MALOCCLUSION AND TOOTH/ARCH
DIMENSIONS IN THE DECIDUOUS
DENTITION OF PRE-SCHOOL CHILDREN
IN NAIROBI.

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V60/71005/2009

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Is submitted in partial fulfilment of the requirements for the Degree of Master of
Dental Surgery in Paediatric Dentistry of the University of Nairobi.

AUGUST 2011
DECLARATION

I, Diana Chebet Rop, declare that this thesis is my original work and has not been presented for the award of a degree in any other university.

Signature: ___________________ Date: ___________________
SUPERVISOR’S APPROVAL

This thesis has been submitted with my approval as a University of Nairobi supervisor.

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DEDICATION

This thesis is dedicated to the Almighty God, the beginning and the end of all things.
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Nairobi, August 2011.

Diana C. Rop
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<td>BDS</td>
<td>Bachelor of Dental Surgery</td>
</tr>
<tr>
<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
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<tr>
<td>KNH</td>
<td>Kenyatta National Hospital</td>
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<tr>
<td>MDS</td>
<td>Master in Dental Surgery</td>
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<tr>
<td>Mm</td>
<td>Millimetre</td>
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<tr>
<td>Nbi</td>
<td>Nairobi</td>
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<td>UON</td>
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DEFINITION OF TERMS

Child:
For the purpose of this study, a child is an individual between 3 to 5 years of age.

Malocclusion:
A set of inter-arch and intra-arch dental deviations from the normal, in the sagittal, vertical and transverse planes.

Normal occlusion:
Flush terminal/mesial step
Class I canine relationship
Ideal overjet of 0-3 mm.
Ideal overbite
Absence of crossbites
Spacing
Absence of dental anomalies
Absence of infraocclusion

Dental anomalies:
Developmental disturbances in tooth size and number. These include: local microdontia, double teeth, hypodontia, hyperdontia.

Infraocclusion
Refers to a tooth that has its occlusal surface 1mm or more cervical to the plane of the fully erupted neighbouring tooth.
ABSTRACT

Normal alignment of teeth not only contributes to oral health but also goes a long way in the overall well-being and personality of an individual. One of the values of monitoring children during the deciduous dentition is to prevent and intercept malocclusion.

Objective: To determine the prevalence of malocclusion, dental anomalies and measure tooth/arch dimensions in the deciduous dentition of 3-5 year old school-going children.

Setting: Public schools in Nairobi, Kenya.

Study design and methodology: This was a two-part cross-sectional study. A total of 402 were examined and their occlusal status recorded. Of these, those with normal occlusion had alginate impressions taken and poured in dental stone to determine the mesio-distal tooth widths and arch dimensions. Measurements were done using an electronic digital calliper to the accuracy of 0.05mm. Data analysis was coded and analysed using SPSS 11.0. Student’s T-test, Chi-square, Mann Whitney and Kruskall Wallis tests were used for statistical analysis.

Results: Bilateral mesial step was found in 70.1% of the children, 27.1% had flush terminal, none had a distal step and 2.7% had asymmetric molar relationships. Class I canine was found in 78.9%, 7.2% with Class II, 5.5% with Class III and 8.5% were asymmetric. Seventy percent of the children had a class I incisor, 14.7% a class II, 13.2% a class III and 1.2% were asymmetric. Fifty percent of the children had an ideal
overbite, 15.7% had an increased overbite, 19.4% a reduced overbite, 5% had an open bite and 4.2% had an edge-edge bite. Of the children examined, 4.7% had an anterior crossbite, 1.5% had a unilateral posterior crossbite and 0.2% a bilateral posterior crossbite. Generalized spacing was seen in 74.9% and 60% in the upper and lower respectively. Dental anomalies were found in 2.7% of the children and infraocclusion in 0.5%.

Mesiodistal widths of all teeth and arch dimensions of males surpassed those of females. The upper first right molar(54), upper second right molar(55), upper right central incisor(51), lower left second molar(75), lower right second molar(85) and lower left first molar(74) were significantly larger in males than females. Upper and lower intercanine widths, upper intermolar, upper and lower arch perimeter were all significantly larger in males than females.

**Conclusion:** The mesial step was the most prevalent molar relationship and spacing was common for this population. Males generally had larger teeth and wider arch dimensions compared to females.
CHAPTER 1

1.1 INTRODUCTION

1.1.1: Malocclusion

Oral health is more than good teeth; it is integral to general health and essential for general well being of a person. The craniofacial complex allows us to speak, smile, kiss, touch, smell, taste, chew, swallow, and to cry out in pain. Oral diseases restrict activities in school, at work and at home causing millions of school and work hours to be lost each year the world over. Malocclusion is not a disease but rather a set of dental deviations which in some cases can influence quality of life.¹ It can be defined as such malpositions and contacts of maxillary and mandibular teeth which interfere with the highest efficiency during excursive movements of jaws which are essential for mastication and normal function.²

Broadly speaking malocclusions are caused by either genetic factors or environmental factors and can occur in any of the three planes: sagittal, vertical and transverse. Environmental factors causing malocclusion in the deciduous dentition include non-nutritive habits such as: digit sucking, lip biting and tongue thrusting.³

In the deciduous dentition spacing usually exists between the teeth and can be utilized for adjustment of permanent successors which are always larger in size. The spaces present are of two types: primate/anthropoid/simian spaces and physiologic/developmental spaces.⁴
The second deciduous molars relationship\textsuperscript{5}, degree of overbite\textsuperscript{6,7} may be used to some degree to predict the occlusion of the permanent dentition. An anterior open bite and unilateral posterior crossbite of the deciduous teeth is almost invariably due to a sucking habit.\textsuperscript{8}

Infraocclusion occurs in the vertical dimension and refers to posterior teeth which are below the occlusal plane\textsuperscript{9} and may result to tipping of adjacent teeth and loss of mesiodistal space.\textsuperscript{10}

1.1.2: Dental Anomalies

Dental anomalies refer to conditions of odontodysmorphogenesis in regards to tooth size, form and number. Supernumerary teeth, hypodontia, macrodontia and microdontia anomalies tend to be associated.\textsuperscript{11} Developmental disturbances in tooth eruption age, size, shape, number, structure and position are more common in the permanent dentition than in the deciduous dentition\textsuperscript{12} although double teeth are seen more frequently in the primary dentition.\textsuperscript{13} There is a relationship between dental anomalies in the primary and permanent dentition.\textsuperscript{14} The identification of such anomalies involves aesthetic and orthodontic consideration.

Malocclusion may result to unfavourable sequelae. These include: psychological problems, disruption of oral function, temperomandibular joint dysfunction, and greater susceptibility to trauma, periodontal disease or dental caries. The main value of observing children during the deciduous dentition is to prevent and intercept malocclusion. In the present era, dentistry is prevention-oriented and the child in the early years of his life is a most desirable patient to recognize the potential problems of
incipient malocclusion. By the age of three the occlusion of the twenty primary teeth is usually established and the relationship of the distal terminal planes of the second deciduous molars can give us an insight into the future permanent molar relationships and whether any malocclusion will develop or not. Specific, defined malocclusions have been identified in which early recognition and simple interceptive treatment may minimize or even eliminate the need for later complex appliance therapy.

