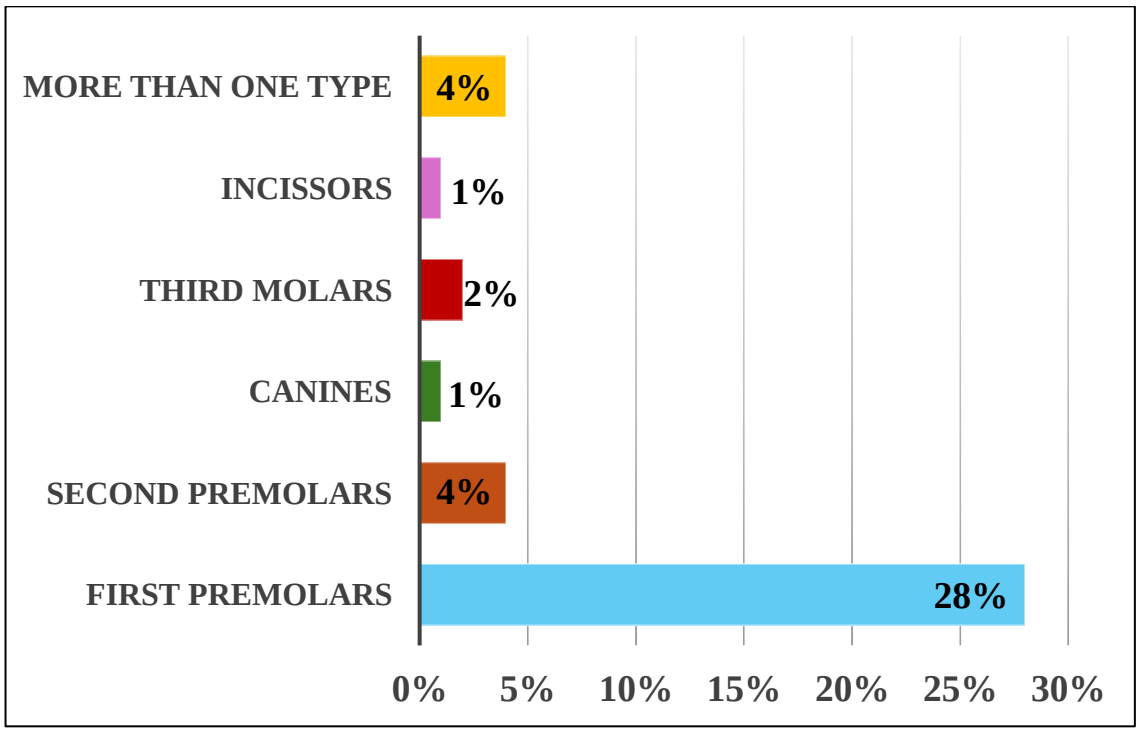


Figure 6: Frequency distribution of recommended tooth extraction by the tooth type.

4.5 Association of Clinical Characteristics and Orthodontic Tooth Extraction

In Table 3, the maxillary and mandibular arch length discrepancies were significantly related to tooth extraction decision during orthodontic treatment (*p=0.024*, and *p=0.002*, respectively). In the maxilla 65%, and in the mandible 76.5% of those with moderate to severe crowding were recommended for orthodontic tooth extraction. Additionally, 52% of the participants aged 13-22 years, and only 20% of the participants aged 33 years and above were recommended for orthodontic tooth extraction *(p=0.032).* All other remaining clinical parameters showed no statistically significant differences *(p>0.05)*.

Table 3: Frequency distribution of clinical characteristics and sociodemographic characteristics and their categories, according to orthodontic tooth extraction decision.

