MALOCCLUSION AND TRAUMATIC DENTAL INJURIES IN RELATION TO OVER-JET AND LIP POSTURE IN 12-15 YEAR OLDS IN NAIROBI.

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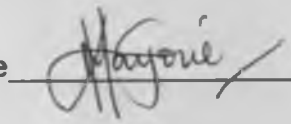
DECLARATION

I Marjorie Kaswii Muasya 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: 27/10/2009

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DEDICATION:

This thesis is dedicated to my mother Anne Mwikali Muasya. You have weathered fierce storms of life yet you remain calm and full of hope. May God give you strength to face each new day in this season of your life.

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ACRONYMS

TDIs – Traumatic Dental Injuries

DAI - Dental Aesthetic Index

OR- Odds Ratio

CPI – Community Periodontal Index

PDL – Periodontal Ligament

mm – millimeter

PE – Physical Education

WHO – World Health Organization

No. - Number

Edn- Edition

eds – Editors

RTAs – Road traffic accidents

df – degrees of freedom

X^2 - Chi- square

CI - Confidence interval

ABSTRACT

Aim: To determine the prevalence and pattern of occurrence of malocclusion and traumatic injuries to permanent anterior teeth and establish any association between traumatic injuries, over-jet and lip posture.

Design: This was a descriptive cross-sectional survey.

Setting: The study was carried out in public primary schools in the City of Nairobi, Kenya over a period of three months.

Subjects and methods: A sample of 1382 boys and girls aged 12–15 years was obtained by multi-stage random sampling of children in 8 divisions, then 16 zones, then schools were interviewed. Registration for malocclusion was done using the Dental Aesthetic Index (DAI) and the variables sought included missing teeth, crowding, over-jet and antero-posterior molar relations. Two hundred and twenty two children with history of traumatic dental injuries were identified. A structured questionnaire was used to obtain information on the trauma, symptoms associated, cause, site of trauma and if any treatment was sought. The data was collected by clinical examination of permanent anterior teeth of the children based on a modification of the WHO criteria with some variables sought including: number of teeth injured, type of teeth injured, classification of the trauma and type of treatment if any. Data was analysed aided by computer using the Statistical Package for Social Sciences (SPSS) programme. Chi-square and odds ratios statistical tests were done to determine the differences in malocclusion and trauma experience between males and females and the difference in trauma experience by different overjet groupings and lip posture. Student's t-test was used to determine difference in mean overjet between

children who had sustained traumatic dental injuries and those who had not. A p value of less than 0.05 was considered significant.

Results: Seven hundred and thirty two (53.0%) of the children examined had either no abnormality or only minor malocclusion, 318(23%) had definite malocclusion, 176(12.7%) and 156(11.3%) had severe malocclusion and very severe or handicapping malocclusion respectively. The mean DAI was 26.6. Prevalence and severity of malocclusion for male and female children did not differ significantly (p=0.139). The prevalence of TDIs was 16.1%. Males had experienced a significantly higher prevalence of trauma (18.8%) than females (13.5%) p=0.008. Amongst the male children, falls were the leading cause of TDIs (37.3%). Approximately half (44.8%) of the females did not remember the cause of injury while 31(36.5%) had sustained TDIs due to falls. One hundred and seventy two (77.5%) children who had experienced TDIs had no symptoms associated with the traumatized teeth. Ninety six (43.2%) of the children were injured while in the home environment. The maxillary central incisors were the most commonly traumatized teeth accounting for 220(73.5%) out of 299 injured teeth. The most frequently observed type of dental trauma was enamel fracture 206(68.9%) followed by enamel-dentin fracture 71(23.8%). Two hundred (90%) children had not sought treatment for TDIs. When frequency of TDIs in the children was related to overjet, it was found that out of the 886 children with overjet of 0-3 mm 104(11.8%) had experienced TDIs. Out of the 502 children with overjet greater than 3 mm, 118 (23.5%) were found to have TDI. The prevalence of TDIs in children with overjet greater than 3 mm was significantly higher than that in children with overjet of 3 mm and less (p=0.000). A significantly higher

prevalence of TDIs was found when children with incompetent lips 124(55.9%) were compared to those with competent lips 98(44.1%), (p=0.000).

Conclusion: There was an overall high prevalence of malocclusion among the children with no significant gender difference for most of the traits. The DAI criteria produced a mean DAI score of 26.6, with 11.3% of subjects exhibiting handicapping malocclusion. Overall traumatized permanent incisors were found to occur fairly frequently with 68.9% of the injured teeth having sustained enamel injuries. A very high proportion of traumatized teeth were untreated. Male gender, overjet greater than 3 mm and incompetent lips were found to be statistically significant risk factors for traumatic dental injuries.

Recommendation: Facilities and personnel should be put in place so that children with very severe or handicapping malocclusion can benefit from subsidized orthodontic therapy by specialists. There is need to improve oral health policies in Kenya so as to incorporate periodic checks ups in order to promptly diagnose and give advice on treatment of TDIs. The high proportion of untreated dental trauma among the children calls for improvement in children, parents and teacher education.

CHAPTER 1
INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

1.1.1 Malocclusion

Malocclusion is a deviation from the normal intra and or intermaxillary relationship of the teeth. It is not a single entity but rather a collection of situations, each in itself constituting a problem and any of the situations can be complicated by a multiplicity of genetic and environmental causes (1). The etiology of malocclusion is considered multi-factorial with three major factors influencing growth and development being hereditary influences, environmental and other specific causes (2). The prevalence and characteristics of malocclusion have been found to vary in different populations and ethnic groups (1,3,4,5,6) with the possibility of the genetic factor accounting for these differences (1).

1.1.2 Aetiology of malocclusion

Of primary importance is genetics whereby, considering the embryogenesis of craniofacial form, development is genetically determined through neural crest cell migration and through this, the expression of homeobox gene information. Epithelial-mesenchymal interaction during the process of craniofacial patterning, induction and programmed cell death is mediated by two groups of regulatory molecules, the growth factor and the steroid/ thyroid/retinoic acid superfamilies. In polygenic multifactorial systems, there is an additional factor, environmental modification (6). The environmental factors that influence malocclusion consist largely of pressures and forces related to physiologic activity; when there is alteration in the equilibrium; these forces then become detrimental resulting in malocclusion. The third group of factors that can cause malocclusion are grouped

under specific causes and these include: disturbances in embryologic development, skeletal growth disturbances, muscle dysfunction, acromegaly and hemimandibular hypertrophy and disturbances in dental development such as congenitally missing teeth, malformed and supernumerary teeth (2).

1.1.3 Impact of malocclusion

There is a general agreement among orthodontists that people are motivated to seek orthodontic care because of the adverse physical, psychological and social effects of malocclusion.

Majority of patients who present for orthodontic treatment do so due to concerns about dentofacial esthetics as they seek improvement in appearance. Other reported functions that may be impaired in persons with malocclusion include mastication, speech and pronunciation, emotional development and social contact (7). Mild forms of dentofacial deviation can predispose people to psychological distress and anxiety. Features such as increased overjet, extreme deep-bite, dental crowding, and spacing have all been reported to be associated with teasing and dissatisfaction (8,9,10,11). Unfavorable consequences of malocclusion on oral health include risk of caries, risk of trauma to upper incisors, predisposition to periodontal diseases and abnormality of stomatognathic function and temporo mandibular joint dysfunction.

1.1.4 Traumatic Dental Injuries

Trauma refers to injury; damage; impairment; external violence producing injury or degeneration (12). The predominant concern of pediatric dentistry has been treatment and prevention of dental caries. With the decline in the prevalence of this disease, the awareness of other oral health problems such as dental trauma

has been raised (13). Majority of traumatic dental injuries (TDIs) to children occur as a result of their activities and so long as the children remain active, these injuries will continue as a frequent dental problem that requires dedicated care (14). An injured permanent tooth is often a traumatic experience to the child and parent who are concerned with the aesthetic appearance. The clinician's concern, however, is usually on the extent, intensity and gravity of the injury, which may not only affect the tooth but also involve the supporting structures as well.

The type of dental traumatic injury varies considerably from minor injuries that do not require any treatment to more severe injuries that require both emergency treatment and several appointments for follow-up and various procedures. Dental trauma may occur as follows: crazing, fracture of enamel (including enamel chipping), fracture of enamel-dentin without pulpal involvement, fracture of enamel-dentin with pulpal involvement, fracture of root, crown-root fracture, concussion injuries, subluxation, intrusion, extrusive luxation, lateral luxation and avulsion (14). Prevalence of dental traumatic injuries to permanent incisors has been found to range from 2.7% to 29.6% (13, 15-21). Boys have a higher likelihood of dental traumatic injuries than girls while children with increased overjet and incompetent lips are more likely to sustain injury to their teeth. The common causes of injuries to children's teeth include falls, collisions, road traffic accidents, sports accidents and fights. Maxillary central incisors are the teeth most commonly affected by traumatic injuries while fractures into enamel and dentin are the most frequently encountered types of injury.

While several studies have been carried out locally to determine the prevalence of malocclusion, a literature search revealed paucity of information in the last twelve years. It is also worth noting that in the latest edition of The World Health Organization, Oral Health Surveys, Basic methods the DAI has been incorporated as criteria for assessing dento-facial anomalies (22).No study has been done in Kenya using this index. In Kenya, very few studies have been done to describe the pattern of TDIs (18-21). In addition, no study has been done to assess the relationship between TDIs, overjet and lip posture. Studies done elsewhere have shown that a positive correlation exists between lip incompetence and increased overjet with TDIs. Should this relationship be found to exist locally, recommendations can be made on their correction in order to prevent or reduce the prevalence of TDIs. Since the primary requisite before dealing with a public health problem is to describe its extent, distribution and associated variables, this study is crucial. It will be carried out so that once the extent of malocclusion, TDIs and their association is described then strategies can be designed for prevention and intervention.

1.2 LITERATURE REVIEW

1.2.1 Malocclusion

The aim of epidemiologic studies of malocclusion is to describe and analyse the prevalence and distribution of malocclusion in a population, the ultimate goal being to identify etiologic factors (23). It is worth noting that prevalence of malocclusion is a topic that presents a great methodological challenge, particularly in terms of applying valid and clinically relevant method for measuring the condition. At the same time data collected ought to be detailed and derived from both males and females in specific age-groups and regions (24). In many instances it is also difficult to directly compare prevalence of malocclusion between investigations as different criteria are adopted to record the conditions, levels of severity of malocclusion, sampling differences in age and gender, availability of study casts and radiographs and variability in accuracy of examiners (25).

Numerous epidemiologic studies have been done worldwide with an aim to describe malocclusion. Gabris et al. (4) in a study of 483 Hungarian adolescents aged 16-18 years reported orthodontic anomalies in 70.4% of the sample. The study also reported that 52.8% of the subjects had a class I occlusion while 29.6% and 20.3% showed a half cusp and full cusp antero-posterior molar relationship respectively. There was crowding in 14.3% of the sample while spacing was reported in 17%. The prevalence of other occlusal traits was: diastema 7.8%, largest anterior maxillary irregularity 56.7% and largest anterior mandibular irregularity 41.8%. 10.8% of the sample showed anterior open bite while 11.6% and 26.1% showed crossbite and deep bite respectively. In this study the differences in the male and female children were not noted for the

different types of malocclusions. Treatment need in this study was assessed using guidelines issued by the Hungarian Ministry of Health and on this basis it was found that 26% needed urgent treatment, while 35% had little need for treatment. The authors found a statistically significant association between the presence of malocclusion, caries experience and levels of oral hygiene ($p<0.05$).

A study on malocclusion and orthodontic treatment need in rural and urban Nigerian children aged 12-18 years showed that 77.4% had normal/minor malocclusion (treatment need: none or slight), 13.4% presented with definite malocclusion(elective treatment need), 5.5% severe malocclusion (highly desirable treatment need) and 3.7% very severe or handicapping malocclusion with a mandatory need for treatment (26). Missing teeth were recorded in 3.7% of the children while crowding and spacing in the incisal segments were recorded in 33.6% and 44.2% of the children respectively. Median diastema occurred in about a quarter of the sample, 12.1% and 29.2% had anterior maxillary and anterior mandibular irregularity respectively. Overjet of more or equal to 3mm was recorded in 14.1% of the sample, with 10.2% of the children showing anterior open bite while 16.2% had half cusp or full cusp antero-posterior molar relationship anomaly. No statistically significant differences were found in the DAI scores between age groups, gender and socio-economic background of the study sample. The authors concluded that Nigerian students had better dental aesthetics and less need for orthodontic treatment than American, Japanese and Australian adolescents.

A recent study by van Wyk et al. (23) on the orthodontic status and treatment need in 6142 South African children aged 12 years reported that 47.7% of the children in the sample presented with good occlusion or minor malocclusion with

treatment need in this group being slight or not required. Just over 52.1% presented with identifiable malocclusion; 21.2% showing definite malocclusion thus requiring elective treatment, 14.1% severe malocclusion with treatment need in this group being highly desirable and 16.9% very severe or handicapping malocclusion that required mandatory treatment. The authors found that the distribution of the number of children in the different DAI groups differed significantly for the different population groups (Asian, Black, Coloured, White), gender and dentition stage but not with location type or employment status of children's parents. When individual occlusal variables were studied, anterior maxillary and anterior mandibular irregularity occurred in more than 50% of the sample while more than 40% showed signs of crowding. Spacing in incisal segments occurred in almost 28% of the sample and midline diastema in 16.66% of children. At the age of 12 years, Black children showed a higher prevalence of maxillary midline diastema of more than 2mm than their White, Coloured and Asian counterparts. Overjet of more than 3mm was reported in 31% while a severe overjet of 6mm or more occurred in only 2.18% of the sample. Mandibular overjet affected only 10.43% of the sample and anterior open bite ranging from 1-8mm affected 7.7% of the children. Almost 44% of the sample had an antero-posterior molar relation discrepancy. The authors concluded that using DAI, prevalence and treatment need were slightly higher for younger children than in older ones and that there is a need to explore the use of dentition stage rather than chronological age as inclusion criteria in surveys using the DAI.

Malocclusion and orthodontic treatment need amongst 289 Tanzanian children aged 12-15 years was studied by Rwakatema et al. (27, 28) using the modified Bjork criteria (29) and the Dental Aesthetic Index. A very high overall prevalence

of malocclusion of 97.6% was reported. Angle's Class II and III malocclusion occurred in 6.9% and 11% of the sample respectively. Using the DAI criteria, it was found that 64.7% of the sample showed no abnormality or minor malocclusion with no treatment required or slight need for treatment, 21.5% definite malocclusion that required elective treatment, 6.9% severe malocclusion and 6.9% severe or handicapping malocclusion that call for a highly desirable and mandatory treatment need respectively. Anterior irregularities were high in the maxilla (46%) and mandible (51.6%) with females exhibiting significantly more irregularities than males in both jaws. Males were found to exhibit more crowding in incisor segments than females. Anterior open bite was 6.2%, deep bite 10.7% and the mean DAI score for the sample was 24.6%.

In Kenya, relatively few reports have been published on occurrence of malocclusion. Ng'ang'a et al. (30) in a study of occlusal anomalies and tooth loss in 13-15 year old children in Nairobi found a malocclusion prevalence of 47%. The prevalence of crowding was given at 25%, anterior open bite 10%, maxillary overjet 23%, traumatic bite and incisor rotation 1% and 4% respectively. The most recent and detailed investigation of prevalence of malocclusion was reported in 1996 by Ng'ang'a et al. (31). Nine hundred and nineteen children aged 13-15 years from Eastern, Western, Southern, Northern and Central Nairobi were assessed using the Bjork registration method. The prevalence of malocclusion was 72% with the predominant antero-posterior relationship of dental arches being neutral occlusion (93%) while distal occlusion was 6% and mesial occlusion 1%. Male children had a significantly higher prevalence of mesial occlusion than females. The specific malocclusion traits were highest for crowding (19%), rotations (19%), posterior crossbite (10%) and frontal open bite

(8%). While significantly more males than females had crossbite, the authors did not find any statistically significant difference in the overall prevalence of malocclusion between males and females. The combined value of prevalence of dental midline shift in both jaws was 18% while median diastema was observed in 15% of the children. It is worth noting that a much higher prevalence of diastema of 35% was reported by Kaimenyi et al. (32) in a study of midline diastema and frenum attachments amongst schoolchildren in Nairobi. The authors suggested that although the frequency of some occlusal anomalies was notably different from those reported in other African countries and among Caucasians, the Bjork classification may well be applied to the East African population.