1.1.3: Tooth/Arch Dimensions

Primary teeth are generally smaller than their permanent analogues, and it has been shown that mesio-distal width of deciduous teeth varies within races and populations and within gender, although sexual dimorphism of the deciduous dentition is small compared to that of the permanent dentition. The differences for antimere tooth were calculated by Clinch and the study found that the girls’ standard deviations of the differences tended to be smaller than in boys meaning that boys tended to have a greater variability of antimere teeth. Arch dimensions have been studied by several authors, some of whom have used the deciduous dentition to predict the tooth size arch length deficiencies in the permanent dentition. Many malocclusions occur as a result of a discrepancy between the arch perimeter and total tooth material and it is generally agreed that the mesiodistal crown width and occlusion in the primary dentition play a significant role in determining space and occlusion in the permanent dentition.
1.2 LITERATURE REVIEW

1.2.1: Prevalence of malocclusion in the deciduous dentition:

Epidemiologic studies of malocclusion are problematic because of different concepts of what defines “malocclusion” and the resultant lack of reasonable criteria amenable for use in large studies.29

Various authors have examined occlusal characteristics and relationships either visually or metrically in the primary dentition and this has been widely investigated.4,30-48 Three types of occlusal patterns in the deciduous teeth in regards to the terminal planes were described by Baume4 these include: flush terminal, mesial step and distal step. Racial predilection for certain molar relationships has been suggested by several authors.30-32 Baume4 visually examined the terminal planes (the distal surface) of second deciduous molars in dental casts of 30 American children in the deciduous dentition. The study found that 76% had a straight terminal plane, 14% a mesial step, and 10% showed a distal step. Infante30 on examining both the distal and buccal surfaces of the second deciduous molars of 680 American white children, found the prevalence of Class I molar relation (flush terminal) to be 79.2%, 19.1% had a Class II (distal step), and 1.7% had a Class III (mesial step). On examining 141 African-American and 75 Apache Indian children, the study found them to have Class I relationship in 88.7% and 89.3% of the children respectively, Class II was seen in 4.3% African-American children and 2% Indian children whereas 7.1% and 8% had Class III molar relationship respectively. Trottman and Elsbach31 examined a total of 238 American children of whom 99 were African-American and 139 were Caucasian. The study found that the prevalence of
Class II molar relationship occurred twice as often in the Caucasian children, 14% compared with 7% for African-American children. The reverse was true for Class III. The prevalence was observed twice as often in the African-American children (17%) than in Caucasian children (8%). The Class I (flush terminal plane) molar relationship was found to be common for both races accounting for 76% and 78% in blacks and whites respectively. In contrast, Anderson\textsuperscript{32} metrically evaluated dental casts of 189 African-American children and compared them to a historical sample of 61 European children. Eighty nine percent of African-American children and 63% of European children exhibited a mesial step terminal plane. The study found that the prevalence of the distal step was lower in African-American children (5%) compared to European children (16%). African-American children had a lower prevalence of flush terminal plane (6%) compared to European children. The conclusion was that in African-American children (as in European children) a mesial step, rather than a flush terminal plane, is the norm for the completed primary dentition. Johannsdotir et al\textsuperscript{33} evaluated 396 6-year-old Icelandic children and found that the commonest relation was a mesial step, 59%. Straight terminal plane and distal step had prevalence of 19% and 22%, respectively. Ferreira et al\textsuperscript{34} examined 356 Brazilian children and the study indicated that 55.9% presented with a mesial terminal step, 37.9% straight terminal plane and 6.2% distal step. A total of 389 Peruvian children were examined by Ramos and Meneses\textsuperscript{35} and the study found a mesial step in 60.7% of the children, followed by flush terminal plane in 23.1% and distal step in 2.9%. Assymetric right/left molar relationship was found in 13.3% of the children examined. Ravn\textsuperscript{36} examined 310 Copenhagen children and found the termination pattern of the dental arches in centric occlusion to be straight in 68%,

\textsuperscript{5}
17.2% mesial step and bilateral distal in 14.8%. In India, Nanda et al\textsuperscript{37} examined 603 3-4 year olds and found 58% with a straight terminal plane, 25.5% with a mesial step and 9% with a distal step. Yilmaz et al\textsuperscript{38} evaluated the molar relationship in 205 Turkish children, and found that Class I (flush terminal plane) was represented by 88.29%, followed by Class II (distal step) in 7.31% and Class III (mesial step) in 4.4%. Farsi and Salama\textsuperscript{39} examined 520 Saudi children and found that 80% of the children had a flush terminal plane molar relationship, 13% a mesial step and 7% distal step. 313 Israeli children were seen by Kaufaman and Koyoumdjisky\textsuperscript{40} and found that 68.3% had a vertical terminal plane and 28.8% had a terminal mesial step. Alhaija and Quidemat\textsuperscript{41} examined Jordanian children and reported bilateral mesial step molar relationship in 47.7% of children followed by bilateral flush terminal molar relationship in 37% and bilateral distal step in 3.7%. Asymmetric right/left molar relationship was found in 11.6% of children examined. In Africa, Otuyemi et al\textsuperscript{42} carried out a study of 525 Nigerian children to assess occlusal relationships and they found that bilateral straight terminal planes of molars was the most prevalent feature (74.5%), mesial step bilaterally in 20.9% and 1.9% with distal step. Onyeaso and Sote\textsuperscript{43} examining Nigerian children in a different location found similar results with a straight terminal plane in 63.7% of the children, mesial step in 31.7% and distal step occlusion in 4.6% of the children. Coetzee et al\textsuperscript{44} examined 214 South African children of African descent, aged between 3 and 8 years. Although some of these children were in early mixed dentition, the study reported flush terminal relationship in 16.8% of right and 19.6% of left second primary molars, bilateral mild mesial step (less than 2mm) in 65.9% of cases. The incidence of a distal step pattern was only 1.9%. A severe mesial step of 2mm or more was seen in 9.3% of
left and 13.6% of right second deciduous molars. A study done in Tanzania\textsuperscript{45} showed that the flush terminal plane accounted for 93.8%, bilateral mild mesial step in 1.6% and severe mesial step also in 1.6%. Kabue et al\textsuperscript{46} studied 221 Kenyan children and diagnosed straight terminal plane in 53% of the children, mesial step in 43% and 1% with distal step occlusion.

The canine relationship has been used as a second reference for occlusal status\textsuperscript{4} and there is less conflicting information on the prevalence. Class I canine has been reported by several authors\textsuperscript{34-46} as the norm and having a higher prevalence (50%-89%) across the races than Class II and Class III. Class II and III canine relationships show racial variability: 8.9% of Peruvian\textsuperscript{35} children having Class II and 1% Class III. Turkish\textsuperscript{38} children had 7.8% of them with Class II and those with Class III were 4.4%. The opposite was seen in Nigerian\textsuperscript{42} children who showed that 14.7% had a Class III and 3% had a Class II, in Indian\textsuperscript{37} and Chinese\textsuperscript{47} children who also showed a higher proportion for the Class III canine relationship.

Distribution of different degrees of overjet was been studied by Otuyemi et al\textsuperscript{42} and the study found that most Nigerian children (68.6%) had ‘ideal’ overjet; whereas increased overjet (greater than 2mm) was found in 14.7% and reverse overjet in 7%. Rwakatema and Ng’ang’a\textsuperscript{45} found an excessive overjet (≥6mm) in 5.1% in Tanzanian children. Coetzee et al\textsuperscript{44} examined black South African children and found the mean positive overjet to be 2.71 mm with a minimum of 0.5 mm and a maximum of 6 mm. In France, \textsuperscript{48} excessive overjet of 6mm or more accounted for 6% of the total sample of 402. Farsi and Salama\textsuperscript{39} found that the majority of Saudi children (76%) had an overjet of 0-2mm. Alhaija and Quidemat\textsuperscript{41} examined the anteroposterior incisor relationship and found that
half of the children examined (50%) presented with Class I incisors with normal overjet. Followed by Class II Division 1 (24.7%), Class II Division 2 (12.5%) and Class III, with reverse overjet in 11.8% of the children examined. 0.1% of Belgian children had an anterior crossbite. Single tooth anterior crossbite was found in 6.1% South African black children, while 7% had more than one anterior tooth in crossbite. 44 Saudi children were found to have a prevalence of anterior crossbite of 2%. 39

Overbite has been measured in different ways by different authors. Coetzee et al44 measured fraction of overbite and the study found normal overbite (1/10 – 3/10) in 43% of subjects, 18.7% had a deep bite (>3/10), another 18.7% presented with an edge-edge bite, while 10.3% presented with an anterior open bite half of whom had a digit-sucking habit. 21.5% Tanzanian children45 were found to have deep-bite (≥50% overlap) and open bite in 1.6%. In Jordan, 44.3% of the children had ideal overbite, 28.2% had increased overbite, 21.8% had reduced overbite, and 5.7% had an anterior open bite.41 In France, 37.4% of the children were reported to have anterior open bites48 A study done in Belgium7 indicated that open bite was the malocclusion with the highest prevalence of 32% of 3-5-year-olds; with deep overbite of >3mm in 2% of the children. The prevalence rates of infraocclusion has been reported to range from 1.3% to 8.9% 9,49 with primary mandibular molars being affected ten times as often as primary maxillary molars.49

The frequency of posterior crossbite in South African black children was found to be 0.9% affecting one tooth and 3.7% more than one tooth. In Tanzania,45 a study found 0.3% crossbite and 0.3% scissor bite. Brazilian children were found to have a total of 20.81% of transverse problems. These included: unilateral crossbite (11.65%), anterior
open bite associated with posterior crossbite (6.99%), bilateral posterior crossbite (1.19%), unilateral posterior crossbite associated with anterior crossbite (0.79%), and full crossbite (0.19%). Jordanian children showed a higher frequency of 7% crossbite with 1.5% being bilateral and 5.5% exhibiting unilateral crossbites. Scissors bites were not found in this population. Saudi children were found to have posterior crossbites in 4% of the population. 76 (10%) of Belgian children were found to have posterior crossbite with only 4 (0.5%) cases being bilateral. Similarly 16% of French children had posterior crossbites.