Description	Categories	**Orthodontic Extraction Decision n (%)**		**Total (n)**	***p-value***
		Yes	**No**		
Maxillary arch length discrepancy	*Mild Crowding*	17(38.6)	27(61.4)	44	*0.024*
	Moderate to Severe Crowding	13(65.0)	7 (35.0)	20	
	Excess Space	10 (27.8)	26(72.2)	36	
Mandibular arch length discrepancy	*Mild Crowding*	19(36.5)	33 (63.5)	52	*0.002*
	Moderate to Severe Crowding	13(76.5)	4(23.5)	17	
	Excess Space	8 (25.8)	23(74.2)	31	
Overjet	*Increased Overjet*	12 (46.2)	14(53.8)	26	*0.457*
	Others (Normal, decreased, negative overjet)	28(37.8)	46(62.2)	74	
Overbite	*Increased Overbite*	9 (47.4)	10(52.6)	19	*0.466*
	Others (Normal, Decreased Overbite, open bite)	50(61.7)	31(38.3)	81	
Age Group	*13-22 years*	26(52.0)	24(48.0)	50	*0.032*
	23- 32 years	10(33.3)	20(66.7)	30	
	33+ years	4 (20.0)	16(80.0)	20	
Lip Status	*Competence*	36(38.3)	58(61.7)	94	*0.169*
	Incompetence	4 (66.7)	2 (33.3)	6	
Angle Classification	*Class I*	31(37.3)	52(62.7)	83	*0.232*
	Others (class II, III)	9(52.9)	8(47.1)	17	
Profile	*Straight*	22(34.4)	42(65.6)	64	*0.126*
	Others (convex, concave)	18(50.0)	18(50.0)	36	
Sex	*Male*	16(34.8)	30(65.2)	46	*0.326*
	Female	24(44.4)	30(55.6)	54	

p<0.05 statistically significant

In Table 4, the unadjusted Poison regression model showed that participants who had moderate to severe crowding in the maxilla and mandible, had higher likelihood of being recommended for orthodontic tooth extraction, compared with the participants who had excess space in the maxillary and mandibular arch ((OR= 2.34, 95%Cl (1.26, 4. 33), *p=0.007*) and (OR=2.96, 95%Cl (1.54, 5.69), *p=0.001*), respectively). Furthermore, participants aged between 13 and 22 years were more likely to be recommended for orthodontic tooth extraction, compared with those who were 33 years and above (OR=2.60, 95%Cl (1.04,6.49), *p=0.04*). However, there were no statistically significant differences in the association between orthodontic tooth extraction recommendation and the lip status as well as facial profiles. In contrast, the results from the adjusted modified Poisson regression model showed that the odds of being recommended for tooth extraction during orthodontic treatment were higher for individuals with moderate to severe crowding in the mandible (OR=2.55, 95%Cl (1.13,5.74), *p=0.02*) and those with convex or concave facial profiles (OR=1.58, 95%Cl (1.01,2.47), *p=0.04*). But, there were no statistically significant differences in the association between orthodontic tooth extraction recommendation and all other remaining clinical characteristics (lip status and maxillary arch length discrepancies) as well as socio-demographic characteristics (such as the participants' age).

Table 4: Modified Poisson regression analysis for factors associated with Orthodontic tooth extraction.

Variables	cOR[95%conf. interval]	*p-value*	aOR[95%conf. interval]	*p-value*
Lip status				
competent	0.57(0.31,1.07)	*0.08*	0.76(0.34,1.66)	*0.49*
incompetent	1			
Mx discrepancy				
Mild crowding	1.39(0.73,2.65)	*0.31*	1.11(0.54, 2.30)	*0.78*
Moderate to Severe crowding	2.34(1.26,4.33)	*0.07*	1.41(0.65, 3.04)	*0.39*
Excess space	1			
Md Discrepancy				
Mild crowding	1.42(0.71,2.84)	*0.33*	1.33(0.61, 2.88)	*0.48*
Moderate to Severe crowding	2.96(1.54,5.69)	*0.001**	2.55(1.13, 5.74)	*0.02**
Excess space	1			
Profile				
Others (Concave Convex)	1.45(0.90,2.32)	*0.11*	1.58(1.01, 2.47)	*0.04**
Straight	1			
Age				
13-22	2.60(1.04,6.49)	*0.04**	2.24 (0.92, 5.41)	*0.07*
23-32	1.67(0.61,4.59)	*0.32*	1.49(0.56, 3.93)	*0.42*
33+	1			