In Kenya, only one published study was found assessing orthodontic treatment need and this was in 13-15 year old children in Nairobi (33). Using the Norwegian treatment need index in 919 children and the subjective need in 739 children, objective treatment need was recorded in 29% and subjective need in 33% of the children. Less than 1% were allocated the "very great need "category. Relatively more females than males were dissatisfied with the appearance of their teeth, and a significantly higher number of females ($p<0.001$) said they would like to have their teeth straightened. The children's perceived need for treatment correlated significantly with the treatment need index. Fixed appliances were found necessary for correcting malocclusion in 23% of the children and removable appliances in 6%. It was suggested that because of possible variation in occlusal conditions and in the degree of need for treatment in different areas of the country, other similar studies should be done to assess the need for treatment in different regions and that future studies should aim at determining

the societal perception of malocclusion upon which treatment standards may be based on.

While the most recent and detailed investigations on the prevalence of malocclusion and treatment need in Kenya were published 12 and 11 years ago respectively (31, 33), no local study on malocclusion has been done using the DAI criteria that links clinical and aesthetic components mathematically to produce a single score which combines the physical and aesthetic aspects of occlusion. A DAI score is obtained by measuring ten occlusal traits intra-orally and inserting the measurements into the DAI equation. The resulting DAI score is then placed in one of four severity categories to determine the relative orthodontic treatment need (34). The dental aesthetic perceptions of a Nigerian population were found to be similar to those of a US population thus the standard DAI found to be applicable without modification as a screening tool as well as in epidemiological surveys to assess orthodontic need (35). One of the aims of the present study was therefore to investigate the prevalence of malocclusion and treatment need of 12-15 year old children in Nairobi, Kenya using the DAI criteria and therefore provide an insight into the current situation with regards to orthodontic problems in this age group.

1.2.2 Prevalence and Age distribution of Traumatic Dental Injuries

Worldwide, numerous studies have been done documenting the prevalence of TDIs in children. Sgan-Cohen et al. (13) in a study of 1195 fifth and sixth grade pupils in Jerusalem found the prevalence of dental trauma to be 29.6%. Similar studies conducted in children aged 10-years old reported prevalence's of injuries to permanent incisors to be 17.4% in Mostoles, Spain (16) and 17% in 8-10 year

old in Canoas, Brazil. (36). In Tanzania, Kahabuka et al. (37) in a study of untreated dental trauma to 4-15-year-olds found a prevalence of 21%. A study done in Nairobi to determine the prevalence of these injuries in 2791 normal and handicapped children aged 5-15 years found this to be 11% in normal and 18% in handicapped children (19). Ng'ang'a et al. (18) on the other hand examined 251 children aged 13-15 years in Nairobi and found fractured incisors to have a prevalence of 16.8%. In rural Kenya, among children aged 12-18 years, the prevalence of fractured permanent incisors was found to be 15% (20).

Regarding the age group most affected by TDIs, Zuhal et al. (38) found this to have been the 9-11-year-old group. Similar results in Kenya found injuries to increase with age from 6% in the 5-7-year-age group to 18% in the 14-15-year group with the age group most affected having being 10-12 years (19). Muriithi et al. (21) in the most recently documented study on traumatic dental injuries in Kenya reported an initial peak of injuries at 4 years of age (13.5%) followed by a second peak at 8 years of age (6.5%). However, this was a hospital-based study and the results may differ from those obtained in prevalence based studies in the community. In Brazil, Grimm et al. (15) found the distribution of trauma cases to increase along with age with the 11 year olds having the highest percentage distribution of trauma. It has been suggested that the 10-12 year old age group is one where most children engage in active and sometimes dangerously aggressive games thus explaining why the distribution of trauma is high (19).

1.2.3 Gender Distribution of Traumatic Dental Injuries.

Boys are affected more often by TDIs of the permanent dentition than girls. In a study of 73,243 school children in Brazil, Grimm et al. (15) found boys were 1.58

times more likely to present with dental trauma. In Jerusalem, however, Sgan-Cohen et al. (13) found no association with gender for mild trauma (trauma limited to enamel). They however found higher levels of boys (16%) to be involved in severe trauma than girls (10.9%). In Spanish children with dental trauma, Tapias et al. (16) found boys had a prevalence of 67.1% and girls 32.9%.

A study by Ng'ang'a et al. involving 250 children consisting of 111 boys and 139 girls reported that 21.6% of males had fractures while fewer injuries were reported in girls; 12.9% (18). Ohito et al. (19) in a local study in Kenya also reported similar findings with boys having a higher prevalence of injuries (14%) than (11%) girls. In another Kenyan study, Muriithi et al. (21) examined hospital records of 505 patients with dental injuries aged 0-15 years old and reported a similar trend with boys sustaining 63.0% of the injuries and girls 37.0%, giving a male: female ratio of 1.7:1.

1.2.4 Distribution of TDIs in the dentition.

Some studies have revealed that maxillary teeth and particularly central incisors are the teeth most affected by dental trauma. Zuhal et al. (38) in a study of 317 patients aged 6 to 17 years with a history of trauma in Southern Turkey found maxillary teeth (88.5%) and central incisors (87.5%) to have been the teeth most affected by trauma. They also found Ellis class II crown fracture to be the most frequently seen type of injury (43.8%). Bauss et al. (39) in a study of 1367 candidates for orthodontic treatment found maxillary teeth to be involved in 96% of trauma cases and mandibular teeth in 4%; the most frequently affected teeth in his study were maxillary central incisors (79.6%) followed by maxillary lateral incisors (16.4%). No significant difference was observed between the right and

left side and the most common types of trauma were fracture of the enamel-dentin without pulpal involvement (42.7%) and fracture of enamel (33.8%). Similar results were also found in a study of 251 school children in Nairobi aged 13-15 years among whom 88.1% of fractures were of maxillary incisors and 11.9% of mandibular incisors (18). However, 83% of the fractures involved enamel only and 17% enamel and dentin with no fractures involving the pulp or avulsions being encountered. Tapias et al. (16) in a study of 470 Spanish school children aged 10 years also found that 55% of fractures involved enamel, 43.9% enamel-dentin and 0.93% enamel-dentin-pulp.

1.2.5 Causes of Traumatic Dental Injuries

Various causes have been attributed to TDIs. Sgan-Cohen et al. (13) in a study of 1195 5th and 6th grade children in Jerusalem found that, at school, the main reasons for trauma were falling, violence and sport while at home they were falls and thrusting of a hard object in the mouth. Zuhal et al. (38) studied 317 patients with trauma in Turkey and found falls to account for 47.6% as the leading cause of trauma followed by collisions (23.7%), bicycle accidents (17.4%), sports accidents (3.8%) and traffic accidents (3.4%). Bauss et al. (39) also showed similar studies among 1367 patients who attended treatment in a private orthodontic practice: the major causes of dental trauma were falls in (49.6%), traffic accidents (17.0%) and sports activities (14.2%). Injuries to children may occur in different settings. In the study by Bauss, 48.2% of accidents had occurred at home, 17% in the street and 13.5% at school while Tapias et al. (16) had different findings with 52.4% of injuries occurring in the street, 18.3% at home, 15.9% in school and 13.4% unknown.

1.2.6 Risk factors for Traumatic Dental Injuries

Increased overjet and inadequate lip coverage are considered significant risk factors for dental traumatic injuries in many clinical studies. Otuyemi (40) in a study of 1016 twelve year old Nigerian children found that of the 111 children with traumatic dental injuries, 71 (64%) had increased incisor overjet (>3mm) compared to 257 of the 905 children (28.4%) in the non-trauma group; similarly 72 (64.9%) of the trauma group had inadequate lip coverage compared to 224 (24.8%) in the non-trauma group. Kania et al. (41) found the risk of incisor injury was greater for children who had a prognathic maxilla and increased overjet. Forsberg et al. (42) also showed similar results whereby post normal occlusion, an overjet exceeding 4mm, short upper lip, incompetent lips and mouth breathing were found to have been factors that significantly increased susceptibility to traumatic dental injury. Dental trauma has been found to be more prevalent among children with an incisal overjet of more than 4mm and with incompetent lips (13). In a study of 459 school children aged 10-12 years in Jordan, Hamdan et al. (43) found that children with an overjet greater than 5mm sustained significantly more injuries to incisors than those with normal overjet. Soriano et al. (44) in a study of 116 children in Brazil aged 12 years found that those with inadequate lip coverage were more likely to have traumatic injuries than those with adequate lip coverage (p=0.000). Also, children with an overjet greater that 5mm were found to have experienced more dental injuries than those with an overjet size equal or lower than 5mm. Artun et al. (45) in a study of 1583 children in early permanent dentition found that the mean overjet was larger (3.9 v 3.0) and lip incompetence more frequent (12.7% v 7.3%) among subjects with injured maxillary incisors than among those without. The odds of maxillary incisor trauma

were 2.8 times higher in subjects with overjet between 6.5 and 9.0mm and 3.7 times higher in subjects with an overjet more or equal to 9.5mm than in subjects with overjet of 3.5mm or less. Nguyen et al. (46) in a meta-analysis of 11 studies that assessed risk of TDIs due to overjet found that for overjet of 3mm and less versus more than 3mm, the pooled OR was 2.3. When the studies were stratified by gender, the pooled ORs were 2.90 and 1.77 for girls and boys respectively thus demonstrating that within the same overjet group the effect of overjet is less for boys than for girls. In the same study when the overjet groups of 3mm and less was compared with that of more than 6mm, the pooled OR was 2.63.

A much higher prevalence of trauma has also been found in individuals with cerebral palsy. In a study of 68 individuals aged 7-21 years, Holan et al. (47) found the prevalence of trauma to have been 57% with boys sustaining slightly less injuries than girls (56% and 59% respectively). These children have uncontrolled head movements which commonly cause dental injuries as the teeth are bumped against hard objects located in the individual's vicinity. Handicapped patients have been found to sustain higher levels of TDIs as depicted in a study of physically and mentally handicapped children by Ohito et al. (19) where these children had a prevalence of 18% of TDIs while normal children had 11% of injuries.

A recently reported risk factor is handedness in relation to traumatic injuries. In a study of 2180 patients aged 13-17 years, old Canakci et al. (48) found that left-handers had a higher level of traumatized permanent incisors with 28.3% of left-handers and 11.7% of right-handers having dental trauma.

Many studies have been done worldwide on traumatic dental injuries to describe their prevalence and associated risk factors. While few studies have been done in Kenya, only one targeted a large sample size of 2342 children. This study was done 18 years ago thus the need to do one that will describe current trends. The other studies had a much smaller sample size of approximately 200, which may not be well representative of the population at large. The most recent study carried out had a sample of 505 children examined but was hospital-based. While the information provided in the study is useful, hospital-based studies have been found to provide less epidemiological evidence than population-based studies thus the need to carry out a study in schools.

No local study has sought to identify the occlusal risk factors in children with traumatized teeth thus the need to explore this. Therefore the main aim of this study was to determine the pattern of occurrence of malocclusion and TDIs and their relationship to over-jet and lip posture so as to fill the gap that exists locally while at the same time provide data that currently reflects the trends of traumatic dental injuries among Kenyan children aged 12-15 years.

1.3 Research problem

Malocclusion is a commonly reported oral anomaly in children and can result in functional and psychologic problems. Studies on malocclusion in the secondary dentition in Kenya are scanty and so far none has been done using the Dental Aesthetic Index. Formulation of health policies and planning of an oral health service is difficult without adequate information on the status of a population.

The anterior teeth have been found to be the teeth most commonly involved in dental traumatic injuries. Trauma to these teeth occurs at an early age and can lead to fractures, pulpitis, pulpal necrosis and eventual loss of anterior teeth that are important both functionally and aesthetically. Lip incompetence and increased overjet have been found to be significant risk factors for TDIs. The current study undertook to establish the situation in the 12-15-year-old age group of children in Nairobi and relate this to over-jet and lip posture. The prevalence of TDIs has been reported to occur at a peak age of 8-11 years (16,37) thus the need to target children above this age group.

Management of TDIs is costly and time consuming to both the parent and child who has to be absent from school. These injuries are preventable and therefore when the factors contributing to their occurrence can be identified, preventive measures can be instituted.

1.4 Justification

While many studies have been conducted worldwide to establish the levels of oral disease, few epidemiological studies have been done in Nairobi to describe the pattern of occurrence of malocclusion and TDIs. No data has been published on the relationship between TDIs and overjet and lip posture in Kenya. The impact of malocclusion and TDI in children's lives is great in terms of functional

and aesthetic disability. There is therefore need to obtain these data in order to lobby for specific public health policies that seek to prevent, intercept or treat malocclusion. Obtaining data on TDIs would be vital in decreasing the prevalence of injuries among children by planning of prevention programmes and improving management of children with TDIs.

1.5 Objectives:

1.5.1 General Objective:

The purpose of this study was to determine the prevalence and pattern of occurrence of malocclusion and traumatic dental injuries (TDIs) and their relationship to over-jet and lip posture in 12-15-year-old Public Primary School Children in Nairobi, Kenya.

1.5.2 Specific Objectives:

1. Describe the pattern of occurrence of malocclusion using the Dental Aesthetic Index
2. Determine prevalence and gender distribution of traumatic dental injuries
3. Determine the etiological factors associated with TDIs
4. Determine the association between size of overjet and TDIs
5. Determine the association between lip posture and TDIs

1.6 Null hypotheses:

i. Malocclusion is not related to gender
ii. Prevalence of TDIs is not different between males and females
iii. Traumatic dental injuries are not related to size of overjet
iv. Traumatic dental injuries are not related to lip posture

1.7 Variables:

1.7.1 Independent:

- Gender
- Overjet
- Lip posture

1.7.2 Dependent:

- Malocclusion
- Traumatic dental injuries

CHAPTER 2

2.0 MATERIALS, SUBJECTS AND METHODS

2.1 Study Area

The study was carried out in Nairobi, which is the Capital City and one of the 8 provinces in Kenya (Figs 2.1 & 2.2). Nairobi covers an area of 696 sq Km and is located on latitude 36 50' East and longitude 17' South, 145 Km south of the equator. It is at an altitude of 5500 feet above sea level. Nairobi is Kenya's principal economic, administrative and cultural center and one of the largest and fastest growing cities in Africa. According to the 1999 Population and Housing Census, Nairobi has a total population of 2,143,254 persons with 649,426 households. 44% of the population is below 15 years of age. It is the most densely populated province in Kenya with 3079 persons per sq. Km. The population in the city continues to increase consistently with an inter-censal growth rate of 4.8% (1989-1999) contributed to by rural-urban migration among other factors. Nairobi acts as the trade and distribution center for Kenya and East Africa at large. Nairobi is divided into eight administrative divisions namely: Kasarani, Westlands, Embakasi, Dagoretti, Kamkunji, Makadara, Starehe and Langata.

Figure 2.1: Map of Kenya showing the location of Nairobi, the study area.