The frequency of spacing in children in Jordan was found to be 61.8% in the upper anterior segment and 61.1% in the mandible. Anthropoid spacing showed predilection for the maxilla compared with mandible (69.6% vs. 51.2%). The frequency for Type I arch (presence of spacing) in Brazilian children was 43.3% for the upper and 46.3% for the lower. The distribution of the primate spaces was: 89.9% for the upper and 67.1% for the lower arch. A study done in France found lack of spacing in 24% of the 407 children.

The overall prevalence of malocclusion ranges from as low as 26.9% in some populations to as high as 73.3% and others in between.

1.2.2: Prevalence of dental anomalies:

Generally the prevalence of dental anomalies is low in the deciduous dentition, ranging from 0.5% to 7%. Microdontia was found to have a very low prevalence in Belgium
(0.1% of 750 children), 1.6% in children in UK, 54 and 2.3% in 905 Japanese children. 55
In Southern China, 6.3% of 936 children examined reported microdontia. 53

Double teeth are thought to occur more often in the primary that in the permanent dentition. 53 There is a marked racial variation in the prevalence of double teeth: 4.1% has been reported both in Japan 56 and Southern China. 53 Brazil had 1.2% of the children with this anomaly; 51 In Finland, 12 and Iceland, 57 it was 0.7%. Whereas USA, 58 and Croatia, 59 reported 0.4%.

Hypodontia has been recorded in Southern China 53 to be as high as 4.1% with other populations ranging between 0% - 0.9%. 7,12,51,58,59 Hyperdontia was high in Taiwan 60 accounting for 7.8% and 0.1%-2.8% for other populations. 7,12,51,53,59

Over 60% of cases with anomalies in the primary dentition are associated with anomalies of the succedaneous permanent dentition. Subjects with hypodontia of the primary dentition have been shown to present with hypodontia of the permanent dentition. However, anomalies of the permanent dentition were seen in 59% of subjects with primary double tooth and 50% of subjects with primary supernumerary tooth. 61

1.2.3: Tooth/arch dimensions

Harris and Lease 21 did a world survey on mesiodistal crown dimensions of the primary dentition and found that all size distributions of the samples were positively skewed because of megadont native Australians and the Europeans had the smallest tooth
crowns of any continental grouping assessed. The other four groups: Africa, New World, Asia and India were intermediate.

Sexual dimorphism is lower in the deciduous dentition as compared to the permanent dentition\textsuperscript{22} with various authors reporting males having generally larger teeth than females\textsuperscript{20,41,62} while others found some teeth dimensions to be larger in females than males.\textsuperscript{22} Moss and Chase\textsuperscript{63} found no statistically significant mesiodistal dimensional differences for any of the antimeres. Warren et al\textsuperscript{29} noted that mesiodistal tooth widths were larger in a contemporary sample compared to an historical sample. Arch dimensions in the deciduous dentition have been shown to be reducing when a contemporary sample was compared to a historical sample.\textsuperscript{64}
1.3: Problem statement

Malocclusion is a common occurrence in children and it may go unnoticed and unattended to early in life. This may predispose to unfavourable sequelae which may be carried on to the permanent dentition. This may worsen the malocclusion and result to complex orthodontic treatment.

Primary teeth are an important unit of study, since they are not simply scaled-down versions of their longer performing successors. Instead, their distinctive sizes and morphologies vary within and among populations and through time. Tooth morphology and size have been employed in various fields of science. One of which is anthropology in sexing human remains; in forensics in identifying the age and gender of an individual; and in orthodontics in predicting the sizes of succedaneous teeth. In paediatric dentistry stainless steel crowns are used routinely in restorations of badly broken down teeth. The sizes of these crowns ideally should be manufactured based on the norm for the given populations. Currently no data is available on mesio-distal width of the deciduous teeth of Kenyans of African origin. In regards to tooth arch dimensions, it has been found that there may be a correlation between tooth size arch length deficiency in the primary dentition and the secondary dentition. This means that the primary dentition may be used to predict certain malocclusions, to some degree, for example, crowding, first permanent molar relationship, crossbite and anterior open bite. Therefore by examining the primary dentition it may be possible to anticipate a malocclusion and hence preventive measures and or interceptive measures may be done to reduce the degree of malocclusion in the permanent dentition and this may shorten or simplify
comprehensive orthodontic treatment which may reflect in reduction of psychosocial impact and cost to the patient and time to the orthodontists. Formulation of preventive health policies and planning of health services regarding malocclusion becomes difficult without adequate information. This then results in a heavier burden placed on the health care system for extensive treatment.

1.4: Justification

Although studies have been done on various aspects of malocclusion in the deciduous dentition in Kenya, there is conflicting information particularly with regards to terminal planes and none has determined the tooth/Arch dimensions in the deciduous dentition.

Thus the purpose of this study is to gather baseline data on prevalence of malocclusion to ascertain the magnitude of the problem in order to formulate preventive and interceptive measures. Whereas the tooth/Arch dimensions will form a data base important for health services planning (for example in regards to use of custom made stainless steel crowns in restorative work), and it forms a basis for future studies for monitoring of population trends.

1.5: Objectives

1.5.1: Broad objective:
To determine the prevalence of malocclusion, dental anomalies and tooth/Arch dimensions.
1.5.2: Specific objectives:

Part I: Malocclusion in the deciduous dentition:

1. To determine the prevalence of malocclusion.
2. To determine arch relationships.
3. To determine prevalence of spacing
4. To determine tooth anomalies in regards to size, shape, and number.

Part II: In tooth/arch dimension in the deciduous dentition, to determine:

1. Mesial distal crown width.
2. Intercanine width.
3. Intermolar width.
4. Arch perimeter.
5. Primate space width

1.6: Null hypotheses

1. There is no difference in the prevalence of malocclusion, dental anomalies between 3, 4 and 5 year-olds and between the different genders.
2. There is no difference in tooth/arch dimensions between males and females.
1.7: Variables

**Independent variables**

Age

Sex

**Dependent variables**

Arch relationships

Dental anomalies

Tooth/arch dimensions
CHAPTER 2
2.0: MATERIALS AND METHODS

2.1: Study Design

This was a two-part descriptive, cross-sectional study.

2.2: Study area:

This study was carried out in Nairobi which is the capital city of Kenya. It is divided into eight administrative divisions.

2.3: Study population

School going children in public pre-schools aged 3-5 years with primary dentition. There were a total of 2499 children of whom 1270 were males and 1229 females enrolled in public pre-schools in the year 2009. Nairobi had a total of 218,378 children aged 3-5 years old (KNBS 2009).

2.3.1: Inclusion criteria

Inclusion criteria for malocclusion:

- 3-5-year-olds in primary dentition. Age was determined from the school records.
- Those with complete deciduous dentition
- Children whose parents/guardians gave consent.
- Children who assented.
Inclusion criteria for tooth/arch dimensions:

- 3-5-year-olds in primary dentition. Age was determined from the school records.
- Those with complete deciduous dentition
- Children whose parents/guardians gave consent.
- Children who assented.
- Those with a normal occlusion

2.3.2: Exclusion criteria

Exclusion criteria for malocclusion:

- Those with erupting permanent teeth
- Those with teeth missing due to caries

Exclusion criteria for tooth/arch dimensions:

- Those with malocclusion.
- Damaged teeth due to caries (teeth with caries in the fissures only with intact walls were included).

2.4: Sample size determination

WHO formula for sample estimation was used in this study.

It states that:
\[ n = \frac{z^2 p(1-p)}{e^2} \]

Where \( n \) = sample size

\( p = \) expected prevalence of malocclusion: 40.5\%\(^{43}\)

\( z = 1.96 (95\% \text{ CL}) \)

\( e = \) maximum tolerable error 5\%, CI=95\%.

Therefore \( n = 370 \) as minimum sample size required.