*Notes: *p<0.05 = statistically significant*. cOR; crude Odds ratio, aOR; adjusted odd ratio

CHAPTER FIVE

5.0 DISCUSION

This is the first study in Tanzania that have assessed the clinical characteristics associated with tooth extraction during orthodontic treatment. The study was conducted among participants who were 13 years and above, and most of the participants were between 13 and 22 years-old, with majority being females. Thus, the participants presented with different clinical and socio-demographic characteristics, which were used by orthodontists to decide whether or not their teeth should be extracted, during treatment

Sociodemographic characteristics

The current study showed that most of the participants belonged to age group 13-22 years. This finding aligns with that found in a study in Nigeria, where the majority of their participants were below 19 years of age (10). As regards sex, the current study showed that females were the majority of the participants. The high number of females compared to that of males was also reported in other studies (10, 36, 57). The high number of female participants in our study can be attributed to the fact that females are usually more concerned with their facial appearances than their male counterparts. Therefore, they tend to seek orthodontic treatment to correct the arrangement of their teeth, which may enhance appearance and social acceptability (60). In the present study, there was a great number of participants belonging to age group 13-22 years. This finding can be explained by the fact that this age group comprised of many teenagers and young adults, who are often more conscious about their appearances (61). In addition, the presence of malocclusion can negatively affect the self-esteem of an individual (62), so they tend to seek orthodontic care in order to boost up their self-confidence. Furthermore, this number might be related to referrals from other Dentists, who prefer to advise the patients to seek treatment before their active growth period cease. As it is known that orthodontists may wish to take advantage of the growth periods in order to intercept or correct malocclusion (63).

5.1 Clinical characteristics of participants

Proper evaluation of the patients' clinical characteristics, provides valuable information for appropriate orthodontic treatment planning, in terms of performing an extraction or not. This study had a high percentage of participants with Class I malocclusion (83%), with Class II and III, having almost the same percentages. This finding is in line with those from studies which were done in Nigeria (21), Kenya (22) and Tanzania (23). Those former studies also reported a high percentage of Class I malocclusion, compared to Classes II and III. This can further be explained by the fact that others studies done in Tanzania reported the same finding.

The findings of this study reported a high percentage of individuals with a straight facial profile, this finding is in line with that reported in Yemen (26). A large percentage of participants with straight facial profile, can be a reflection of a high number of skeletal Class I malocclusion among them. Furthermore, majority of the current participants had mild to moderate crowding. This might have decreased their likelihood of having severe dental protrusion, which can result in changes of their facial profiles, to be either concave or convex.

In this study, 19% and 11% of participants had increased overjet and open bite, respectively. These proportions are higher compared to those reported in a study by Yemitan et al. (21). The variation might be due to differences in study designs, where, the current study was a cross-sectional hospital-based, while that of Yemitah et al., was a systematic review. Regarding the lip status, 94% of the patients involved in this study had competent ones. This finding is in accordance with those which were reported in studies from Nepal and Syria, which reported greater proportions of individuals with competent lips (32 and 33, respectively). The high percentage of participants with competent lips in this study, can be attributed to a high percentage of people with straight facial profiles together with a Class I skeletal pattern, Angle's Class I malocclusion and mild to moderate crowding (64).

In summary, these findings enabled provision of the picture of the clinical characteristics within the patients' population, thereby, can facilitate the orthodontists in planning properly the patients' management and interventions.