9.1.2 MAP OF NAIROBI

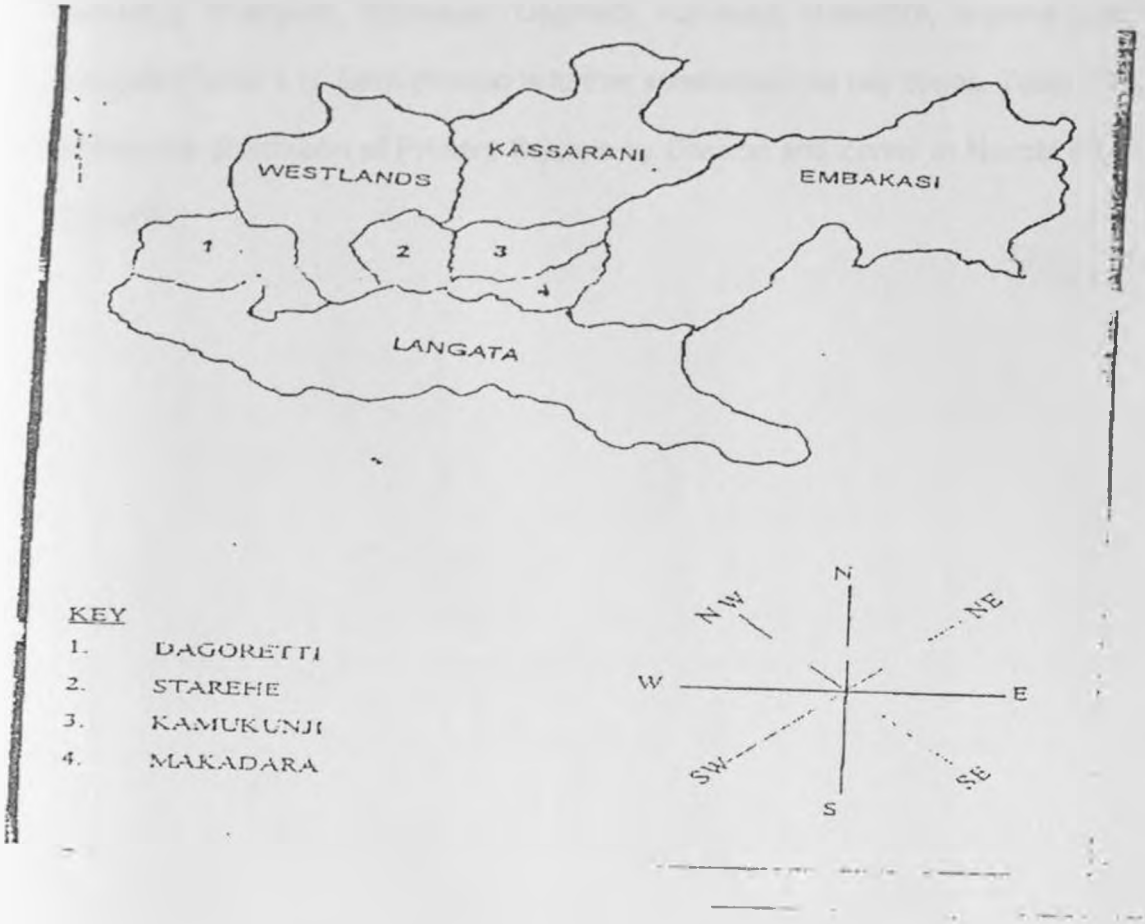

Figure 2.2: Map of Nairobi (Showing divisions in Nairobi).

2.2 Primary Schools in Nairobi

The study was done in public schools, which are managed by the City Council. The council's education department has divided the City into 8 divisions namely Kasarani, Westlands, Embakasi, Dagoretti, Kamkunji, Makadara, Starehe and Langata (Table 1.1). Each division is further subdivided into two zones. Table 1.1 shows the distribution of Primary Schools by Division and Zones in Nairobi City Council.

Table 2.1: Distribution of Nairobi City Council Public Primary Schools

Division	Zones	Number of schools
Kasarani	Ruaraka	12
	Kahawa	14
Westlands	Kilimani	12
	Parklands	13
Embakasi	Kayole	16
	Dandora	13
Dagoretti	Riruta	12
	Waithaka	12
Kamukunji	Bahati	10
	Eastleigh	7
Makadara	Viwanda	12
	Buruburu	14
Langata	Karen	6
	Nairobi West	8
Starehe	Juja Road	16
	Central	15

The Primary School classes are from Standard 1 to Standard 8 with the age of entry into Standard 1 ranging from 6-7 years of age while the age of exit from Standard 8 ranges from 13 to 15 years of age.

2.3 Study Population

The study population was defined as children aged 12-15 years from public primary schools in Nairobi.

2.4 Study Design

This was a descriptive cross-sectional study using school-based study groups.

2.5 Sample Size Determination

The sample size was estimated using the WHO recommended formula (49) below:

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

Where:

n: minimum sample size

Z:Standard normal deviate set at 1.96 corresponding to a confidence level of 95%

P:Estimated local prevalence of TDIs 16.8% (7)

C:1-Confidence level (where confidence level is 95%)

Therefore:

$$n = \frac{(1.96)^2 \times 0.168(1-0.168)}{(0.05)^2} \qquad n=215$$

Given the prevalence of TDIs at 16.8%, to obtain a sample size of 215 children with TDIs required screening of at least 1280 children.

2.6 Sampling Procedures

The study sample comprised of 12-15-year-old primary school children from public schools within Nairobi. Sampling was done by multi-stage cluster sampling

method in order to determine the schools that would be involved in the study. The 8 school divisions were listed and numbered 1 to 8 after which a table of random numbers was used to select 6 divisions. For each division selected, the school zones were listed and one zone selected per division. The schools in each of the six zones selected were then listed and one school per zone selected. At each stage the table of random numbers was used.

The schools selected were Ndurarua Primary School in Waithaka Zone, Dagoretti Division, Statehouse Primary School in Kilimani Zone, Westlands Division, St Brigid's Primary School in Central Zone, Starehe Division, Kimathi Primary in Bahati Zone Kamkunji Division, Plainsview Primary School in Viwanda Zone, Makadara Division and Kibera Primary School in Karen Zone, Langata Division. The number of children to be examined in each school was obtained by proportionate sampling. In each of the schools selected, class registers for Standard 6, 7 and 8 (which are the classes where children aged 12 -15 years were found) were obtained and then the children to be examined were randomly selected. Consent forms were issued a week prior to data collection and during the next visit to the schools only the children with consent from their parent or guardian participated in the study.

2.7 Inclusion Criteria

- School children aged 12-15 years of age
- Children who had obtained parental consent to participate in the study
- Children who assented to participate in the study

2.8 Exclusion Criteria

- Children with history of orthodontic therapy

- Children undergoing orthodontic therapy
- Children with discoloured anterior teeth but no history of trauma
- Children with restored anterior teeth but no history of trauma
- Children in mixed dentition
- Children who did not assent to participate in the study

Children with discoloured anterior teeth and with restored anterior teeth but no history of trauma were excluded since these may have been caused by dental caries.

2.9 Data Collection Instruments and Procedures:

2.9.1 Calibration

Prior to data collection ten dental casts of patients that represented the types of malocclusion that were expected in the population were selected and subjected to a full orthodontic examination at the University of Nairobi School of Dental Sciences.

Training and calibration consisted of the following: one supervisor, Peter M Ng'ang'a calibrated the investigator and one assistant (A community oral health officer) who was recruited to assist in oral examinations. Calibration involved registration of traumatic dental injuries on actual patients at the University of Nairobi Dental Hospital while for malocclusion calibration using the DAI was done on study models that represented different types of malocclusion likely to be encountered in the field. This was then followed by calibration on actual patients seen at the University Of Nairobi School Of Dental Sciences. The Kappa values for intra and inter-examiner variability were 0.9244 and 0.9103 respectively with $p>0.05$ thus showing acceptable agreement within and between examiners. Two

field assistants were trained on recording during the oral examinations as well as disinfection and sterilization of the instruments to be used. They were also responsible for recalling every 10th child for re-examination without informing the examiners of this.

During the data collection the investigator was under constant monitoring by the supervisors.

2.9.2 Data Collection

An intra-oral examination was carried out for each child under natural light with the child seated on a classroom chair and the examiner standing.

A dental mouth mirror, gauze and a Michigan "O" probe were used. For the protection of the examiners, surgical masks and disposable latex gloves were used. After each child was examined, gloves were changed.

The children were examined for malocclusion and traumatic dental injuries.

2.9.3 Protocol for examination and recording of malocclusion:

The Dental Aesthetic Index (50) criteria was used to determine the malocclusion. The index has been adopted by the World Health Organization as a cross-cultural index (22) and it identifies deviant occlusal traits and links clinical and aesthetic components mathematically to produce a single score. The structure of the DAI consists of 10 prominent traits of malocclusion, weighted on the basis of their relative importance according to a panel of lay judges (50).

The criteria were as below:

Missing incisor, canine and premolar teeth:

The number of missing permanent incisor, canine and premolar teeth in the upper and lower arches were counted. Missing tooth not recorded if space was closed, if a primary tooth as still in position and its successor has not yet erupted

or if a missing incisor, canine or premolar tooth had been replaced by a fixed prosthesis. Teeth extracted for aesthetic reasons were not recorded.

Crowding in the incisal segments:

Upper and lower incisal segments were examined for crowding. Crowding in the incisal segment was the condition in which the available space between the right and left canine teeth was insufficient to accommodate all four incisors in normal alignment. Teeth may be rotated or displaced out of alignment in the arch. They were recorded as follows:

0 No crowding

1 One segment crowded

2 Two segments crowded

If in doubt the lower score was assigned. Crowding was not recorded if the four incisors were in proper alignment but either or both canines were displaced.

Spacing in the incisal segments:

Spacing is the condition in which the amount of space available between the right and left canine teeth exceeds that required to accommodate all four incisors in normal alignment. If one or more incisor teeth had proximal surfaces without any interdental contact, the segment was recorded as having space. Space from an exfoliated primary tooth was not recorded if it appeared that the permanent replacement would soon erupt. Recorded as follows:

0 No spacing

1 One segment spaced

2 Two segments spaced

If in doubt the lower score was assigned

Diastema:

A midline diastema is defined as the space, in millimeters between the two permanent maxillary incisors at the normal position of the contact points. It was measured at any level between the mesial surfaces of the central incisors and recorded to the nearest whole millimeter.

Largest anterior maxillary irregularity:

They may be rotations out of, or displacements from normal alignment. The four maxillary incisors were examined to locate the greatest irregularity. The tip of a CPI probe was placed in contact with the labial surface of the most lingually displaced or rotated incisor while the probe was held parallel to the occlusal plane and at right angles to the normal line of the arch. The irregularity to the nearest whole millimeter was estimated from the markings on the probe. Irregularities on the distal surface of the lateral incisors were also considered.

Largest anterior mandibular irregularity:

It was registered if there was rotation out of or displacement from normal alignment of the anterior mandibular teeth. The tip of the probe was placed in contact with the labial surface of the most ligually displaced or rotated incisor with the probe held parallel to the occlusal plane and at right angles to the normal line of the arch. The irregularity to the nearest whole millimeter was estimated from the markings on the probe. Irregularities on the distal surface of the lateral incisors were also considered.

Anterior maxillary overjet:

With the teeth in centric occlusion the distance from the labio-incisal edge of the most prominent upper incisor to the labial surface of the corresponding lower incisor was measured with the CPI probe parallel to the occlusal plane. It was

recorded to the nearest whole millimeter. No recording if all maxillary incisors were missing or in lingual crossbite. If incisors occluded edge to edge, the score was zero.

Anterior mandibular overjet:

It was measured from the labio-incisal edge of the most prominent mandibular incisor to the labial surface of the maxillary incisors. This was considered present when the length was greater than zero millimeters. It was not recorded if a lower incisor was rotated so that one part or its edge was in cross-bite (i.e. labial to the upper incisor).

Vertical anterior open bite:

If there was lack of vertical overlap between any of the opposing pairs of incisors the amount was estimated to the nearest whole millimeter using the CPI probe.

Antero-posterior molar relation:

The right and left permanent upper and lower first molars were assessed with the teeth in occlusion and the largest deviation from normal molar relation was recorded as follows:

O Normal

1 Half cusp. The lower first molar was half a cusp mesial or distal to its normal relation.

2 Full cusp. The lower first molar was one cusp or more mesial or distal to its normal relation

The severity of malocclusion was classified as shown in the table below:

Table 2.2: The DAI groups of severity of malocclusion and treatment need.

DAI score	Severity of malocclusion	Treatment indication
≤25	No abnormality or minor malocclusion	No or slight need
26-30	Definite malocclusion	Elective
31-35	Severe malocclusion	Highly desirable
36 or more	Very severe or handicapping malocclusion	Mandatory

The regression equation used for calculating standard DAI scores was as follows (50): (missing visible teeth x 6) + (crowding) + (spacing) + (diastema x 3) + (largest anterior maxillary irregularity) + (largest anterior mandibular irregularity) + (anterior maxillary overjet x 2) + (anterior mandibular overjet x 4) + (vertical anterior open bite x 4) + (antero-posterior molar relation x 3) + 13. The sum is then equal to an individual's standard DAI score.

Lip posture was also measured. Lips were recorded as competent if the child entered the room (before being aware of the impending examination) with closed lips (2) or the lips were separated at rest by less than 3mm and incompetent if the lips were separated at rest by more than 3mm (53).

Results of this examination were recorded in a clinical examination form (Appendix 1).

2.9.4 Traumatic dental injuries:

A structured self administered questionnaire (Appendix 2) with both open and close-ended questions was administered to the children and the information sought included: age, sex, symptoms associated with traumatized teeth, etiology of trauma, place of injury and if any treatment had been sought.

The teeth examined were: 13, 12, 11, 21, 22, 23, 33, 32, 31, 41, 42 and 43. Traumatic injuries were recorded based on a modification of the WHO criteria (51) as below:

Enamel infraction: An incomplete fracture of enamel without loss of tooth substance

Enamel fracture: A fracture with loss of enamel only

Enamel-dentin fracture: A fracture with loss of enamel and dentin but not involving the pulp

Complicated crown fracture: A fracture involving enamel and dentin and exposing the pulp.

Luxation injuries: these included concussion, subluxation, extrusive luxation, lateral luxation and intrusive luxation.

- Concussion: An injury to the tooth-supporting structures without abnormal loosening or displacement of the tooth but with increased reaction to percussion
- Subluxation: An injury to the tooth supporting structures with abnormal loosening but without displacement of the tooth
- Extrusive luxation: Partial displacement of the tooth out of its socket
- Lateral luxation: Displacement of the tooth in a direction other then axially.

- Intrusive luxation: Displacement of a tooth into the alveolar bone.

Avulsion: Complete displacement of a tooth out of its socket

The investigator also recorded teeth with discoloration and restorations after verification that these teeth had sustained traumatic injuries.

The results were recorded in a clinical examination form (Appendix 3).

2.10 Data analysis and presentation

Data collected was entered into a computer and analyzed using statistical package for social sciences [SPSS] 12.0[SPSS Inc, Chicago, Illinois, USA] with the help of a biostatistician. Data cleaning was done by running frequencies and re-entering missing data. The information obtained from the study was organised and presented as descriptive statistics in the form of frequency tables, pie charts and graphs.

For each variable frequencies were computed. Chi-square and odds ratios statistical tests were done to determine the differences in malocclusion and trauma experience between males and females and the difference in trauma experience by different overjet groupings and lip posture. Mann Whitney test was done to determine the difference in mean traumatized teeth between male and female children. Student's t-test was used to determine difference in mean overjet between children who had sustained traumatic dental injuries and those who had not. A p value of less than 0.05 was considered significant.

2.11 Logistical considerations

Transport: The investigator and assistants used a personal vehicle and where this was not possible hired a taxi to get to the schools.

Crowd control: The children completed the questionnaire in their respective classrooms under the supervision of the investigator and trained assistant and were at liberty to ask questions any time during the exercise. The intra-oral examination was then done in a separate room. The children were called using the order of names in the class list and examined. In order not to interfere with the school programme, the Head teachers were requested to allow for the data collection to be done during the time allocated for clubs and games.

2.12 Ethical considerations

- Ethical approval for the research was sought and obtained from the Kenyatta National Hospital and University of Nairobi Ethics, Research and Standards Committee (Appendix 5)
- Permission was also sought from The Nairobi City Council Education Department following which head teachers from the schools were consulted to grant permission for the research to be carried out in their schools.
- Consent was obtained from parents through a form that each child was asked to have signed by their parent/guardian prior to the day of data collection (Appendix 4). All information obtained was handled with confidentiality.
- Any participant was at liberty to decline to participate in the study. On completion, the results of the study shall be published in order to benefit the community at large.
- Children found to have any dental diseases were advised accordingly and given referral letters to the nearest oral health facility.

CHAPTER 3

3.0 RESULTS:

3.1 Socio-demographic characteristics:

A total of 1382 children were recruited from 6 City Council primary schools interviewed and examined. The children were from 6 City Council primary schools in Nairobi. The male children from various primary schools were distributed as follows: Kibera Primary school 203(30.2%), Ndurarua 177(26.3%), State House 87(12.9%), Plainsview 80(11.9%), Kimathi 65(9.7%) and St. Brigid Primary Shool 60(8.9%). The distribution of the female children was as follows: 254(33%) Kibera, 160(22.5%) Ndurarua, 97(13.7%) Kimathi, 89(12.5%) State House, 85(12%) Plainsview and 45(6.3%) St. Brigid Primary Shool (Table 3.1).