2.5: Sampling procedure

The study sample was identified through a two-stage sampling technique. All the eight divisions in Nairobi province were selected for sampling. In the first stage, a random sample of one primary school from each division was selected. It was done first by assigning a number to each school in each division. Each division had its number frame. Using a table of random sampling numbers, at least one school was selected from each division (Table 1).

The second stage involved systematic random sampling of pupils from each selected school for clinical examination. It was done by identifying all those within the age of 3-5 years with primary dentition and every third child who met the inclusion criteria was examined until the sample size was achieved and a total of 402 children were examined to determine malocclusion. Out of these children alginate impressions were taken of those who met the inclusion criteria and a total of seventy eight casts were measured to determine tooth/arc dimensions. The total of these selected pupils from each selected
primary school constituted a representative sample size for clinical examination and
dental cast measurement.

Table 1: Distribution of pupils examined in the various schools

<table>
<thead>
<tr>
<th>Division</th>
<th>School</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dagoretti</td>
<td>Upper Hill</td>
<td>30</td>
<td>19</td>
<td>49</td>
</tr>
<tr>
<td>Embakasi</td>
<td>Unity</td>
<td>36</td>
<td>42</td>
<td>78</td>
</tr>
<tr>
<td>Makadara</td>
<td>Njoro</td>
<td>37</td>
<td>41</td>
<td>78</td>
</tr>
<tr>
<td>Starehe</td>
<td>Parklands</td>
<td>26</td>
<td>17</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Ngara East</td>
<td>23</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>Langata</td>
<td>Nairobi West</td>
<td>16</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>Westlands</td>
<td>Kileleshwa</td>
<td>19</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Lady Northey</td>
<td>14</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>Kamukunji</td>
<td>Bahati</td>
<td>11</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>212</td>
<td>190</td>
<td>402</td>
</tr>
</tbody>
</table>

2.6: Calibration

The principal investigator was calibrated by an orthodontist and the Cohen kappa score
for inter-examiner reliability was 0.7888 for clinical examination and for tooth-arch
dimensions, Spearman’s Correlation value of $r=0.872$; $p$ value =0.0000($p<0.05$)
indicating the correlation between the two examiners was significant. A pre-test was
done both in the clinic and the field in the presence of all research team members after they had been recruited.

2.7: Data collection and instruments

Data collection was in two stages. The first stage of data collection was a clinical examination. In the second stage, dental casts of those who met the inclusion criteria were measured to determine the tooth/Arch dimensions.

2.7.1: Registration of Malocclusion

The clinical examination was carried out under natural daylight. Disposable examination gloves and sterile mouth mirrors were made available for each individual during clinical examination. Occlusion was assessed while each child was biting on his back teeth with the jaws in centric relation. For some children, especially in the younger age groups, the jaws had to be guided into this position. The cheek was retracted on each side so observations could be made with a dental mirror while looking at right angles to the buccal surfaces on each side.

- Occlusion and tooth/Arch dimensions were registered according to the guidelines of Alhaija & Qudeimat.41

Molar occlusion

- Flush terminal plane: the distal surfaces of the upper and lower second primary molars in the same vertical plane in centric occlusion.
• Mesial step: the distal surface of the lower second primary molar in anterior relationship to the distal surface of the upper second molar in centric occlusion.

• Distal step: the distal surface of the lower second primary molar in posterior relationship to the distal surface of the upper second molar in centric occlusion.

**Canine relationship:**

• Class I: The tip of the upper primary canine in the same vertical plane as the distal surface of the lower primary canine in centric occlusion.

• Class II: The tip of the upper primary canine in anterior relationship to the distal surface of the lower primary canine in centric occlusion.

• Class III: The tip of the upper primary canine in posterior relationship to the distal surface of the lower primary canine in centric occlusion.

**Incisor relationship**

• Class I: The lower incisor edges occlude with or lie immediately below the cingulum plateau of the upper central incisors.

• Class II: The lower incisor edges lie posterior to the cingulum plateau of the upper incisors.

• Class III: The lower incisor edges lay anterior to the cingulum plateau of the upper incisors. The overjet is reduced or reversed.
**Overjet**

- Measured from the labial surface of lower incisor to the incisal edge of most labial upper incisor.

**Overbite**

- Ideal: The incisal tips of the primary lower central incisors occluding on the cingulum plateau of the upper primary central incisors in centric occlusion.

- Increased: The incisal tips of the lower primary central incisors occluding posterior to the cingulum plateau in centric occlusion.

- Reduced: The incisal tips of the lower primary central incisors occluding anterior to the cingulum plateau in centric occlusion.

- Anterior open bite: There is no vertical overlap between upper and lower primary incisors in centric occlusion.

- Edge to edge

**Crossbite**

- The buccal cusp of the upper tooth occludes lingual to the cusp of the corresponding lower tooth.

**Infraocclusion**

A tooth was recorded as infraoccluded, when its occlusal surface was 1mm or more cervical to the occlusal plane of the fully erupted neighbouring teeth. (9)
Infraocclusion was recorded by direct inspection. In cases where the tooth morphology was lost due to caries or restorations, such teeth were excluded.

**Dental anomalies**

Those representing variations in tooth size, morphology and number were recorded according to the Kreiborg criteria as described by Cavarlho et al.

1) Local microdontia: single tooth smaller than normal;

2) Fusion: union in dentine and/or enamel between two or more separately developed normal teeth.

3) Gemination: incomplete division of a tooth germ.

4) Hypodontia: absence of one or only a few teeth.

5) Hyperdontia: presence of a supernumerary tooth.

Because clinical distinction between fusion and gemination was difficult, these were grouped under the term double teeth.

**2.7.2: Measurement of Tooth/Arch dimensions**

Alginate impressions and wax bites were taken for those with normal occlusion according to the guidelines by Bishara et al. (17) Normal occlusion was defined as those with no apparent facial disharmony, no missing teeth, no history of orthodontic treatment, a flush or mesial terminal step, ideal overbite, and 0 – 3mm overjet. Suitable sterile trays were availed for each child. After sterilization in 2% glutaraldehyde solution for ten minutes, and rinsing, the impressions were wrapped in damp gauze and
transported to the laboratory in plastic zipper storage bags (Baco™) and then poured in dental stone within three hours and trimmed accordingly. All measurements of the teeth and arch dimensions were made on casts using an electronic digital calliper (Masel™ USA).

1. Mesial distal crown width was measured as the greatest diameter between the mesial and distal surfaces of the crown, parallel to the occlusal surface.

2. Intercanine width was measured from the cusp tip of canine on one side to the cusp tip on the other side as shown in Figure 1.

3. Intermolar width was measured from the mesiobuccal cusp tip of the second molar on one side to the mesiobuccal cusp tip of the second molar on the other side (Figure 1).

4. Arch perimeter was measured as a combined sum of anterior and posterior right and left segments for each arch (Figure 2).

Figure 1: Arch width measurements.
Figure 2: Arch perimeter measurements. Total arch perimeter for each arch was obtained by summing segment measurements: A+B+C+D.

Width of the primate (anthropoid) spaces was measured by holding the calliper’s ends parallel to the occlusal plane.

Figure 3: Illustration of measurement of anthropoid spaces.
2.8: Validity and reliability

The use of a standard examination and measurement procedure was employed for all participants. The supervisor calibrated the investigator. A duplicate clinical examination was performed for every tenth child and Cohen’s kappa index was used to calculate intra-examiner reliability. A Kappa score of 0.98 was recorded. Twenty randomly selected casts were re-measured, and the Spearman’s correlation test showed $r=0.92$ which was significant at $p=0.000 (p<0.05)$.

2.9: Minimization of errors and bias

The study population was restricted to those meeting the inclusion criteria. The sliding electronic calliper (Masel\textsuperscript{TM}) was calibrated. The investigator carried out all the examinations and the assistant recorded the findings in the recording schedule.

2.10: Data presentation and analysis

Data was coded and analysed using SPSS version 11.0 software

Basic standard descriptive statistics to measure percentage, proportions, means, mode median and standard deviation of the variables in the selected sample was applied. Chi-square test was used to assess the relationship between categorical data and two-sample t-test for continuous data. Kruskal Wallis and Mann Whitney U test were used to assess data without normal distribution. Data was presented using tables, graphs and pie charts.
2.11: Ethical consideration

Ethical approval was sought from KNH Ethics and Research Committee, Kenya. Permission to conduct the study was sought from the Mayor of Nairobi City Council through the Director Education Officer and the head teachers of the selected nursery schools. Informed consent of the parents of the pupils participating in the study was obtained through the head teachers of the selected nursery schools. He/she sent a consent form requesting concerned to fill the form. Parents/guardians were told the purpose of the study before oral examination and impression taking. A child was allowed to drop out of the study on his/her own wishes without threat. Confidentiality of study participants and protection of their identity was strictly observed.