5.2 Prevalence of orthodontic tooth extraction decision among the involved participants

In the present study, many people were recommended for tooth extraction, with a prevalence of 40%. This finding is in line with that which was reported in Pakistan (28). Conversely, it is different from that which was reported in Nigeria (10) and Brazil (35), where higher percentages were reported. The lower prevalence of extraction recommendations, might be due to a high number of participants with class I malocclusion and a possible consideration of the facial and smile aesthetics. Also, it can be due to the fact that majority of the participants had mild to moderate crowding. The availability (in the current study site) of other none extraction treatment approaches such as the use of expanders, proximal stripping, functional and orthopaedics appliances, might have as well contributed to the lower prevalence (37, 38).

Therefore, this finding has provided a valuable information about the prevalence of tooth extraction as part of orthodontic treatment, which may add into the evidence-based decision making, leading to better orthodontic care to patients.

5.3 Orthodontic tooth extraction decision by teeth type

Regarding the type tooth to be extracted, first premolars were chosen in 28% of the participants. This finding corresponds to that reported in a study which was conducted in Nigeria (10), where first premolars were opted for extraction in 28.6% of the participants. Furthermore, in studies which were done in Brazil (35) and Chennai (40), the same choice, of first premolar extraction was reported. The possible reasons for choosing the first premolars might be due to their strategic location within the dental arch, which allows for a more controlled redistribution and utilization of space to relieve crowding. In addition, it may facilitate easy retraction of anterior segment (40, 44).

Thus, the pattern of extraction preferences identified in this study, plays a crucial role in supporting evidence-based approaches in orthodontic practices. It enhances clinical decision-making and promotes more precise management of space and teeth/jaw alignments.

5.4 Association between patients' clinical characteristics and orthodontic tooth extraction decision

In bivariate analysis, the findings of our study revealed that presence of moderate to severe crowding in both jaws, significantly increased the likelihood of tooth extraction to be decided for orthodontic treatment. However, after controlling for all other factors in the adjusted modified Poisson logistic regression model, only moderate to severe crowding in the mandible remained as a significant determinant for tooth extraction to be opted as a preferred orthodontic treatment modality. This result is consistent with those obtained in studies from Athens (15) and China (53). In this study, most of the participants who were recommended for tooth extraction had moderate to severe crowding. Thus, the decision to perform extraction can be due to the fact that, in cases of severe or moderate crowding, extraction of teeth helps to create spaces to align the teeth. Besides, it helps to reduce relapses following orthodontic treatment completion, enhance functions and improve aesthetics (44).

With regards to the facial profiles in the adjusted modified Poisson regression model, the results showed that they significantly increased the likelihood of tooth extraction to be decided for the present participants. This finding aligns well with that from a study in Pakistan, where facial profiles were found to be associated with tooth extraction (28). This finding can be explained by the fact that participants who present with convex or concave profiles, mostly they have had Class II or III malocclusion. Extracting their teeth, can help to provide space for alignment of their teeth, thereby improving their functions, jaw relationship and aesthetics(65, 66).

In this study during bivariate analysis, most of the participants who were 13-22 years, were opted for tooth extraction during orthodontic treatment. Nevertheless, this finding did not remain significant in the adjusted modified Poisson logistic regression analysis. In the contrary, a study from India reported a high frequency of tooth extraction in their adolescent participants (36). The reason for our findings could be, the participants' age might have been a possible

confounding factor, and it was not a stronger predictor for recommending tooth extraction, as compared to stronger ones like mandibular discrepancies and the facial profile.

Hence, the present study revealed that mandibular crowding and facial profile (concave and convex) significantly increase the likelihood of tooth extraction during orthodontic treatment. Moreover, this research has provided an important clinical insight, which may help orthodontists to make an informed treatment decision, when planning treatment for cases of moderate to severe mandibular crowding.

5.5 Conclusion

A considerable proportion (40%) of the participants were recommended to undergo tooth extraction during orthodontic treatment. The decision towards tooth extraction during orthodontic treatment, was related to the extent of dental crowding in the mandible, concave and convex facial profiles.