Table 3.1: Distribution of the children by school and gender:

GENDER	NAME OF PRIMARY SCHOOL						
	KIBERA	NDURARUA	STATE HOUSE	PLAINS VIEW	KIMATHI	ST. BRIGID	Total
Male	203 (30.2%)	177 (26.3%)	87 (12.9%)	80 (11.9%)	65 (9.7%)	60 (9.0%)	672
Female	234 (33.0%)	160 (22.5%)	89 (12.5%)	85 (12.0%)	97 (13.7%)	45 (6.3%)	710
TOTAL	437	337	176	165	162	105	1382

Of the 1382 children, 672 (48.6%) were males while 710 (51.4%) were female. Of the children examined, 339(24.6%) were 12 years old, 433(31.3%) were 13 years of age while 441(31.9%) and 169(12.2%) were 14 and 15 years old respectively

(Table 3.2). The mean age for the 1382 children was 13.3 years (SD 0.98) with a median age of 13.0. The mean age of the male children was 13.4years (SD 0.99) while that for the female children was 13.2 years (SD 0.95).

Table 3.2: Distribution of the children examined by age and gender: M=Male, F=Female

Age(years)	M		F		Total	
	n	%	n	%	n	%
12	142	21.1%	197	27.8%	339	24.6%
13	195	29%	238	33.5%	433	31.3%
14	233	34.7%	208	29.3%	441	31.9%
15	102	15.2%	67	9.4%	169	12.2%
Total	672	48.6%	710	51.4%	1382	100%

3.2 The occurrence and pattern of malocclusion recorded according to the Dental Aesthetic Index

3.2.1 Missing incisor, canine and premolar teeth:

In the current study 1382 children were examined for malocclusion. Seventy (5.1%) children were found to have missing teeth clinically; 37(5.51%) of these being male and 33(4.65%) females (Table 3.3). There was no significant difference in the overall prevalence of missing teeth when male and female children were compared (Pearson chi-square=0.529, 1df, p=0.467). There were 46 children missing one tooth; 26(3.87%) were males and 20(2.82%) were

female children. The greatest number of missing teeth recorded was 6 seen in 1(0.15%) male child.

Table 3.3: Distribution of the children by the number of missing teeth:

Number of missing teeth	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
Children with missing teeth	37	(5.51%)	33	(4.65%)	70	(5.1%)
Children without missing teeth	635	(94.49%)	677	(95.35%)	1312	(94.90%)
1 tooth missing	26	(3.87%)	20	(2.82%)	46	(3.3%)
2 teeth missing	7	(1.04%)	12	(1.69%)	19	(1.4%)
3 teeth missing	2	(0.30%)	0	(0%)	2	(0.15%)
4 teeth missing	1	(0.15%)	1	(0.14%)	2	(0.15%)
6 teeth missing	1	(0.15%)	0	(0%)	1	(0.1%)

3.2.2 Distribution of children with crowding in the incisal segments:

Crowding was found in 652(47.2%) of the children who were examined. Three hundred and twenty five (48.4%) male and 327(46.1%) female children presented with crowding. When those with crowding were further evaluated, 194(28.9%) males and 197(27.8%) females showed crowding in one segment while 131(19.5%) males and 130(18.3%) females had crowding in two segments(Table 3.4).There was no significant difference in the distribution of crowding between male and female children (Pearson chi-square=0.758, 2df, p=0.685).

Table 3.4: Distribution of children with crowding in the incisal segments.

Crowding in incisal segments	Male n (%)	Female n (%)	Total n (%)
No crowding present	347 (51.6%)	383(53.9%)	730(52.8%)
Crowding present	325(48.4%)	327(46.1%)	652(47.2%)
One segment crowded	194(28.9%)	197(27.8%)	391(28.3%)
Two segments crowded	131(19.5%)	130(18.3%)	261(18.9%)

3.2.3 Distribution of spacing of teeth in the incisal segments by gender:

The study found that 644 (46.6%) of the children examined had spacing in the incisal segments. About half (46.7%) of the male and (46.4%) of the female children showed spacing. Among the male children 186(27.7%) had spacing limited to one segment while this was found in 170(23.8%) females. One hundred and twenty eight (46.7%) and 160(22.6%) male and female children respectively had spacing in both the maxillary and mandibular arches. There was no statistically significant difference in the distribution of spacing when male and female children were compared (Pearson chi-square=4.037, 2df, p=0.133) (Table 3.5).

Table 3.5: Distribution of spacing by gender:

Spacing in incisal segments	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
No spacing present	358	(53.3%)	380	(53.6%)	738	(53.4%)
Spacing present	314	(46.7%)	330	(46.4%)	644	(46.6%)
One segment spaced	186	(27.7%)	170	(23.9%)	356	(25.8%)
Two segments spaced	128	(19.0%)	160	(22.5%)	288	(20.8%)

3.2.4 Prevalence of midline maxillary diastema.

Out of the 1382 children examined, 289(20.2%) had dentitions that exhibited a diastema.

Among the children with diastema 69(10.3%) males and 69(9.7%) females had a diastema of 1mm. Forty three (6.4%) males and 45(6.3%) females had a diastema of 2mm while 17(2.5%) males and 26(3.7%) females had a 3mm diastema. Eight children had a 4mm diastema with 2(0.3%) being males and 6(0.8%) females. Four (0.6%) male children had a diastema of 5mm. The largest diastema found in males was 6mm as seen in 1 child and 8mm in females as seen also in 1 child (Table 3.6). There was no statistically significant difference in the prevalence of diastema between the male and female children (Pearson chi-square=0.359, 1df, p=0.549)

Table 3.6: Distribution of the children by size of diastemata:

Diastema	Male		Female	
	n	(%)	n	(%)
1 mm	69	(10.3%)	69	(9.7%)
2 mm	43	(6.4%)	45	(6.3%)
3 mm	17	(2.5%)	26	(3.7%)
4 mm	2	(0.3%)	6	(0.8%)
5 mm	4	(0.6%)	4	(0.6%)
6 mm	1	(0.1%)	2	(0.3%)
8 mm	0	(0.0%)	1	(0.1%)
Total	136	(20.2%)	153	(21.5%)

3.2.5 Largest anterior maxillary irregularity:

The results of the study show that 533(38.6%) of the children had incisor irregularity in the maxillary arch with 276(38.87%) being female and 257(38.24%) being male children. The size of irregularities in females ranged from 1 to 7mm with 97(13.66%) girls exhibiting a 2mm irregularity and only 1(0.14%) having 7mm irregularity (Table 3.7). In males the incisor irregularity ranged from 1-9mm with 3mm irregularity being the most common as found in 86(12.80%) of the boys and only 1(0.15%) showed 9mm irregularity. Overall there was no statistically significant difference in the largest anterior maxillary irregularity between male and female children with a Pearson chi-square=0.068, 1df, p=0.794.

Table 3.7: Distribution of children by maxillary irregularity

Maxillary irregularity	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
No irregularity present	415	(61.76%)	434	(61.13%)	849	(61.4%)
Irregularity present	257	(38.24%)	276	(38.87%)	533	(38.6%)
1 mm	57	(8.48%)	58	(8.17%)	115	(8.3%)
2 mm	78	(11.60%)	97	(13.66%)	175	(12.7%)
3 mm	86	(12.8%)	87	(12.25%)	173	(12.5%)
4 mm	21	(3.13%)	18	(2.53%)	39	(2.8%)
5 mm	7	(1.04%)	9	(1.27%)	16	(1.2%)
6 mm	5	(0.74%)	6	(0.85%)	11	(0.8%)
>6 mm	3	(0.45%)	1	(0.14%)	4	(0.3%)

3.2.6 Largest anterior mandibular irregularity

Incisor irregularity in the mandibular arch was found in 430 (31.1%) of the children examined. Two hundred and twenty (32.7%) were male and 210(29.6%) female. In male children mandibular irregularity ranged from 1 to 6mm with 117(17.4%) children showing an irregularity of 1mm. The female children had incisor irregularity ranging from 1 to 9mm with (15.4%) having 1mm irregularity and only 1(0.1%) child showing a 9mm irregularity (Table 3.8). Overall there was

no significant difference in the largest anterior mandibular irregularity between male and females (Pearson chi-square=1.565, 1df, p=0.211).

Table 3.8: Distribution of children by mandibular irregularity:

Mandibular irregularity	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
No irregularity	452	(67.3%)	500	(70.4%)	952	(68.9%)
Irregularity present	220	(32.7%)	210	(29.6%)	430	(31.1%)
1 mm	117	(17.4%)	109	(15.4%)	226	(16.4%)
2 mm	71	(10.6%)	59	(8.3%)	130	(9.4%)
3 mm	26	(3.9%)	34	(4.8%)	60	(4.3%)
4 mm	4	(0.6%)	2	(0.3%)	6	(0.4%)
>5 mm	2	(0.2%)	6	(0.8%)	8	(0.6%)

3.2.7 Anterior maxillary overjet:

Maxillary overjet in the current study ranged from 0-9mm in boys and 0 -11mm in girls. Eight hundred and twenty children; 380 males (56.5%) and 440 females (62%) had normal overjet of 1-3mm in size. Four hundred and sixty six had overjet of 4 to 6mm, males accounting for 36.6% and females 31%. Twenty eight (4.2%) boys and 32(4.5%) girls had an edge to edge incisor relationship while 18(2.7%) males and 18(2.5%) females showed overjet greater than 7mm (Table 3.9). There was no significant difference in the categories of anterior maxillary overjet when male and female children were compared. Pearson chi-square=5.064, 2df, p=0.79.

Table 3.9: Distribution of the children by size of anterior maxillary overjet:

Anterior maxillary overjet	Male n	(%)	Female n	(%)	Total n	(%)
0 mm	28	(4.2%)	32	(4.5%)	60	(4.4%)
1 to 3 mm	380	(56.5%)	440	(62%)	820	(59.3%)
>3 to 6 mm	246	(36.6%)	220	(31%)	466	(33.7%)
>6 mm	18	(2.7%)	18	(2.5%)	36	(2.7%)
Total	672	(100%)	710	(100%)	1382	(100%)

3.2.8 Anterior mandibular overjet:

Majority of the children examined (93.8%) did not show anterior mandibular overjet. However 43(6.40%) boys and 43(6.06%) girls showed occlusions that had a reverse overjet. In boys the anterior mandibular overjet ranged from 1-4mm while in girls this ranged from 1-3 mm as shown in Table 3.10. There was no statistically significant difference in the prevalence of anterior mandibular overjet between gender (Pearson chi-square=0.069, 1df, p=0.792).

Table 3.10: Distribution of the children by size of anterior mandibular overjet:

Anterior mandibular overjet	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
Absent	629	(93.60%)	667	(93.94%)	1296	(93.8%)
Present	43	(6.40%)	43	(6.06%)	86	(6.2%)
1 mm	14	(2.08%)	18	(2.54%)	32	(2.3%)
2 mm	15	(2.23%)	17	(2.39%)	32	(2.3%)
≥ 3 mm	14	(2.09%)	8	(1.13%)	22	(1.6%)

3.2.9 Vertical anterior open bite:

In the present study, 194(14.0%) children presented with anterior open bite with 77(39.69%) being males and 117(60.31%) females. In both gender, the size of anterior open bite ranged from 1 to 9 mm (Table 3.11). Female children had a statistically significant higher prevalence of anterior open bite than the male children with a Pearson chi-square=7.211, 1df, p=0.007.

Table 3.11 Distribution of the children by size of anterior open bite:

Anterior open bite	Male n	(%)	Female n	(%)	Total n	(%)
Absent	595	(88.54%)	593	(83.52%)	1188	(86.0%)
Present	77	(11.46%)	117	(16.48%)	194	(14.0%)
1 mm	26	(3.87%)	44	(6.20%)	70	(5.1%)
2 mm	23	(3.42%)	38	(5.35%)	61	(4.4%)
3 mm	15	(2.23%)	13	(1.83%)	28	(2.0%)
4 mm	4	(0.60%)	8	(1.13%)	12	(0.9%)
5 mm	2	(0.30%)	6	(0.85%)	8	(0.6%)
6 mm	5	(0.74%)	5	(0.70%)	10	(0.7%)
>6 mm	2	(0.30%)	3	(0.42%)	5	(0.3%)

3.2.10 Antero-posterior molar relation:

It was found that 1038(75.1%) children had a normal molar relationship while 344(24.9%) had a discrepancy in the antero-posterior molar relationship.

Of the affected group, 149(22.2%) males and 148(20.8%) females presented with a half cusp discrepancy while 26(3.9%) males and 21(3.0%) females showed a full cusp discrepancy (Table3.12).

The male and female children did not demonstrate a statistically significant difference in their antero-posterior molar relation with a Pearson chi-square=1.357, 2df, p=0.507.

Table 3.12: Distribution of the children by antero-posterior molar relationship

Molar relation	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
Normal	497	(73.96%)	541	(76.2%)	1038	(75.1%)
Half cusp	149	(22.17%)	148	(20.85%)	297	(21.5%)
Full cusp	26	(3.87%)	21	(2.95%)	47	(3.4%)

3.2.11 Distribution of the children by malocclusion and treatment need

Table 3.17 presents the distribution of the children by malocclusion and treatment need according to the Dental Aesthetic Index. Seven hundred and thirty two (53.0%) of the children were found to have either no abnormality or had minor malocclusion. Considering the gender distribution, half of the male children, 340 (50.6%) had normal or minor malocclusion where orthodontic treatment need is 'slight' or 'not indicated'. 168(25%) had definite malocclusion with treatment need for this group considered as 'elective'. 93 (13.8%) had severe malocclusion thus "highly desirable" treatment need while those with very severe/handicapping malocclusion that necessitated 'mandatory" treatment were 71(10.6%). Similarly, half of the female children 392(55.2%) showed normal occlusion or minor

malocclusion with slight or no indication for treatment. 150(21.1%) showed definite malocclusion that requires 'elective' treatment; 83(11.7%) and 85(12.0%) showed severe and very severe/handicapping malocclusion respectively with treatment need in these being 'highly desirable' and 'mandatory'. (Table 3.13)There was no statistically significant difference in the severity of malocclusion and treatment needs between the gender with a Pearson chi-square=5.497, 3df, p=0.139. Therefore the null hypothesis H_1 that malocclusion is not related to gender is accepted.

Table 3.13: Distribution of the children by malocclusion and treatment need based on the DAI criteria:

Severity of malocclusion (DAI score)	Treatment indication	Male		Female		Total	
		n	(%)	n	(%)	n	(%)
No abnormality or minor malocclusion (≤25)	None or slight need	340	(50.6%)	392	(55.2%)	732	(53.0%)
Definite malocclusion (26-30)	Elective	168	(25.0%)	150	(21.1%)	318	(23.0%)
Severe malocclusion (31-35)	Highly desirable	93	(13.8%)	83	(11.7%)	176	(12.7%)
Very severe or handicapping malocclusion (≥36)	Mandatory	71	(10.6%)	85	(12.0%)	156	(11.3%)
Total		672	(100%)	710	(100%)	1382	(100%)

The mean DAI score in the sample was 26.6 (SD 7.8). The scores ranged from 13-65, with a median DAI score of 25 and a mode of 23. The mean DAI score covered around 59.5 cumulative percent of the population (Figure 3.1). According to gender, mean DAI scores were 26.6 (SD 7.4) and 26.6 (SD 8.1) for males and females respectively.