Research data was limited to authorized persons. Ethical laws and code of conduct were observed.

The study was done by a dental paediatric resident under the competent guidance of an orthodontist. Oral health education was given on individual basis to the examined children. Pupils found to be in need of treatment were given a referral note to a dental clinic of their choice and those needing specialist care were referred to the UON Dental School hospital and KNH dental clinic.
2.12: Scope and limitation

Deciduous malocclusion was examined from an objective view and did not involve perception from the subjects’ point of view. Non-nutritive habits were not recorded in this study. Dental anomalies were recorded according to physical appearance, no radiographs were taken. Only dimensions involving the mesiodistal crowns of teeth and arch dimensions were assessed. The study was limited to public pre-school going children in Nairobi with deciduous dentition.
CHAPTER 3

3.0: RESULTS

3.1: Malocclusion

A total of 402 children who met the selection criteria were examined of whom 212 were males and 190 were females. Table 2 shows the number of children examined according to age and gender.

Table 2: Number of children according to age and sex

<table>
<thead>
<tr>
<th>Age(years)</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>67</td>
<td>67</td>
<td>134</td>
</tr>
<tr>
<td>4</td>
<td>88</td>
<td>73</td>
<td>161</td>
</tr>
<tr>
<td>5</td>
<td>57</td>
<td>50</td>
<td>107</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>212</strong></td>
<td><strong>190</strong></td>
<td><strong>402</strong></td>
</tr>
</tbody>
</table>

Tables 3 and Figure 4 show the distribution of different anteroposterior relationships of molars. Mesial step molar was the most predominant terminal plane accounting for 282 (70.1%), followed by flush terminal plane in 109 (27.1%). Asymmetrical (right/left) molar relationships were found in 11 (2.7%) children. No distal step was recorded. There was no significant difference in molar relationships between males and females and across age groups.
Table 3: Distribution of anteroposterior relationship of molars according to age in 3-5-year-olds (n=402).

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Flush terminal</th>
<th>Mesial step</th>
<th>Distal step</th>
<th>Asymmetric</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>33(24.6%)</td>
<td>97(72.4%)</td>
<td>0</td>
<td>4(3%)</td>
<td>134</td>
</tr>
<tr>
<td>4</td>
<td>39(24.2%)</td>
<td>118(73.3%)</td>
<td>0</td>
<td>4(2.8%)</td>
<td>161</td>
</tr>
<tr>
<td>5</td>
<td>37(34.6%)</td>
<td>67(62.6%)</td>
<td>0</td>
<td>3(2.8%)</td>
<td>107</td>
</tr>
<tr>
<td>Total</td>
<td>109(27.1%)</td>
<td>282(70.1%)</td>
<td>0</td>
<td>11(2.7%)</td>
<td>402</td>
</tr>
</tbody>
</table>

Figure 4: Pie-chart showing distribution of molar relationship in all the 3-5 year-olds (n=402).
A total of 317 (78.9%) children had a Class I canine, 29(7.2%) Class II, 22(5.5%) Class III and 34(8.5%) were not bilaterally symmetric as seen in Table 4 and Figure 5.

**Table 4: Distribution of canine relationships in 3-5 year-old children (n=402).**

<table>
<thead>
<tr>
<th>Age(years)</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Asymmetric</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>102(76.1%)</td>
<td>13(9.7%)</td>
<td>10(6.7%)</td>
<td>9(6.7%)</td>
<td>134</td>
<td>0.03*</td>
</tr>
<tr>
<td>4</td>
<td>137(85%)</td>
<td>7(4.3%)</td>
<td>8(5%)</td>
<td>9(5.6%)</td>
<td>161</td>
<td>0.03*</td>
</tr>
<tr>
<td>5</td>
<td>78(72.9%)</td>
<td>9(8.4%)</td>
<td>4(3.7%)</td>
<td>16(14.9%)</td>
<td>107</td>
<td>0.03*</td>
</tr>
<tr>
<td>Total</td>
<td>317(78.9%)</td>
<td>29(7.2%)</td>
<td>22(5.5%)</td>
<td>34(8.5%)</td>
<td>402</td>
<td></td>
</tr>
</tbody>
</table>

*Chi-square test. Significant at p<0.05

The anteroposterior incisor relationship showed that most of the children (70.9%) had a bilateral Class I, 14.8% Class II, 13.2% Class III and 1.2% were asymmetrical as shown in Figure 5. The mean overjet was 2.46mm and there was no statistical difference between age and gender. A total of 317 (78.85%) children had an ideal overjet and 67 (16.66%) had an increased overjet. There were 18(4.47%) children who had an anterior crossbite. There was no significant difference in incisor relationship in both age and gender.
The distribution of overbite is shown in Table 5 and 6 which indicates that 53.4% had an ideal overbite, 16.5% increased, and 20.4% reduced, 5.2% showed an open bite and 4.5% an edge-edge bite. There was no significant difference across age groups but there was a significant difference between genders.

**Table 5: Distribution of vertical relationships across age groups in 3-5 year-olds (n=402)**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Ideal</th>
<th>Increased</th>
<th>Reduced</th>
<th>Open bite</th>
<th>Edge-edge</th>
<th>p value (p&gt;0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>69(55.6%)</td>
<td>25(20.2%)</td>
<td>20(16.1%)</td>
<td>6(4.8%)</td>
<td>4(3.2%)</td>
<td>0.47*</td>
</tr>
<tr>
<td>4</td>
<td>87(55.8%)</td>
<td>23(14.7%)</td>
<td>32(20.5%)</td>
<td>8(5.1%)</td>
<td>6(3.8%)</td>
<td>0.47</td>
</tr>
<tr>
<td>5</td>
<td>48(30.8%)</td>
<td>15(9.6%)</td>
<td>26(16.7%)</td>
<td>6(3.8%)</td>
<td>7(4.5%)</td>
<td>0.47*</td>
</tr>
<tr>
<td>Total</td>
<td>204(53.4%)</td>
<td>63(16.5%)</td>
<td>78(20.4%)</td>
<td>20(5.2%)</td>
<td>17(4.5%)</td>
<td></td>
</tr>
</tbody>
</table>

*Chi-square test.
Table 6: Distribution of vertical relationships between gender in 3-5-year-olds (n=402)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Ideal</th>
<th>Increased</th>
<th>Reduced</th>
<th>Open bite</th>
<th>Edge-edge</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>112(55.2%)</td>
<td>24(11.8%)</td>
<td>50(24.6%)</td>
<td>8(3.9%)</td>
<td>9(4.4%)</td>
<td>0.02*</td>
</tr>
<tr>
<td>F</td>
<td>92(51.4%)</td>
<td>39(21.8%)</td>
<td>28(15.6%)</td>
<td>12(6.7%)</td>
<td>8(4.5%)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Total</td>
<td>204(53.4%)</td>
<td>63(16.5%)</td>
<td>78(20.4%)</td>
<td>20(5.2%)</td>
<td>17(4.5%)</td>
<td></td>
</tr>
</tbody>
</table>

*Chi-square test. Significant at p<0.05

Infraocclusion was noted in 2(0.5%) subjects both affecting the mandibular arch, specifically 74 and 84 (Table 7).

Table 7: Frequency of infraocclusion in 3-5 year-olds (n=402).

<table>
<thead>
<tr>
<th>Tooth No</th>
<th>No and %</th>
</tr>
</thead>
<tbody>
<tr>
<td>55/65</td>
<td>0</td>
</tr>
<tr>
<td>54/64</td>
<td>0</td>
</tr>
<tr>
<td>74/84</td>
<td>2(0.5%)</td>
</tr>
<tr>
<td>75/85</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>2(0.5%)</td>
</tr>
</tbody>
</table>
In the transverse plane, 6(1.5%) children had a unilateral posterior crossbite where as 1(0.2%) had a bilateral crossbite, 3(0.7%) had scissor bites one of which was bilateral as shown in Table 8.