5.6 Limitations of the study

The investigator did not attain the expected sample size due to a low number of participants who fit the inclusion criteria, which led to cells with few counts for some output in bivariate and wide confidence intervals for some output in the multivariate analysis. The low number of participants can be linked to changes in the National Health Insurance schemes (package) and payment policies, which may have negatively affected the acquisition of services, including orthodontic services, hence the attendees. However, it is worth mentioning that the number of participants in the current study is slightly higher than that of a similar study conducted in Iraq (67). Lastly, the current study is a cross-sectional hospital-based study, which may not establish a causal relationship between the related factors. However, it does shed light on the clinical factors associated with orthodontic tooth extraction choices for Tanzanian patients seeking orthodontic care.

5.7 Recommendation

- Given the variety of clinical characteristics found within the study participants, clinicians should continue to adhere to an individualized treatment plan for orthodontic patients, to address irregularities based on patients' unique features.
- Provided a significant percentage of recommended extractions, future research should study the long-term outcome between orthodontic extraction and non-extraction treatment. Furthermore, more studies are recommended to establish long-term extraction trends and patterns in MUHAS dental clinics.
- Before the extraction decision is made, proper facial profile and study model analysis should be done to accurately assess crowding severity and the patient's facial profile and assess whether extractions would enhance or worsen patients' facial aesthetics.

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APPENDICES

Appendix I: Informed consent form (English version)

CLINICAL CHARACTERISTICS ASSOCIATED WITH THE DECISION TO EXTRACT TEETH AMONG ORTHODONTIC PATIENTS AT MUHAS DENTAL CLINIC, TANZANIA

ID no ⌊_⌊_⌊_ **Age…. (Yrs.)** **Sex: (M=1, F=2)** ⌊_⌊

Consent to participate in a study.

Greetings! My name is Dr. Yonazi Mbonea Reuben, a postgraduate student at Muhimbili University of Health and Allied Sciences. I am doing research on clinical characteristics associated with decision to extract teeth among orthodontic patients at MUHAS dental clinic, Tanzania.

The purpose of the study is to assess the clinical characteristics associated with the decision to extract teeth among orthodontic patients at MUHAS dental clinic in Dar es salaam, Tanzania.

What participation involves

If you agree to participate in the study, the investigator will examine your oral cavity and use your radiographs, photographs and study model to assess the characteristics used in extraction versus non-extraction decision.

Confidentiality

All information collected will be entered into the computer with an identification number. The information taken from the radiographs and study model will be handled with confidentiality throughout the study.

Risks

There is no direct risk associated with this study.

Right to withdraw and alternatives

Taking part in this study is completely voluntary. If you choose not to participate in the study, it will be understood.

Benefits

If you agree to take part in this study, you will benefit from knowing the right treatment options and outcome. In addition, the attending doctor will know the right treatment option for you.

In case of any injury

We do not expect any harm from your participation.

Who to contact

If you have any questions regarding this study, you should contact Dr. Yonazi Mbonea Reuben on +255782372098. In case you have questions about your rights as a participant, you may call**,** Dr. Nahya Masoud, Chairperson MUHAS research and Publications committee, P. O. Box 65001, Telephone: 255 2150302-6 Dar es Salaam or Supervisors of this study Dr. Ferdinand Machibya. (Phone 0764982522) and Dr. Matilda Mtaya (Phone 0754212109).

Signature

I …… have read the content of this form. My questions have been answered. I agree to participate in this study**.**

Signature of participant ……Signature of witness …….

Date of signed consent …/…/ 2024

Participant agrees □Participant does NOT agree on □

Appendix II: Fomu Ya Ridhaa Ya Ushiriki

FOMU YA RIDHAA KUHUSU TATHIMINI YA SABABU ZINAZOPELEKEA UAMUZI WA KUNG'OLEWA JINO MIONGONI MWA WAGONJWA WA UPANGAJI MENO KATIKA KLINIKI YA MENO MUHAS, DAR ES SALAAM TANZANIA.