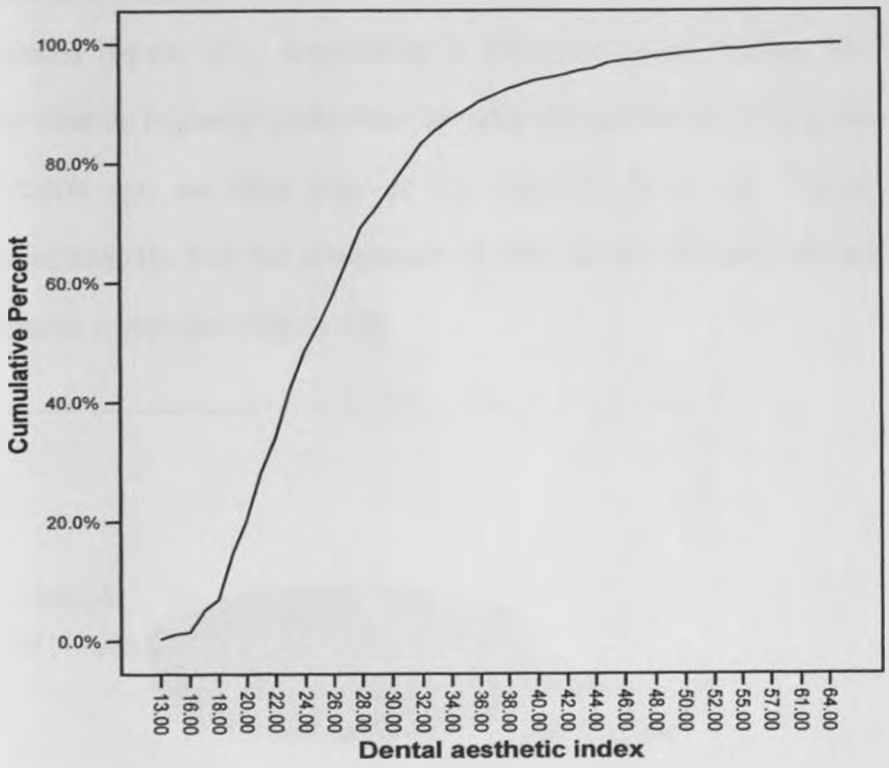

Figure 3.1: Cumulative percentage of the subjects' DAI scores (n=1382)

3.3 Prevalence and gender distribution of traumatic dental injuries in 12-15-year-old children in Nairobi

3.3.1 Distribution of children with traumatic dental injuries by Gender and Age.

Out of the 1382 children who were examined, 222(16.1%) had experienced traumatic dental injuries; 126 (56.8%) of these were males while 96 (43.2%) were females (figure 3.1). Experience of traumatic dental injuries was found to be significantly higher in males than females with a Pearson Chi square=7.001, 1df; p=0.008 and an odds ratio of 1.5 (95% CI: 1.11-1.97). Therefore the null hypothesis H_O that the prevalence of TDIs is not different between males and females is rejected (Figure 3.2).

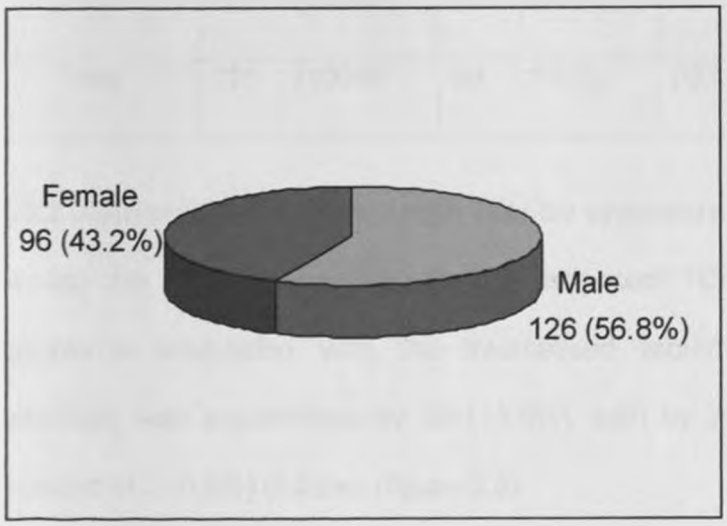

Figure 3.2: Distribution of children with TDIs by gender

Out of the 222 children who had experienced TDIs 72(32.4%) were 13 years old, 64(28.8%) were 14 years old while 47(21.2%) and 39(17.6%) were aged 12 and 15 years respectively (Table 3.14). It was found that the prevalence of TDIs in 13

year-olds was significantly higher than in children of other ages examined, with a Pearson Chi-square of 8.27, 3df, p=0.041.

Table 3.14: Distribution of children with TDIs by Age and Gender

Age (years)	Children with TDIs					
	Male		Females		Total	
	n	(%)	n	(%)	n	(%)
12	27	(21.4%)	20	(20.8%)	47	(21.2%)
13	42	(33.3%)	30	(31.3%)	72	(32.4%)
14	38	(30.2%)	26	(27.1%)	64	(28.8%)
15	39	(17.6%)	20	(20.8%)	39	(17.6%)
Total	126	(100%)	96	(100%)	222	(100%)

3.3.2 Distribution of children with TDIs by symptoms.

Among the 222 children who had experienced TDIs, 172 (77.5%) had no symptoms associated with the traumatised tooth/teeth. However, thermal sensitivity was experienced by 28 (12.6%), pain by 20 (9%) and swelling was reported in 2 (0.9%) children (figure 3.3).

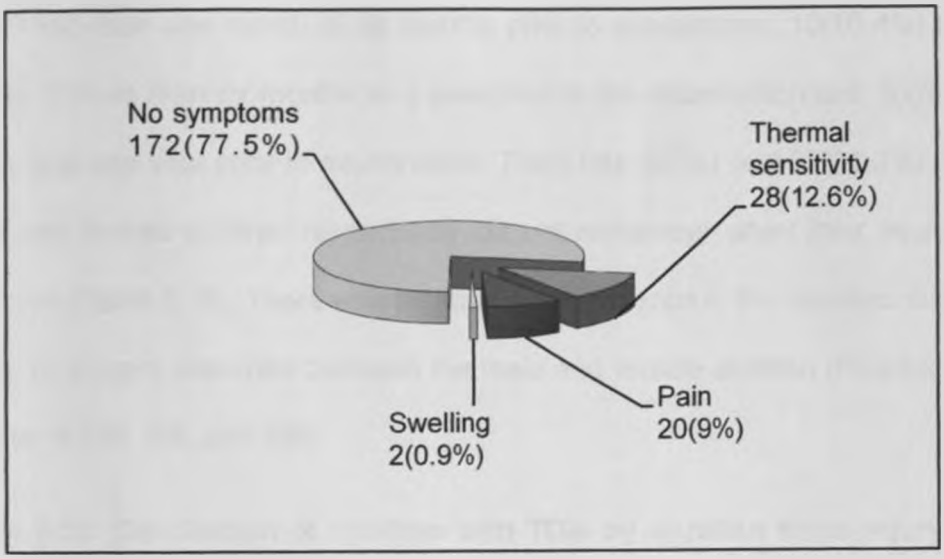

Figure 3.3: Distribution of children with TDIs by symptoms

3.3.3 Distribution of children with TDIs by duration since injury was sustained

About half the children 119(53.6%) reported to have sustained TDIs more than one year prior to the examination. Sixty four (28.8%) children did not remember when their teeth had been injured while 29(13.1%) reported to have been injured between six months to a year prior to the examination. Eight (3.6%) children had been injured in the period of more than one month to six months prior to examination while only 2(0.9%) children had been injured in the month prior to the date of examination (Table 3.15).

Of the boys with TDIs, 2(1.6%) had experienced injury within the month prior to examination. Similarly, 2(1.6%) had been injured in the period of more than one month to six months prior to examination, 19(15.1%) in the period of more than six months to a year prior to examination while 69(54.8%) had been injured more than one year prior to the date of examination. Among the girls, none had sustained TDIs in the last month prior to examination. Six (6.3%) had sustained

TDIs more than one month to six months prior to examination, 10(10.4%) in the period of more than six months to a year prior to the examination and 50(52.1%) more than one year prior to examination. Thirty four (27%) and 30(31.3%) of the male and female children respectively did not remember when their injury had occurred (Table 3.15). There was no statistical difference in the reported duration since TDIs were sustained between the male and female children (Pearson Chi-square=6.135, 4df, p=0.189)

Table 3.15: Distribution of children with TDIs by duration since injury was sustained.

Duration since TDI	Male		Female		Total	
	n	(%)	n	(%)	n	(%)
One month or less	2	(1.6%)	0	(0%)	2	(0.9%)
> one month to 6 months	2	(1.6%)	6	(6.3%)	8	(3.6%)
> 6 months to 1 year	19	(15.1%)	10	(10.4%)	29	(13.1%)
> 1 year	69	(54.8%)	50	(52.1%)	119	(53.6%)
Don't remember	34	(27%)	30	(31.3%)	64	(28.8%)

3.3.4 Distribution of the children with TDIs by site where injury occurred:

Fifty eight (46%) male children and 38(39.6%) females sustained TDIs at home. Thirty six (28.6%) of males and 23(24%) of females were injured at school. Thirty (23.8%) male children and 32(33.3%) of the females did not remember where the

injuries occurred while 2(1.6%) boys and 3(3.1%) girls were injured at other sites such as the road between home and school (2 boys and 2 girls) while 1 girl was injured during a school trip (Figure 3.4). There was found to be no statistically significant difference in the site where injury had occurred between the male and female children (Pearson Chi-square=3.169, 2df, p=0.205).

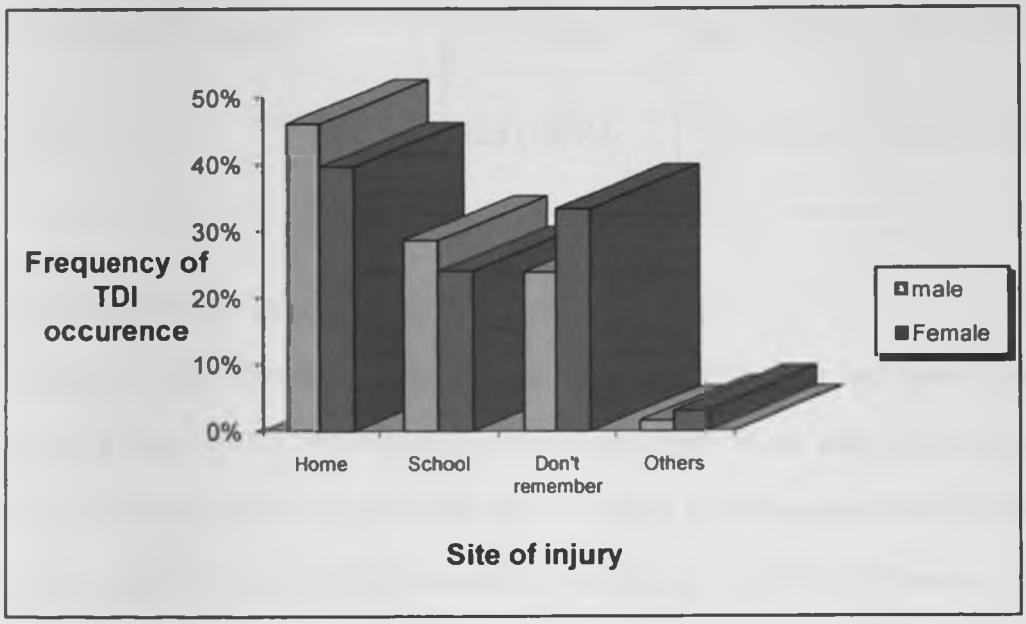

Figure 3.4 Distribution of the children with TDIs by gender and site where injury occurred.

3.3.5 Distribution of children with TDIs according to whether they sought treatment:

Out of the 222 children who had sustained TDIs, only 22(9.9%) had sought treatment. Of the male children with TDIs, 14(11.1%) confirmed having sought treatment for the injured teeth while only 8(8.3%) female children confirmed having done so. The rest of the 112(88.9%) males and 88(91.7%) of the female children had not sought treatment at all (Table 3.16).

Table 3.16: Distribution of children with TDIs according to whether they sought treatment:

Treatment History	Males n (%)	Females n (%)	Total n (%)
Sought treatment	14 (11.1%)	8 (8.3%)	22 (9.9%)
Did not seek treatment	112 (88.9%)	88 (91.7%)	200 (90.1%)
Total	126 (100%)	96 (100%)	222 (100%)

3.3.6 Distribution of injured teeth by type of injury:

Among the 222 children who had sustained TDIs, 299 teeth had been injured giving a mean of 1.4 (SD 0.6) teeth injured per child. There was a mean of 1.4 (SD 0.6) injured teeth per male child and 1.3 (SD 0.6) per female child. The male and female children did not demonstrate a statistically significant difference in the mean injured teeth per child (Z=-0.485, p=0.628). Majority of the individuals with injured teeth 206(68.9%) had enamel fracture while enamel-dentin fractures were the second most common being encountered in 71(23.8%) of the teeth (Table 3.17). Six (2%) teeth were discolored, 4(1.3%) had been avulsed and 3(1.0%) were restored. Complicated crown fracture and luxation injuries were each found in 1(0.3%) tooth. Combined injuries were found in 7(2.3%) of the teeth (Table 3.17).

Table 3.17 Distribution of teeth by type of injury:

Type of injury	No of teeth injured	% of teeth injured
Enamel fracture	206	68.9%
Enamel-dentin fracture	71	23.8%
Discolored	6	2%
Avulsed	4	1.4%
Restored	3	1%
Complicated crown fracture	1	0.3%
Luxated	1	0.3%
Combined injuries	7	2.3%
Total	**299**	**100%**

3.3.7 Distribution of TDI by tooth type

Out of the 299 teeth that had sustained TDIs, the maxillary central incisors were the most commonly traumatized with the right central incisor having been involved in 120 (40.1%) cases and the left one in 100(33.5%) cases. The maxillary left and right lateral incisors sustained 24(8%) and 23(7.7%) injuries respectively. In the mandibular arch, the right central incisor had the highest number of injuries, 13(4.4%) while the left one had 9(3%) of injuries. The left lateral incisor had 7(2.3%) of the injuries while the least injured incisor was the right lateral incisor having sustained 3(1.0%) injuries No traumatized canines were either reported or found on examination (Figure 3.5).

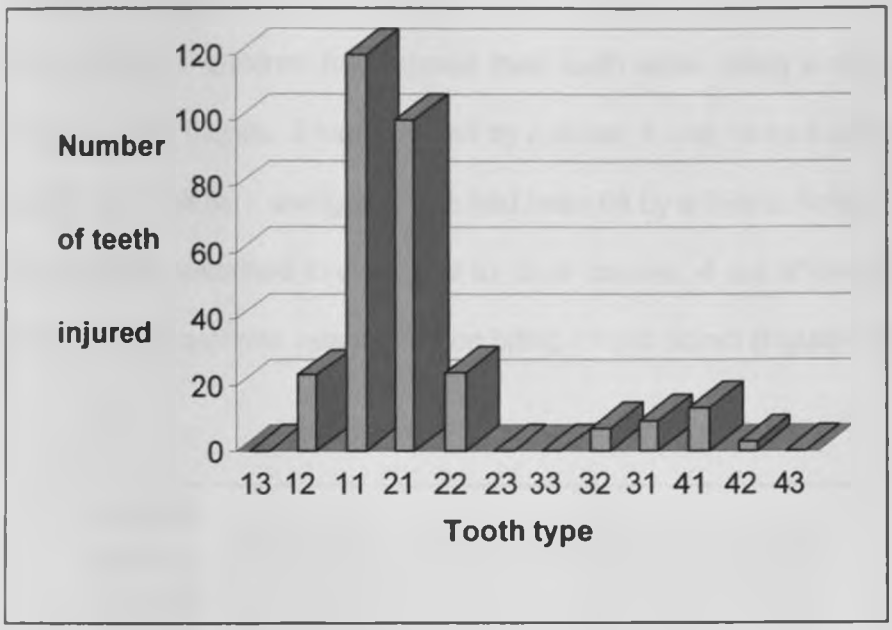

Figure 3.5: Distribution of TDI by tooth type

3.4 Etiological factors associated with TDIs

3.4.1 Gender distribution of TDIs according to cause of injury:

When the 222 children with TDIs were interviewed, a variety of causes of the TDIs were encountered. Amongst the 126 male children with TDIs, falls were the leading cause of TDIs as reported by 47(37.3%). Out of the 96 females with TDIs falls were reported in 31(36.5%). About 28(22.2%) male children did not remember the cause of injury while this was the case in approximately half of the females 43(44.8%). Collision with a stationary object caused TDIs in 23(18.3%) of males and 9(9.3%) of the females. 6(4.8%) and 3(2.4%) of the males had been injured in a fight and during games respectively while none of these was found as a cause of injury amongst females. Only a few cases of injuries due to road traffic accidents (RTA) were encountered in 1(0.8%) male and 4(4.2%) female children.