**Table 8: Distribution of posterior crossbite in 3-5 year-olds (n=402)**

<table>
<thead>
<tr>
<th>Crossbite</th>
<th>No and %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral</td>
<td>6(1.5%)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>1(0.2%)</td>
</tr>
<tr>
<td>Scissor bite</td>
<td>3(0.7%)</td>
</tr>
<tr>
<td>No crossbite</td>
<td>392(97.5%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>402</strong></td>
</tr>
</tbody>
</table>

The frequency, type and location of spacing in the upper and lower arches are shown in Table 9. 323(80.3%) had some form of spacing. In the upper arch, 301(74.9%) and 241(60%) in the lower had generalized anterior spacing. Those with anthropoid spacing only were 74(18.4%) in the upper, 12(3%) in the lower and 52(12.9%) with both primate spaces in the upper and lower arches.
Table 9: Frequency of spacing in 3-5 year-olds (n=402).

<table>
<thead>
<tr>
<th>Space condition</th>
<th>Arch</th>
<th>No and %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generalized spacing</td>
<td>Upper</td>
<td>301(74.9%)</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>241(60%)</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>323(80.3%)</td>
</tr>
<tr>
<td>Only anthropoid spaces</td>
<td>Upper</td>
<td>74(18.4%)</td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td>12(3%)</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>52(12.9%)</td>
</tr>
</tbody>
</table>

Dental anomalies were found in 9(2.2%) children as seen in Table 10. 4(1%) had double teeth, 4(1%) hypodontia and 1(0.2%) had hyperdontia.

Table 10: Distribution of dental anomalies in 3-5 year-olds (n=402)

<table>
<thead>
<tr>
<th>Dental anomaly</th>
<th>No and %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double teeth</td>
<td>4(1%)</td>
</tr>
<tr>
<td>Hypodontia</td>
<td>4(1%)</td>
</tr>
<tr>
<td>Hyperdontia</td>
<td>1(0.2%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>9(2.2%)</strong></td>
</tr>
</tbody>
</table>

Overall prevalence for malocclusion was 60.94%.
3.2: Tooth Dimensions

3.2.1: Mesio-distal width of teeth

The mean mesiodistal width of deciduous teeth in males and females is shown for the maxillary and mandibular arches in Tables 11 and 12 respectively. In the upper arch, the mesiodistal width of the tooth number 54, 55 and 51 were significantly larger in males than in females. In the lower arch, males showed significantly larger 75, 85, and 74 molars compared to females. These were all significant at $p<0.05$. 
Table 11: Mesiodistal width of upper primary teeth in 3-5 year-olds (n=78).

<table>
<thead>
<tr>
<th>Tooth No.</th>
<th>Males n=42</th>
<th>Females n=36</th>
<th>Total mean n=78</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>9.52</td>
<td>9.22</td>
<td>9.38</td>
<td>t-test(p&lt;0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p =0.032</td>
</tr>
<tr>
<td>54</td>
<td>7.72</td>
<td>7.47</td>
<td>7.61</td>
<td>2.477</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.015</td>
</tr>
<tr>
<td>53</td>
<td>6.94</td>
<td>6.81</td>
<td>6.88</td>
<td>1.406</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.164</td>
</tr>
<tr>
<td>52</td>
<td>5.56</td>
<td>5.42</td>
<td>5.50</td>
<td>1.666</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.10</td>
</tr>
<tr>
<td>51</td>
<td>6.89</td>
<td>6.69</td>
<td>6.80</td>
<td>2.039</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.045</td>
</tr>
<tr>
<td>61</td>
<td>6.95</td>
<td>6.80</td>
<td>6.88</td>
<td>1.597</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.114</td>
</tr>
<tr>
<td>62</td>
<td>5.62</td>
<td>5.50</td>
<td>5.57</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.157</td>
</tr>
<tr>
<td>63</td>
<td>6.91</td>
<td>6.72</td>
<td>6.82</td>
<td>1.925</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.058</td>
</tr>
<tr>
<td>64</td>
<td>7.70</td>
<td>7.48</td>
<td>7.60</td>
<td>1.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.056</td>
</tr>
<tr>
<td>65</td>
<td>9.40</td>
<td>9.16</td>
<td>9.29</td>
<td>1.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.052</td>
</tr>
</tbody>
</table>

*This was statistically significant at p<0.05.
Table 12: Mesiodistal width of lower primary teeth in 3-5 year-olds (n=78).

<table>
<thead>
<tr>
<th>Tooth No.</th>
<th>Males</th>
<th>Females</th>
<th>Total mean</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>10.55</td>
<td>10.21</td>
<td>10.39</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>8.44</td>
<td>8.15</td>
<td>8.31</td>
<td>2.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>6.04</td>
<td>5.91</td>
<td>5.98</td>
<td>1.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>4.73</td>
<td>4.69</td>
<td>4.71</td>
<td>0.622</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>4.18</td>
<td>4.17</td>
<td>4.17</td>
<td>0.194</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.847</td>
</tr>
<tr>
<td>81</td>
<td>4.20</td>
<td>4.15</td>
<td>4.18</td>
<td>0.632</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.967</td>
</tr>
<tr>
<td>82</td>
<td>4.71</td>
<td>4.71</td>
<td>4.71</td>
<td>-0.042</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.967</td>
</tr>
<tr>
<td>83</td>
<td>6.00</td>
<td>5.90</td>
<td>5.95</td>
<td>0.971</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.334</td>
</tr>
<tr>
<td>84</td>
<td>8.37</td>
<td>8.19</td>
<td>8.29</td>
<td>1.446</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.152</td>
</tr>
<tr>
<td>85</td>
<td>10.41</td>
<td>10.10</td>
<td>10.27</td>
<td>2.467</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.016</td>
</tr>
</tbody>
</table>

*This was statistically significant at p<0.05.
3.2.2: Dental Arch Dimensions

In all arch dimensions, the measurements for the males exceeded those of females (Tables 13 & 14). In both arches, intercanine width was significantly larger in males. Mean intercanine width in the upper arch was 31.11 mm in males and 29.11 mm in females. The 2 mm difference was statistically significant (p<0.05). In the lower arch, 23.86 mm intercanine width was recorded in males and 22.92 mm in females. The 1.14 mm difference was statistically significant at p<0.05.

Intermolar dimensions in the maxillary arch were 2.01 mm significantly different statistically: 45.95 mm in males and 43.94 mm in females. In the mandibular arch, the intermolar dimensions were 38.24 mm and 37.54 mm in males and females respectively, but the difference was not statistically significant.

Arch perimeter dimensions of both the upper and lower were significantly larger in males (p<0.05). In the upper, a difference of 1.9 mm was found between genders: 77.01 mm in males and 75.08 mm in females. In the lower, males had 70.64 mm and females 67.19 mm, giving a difference of 3.45 mm.

The total mean upper primate space for both males and females was 1.22 mm for the upper arch and 0.85 mm for the lower arch. There were no statistically significant differences between the genders.
### Table 13: Upper arch dimensions in the deciduous dentition of 3-5 year-olds (n=78).

<table>
<thead>
<tr>
<th></th>
<th>Dimensions (mm)</th>
<th>Males</th>
<th>Females</th>
<th>Total mean</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n=42</td>
<td>n=36</td>
<td>n=78</td>
<td>t-test (p&lt;0.05)</td>
</tr>
<tr>
<td>Intercanine width</td>
<td></td>
<td>31.11</td>
<td>29.11</td>
<td>30.19</td>
<td>3.594</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.001</td>
</tr>
<tr>
<td>Intermolar width</td>
<td></td>
<td>45.95</td>
<td>43.94</td>
<td>45.03</td>
<td>4.410</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.000</td>
</tr>
<tr>
<td>Arch perimeter</td>
<td></td>
<td>77.01</td>
<td>75.08</td>
<td>76.12</td>
<td>2.353</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.021</td>
</tr>
<tr>
<td>Primate space</td>
<td></td>
<td>1.25</td>
<td>1.20</td>
<td>1.22</td>
<td>0.209</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.835</td>
</tr>
</tbody>
</table>

*This was statistically significant at p<0.05.
Table 14: Lower arch dimensions in the deciduous dentition of 3-5 year-olds (n=78).