Namba ya usajili ☐☐☐ **Umri….. (Miaka)** **Jinsia: (me=1, ke=2)** ☐

Ridhaa ya kushiriki kwenye utafiti

Salaam! Naitwa Daktari Yonazi Mbonea Reuben, mwanafunzi wa uzamili katika chuo kikuu cha Tiba za Afya cha Muhimbili. Ninafanya utafiti wakutathimini sababu zinazopelekea kung'oa meno katika tiba ya upangaji meno,katika kliniki ya meno ya MUHAS, Dar es salaam, Tanzania.

Lengo la utafiti

Kutathimini sababu zinazopelekea uamuzi wa kung'oa meno, miongoni mwa wagonjwa wa upangaji meno katika kliniki ya meno ya MUHAS, Dar es salaam, Tanzania.

Ushiriki wako ni wa namna gani?

Ikiwa unakubali kushiriki kwenye utafiti, mtafiti atatumia vipimo vitakavyochukuliwa kutathimini uhitaji wa kung'oa au kutokung'oa meno.

Usiri

Taarifa zote zitakazochukuliwa pamoja na vipimo vitatunzwa kwausiri kipindi chote cha utafiti na hata baada ya utafiti huu.

Madhara

Hatutarajii kwamba utapata madhara yoyote kutokana na utafiti huu.

Faida

Kwa kuhudhuria utafiti huu, itakusaidia kujua aina ya tiba itakayokufaa, pia itamsaidia daktari kufanya maamuzi sahihi katika kukupa huduma.

Haki ya kujitoa

Ushiriki wako ni wa hiari, unaweza kujitoa wakati wowote katika utafiti huu. Ukiamua kutokushiriki hautalaumiwa

Mawasiliano

Ukiwa na maswali kuhusu utafiti huu wasiliana nami Dr. Yonazi Mbonea Reuben kwa nambari ya simu +255782372098. Kama una swali kuhusu stahiki zako kama mshiriki unaweza kumpigia simu, Mwenyekiti wa kamati ya Utafiti na Uchapishaji MUHAS**,** Dr. Nahya Masoud Simu: 255 2150302-6 au msimamizi wa utafiti huu Dr. Ferdinandi (simu0764982522) na Dr Matilda Mtaya (simu 0754212109).

Saini

Mimi _____ nimekubali kushiriki utafiti huu baada ya maswali yangu yote kujibiwa.

Saini ya mshiriki _____

Saini ysa shahidi _____ Tarehe __/___/2024

Mshiriki amekubali □ Amekataa □

Appendix III: Assent Form (English version)

ASSENT TO PARTICIPATE IN A RESEARCH STUDY

Subject's Name: _____ **Birth Date:** _____

Class _____

1. Dr. Yonazi M. Reuben is doing a research study on clinical characteristics associated with decision to extract teeth among orthodontic patients at MUHAS dental clinic, Tanzania
2. We are requesting you to take part in this research because we want to learn more about clinical characteristics that make orthodontists to choose extraction approach among Orthodontic patients attending MUHAS dental clinic for orthodontic care.
3. If you agree to take part in this study, you will be asked to: respond to the questions on the questionnaire through interview and the investigator will take x ray, photographs, dental impressions and examine your oral cavity to identify any clinical characteristic contributing to extraction approach.
4. Things that happen to people in research studies that make them feel bad are called "risks." There are no direct risks that are associated with this study.
5. Things that happen to people in research studies that are good are called "benefits." The benefit for this research study is: you will benefit from knowing the right treatment options, and treatment duration
6. We will do everything possible to keep your information private.

7. You do not have to be in this study if you don't want to. You may stop being in this study at any time. Remember, being in this study is up to you.
8. We will also ask your parent(s) or caregiver to give their permission for you to take part in this study. But even if they say "yes," you can still decide not to do this.
9. You can ask any questions that you have about the study. If you have other questions later, you can ask me next time you see me.