Among the male children 18(14.2%) had sustained injuries due to other causes out of which 7 children had injured their teeth while biting a hard object, 4 in collisions with friends, 3 had been hit by a stone, 1 was hit by a compass, 1 hit by a golf ball, 1 hit by a swing and one had been hit by a friend. Among the females, 5(5.2%) had sustained injuries due to other causes; 4 out of these having been hit by a stone and one was injured on biting a hard object (Figure 3.6).

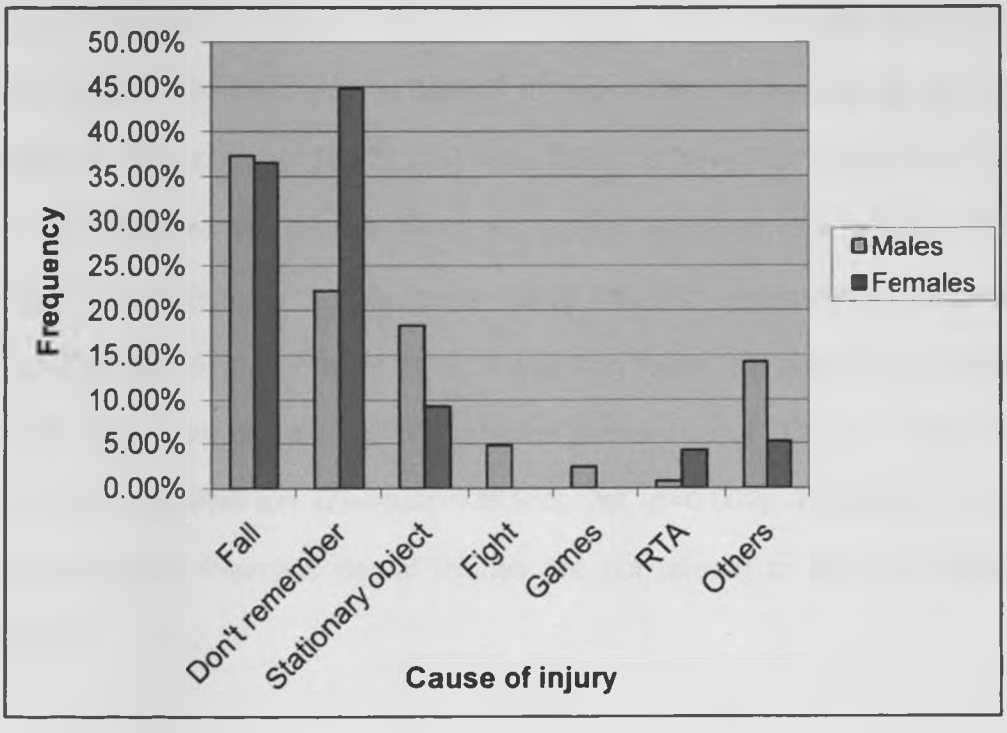

Figure 3.6: Distribution of the children with TDIs according to cause of injury.

3.5 Distribution of lip posture in the sample.

Lip posture was also assessed. Lips were recorded as competent if the child entered the room (before being aware of the impending examination) and presented with closed lips (2) or the lips were separated at rest by less than 3mm

and incompetent if the lips were separated at rest by more than 3mm. In the present study 841(60.9%) of the children had competent lips and out of these 380 (56.5%) were male children and 461 (64.9%) females. There were significantly more female children with competent lips than their male counterparts with a Pearson Chi-square=10.182, 1df, p=0.001.

3.6 Association between size of overjet and traumatic dental injuries

When the frequency of TDIs in the children was related to overjet it was found that out of the 886 children with overjet of 0-3mm 104(11.8%) had experienced TDIs while 776(88.2%) had not(Table 3.18, figure 3.9). Of the 466 children with overjet >3 mm to 6mm, 105(22.5%) were found to have TDI while 361(77.5%) had not sustained any injuries. Thirty six children were reported to have overjet greater than 6mm and in this group 13(36.1%) had experienced TDIs while 23(63.9%) did not have injured teeth. It was thus found that children with overjet greater than 3mm had a significantly higher prevalence of TDIs than those with 3mm and less(Pearson chi-square=36.955, 2df, p=0.000). Therefore the null hypothesis that traumatic dental injuries are not related to size of overjet is rejected.

Table 3.18: Relation of TDIs with anterior maxillary over jet

Size of over jet	Children with injury n=222		Total n=1382	
	n	%	n	(%)
0 to 3 mm	104	(11.8%)	886	(100%)
>3 to 6 mm	105	(22.5%)	466	(100%)
>6 mm	13	(36.1%)	36	(100%)
Total	222		1382	

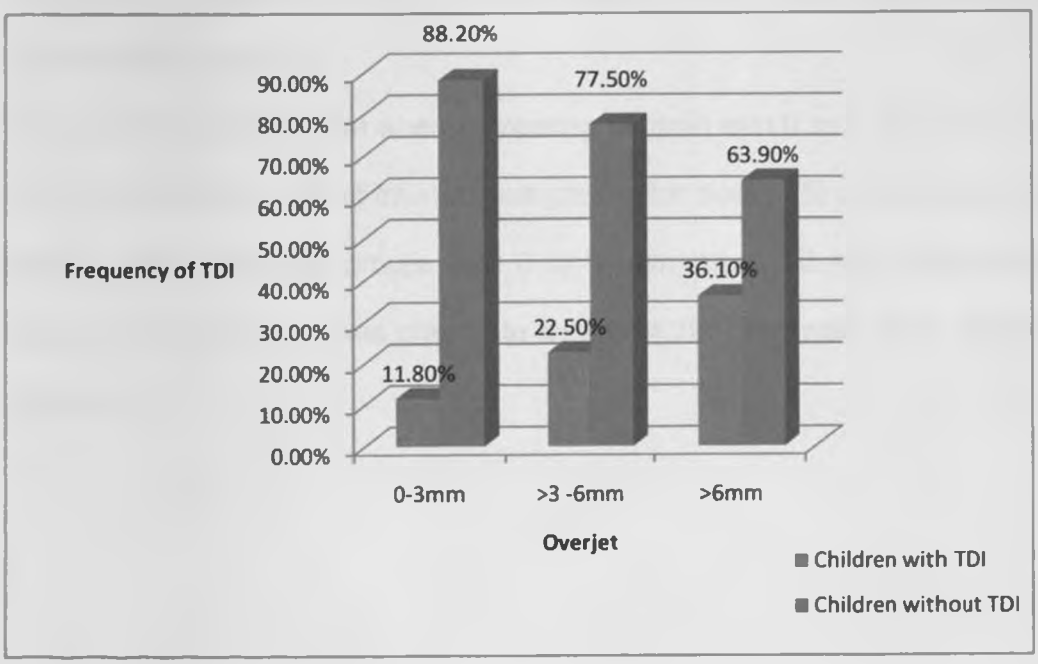

Figure3.7: Frequency distribution of TDIs by size of overjet

The mean anterior maxillary over jet in children with TDIs was 3.75 mm (SD 1.8) while that in children without TDIs was 3.16 mm(SD 1.6) thus demonstrating that children with TDIs had a significantly larger anterior maxillary overjet when compared to those without TDIs (t=5.057, p=0.000).

When the over jet group of 3mm and less was compared with that of more than 3mm the odds ratio was 2.3 (CI: 1.70-3.10, Yates corrected Chi Square=31.52, p=0.000)

Comparing the over jet groups of 3mm and less with that of more than 6mm resulted in an odds ratio of 4.2 (CI: 1.95-9.01, Yates corrected Chi square=16.20, p=0.000) ; demonstrating that the odds of trauma increased with increasing overjet. This study confirms that traumatic injuries to anterior teeth increase with an increase in overjet hence the null hypothesis H_3 that TDIs are not related to size of overjet is rejected.

This study also showed that when comparing children with 0 to 3 mm versus >3 mm overjet the odds ratio of trauma were greater for male (2.5) than female (2.0) children, while when the groups with 0 to 3 mm versus >6 mm overjet were compared the odds ratio was greater in female (4.22) than male (4.17) children (Table3.19).

Table 3.19: Gender analysis of odds ratio based on over jet groups

Gender	Overjet groups compared	Odds ratio(CI)	X^2	P value
Male	0-3 mm vs >3 mm	2.5(1.6-3.7)	19.82	P=0.000
Female	0-3 mm vs >3 mm	2.0 (1.3-3.2)	9.59	P=0.001
Male	0-3 mm vs >6 mm	4.17 (1.4-12.3)	7.27	P=0.006
Female	0-3 mm vs >6 mm	4.22 (1.3-12.8)	6.75	P=0.009

3.7 Association between lip posture and TDIs

Of the 222 children with TDIs, 124(55.9%) had incompetent lips in comparison to 416(35.9%) out of the1160 children from the non trauma group. The odds ratio of sustaining TDIs for the children with incompetent lips was 2.3 (95% CI 1.7-3.0) thus demonstrating that the children with incompetent lips had a higher likelihood of sustaining TDIs than their counterparts with competent lips (Table 3.20). A significantly higher prevalence of TDIs was found when children with incompetent lips were compared to those with competent lips (Chi-square=31.29, 1df, p=0.000) (Table3.20). Therefore the null H_4 hypothesis that traumatic dental injuries are not related to lip incompetence is rejected.

Table 3.20: Relation of TDIs with lip posture:

Trauma experience	Competent lips		Incompetent lips		Total	
	n	%	n	%	n	%
Children with TDIs	98	(44.1%)	124	(55.9%)	222	(100%)
Children without TDIs	744	(64.1%)	416	(35.9%)	1160	(100%)

CHAPTER 4

4.0 DISCUSSION

The main objective of this study was first to determine the prevalence and pattern of occurrence of malocclusion and TDIs among 12 – 15 year old Public Primary School Children in Nairobi and then determine the relationship between TDIs, over-jet and lip posture.

SAMPLE AND GENDER DISTRIBUTION

The study population was selected using multi-stage cluster random sampling in order to determine the schools that were to be involved in the study while the number of children to be examined in each school was obtained by proportionate sampling. A total of 1382 children were selected and studied. This number was 1.01% of the 136001 primary school children in Nairobi at the time of study and therefore slightly above the 1% sample size recommended by WHO (54). This ensured representativeness of the sample to the general population of primary school children in this age group.

METHODOLOGICAL CONSIDERATIONS

An ideal index should be one that meets the strict requirements for validity and reliability and has been used frequently in order for an investigator to compare their finding to other studies. The selection of an index to measure any condition is thus dependent on two factors: the objective to the investigation and the ability of the examiner to reproduce the diagnosis on which the index is based (55).

The DAI criteria was selected for assessing malocclusion. It integrates psychosocial and physical elements of malocclusion and is particularly sensitive to occlusal conditions that have potential for causing psychological or social

dysfunction. The DAI links peoples' perception of aesthetics with anatomical trait measurements by regression analysis to produce a single score (5). Once an individual's score has been calculated, it is placed on a scale to determine the point at which the score falls between the most and least aesthetic dental appearances. The further a DAI score falls from the norm of most acceptable dental appearances the more likely the condition if left untreated may be either socially or physically handicapping or both. In their latest Oral Health Surveys, Basic Methods (22) the WHO incorporated the DAI criteria for assessing dento-facial anomalies. In view of this recent endorsement of the DAI by the WHO the index was chosen for use in the present investigation. Moreover, Otuyemi et al (57) in a study aimed at determining the perceptions of dental aesthetics by Nigerian students reported that the standard DAI can be used without modification in Africans thus suggesting that different racial and cultural groups may share a common conception of beauty and that certain perceptions of dental aesthetics among different ethnic and racial groups are similar. This further indicates that the DAI can be used without modification in epidemiological surveys to assess orthodontic treatment need.

No radiographs or impressions for study models were taken in this study. It is therefore likely that there may have been an over or underestimation of some of the occlusal traits observed such as missing teeth. Most 12-year old children presented in the early permanent dentition stage. Those in late mixed dentition stage were excluded from the current study due to unavailability of radiographs to determine the presence or absence of unerupted permanent canines and premolars.

In the present study a modification of the WHO criteria (51) was used where discoloured, and/or restored teeth with history of traumatic injury were also recorded as TDIs. However, determination of fractures of the roots as classified in the WHO criteria (51) was omitted as radiographs were not taken since this was not included in the study design. Laceration(s), contusions and abrasions of the gingiva and/ or oral mucosa were also omitted due to the study design (cross-sectional). It had been expected that majority of the soft tissue injuries would have healed by the time of the study as normally the soft tissue injuries heal without scarring hence they would not have been accurately reported. Underestimation of traumatized teeth may have occurred because no artificial light was used thus enamel infraction and restored teeth could have been missed.

PATTERN OF OCCURRENCE OF MALOCCLUSION ACCORDING TO THE DAI.

Intra-arch irregularities and malalignment

Missing incisors, canines and premolars were observed in 5.1% of the children in the current study. This is a slightly lower prevalence than the 6.3% reported by Ng'ang'a and Ng'ang'a (58) and 6.9% reported by Rwakatema et al in a study of 298 Tanzanian children aged 12 – 15 years using the DAI criteria. In the present study, male and female children did not show any significant difference in the overall prevalence of missing teeth (p=0.467). The difference between the current study and Ng'anga' and Ng'ang'a's study could be explained by the fact that they studied a selected sample seen at a private clinic and used radiographs to compliment clinical examination. The current study reported that out of the 70 children with missing teeth, 75.7% had one or two missing teeth which is in line

with their findings of 80%. Rwakatema et al. reported a slightly higher prevalence than the current study and could possibly be explained by their smaller sample size and also probably by ethnic differences between Kenyan and Tanzanian children. Their study also showed no statistically significant gender difference in prevalence of missing teeth.

The present study found an overall of 47.2% children with crowding in incisal segments. This is much higher than the prevalence reported by Ng'ang'a et al. of 16% and 19% in two previous studies in Mandera and Nairobi respectively (20, 31). These differences are likely due to the fact that different criteria of assessing crowding were used for the two studies. Dental crowding (using the DAI criteria) in at least one dental arch was reported in 33.6% of Nigerians (26) and in 41.2% of Tanzanian 12-15 year olds(28); percentages that were similar to the present study. Jenny et al. (59) have suggested that inheritance differences in tooth size and arch size may be one reason that leads to crowding.

The prevalence of spacing in this population (46.6%) was similar to that of Otuyemi et al. (26) in Nigerian adolescents, but higher than that reported by van Wyk et al. of 27.7% (23) in 12 year old South African children. This may be due to sampling difference in terms of age and ethnicity.

The frequency of Nairobi children with an anterior maxillary irregularity was 38.6% while anterior mandibular irregularity was found in 31.1% of the children. These values were lower than those reported in Tanzanian children (28) for anterior maxillary irregularity (46.0%) and anterior mandibular irregularity (51.6%). This could probably be as a result of ethnic differences.

Twenty percent of the children in the present study had midline maxillary diastema thus agreeing with the findings of Ng'ang'a et al. (31). The findings of the present study are however much lower than those of Hassanali et al. (60) who reported a prevalence of diastema of 61.3% among the Maasai community in Kenya. One reason for this observation may be the fact that the Maasai community is exposed to dental mutilation (60) thus may have higher prevalence of missing teeth leading to high prevalence of midline maxillary diastema.

Discrepancies in interarch relationship

The results indicate that the predominant antero-posterior molar relationship was normal, which is a common finding in Kenya and elsewhere in the world (4,20,28, 35). Categorization of malocclusion into half cusp and full cusp has not been reported before in studies of malocclusion in Kenya. Half and full cusp discrepancy was found in 24.9% of the current sample thus falling within the range (16.2%-32.5%) reported by other researchers in Tanzania and Nigeria (28, 26) but much lower than data from Hungary, South Africa and Peru (4, 23, 61) which have reported this to range from 44.5%-52.1%. van Wyk et al. (23) in the South African study reported the antero-posterior molar relation to differ significantly for the different population groups (Asian, Black, Coloured and White children). One explanation for this difference could be due to the fact that there was variation in the races they studied.