<table>
<thead>
<tr>
<th>Dimensions(mm)</th>
<th>Males n=42</th>
<th>Females n=36</th>
<th>Total mean n=78</th>
<th>Statistical test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercanine width</td>
<td>23.86</td>
<td>22.92</td>
<td>23.43</td>
<td>t-test (p&lt;0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.009</td>
</tr>
<tr>
<td>Intermolar width</td>
<td>38.24</td>
<td>37.54</td>
<td>37.92</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.157</td>
</tr>
<tr>
<td>Arch perimeter</td>
<td>70.64</td>
<td>67.19</td>
<td>69.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*p=0.003</td>
</tr>
<tr>
<td>Primate space</td>
<td>0.92</td>
<td>0.76</td>
<td>0.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p=0.228</td>
</tr>
</tbody>
</table>

*This was statistically significant at p<0.05.
CHAPTER 4

4.0: DISCUSSION

4.1: Malocclusion

As described before epidemiologic studies of malocclusion in the deciduous dentition are problematic due to different concepts as to what defines "malocclusion". The modified Foster and Hamilton criteria was used in this study as it defines the occlusal status in the anteroposterior, vertical and transverse dimensions. In the permanent dentition Angle’s classification of malocclusion describes the sagittal relationship of the buccal surfaces of the maxillary and mandibular first molars. For the deciduous dentition, various authors have classified the terminal planes either visually or metrically, using either the distal surface or buccal surface of the second deciduous molars. In this study, the distal surface were visualised during clinical examination as the terminal plane acts as a guideline for the erupting permanent molars.

Tooth-arch dimensions can either be measured directly intra-orally or indirectly using dental casts. Errors in measurements done directly intraorally, particularly for the posterior region, have been reported and therefore dental casts offered a more accurate analysis of the tooth-arch dimensions.

The findings in this study indicated that the mesial step was the most prevalent (70.1%) relationship of the second deciduous molars (Figure 4). The flush terminal relationship was found in 27.1% of the cases. Bishara et al have predicted the percentage of terminal planes that will result into the various molar relationships of the first permanent molars and found that the presence of a mesial step in the deciduous dentition indicates
a greater probability for a Class I molar relationship and a lesser probability for a Class II molar relationship. The high prevalence of mesial step could be supported by the fact that 93% of Kenyan adolescents were found to have neutral occlusion.\textsuperscript{66} Other studies have found similar results in African American\textsuperscript{32} and Brazilian children.\textsuperscript{34} In contrast, there are other studies that have found the flush terminal plane to be prevalent in Kenyan,\textsuperscript{46} Nigerian,\textsuperscript{42} Tanzanian,\textsuperscript{45} Indian\textsuperscript{37} and Jordanian children.\textsuperscript{41} Bishara\textsuperscript{3} emphasizes that determining the terminal plane in the primary dentition stage is of great importance to the clinician because the erupting first permanent molars are guided by the distal surfaces of the second primary molars as they erupt into occlusion.

This study did not show any differences of the anteroposterior molar relationship across the ages (Table 3) and this was similar to the study by Alhaija et al\textsuperscript{41} which did not find any statistically significant difference between age groups. Infante\textsuperscript{30} found a lower prevalence of Class II malocclusion in 5-year old white children compared to 2-year-olds: 14.1% and 26.5%, respectively. The theory explaining these findings was that of horizontal mandibular catch-up growth in normal children during the preschool years. This was disputed by Baume\textsuperscript{4} who found that the terminal planes remained constant with age during the deciduous dentition and this could explain the fact that the molar relationship showed no difference across the age groups.

There were no gender differences in molar relationship and this was in agreement with Infante\textsuperscript{30} Alhaija et al\textsuperscript{41} and Otuyemi et al.\textsuperscript{42} The asymmetrical distribution of molar relationships has been thought to be due to variations in space conditions.\textsuperscript{41,42}
The canine relationship showed that 78.9% had a Class I, 7.2% had Class II, 5.5% had Class III and 8.5% were asymmetric (Table 4, Figure 5). This was similar to other authors\textsuperscript{34,39,41,42} who also showed that the most prevalent canine relationship was a Class I. There was a difference, in regards to prevalence, of children with distal step molar relationship and Class II canine relationship (Table 3,4). This discrepancy in sagittal relations may have been influenced by sucking habits. Thus it is important, in children with a Class II canine, to rule out non-nutritive habits. Otuyemi et al\textsuperscript{42} reported the reverse in reference to Class II and III canine relationship, whereby the Class III canine relation had a higher frequency than Class II as compared to this study which reported a higher frequency for Class II.

The anteroposterior relationship of incisors in this study showed that 70.9% had a Class I, 14.7% a Class II, and 13.2% a Class III as seen in Figure 5. Jordanian\textsuperscript{41} children were found to have a lower percentage of Class I (50%), and a higher percentage for Class II (38.2%) compared to the Kenyan children of African descent. In regards to metric values of overjet, the mean overjet was 2.46mm with 78.85% having an ideal overjet, and 16.66% increased overjet in this study. There was no significant difference across age groups and this was in agreement with Baume\textsuperscript{4} who stated that: “not a single case substantiated the theory that there is a forward growth of the alveolar frontal sections during the period of the primary dentition” but this was disputed by Farsi and Salama,\textsuperscript{39} who have found a reduction in overjet with age indicating an increase of anteroposterior growth as they noted that the prevalence of 0-1mm overjet was significantly higher, and that of 2-3mm significantly lower in the elder age group(5 year-olds).
A prevalence of anterior crossbites (4.47%) was found in this study. This was lower than in Nigerian children, of whom Otuyemi et al.\textsuperscript{42} reported a 7%. Although Trottman and Elsbach\textsuperscript{31} pointed out a significant racial difference in regards to crossbite and found that it was observed four times more often in African American children (16% compared with 4% in Caucasian children), this was not the case for this population possibly due to genetic and environmental differences. The low prevalence nonetheless indicates the need to diagnose early those with anterior crossbites because if not corrected at an early age, it will result in anteroposterior and transverse growth restriction.

The vertical anterior relationship showed that overbite was ideal in 53.4%, increased in 16.5%, and reduced in 20.4%, 5.2% of the children showed an open bite and 4.5% an edge-edge bite (Tables 5 and 6). There was no significant difference across the age groups. According to Baume\textsuperscript{6} the overbite in the deciduous dentition remained constant except when subjected to environmental influences such as attrition and habits. Thus vertical malocclusion may also indicate presence of deleterious habits. It is therefore important to cease these habits to prevent malocclusion in the permanent dentition. The results of anterior open bite reported in this study were comparable to those reported for Nigerian\textsuperscript{42} and Jordanian children.\textsuperscript{41} In contrast Saudi children\textsuperscript{39} had twice the percentage (9.2%) of anterior open bite while that reported in Belgium\textsuperscript{7} was six times (32%) that of the present study. The low prevalence of open bites, in this population, could be explained by the lower incidence of non-nutritive habits in this population\textsuperscript{67} compared to Caucasians\textsuperscript{68} who may also have a higher prevalence of using pacifiers. In a Danish\textsuperscript{7} study it was observed that that the frequency of children with open bite was almost halved between the age of 3 and 5, probably due to a decline in sucking habits.
In this population there was a significant difference between genders of anterior vertical relationship with girls reporting anterior open bite in almost twice (6.7%) the number compared to boys (3.9%). It may indicate that a higher percentage of girls engage in deleterious non-nutritive habits.

In the posterior region, infra-occlusion was seen in 2 children both affecting the lower first deciduous molars. It has been found that primary mandibular molars are ten times affected as often as primary maxillary molars. This low finding was similar to that of other studies in Africa. Although in Israeli children a much higher prevalence of 24.8% was reported. The low prevalence in this study could be due to criteria used to measure infraocclusion (1mm below marginal ridge) whereas the Israeli study used 0.5mm as the cut off. It has also been shown that the occurrence of primary teeth in infraocclusion increases with the child’s age and that may account for the relatively low prevalence in this study. Although Africans and Orientals have been shown to have a lower prevalence compared to Caucasians and Hispanics, the number of children with submerged teeth were too few in this study to be analysed.

The prevalence of posterior crossbite in the primary dentition has been reported as ranging from 7% to 17% and some authors have suggested that there is ethnic difference in terms of prevalence, whereas Trottman and Elsbach did not find any significant difference between races. In the present study, a total of 2.5% of the children had posterior crossbites. This was similar to that found in other African children but lower compared to Caucasians who had a range of 7%-13%. One reason for the low prevalence of posterior crossbites in the deciduous dentition in this population may be the low prevalence of non-nutritive habits which have been
reported in 15% of this population\textsuperscript{67} compared to 75% of Caucasian\textsuperscript{68} thus explaining the more than threefold decrease in prevalence of posterior crossbite in this population. Posterior crossbite in the primary dentition most often results in crossbite of the permanent dentition.