☐ No, I do not want to be in this study.

☐ Yes, I do want to be in this study.

_____ _____

Signature of Subject Date

Appendix IV: Fomu Ya Ridhaa Ya Ushiriki Kwa Watoto

IDHINI YA KUSHIRIKI KATIKA UTAFITI

Jina la Mshiriki……. Tarehe ya Kuzaliwa…….

Darasa…….

1. Daktari Yonazi M. Reuben anafanya utafiti kuhusu sababu zinazopelekea uamuzi wa ung'olewaji wa meno miongoni mwa wagonjwa wa upangaji meno katika kliniki ya kinnywa na meno MUHAS.
2. Tunakuomba ushiriki katika utafiti huu uonaochunguza sababu zinazopelekea uamuzi wa ung'olewaji wa meno miongoni mwa wagongonjwa wakati wa tiba ya kupanga meno katika clinic ya kinywa na meno ya MUHAS.
3. Ikiwa utakubali kushiriki katika utafiti huu, utaulizwa: kujibu maswali kwenye maswali ya utafiti kupitia mahojiano na mchunguzi atakuchunguza kinywa chako, pamoja na kuchukua vipimo ili kutambua sababu zinazopelekea ung'olewaji wa meno wakati wa tiba ya kupanga meno.
4. Mambo yanayowakumba watu katika utafiti ambayo huwafanya wahisi vibaya huitwa "hatari." Hakuna hatari ya moja kwa moja inayohusiana na utafiti huu.
5. Mambo yanayowakumba watu katika utafiti ambayo ni mazuri huitwa "faida." Faida za utafiti huu ni: itakusaidia kujua aina ya tiba itakayokufaa,muda utakaohitajika katika tiba, pia itamsaidia daktari kufanya maamuzi sahihi katika kukupa huduma
6. Tutafanya kila tuwezalo kuhifadhi taarifa yako kwa siri.
7. Hauhitajiki kuwa katika utafiti huu ikiwa hutaki. Unaweza kuacha kushiriki katika utafiti huu wakati wowote

8. Pia tutamuomba mzazi/mlezi wako idhini ya kushiriki katika utafiti huu. Lakini hata kama watasema "ndiyo," bado unaweza kuamua kutoshiriki.
9. Unaweza kuuliza maswali yoyote unayoyahitaji kuhusu utafiti huu. Ikiwa utakuwa na maswali mengine baadaye, unaweza kunipata wakati utakaponiona tena.

☐ Hapana, Sitaki kushiriki katika utafiti huu.

☐ Ndiyo, Nataka kushiriki katika utafiti huu.

Sahihi ya Mshiriki ……Tarehe…….

Appendix V: Questionnaire (English Version)

CLINICAL CHARACTERISTICS ASSOCIATED WITH THE DECISION TO EXTRACT TEETH AMONG ORTHODONTIC PATIENTS AT MUHAS DENTAL CLINIC, TANZANIA

ID no ⌊_⌊_⌊_⌋ **DATE** ⌊_⌊_⌊_⌊_⌊_⌊_⌋

Socio-Demographic Characteristics from Patient participants

1. Age…... (yrs.)
2. Sex: (M=1, F=2) ⌊_⌋

Information on Extraction decision from Orthodontists

3. Orthodontic extraction decision Yes_____ No_____
4. Type of extracted teeth during orthodontic care_____

Appendix VI: Questionnaire (Swahili Version)

DODOSO KUHUSU TATHIMINI YA SABABU ZINAZOPELEKEA UAMUZI WA KUNG'OLEWA JINO MIONGONI MWA WAGONJWA WA UPANGAJI MENO KATIKA KLINIKI YA MENO, MUHAS, TANZANIA.