According to Moyers (62) an overjet between 1mm and 3mm is considered normal. The results of the current study indicated that 59.3% of the subjects presented with normal maxillary overjet thus corroborating those of vanWyk (23) in South African children. Occurrence of extreme maxillary overjet ($\geq$6mm) (9.9%)

was in agreement with previous findings by Ng'ang'a et al. (31) in Nairobi children while mandibular overjet was found in 6.2% of the children a value somewhat higher than that reported by previous regional studies of 0%-1.4% (26, 28, 31).

In the present study about 14% of the children presented with anterior open bite, a value similar to that reported in Nigerian adolescents (26) but about twice that reported in previous East African studies (28,31). The prevalence of anterior open bite in females was significantly higher than that in males (p=0.007) thus confirming the findings of van Wyk in South Africa (23). The actual cause of the male and female difference is unknown but it could be possible that more females perform digit sucking thus predisposing them to developing anterior open bite.

Malocclusion and treatment need according to the DAI

Based on the DAI criteria (34) the present study showed that 53% of the children had normal occlusion or minor malocclusion for which orthodontic treatment need was "none or slight"; 23% had definite malocclusion with "elective" treatment need; 12.7% were judged to have conditions for which orthodontic treatment was "highly desirable"; and 11.3% had very severe or handicapping malocclusion for which orthodontic treatment was "mandatory". These are in agreement with the findings of vanWyk et al. (23) who reported that 47.7% of 12-year-old South African children had normal or minor malocclusions, 21.29% had definite malocclusion, 14.12% severe malocclusion and 16.89% had very severe or handicapping malocclusions. Our findings differ slightly from those of Rwakatema et al. (27) who reported 64.7% of 12-15 year old Tanzanian children as having no abnormality or minor malocclusion, 21.5% with definite malocclusion, while 6.9% showed severe malocclusion and 6.9% very severe or handicapping

malocclusion using the DAI criteria. These findings show a slightly higher proportion of Tanzanian children with none or slight treatment need as compared to the current study. They also show a slightly lower percentage of children with severe and very severe/handicapping malocclusions in Tanzanian children when compared to Kenyan children. The disparities could have been caused by sample size and sampling differences whereby a sample of 289 children participated in the Tanzanian study as compared to 1382 in the current study. Another possible reason for the differences could be that their study was in Moshi Municipality which is more rural as compared to the current study which was carried out in Nairobi; the Capital City of Kenya, a more cosmopolitan town and home to multiple ethnic groups. Further studies are necessary in both Kenyan and Tanzanian children to verify if the differences in malocclusion between the children of these two countries are significant or not and also determine whether ethnicity is a contributing factor.

The current study reported a mean DAI of 26.6. Katoh et al. (1) have reported a mean DAI score of 31.8 in Native Americans and 30.1 in Japanese which is slightly higher than the current study. It would seem that Africans generally have better dental appearance and less orthodontic treatment need than Caucasians or Orientals (26). Otuyemi et al. (26) and Rwakatema et al. (27) reported mean DAI of 22.3 and 24.6 in Nigerian and Tanzanian children respectively which are relatively lower compared to findings in the present study.

The results of the present study indicate that the prevalence and severity of malocclusion for male and female children does not differ significantly ($p=0.139$) and thus are in accordance with previous studies (26, 27). They however contrast

those of vanWyk et al. (23) who reported prevalence of malocclusion to be higher in boys than girls (p=0.0015). This could be because more boys than girls in their study were in mixed dentition stage and thus, the differences in the stage of dental development could have contributed to the difference in the DAI scores. No other Kenyan study using the DAI has been previously been reported.

There was an overall high prevalence of malocclusion reported in the current study. No significant gender difference was recorded for most traits except for vertical anterior openbite whereby female children had a statistically significant higher prevalence than their male counterparts.

PREVALENCE AND GENDER DISTRIBUTION OF TDIs

Based on the WHO criteria, 16.1% of the study population had experienced TDIs. Ng'ang'a et al. (18) reported a prevalence of fractured incisors of 16.8% in 13-15 year olds which is almost similar to the current study. They however did not use a specific index while the current study used a modification of the WHO criteria and recorded other injuries apart from fractures. Ohito et al. (19) found TDIs to occur in 11% of normal children aged 5-15 years. It is likely that the prevalence in the current study is similar to that of Ng'ang'a as the age-groups studied were similar while Ohito's study reports of a lower prevalence of TDIs in normal children maybe due to the wide age range (5-15 year olds) they studied. Muriithi et al. (21) in a recent hospital based study of 0-15-year olds reported dental injuries to have a prevalence of 4.8%. This is a much lower prevalence than in the current study and could be explained by the fact that theirs was a hospital based study and not all children with dental injuries report to hospital to seek dental care.

In the present study, males experienced significantly more trauma than females (male to female ratio of 1.3:1). This was in agreement with Kenyan studies which had reported a male to female ratio of 2:1, 1.7:1 and 14% prevalence versus 11% in males and females respectively (18, 21, 19). This was also in agreement with other studies done outside Kenya (63, 64, 65). Love et al. (63) and Tangade (64) in New Zealand and India respectively reported a male to female ratio of 1.9:1 and 1:0.5 in secondary teeth, while Soriano et al. (65) in a study of 12 year old Brazil children reported 12.2% and 8.8% males and females respectively having experienced TDIs. This could be explained by the fact that boys engage in contact sport and are generally more aggressive in nature and are therefore at greater risk of accidents while girls display more mature behavior at this age and engage in more passive games (19, 37, 66). The present study also reported that males had a statistically significant higher prevalence of incompetent lips than females. Lip incompetence has been reported in previous studies (13, 44, 65) to be a significant risk factor for TDIs and this could be a possible explanation as to why more male children had sustained TDIs than their female counterparts.

In this study it was observed that 13-year-olds experienced more trauma than children of other age groups examined and they accounted for a third (32.4%) of children with TDIs. In the secondary dentition TDIs have been reported to peak at different ages in different studies. The results of the present study differ from those of Ohito et al. (19) who reported three quarters of injuries to occur between 10-12 years of age. The results also differ from those of Muriithi et al. (21) who found 5.3% of 12-year-olds to have experienced dental injuries while 13, 14 and 15 year olds had a lower prevalence of 4.0%, 3.6% and 3.6% respectively. The

larger age ranges studied by Ohito and Muriithi may account for the differences in the ages when TDIs peak. It is notable that Muriithi's study was hospital based. However, it is worth noting that when questioned on the duration elapsed since injury occurred majority (55.6%) of 13 year olds in the current study reported this to have been more than a year ago meaning they were 12 years or younger and thus they may have been injured while in the 10-12 year age bracket.

In the present study 172(77.5%) children who had experienced TDIs reported no symptoms while 48(21.6%) experienced thermal sensitivity or pain and 2(0.9%) had a swelling related to the injury. A hospital based study in Jordan (67) reported differing findings from the current study with 32.8% of children having presenting complaint of aesthetic or parental concern while 31.3% had presented due to pain or sensitivity. The Jordanian study (67) reported that 17.5% of the children had swelling/sinus which is a larger proportion than 0.9% reported in the present study. This could be because theirs was a hospital based study which is biased as many times patients present due to symptoms such as pain/sensitivity/swelling while a field based study would be expected to report a higher level of asymptomatic teeth. No local study has been published on the symptoms associated with traumatized teeth.

The results of the current study corroborate those of Bauss (39), Rajab (66) and Soriano (65) that majority of TDIs are sustained in the home environment. Sgan-Cohen (13) in a study of 1195 children aged 9 to 13 years in Jerusalem reported similar proportions of injured teeth as follows: outside (36.4%), at school (32.2%) and at home (31.4%). It is important to note that the category, "outside", is not well defined and it could be that injuries sustained in the home environment may

have been outside rather than inside the house which may explain the difference with the current study. In the current study it was noted that 30 (23.8%) male and 32(33.3%) female children did not remember the site of injury. These children are young and may not have good recall of events and this could explain why quite a large proportion did not remember where the injuries occurred.

The majority, (90.1%) of the children who had sustained TDIs had not sought any treatment following injury. This finding is in agreement with the study by Al-Khateeb et al. (68) in Jordan indicating that only 16% of 13-15 year olds had received treatment for coronal fractures of anterior teeth. In the current study 68.9% of children had enamel fractures and may not have seen the need to seek dental care, because they did not have any complaint as evidenced by 77.5% who had no symptoms or sometimes were unaware of their injured teeth and thus did not seek dental treatment following injury. The results of the present study however differ from those of Al-Jundi (67) which reported that 43.1% of children in a hospital based study had not gone for treatment at time of injury; they also reported that the average time between trauma and seeking dental treatment was 5 months. This could be explained by the fact that the children who present to hospital are a biased sample as often times they do so because of symptoms.

The commonest fractures in the current study were those involving only enamel and were observed in 68.9% of the injured teeth. Enamel-dentin fractures was encountered in 23.8% of the teeth that had been injured while 2% were discoloured, 1.4% had been avulsed, 1% had been restored following TDI and 2.9% had sustained either complicated crown fracture, luxation injury or multiple injuries. This corroborated the findings of previous studies (17,18,37,44,65,68).

The permanent teeth are firmly embedded in alveolar bone and are more likely to fracture when injured as compared to primary teeth (68).The results however contrasted those of a local hospital based study (21) which found a predominance (47.5%) of luxation injuries. This could be because most of the teeth that had been luxated had healed by the time this study was done while in the hospital based study, majority of the patients (69.5%) presented on the day of injury or one day after trauma prior to healing. Maxillary central incisors were the teeth most involved in dental trauma. Similar findings have been reported in other studies (18,21,24,65). The explanation for this probably relates to the morphology and vulnerable location of these teeth. The importance of this finding lies in the fact that these incisors play an important role in aesthetic, phonetic and functional activities (65). In the present study the number of injured teeth per child was 1.4. This rate has been reported to vary from 1.3-1.62 (18,66,69). It is possible to under report this figure in a retrospective study as the current one because several teeth may have sustained injuries such as luxation which would have healed by the time the examination was done. Classification used in various studies and type of study location has also been reported to account for the variation in this figure (70).

ETIOLOGICAL FACTORS ASSOCIATED WITH TDIs

The main reported causes of TDIs in males were falls, collisions with stationary objects, fights and accidents during games. About 45% of females did not remember the cause of TDI while this was the case in 22.2% of males. These results are in agreement with the findings of Soriano (44). None of the female children indicated having been injured during fighting or games. The above results are in line with those by Ohito et al (19). and Muriithi et al. (21) where falls were the number one cause of injuries; Ohito et al, however did not analyze aetiology of injury based on gender. Eleven percent of children in Ohito et al's study had been hit by a stationary object which is almost similar to 14.4% as found in the current study. Quite noteworthy is that their study did not report any children who did not remember the cause of injury unlike in the current study where 22.2% of males and 44.8% of female children did not remember. This could have been due to differences in the design of questionnaire for data collection used. In the current study an open ended questionnaire was used thus giving children the freedom to state if they had no memory for the cause of injury. TDIs as a result of road traffic accidents were encountered in 0.8% of male and 4.2% of female children in the current study. This is a much lower prevalence than that reported by Muriithi et al. (21) who found 5.1% and 3.2% of male and female children respectively to have been injured following RTAs. The differences could be due to the fact that they studied a wide age-range of 0-15 year olds and it could be possible that younger children tend to be more careless and play nearer roads thus have a greater likelihood of being involved in accidents than the older group in the current study.

ASSOCIATION BETWEEN SIZE OF OVERJET AND TDIs

In previous studies the employed cut-off point for increased overjet varies from one study to another; the commonly used ones being 3mm and 6mm (46). Ultimately this study categorized overjet into normal: 0-3 mm, moderate : > 3 mm-6 mm and severe : > 6 mm for purposes of comparing the findings to those reported in literature. This study showed that children with an overjet of more than 3 mm had a significantly higher prevalence of TDIs than those with 3 mm or less (p=0.000) thus the null hypothesis that TDIs are not related to size of overjet was rejected. When the overjet group of 3 mm and less was compared with that of more than 3 mm the OR was 2.3 thus indicating that children with the later overjet are twice more prone to TDIs than the former. The findings of the present study are in agreement with regional findings by Kahabuka et al. (71), African findings by Otuyemi et al. (40), and international findings by Sgan-Cohen et al. (13,72), Baldava et al. (73), Al-Khhateeb et al. (68) and a systematic review by Nguyen et al. (46) who concluded that children with an overjet larger than 3mm are approximately twice as much at risk of TDI on anterior teeth than those with a lesser overjet. The findings of the current study are however contrary to those of Marcenes et al. (74) and Stokes et al. (75) who reported no relationship between injury to maxillary incisors and increased overjet. The discrepancy may represent racial differences between Kenyan and Brazilian children.

Comparing the overjet groups of 3mm and less with that of more than 6mm yielded an OR of 4.2 thus corroborating the assertion in previous literature (13,17,46) that risk of trauma can increase with increasing overjet size.

When the children with overjet of ≤3 mm versus >3 mm were stratified by gender, the ORs were 2.0 (CI=1.28-3.20) and 2.5 (CI=1.63-3.72) for girls and boys respectively thus demonstrating that within the same overjet group boys were more at greater risk of TDIs than girls. Our findings are contrary to those of a meta-analysis by Nguyen et al. (46) who reported that within the same overjet group, the effect of overjet was less for boys than girls. This is an interesting finding that requires further study.

The current study reported the mean anterior maxillary overjet in children with TDIs to be 3.75 mm (SD1.8) while that in children without TDIs was 3.16 mm (SD1.6) thus demonstrating that children with TDIs had a significantly larger anterior maxillary overjet than those without TDIs (p=0.000). The findings of the current study corroborate those of Artun et al. (45) that mean overjet was larger (3.9 mm versus 3.0 mm) among subjects with injured maxillary incisors than among those without injury.

Children with anterior maxillary overjet greater than 3 mm were found to be at greater risk of TDIs than those with overjet of 3 mm and less with risk of injury to anterior teeth tending to increase with increasing size of overjet. The mean overjet for children who had experienced TDIs was significantly higher than for those who did not have injured anterior teeth.

ASSOCIATION BETWEEN LIP POSTURE AND TDIs

A significantly higher prevalence of TDIs was found when children with incompetent lips were compared to those with competent lips (p=0.000; OR: 2.25 CI, 1.7-3) thus rejecting the null hypothesis that traumatic dental injuries are not related to lip incompetence. Our findings thus corroborate the assertion by

previous studies in East Africa and elsewhere (71, 13, 44, 65, 68) that lip competence has a significant influence on occurrence of TDIs. Competent lips act by cushioning the incisors from traumatic forces thus in absence of these the teeth experience trauma directly and are more likely to sustain TDIs.

On cross tabulating overjet and lip competence, only 33.3% of children with normal overjet (≤3 mm) had incompetent lips, whereas half of the children with increased overjet (>3 mm) had incompetent lips ($p=0.000$). This is in line with a recent study by Kahabuka et al. (71) in Tanzania. A possible explanation is that when the overjet is increased the maxillary incisors displace the upper lip forwards thus increasing the interlabial distance which results in lip incompetence.

Children with incompetent lips were found to be at greater risk of TDIs compared to those with competent lips.

STUDY LIMITATIONS:

- The study design did not include taking radiographs to confirm missing incisors, canines and premolars thus this component of malocclusion may have been over reported since teeth seen as clinically missing may have been present within the underlying bone.
- Subjects were examined for traumatic dental injuries under natural light while seated on a chair. It is possible that enamel infraction may have been overlooked thus prevalence of TDI may have been under reported.
- When avulsed teeth and teeth with complicated crown fractures with complete loss of crown were encountered the anterior maxillary overjet was measured from the adjacent tooth. This may have led to over or under estimation of the size of overjet.

CONCLUSIONS:

- There was a high overall prevalence of malocclusion with no significant gender difference for most traits recorded.
- The DAI criteria produced a mean DAI score of 26.6, with 11.3% of subjects exhibiting handicapping malocclusion.
- The prevalence of TDIs was comparable with previous studies with males having experienced significantly more traumatized teeth than females.
- Maxillary central incisors were the teeth most frequently injured teeth
- Falls were the leading cause of TDIs
- Majority of children with TDIs experienced no symptoms associated with the traumatized teeth.
- Majority of the children with TDIs had not sought treatment following the trauma.