The prevalence of spaced dentition is different in various ethnic groups ranging from 15% to 90\textsuperscript{.36,41,42,72} This study showed a high prevalence of spacing in Kenyan children. 80.3% of the children had some form of spacing in both arches and 12.9% had only anthropoid spaces. This could mean that the low prevalence of crowding in this population (19%) reported by Ng’ang’a et al\textsuperscript{66} could be due to high prevalence of spacing in the deciduous dentition which allows for the fitting of the larger permanent teeth.

Dental anomalies in the deciduous dentition were observed in 2.2% of the children examined. Double teeth and hypodontia each had a similar distribution (1%) but much higher than hyperdontia (0.2%). Although these two conditions may have been underreported due to lack of radiographs, the findings nevertheless collaborated with other studies\textsuperscript{51-61} which have reported low findings. Double teeth have been reported to be more common in primary than in the secondary dentition.\textsuperscript{53}

4.2: Tooth/Arch Dimensions

4.2.1: Mesio-distal width

Primary teeth have distinctive sizes and morphology and vary within and among populations and through time.\textsuperscript{21} The results of this study on sexual dimorphism revealed
that males exhibited larger teeth than females for all tooth types (Tables 11, 12). These findings were consistent with those reported for other populations for all tooth types\textsuperscript{62, 41, 74} and some tooth types\textsuperscript{22, 74}. Sexual dimorphism is low in the primary dentition, averaging 2% across all 10 tooth types with the incisors and molars tending to be the most dimorphic unlike the canine in the permanent dentition\textsuperscript{21}. In this study, three tooth types (55, 54, 51 and 75, 74, 85) were found to be significantly dimorphic with males having larger teeth than females for all tooth types. Some of these findings were similar to those reported for Caucasians\textsuperscript{22, 62} which indicated the first and second lower primary molar to be significantly different between the genders. Whereas in Australian Aboriginal\textsuperscript{73} teeth, the gender tooth size differences was greatest in the maxillary first molar and mandibular first incisor. In Chinese children, Yuen et al\textsuperscript{76} found that none of the primary teeth showed a significant sex difference in mesiodistal tooth width.

In comparing the sum means of the ten tooth types across continents, within the six divisions, namely: Australia, India, Europe, Asia, New World and Africa, it has been noted that native Australians have exceptionally large permanent teeth,\textsuperscript{21} and the same is true of their primary teeth.\textsuperscript{74} Modern Europeans possess comparatively small mesiodistal diameters. Other four groups, including Africans, are intermediate.\textsuperscript{21} The findings of this study collaborate with those of Harris and Lease.\textsuperscript{21}

\subsection*{4.2.2: Dental Arch dimensions}

Dental arch dimensions were generally larger in males (Tables 13, 14). The upper and lower intercanine width, both arch perimeters and maxillary intermolar width were significantly larger in males. In comparison to North American Caucasian children,\textsuperscript{64}
Kenyan children of African descent had slightly higher arch dimensions. Each of the maxillary and mandibular total arch length was significantly higher in both males and females \((p<0.05)\) in this study. Maxillary and mandibular intercanine widths were greater in this study compared also to those of Jordanian \(^{41}\) and Polish \(^{25}\) children. Comparison with other studies was difficult due to different methodology used by different authors.

In general, the prevalence of primate space was 12.9\% for both males and females. Primate spaces tended to be larger in males than females. The average primate space in males (both sides combined) was 1.25mm and 0.92 mm in the upper and lower arches, respectively. In females it was 1.20mm and 0.76mm. Alhaija and Quidemat \(^{41}\) reported wider spaces in Jordanian children of 2.8mm and 2.31mm in males and 1.93mm and 1.47mm in females for the upper and lower arches respectively. Likewise, El-Nofely et al \(^{72}\) studying Egyptian children reported 2.56mm in the upper arch and 1.57mm in the lower arch.

**Conclusions**

**Malocclusion**
The overall prevalence of malocclusion was 60.94\%. The mesial step was the most prevalent terminal plane relationship, followed by flush terminal. Class I canine was found in 78.9\% and majority of the children had a Class I incisor with 50.7\% having an ideal overbite. 2.2\% of the children presented with dental anomalies, 0.5\% had infraocclusion. Spacing was prevalent for this population with 80.3\% having spaced dentitions.
**Tooth/arch dimensions**  
Males generally had larger tooth-arch dimensions, all upper arch dimensions, lower intercanine and arch perimeter being significantly larger in males than females. Teeth number 55, 54, 51, 75, 85 and 74 were significantly larger in males than females.

**Recommendations**

The relatively high prevalence of malocclusion indicates a need for screening of malocclusion in pre-school children in Kenya through:

- Policy change: for example mandatory school annual check-up
- Dental school curriculums incorporating outreach programs.

Gender and racial differences of tooth/arch dimensions has an implication in the clinical setup in regards to:

- Stainless Steel Crowns for restorative work (it may indicate a need for custom made sizes)
- Formulation of a set of normal standards for this population.

These findings require studies of other larger populations in Kenya to ascertain these differences.
References


15. Dutra ALT, Berto PM, Vieira LDS, de Toledo OA. Longitudinal changes in the molar relationship from primary to permanent dentition. ConScientiae Saude. 2009; 8:171-176.


APPENDIX I: CONSENT FORM

The purpose of the study
I, Dr. Diana Rop from the University of Nairobi would like to seek your consent for your child’s participation in a study aimed at determining malocclusion, dental anomalies and tooth arch dimensions of the deciduous dentition among school going children. The information I get is part of my research for a thesis as a partial fulfilment for the degree of Master of Dental Surgery in Paediatric Dentistry.

How do you participate?
I shall look into your child’s mouth and record some observations. I shall then proceed to take measurements by placing some gel material into your child’s mouth. The examination and measurement taking shall be carried out using (clean) sterile instruments and materials.

Voluntary participation
Your child’s participation in the study is voluntary. You can terminate his/her participation at will without any consequences. Also understand that participation in the study does not entail financial benefits.

Anticipated risk
No risk is anticipated for participating in the study.

Confidentiality
The information given to the researcher will be kept in strict confidence. No information, by which your identity can be revealed, will be released or published.
If you are satisfied with my explanation and you are willing to have your child participate, please sign the consent form.

Consent form
I ___________________________________ of ______________________
Having understood the nature of study as explained to me by Dr. Diana Rop of University of Nairobi is willing to have my child to participate in the study.

Name___________________________Signed____________Date_________
Patient
I confirm that I have explained the nature of the study to the patient.
Name __________________________Signed____________Date__________
Investigator
Appendix II: EXAMINATION FORM FOR REGISTRATION OF MALOCLUSION

ID No. _______  Region. ________________

Gender (M/F) _____  Age (years) ________

I: Occlusion (tick one)
A. Molar occlusion
   - Bilateral Flush terminal plane
   - Bilateral Mesial step
   - Bilateral Distal step
   - Asymmetric

B. Canine relationship
   - Bilateral Class I
   - Bilateral Class II
   - Bilateral Class III
   - Asymmetric

C. Incisor relationship
   - Bilateral Class I
   - Bilateral Class II
   - Bilateral Class III
   - Overjet (mm) __________

D. Overbite
   - Ideal
   - Increased
   - Reduced
   - Open bite
   - Edge-edge
E. Crossbite

- Anterior teeth:
  - Normal
  - One tooth
  - >One tooth
- Posterior teeth
  - Normal
  - Unilateral
  - Bilateral

Ib. Spacing (tick appropriate)

- Anthropoid spaces
  - Upper
  - Lower
- Generalized anterior spacing
  - Upper
  - Lower
  - No spacing

II: Dental anomalies (tick appropriate)

- Local microdontia
- Double teeth
- Hypodontia
- Hyperdontia
- Others _____________

III: Infraocclusion

- Upper
- Lower

Tooth affected:

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APPENDIX III: DATA COLLECTION FORM FOR TOOTH/ARCH DIMENSIONS

ID No. ______ Region. ________________

Gender (M/F) _____ Age (years) _____

I. Mesiodistal width of primary teeth (mm)

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II. Arch dimensions (mm)

Upper arch
- Intercanine width
- Intermolar width
- Anterior segment length (R/L)
- Posterior segment length (R/L)
- Arch length
- Anthropoid space

Lower arch
- Intercanine width
- Intermolar width
- Anterior segment length
- Posterior segment length
- A – P Arch length
- Anthropoid space