No. ya utambulisho |_|_|_| **Tarehe** |_|_|_|_|_|_|

Taarifa za mshiriki

1. JINSIA (***weka √ sehemu husika***) a) Mwanaume _____ b) Mwanamke _____
2. UMRI: _____

Taarika toka kwa Daktari

3. Je umepanga kung'oa wakati wa matibabu ya kupanga meno? Ndio _____ Hapana _____
4. Umepanga kung'oa aina ipi ya meno _____

Appendix VII: Data sheet for clinical characteristics

1. Age…….
2. Sex…….

3.A Table for Tooth materials

Maxilla												
Tooth number												
		15	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**TOTAL**
Tooth size												
Mandibular												
Tooth number												
		45	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**TOTAL**
Tooth size												

4a. Arch length measurement _____

4b. Arch length tooth material discrepancy _____

5.Overjet _____

6. Overbite _____

7. Lip status _____

8. Angle's Classification_____

9. Profile_____

Appendix VIII: Ethical Clearances

UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGY

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

OFFICE OF THE DIRECTOR – RESEARCH, PUBLICATIONS AND INNOVATION

Ref. No.DA.282/298/01.C/2082

Date: 11/03/2024

MUHAS-REC-03-2024-2082
YONAZI MBONEA REUBEN
MUHAS

RE: APPROVAL FOR ETHICAL CLEARANCE FOR A STUDY TITLED: A DECISION ON ORTHODONTIC TOOTH EXTRACTION APPROACH, BASED ON CLINICAL CHARACTERISTICS AND RADIOLOGICAL FEATURES OF PATIENTS SEEKING ORTHODONTIC CARE AT MUHAS DENTAL CLINIC

Reference is made to the above heading,

I am pleased to inform you that the Chairman has on behalf of the University Senate, approved ethical clearance of the above-mentioned study, on recommendations of the Senate Research and Publications Committee meeting accordance with MUHAS research policy and Tanzania regulations governing human and animal subjects research.

APPROVAL DATE: 11/03/2024
EXPIRATION DATE OF APPROVAL: 11/03/2025

STUDY DESCRIPTION:
Purpose:

The purpose of the cross-sectional study is to evaluate patients' clinical characteristics and radiographic features leading to orthodontic tooth extraction decision among patients seeking orthodontic care at MUHAS Dental Clinic

The approved protocol and procedures for this study is attached and stamped with this letter, and can be found in the link provided: https://irb.muhas.ac.tz/storage/Certificates/Certificate%20-%2014554.pdf and in the MUHAS archives.

The PI is required to:

1. Submit bi-annual progress reports and final report upon completion of the study.
2. Report to the IRB any unanticipated problem involving risks to subjects or others including adverse events where applicable.
3. Apply for renewal of approval of ethical clearance one (1) month prior its expiration if the study is not completed at the end of this ethical approval. You may not continue with any research activity beyond the expiration date without the approval of the IRB. Failure to receive approval for continuation before the expiration date will result in automatic termination of the approval for this study on the expiration date.
4. Obtain IRB amendment (s) approval for any changes to any aspect of this study before they can be implemented.
5. Data security is ultimately the responsibility of the investigator.
6. Apply for and obtain Data Transfer Agreement (DTA) from NIMR if data will be transferred to a foreign country.
7. Apply for and obtain Material Transfer Agreement (MTA) from NIMR, if research materials (samples) will be shipped to a foreign country.
8. Apply for and obtain permission to publish the results from National Institute for Medical Research. The application should be before submitting to a publisher and not concurrently through the email publications@nimr.or.tz.
9. Any researcher, who contravenes or fail to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine as per NIMR Act No. 23 of 1979, PART III section 10 (2)
10. The PI is required to ensure that the findings of the study are disseminated to relevant stake holders.
11. PI is required to be versed with necessary laws and regulatory policies that govern research in Tanzania. Some guidance is available on our website https://drp.muhas.ac.tz/.



Dr. Nahya Salim Masoud,

Chairperson, MUHAS Research and Ethics Committee