- Children with anterior maxillary overjet greater than 3 mm were found to be at greater risk of TDIs than those with overjet of 3 mm and less with the risk of injury to anterior teeth tending to increase with increasing overjet
- Children with incompetent lips were found to be at a greater risk of TDIs compared to those with competent lips.

RECOMMENDATIONS:

- A similar study should be carried out in children attending private primary schools in Nairobi in order to determine the prevalence of malocclusion and TDIs and if any differences exist between children in public and private schools.
- Oral health policies should be instituted so that children with very severe or handicapping malocclusion could benefit from subsidized orthodontic therapy by specialists.
- Preventive educational programmes directed at school children, teachers and parents should be instituted to prevent the occurrence of TDIs and also offer information on need for treatment should they occur.
- There is need to improve oral health policies in Kenya so as to incorporate periodic check ups of school children as the majority of children with TDIs presented with untreated trauma. This would aim at prompt diagnosis and management of TDIs.
- Prospective cohort studies should be carried out in order to confirm the association between increased overjet and incompetent lips with TDIs.

REFERENCES

1. Katoh Y, Ansai T, Takehara T, Yamashita Y, Miyazaki H, Jenny J, Cons N C. A Comparison of DAI scores and characteristics of occlusal traits in three ethnic groups of Asian origin. Int Dent J 1998; 48: 405-11.
2. Proffit WR, Fields HW. The etiology of orthodontic problems In: Proffit WR, Fields HW, eds. Contemporary Orthodontics. 3rd edn. Missouri: Mosby, 2000: pp 113-144.
3. Onyeaso C O, Be Gole E A. Orthodontic treatment need in an accredited graduate orthodontic center in North America: A pilot study. J Contemporary Dent Practice 2006; 2:1-8.
4. Gábris K, Márton S and Madléna M. Prevalence of malocclusions in Hungarian adolescents. Eur J Orthod 2008:6; 467–470.
5. Onyeaso C O & Aderinokun G A. The relationship between dental aesthetic index (DAI) and perceptions of aesthetics, function and speech amongst secondary school children in Ibadan, Nigeria. Int J Paed Dent 2003; 13:336–341.
6. Mossey P A. The Heritability of Malocclusion: Part 1-Genetics, Principles and Terminology. Br J Orthod 1999; 26:103–113.
7. Bernabe´ E, Tsakosb G, Oliveirac C M, Sheihamd A. Impacts on Daily Performances Attributed to Malocclusions Using the Condition-Specific Feature of the Oral Impacts on Daily Performances Index. Angle Orthod 2008; 2:241-247.
8. Marques LS, Ramos-Jorge ML, Paiva SM, Pordeus IA. Malocclusion: esthetic impact and quality of life among Brazilian school children. Am J Orthod Dentofacial Orthop. 2006; 129: 424–427.

9. Kilpelainen PV, Phillips C, Tulloch JF. Anterior tooth position and motivation for early treatment. Angle Orthod. 1993; 63:171–174.

10. Sheats RD, McGorray SP, Keeling SD, Wheeler TT, King GJ. Occlusal traits and perception of orthodontic need in eighth grade students. Angle Orthod. 1998; 68:107–114.

11. Bernabe E, Flores-Mirb C, Influence of Anterior Occlusal Characteristics on Self-perceived Dental Appearance in Young Adults. Angle Orthod 2007; 5: 831-836.

12. Zahid L, Tandon S. Oral and Maxillofacial Injuries in Children. In: Tandon S. Textbook of Pedodontics. Ist Edition. India: Paras Medical Publisher, 2003, pp 490-534.

13. Sgan-Cohen HD, Megnagi G, Jacobi Y. Dental trauma and its association with anatomic, behavioral, and social variables among fifth and sixth grade schoolchildren in Jerusalem. Community Dent Oral Epidemiol 2005; 33:174-180.

14. Glendor U, Marcenes W, Andreasen JO. Classification, epidemiology and etiology. In: Andreasen JO, Andreasen FM. Textbook and colour atlas of traumatic injuries to the teeth. 4th ed, Blackwell Munksgaard, 2007, pp 217-222.

15. Grimm S, Frazao P, Antunes JLF, Castellanos RA, Narvai PC. Dental injury among Brazilian schoolchildren in the state of Sao Paulo. Dent Traumatol 2004; 20: 134-138.

16. Tapias MA, Jimenez-Garcia R, Lamas F, Gil AA. Prevalence of traumatic crown fractures to permament incisors in a childhood population: Mostoles, Spain. Dent Traumatol 2003; 19: 119-122.

17. Shulman JD, Peterson J. The association between incisor trauma and occlusal characteristics in individuals 8-50 years of age. Dent Traumatol 2004; 20: 67-74.

18. Ng'ang'a PM, Valderhaug J. The prevalence of fractured permanent incisors in 13 to 15 year old school children in Nairobi. Afr Dent J 1988; 2: 76-79.

19. Ohito FA, Opinya GN, Wang'ombe J. Traumatic dental injuries in normal and handicapped children in Nairobi, Kenya. East Afr Med J. 1992; 69: 680-682.

20. Ng'ang'a PM, Karongo PK, Chindia ML, Valderhaug J. Dental caries, malocclusion and fractured incisors in children from a pastoral community in Kenya. East Afr Med J 1993; 70: 175-178.

21. Muriithi H M, Masiga M A, Chindia M L. Dental injuries in 0-15 year olds at the Kenyatta National Hospital, Nairobi. East Afr Med J 2005; 11: 592-597.

22. World Health Organization. Oral Health Surveys, Basic methods. 4th edn. Geneva: World Health Organization, 1997.

23. van Wyk PJ, Drummond RJ. Orthodontic status and treatment need of 12-15-year-old children in South Africa using the Dental Aesthetic Index. SADJ 2005; 60:334-338.

24. Ng'ang'a P M. An overview of epidemiologic and related studies undertaken on common dental diseases and conditions in Kenya between 1980-2000. Afr J Oral Health Sci 2002; 1:103-111.

25. Shaw N C. Terminology, prevalence and aetiology of malocclusion. In: WC Shaw (eds.) Orthodontics and occlusal management. London: Butterworth-Heinemann Ltd, 1994, pp 134-144.

26. Otuyemi O, Ogunyinka A, Dosumu O, Cons NC, Jenny J. malocclusion and orthodontic treatment need of secondary school students in Nigeria according to the dental aesthetic index (DAI). Int Dent J 1999; 49:203-210.

27. Rwakatema DS, Ng'ang'a PM, Kemoli AM. Orthodontic treatment needs among 12-15 year olds in Moshi, Tanzania. East Afr Med J 2007; 84:226-232.

28. Rwakatema DS, Ng'ang'a PM, Kemoli AM. Prevalence of malocclusion among 12-15 year olds in Moshi, Tanzania. East Afr Med J 2006; 83: 372-379.

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

30. Ng'ang'a PM. A study of occlusal anomalies and tooth loss in children aged 13-15 years in Nairobi. E Afr Med J 1991; 68: 980-988.

31. Ng'ang'a PM, Ohito F, Ogaard B, Valderhaug J. The prevalence of malocclusion in 13-15 year old children in Nairobi, Kenya. Acta Odontol Scand 1996; 54:126-130.

32. Kaimenyi JT. Occurrence of midline diastema and frenum attachments amongst school children in Nairobi, Kenya. Indian J Dent Res 1998; 9:67-71.

33. Ng'ang'a PM, Stevnic A, Ohito F, Ogaard B. The need and demand for Orthodontic treatment in 13-15 year olds in Nairobi, Kenya. Acta Odontol Scand 1997; 55: 325-328.

34. Jenny J, Cons NC. Establishing malocclusion severity levels on the Dental Aesthetic Index (DAI) scale. Aust Dent J 1994; 41:43-46.

35. Otuyemi OD, Ogunyinka A, Dosumu O, Cons NC, Jenny J, Kohout FJ, Jakobsen J. Perceptions of dental aesthetics in the United States and Nigeria. Community Dent Oral Epidemiol 1998; 26:418-420.

36. Toro MF, dos Santos PR, Kramer PF, Feldens CA, Sari GT. Prevalence of crown fractures in 8-10 year old Schoolchildren in Canoas, Brazil. Dent Traumatol 2004; 20: 251-254.

37. Kahabuka FK, Plasschaert A, van't Hof MA. Prevalence of teeth with untreated dental truma among nursery and primary schools pupils in Dar es Salaam, Tanzania. Dent Traumatol 2001; 17: 109-113.

38. Zuhal K, Semra OEM, Huseyin K. Traumatic injuries of the permanent incisors in children in southern Turkey: a retrospective study. Dent Traumatol 2005; 21: 20-25.

39. Bauss O, Rohling J, Schwestka-Polly R. Prevalence of traumatic injuries to the permanent incisors in candidates for orthodontic treatment. Dent Traumatol 2004; 20: 61-66.

40. Otuyemi OD. Traumatic anterior dental injuries related to incisor overjet and lip competence in 12-year-old Nigerian children. Int J Paed Dent 1994; 4: 81-85.

41. Kania MJ, Keeling SD, Mc Gorray SP, Wheeler TT, King GJ. Risk factors associated with incisor injury in elementary school children. Angle Orthod 1996; 6: 423-432.

42. Forsberg CM, Tedestam G. Etiological and predisposing factors related to traumatic injuries to permanent teeth. Swed Dent J 1993; 5: 183-190.

43. Hamdan MA, Rock WP. A study comparing the prevalence and distribution of traumatic dental injuries among 10-12 year old children in an urban and rural area in Jordan. Int J Paed Dent 1995; 4: 237-241.

44. Soriano EP, Caldas Jr AF, Goes PSA. Risk factors related to traumatic dental injuries in Brazilian school children. Dent Traumatol 2004; 20: 246-250.

45. Artun J, Behbehani F, Al-Jame B, Kerosuo H. Incisor trauma in an adolescent Arab population: prevalence, severity and occlusal risk factors. Am J Orthod Dentofacial Orthop. 2005; 3: 347-352.

46. Nguyen OV, Bezemer PD, Habets L, Prahl-Andersen B. A systematic review of the relationship between overjet size and traumatic dental injuries. Eur J Orthod 1999; 21:503-515.

47. Holan G, Peretz B, Efrat J, Shapira J. Traumatic injuries to the teeth in young individuals with cerebral palsy. Dent Traumatol 2005; 21: 65-69.

48. Canakci V, Akgul HM, Akgul N, Canakci CF. Prevalence and handedness correlates of traumatic injuries to the permanent incisors in 13-17 year old adolescents in Erzurum, Turkey. Dent Traumatol 2003; 19: 248-254.

49. Vaughan JP, Morrow RH. Manual of Epidemiology for District Health Management. Geneva: World Health Organization, 1997.

50. Cons NC, Jenny J, Kohout FJ. DAI: The Dental Aesthetic Index. Iowa City: College of Dentistry University of Iowa, 1986.

51. Application of the International Classificaton of Diseases to Dentistry and Stomatology IDC-DA, 3rd edn. Geneva: WHO, 1995.

52. Andreasen JO, Andreasen FM. Classification, etiology and epidemiology of traumatic dental injuries. In: Andreasen JO, Andreasen FM, eds.

Textbook and Color Atlas of Traumatic Injuries to the Teeth, 3rd edn. Copenhagen: Munksgaard, 2007: 151-177.

53. Proffit WR, Fields HW. Orthodontic Diagnosis: The development of a Problem List. In: Proffit WR, Fields HW, eds. Contemporary Orthodontics. 3rd edn. Missouri: Mosby, 2000: pp 148-195.

54. Vaughan JP, Morrow RH. Manual of Epidemiology for District Health Management. Geneva: World Health Organization, 1998.

55. So LL. Tang LK. A comparative study using the Occlusal Index and the Index of Orthodontic Treatment Need. Angle Orthod 1993; 63: 57-64.

56. Jenny J, Cons NC. Comparing and contrasting two orthodontic indices, the Index of Orthodontic Treatment Need and DAI. Am J Orthod Dentofacial Orthop 1996; 110:410-416.

57. Otuyemi OD, Oguyinka A, Dosumu O, Cons NC, Jenny J. Kohout FJ, Jakobsen J: Perceptions of dental aesthetics in the United States and Nigeria. Community Dent Oral Epidemiol 1998; 26: 418-420.

58. Ng'anga' RN and Ng'ang'a PM. Hypodontia of permanent teeth in a Kenyan population. East Afr Med J 2001; 78:200-203.

59. Jenny J, Cons NC, Kohout FJ, Jakobsen J. Differences in need for orthodontic treatment between native Americans and the general population based on DAI scores. J Public Health Dent. 1991; 51: 234-238.

60. Hassanali J, Amwayi P, Muriithi A. Removal of deciduous canine tooth buds in Kenyan rural Maasai. East Afr Med J 1995; 72:207-209.

61. Bernabe' E, Flores-Mir C. Orthodontic treatment need in Peruvian young adults evaluated through Dental Aesthetic Index. Angle Orthod 2006; 76: 417-421.

62. Moyers RE. Handbook of orthodontics, 4th edition. Chicago: Year Book Medical Pub; 1988.

63. Love RM, Ponnambalam Y. Dental and maxillofacial skeletal injuries seen at University of Otago School of Dentistry, New Zealand 2000-2004. Dent Traumatol 2008; 24: 170-6.

64. Tangade PS. The prevalence of Anterior Teeth Fracture and its Relation to Malocclusion in 12 and 15 Year Old School Children Balgaum City India. J Oral Health Comm Dent 2007;1: 7-11.

65. Soriano EP, Caldas Jr AF, Carvalho MVD, Amorim Filho HA. Prevalence and risk factors related to traumatic dental injuries in Brazilian schoolchildren. Dent Traumatol 2007;23: 232-240.

66. Rajab LD. Traumatic dental injuries in children presenting for treatment at the Department of Pediatric Dentistry, Faculty of Dentistry, University of Jordan, 1997-2000. Dental Traumatol 2003; 19:6-11.

67. Al-Jundi SH. Dental emergencies presenting to a dental teaching hospital due to complications from traumatic dental injuries. Dent Traumatol 2002; 18: 181-185.

68. Al-Khateeb S, Al-Nimri K, Abu Alhaija E. Factors affecting coronal fracture of anterior teeth in North Jordanian children. Dent Traumatol 2005; 21: 26-28.

69. Sandalli N, Sildir S, Guler N. Dlinical investigation of traumatic injuries in Yeditepe University, Turkey during the last 3 years. Dent Traumatol 2005;21:188-194

70. Baston EB, Freer TJ & Mc Namara JR. Epidemiology of dental trauma: A review of literature. Aust Dent J 2000;45:2-9.

71. Kahabuka FK, Mugonzibwa EA. Risk factors for injuries to maxillary permanent incisors and upper lip among school children in Dar es Salaam, Tanzania. Int J Paediatr Dent 2009; 2:148-54.

72. Sgan-CohenHD, Yassin H, Livny A. Dental trauma among 5th and 6th grade Arab School children in Eastern Jerusalem. Dent Traumatol 2008; 24: 458–461.

73. Baldava P, Anup N. Risk factors for traumatic dental injuries in an adolescent male population in India. The Journal of Contemporary Dental Practice 2007;6:1-10.

74. Marcenes W, Alessi ON, Traebert J. Causes and prevalence of traumatic injuries to the permanent incisors of school children aged 12 years in Jaragua do Sul, Brazil. Int Dent J 2000; 50: 87-92.

75. Stokes AN, Loh T, Teo CS, Bagramian RA. Relation between incisal overjet and traumatic injury: a case control study. Endod Dent Traumatol 1995; 1: 2-5.

Malocclusion and Traumatic Dental Injuries in relation to over-jet and lip posture in 12–15 year olds in Nairobi.

APPENDIX 1: Clinical examination form for registration of malocclusion (According to DAI criteria)

1. Missing incisor, canine and premolar teeth
   (Enter number of teeth) ☐
2. Crowding in the incisal segments
   - 0- No crowding
   - 1- One segment crowded ☐
   - 2- Two segments crowded
3. Spacing in the incisal segments
   - 0- No spacing ☐
   - 1- One segment spaced
   - 2- Two segments spaced
4. Diastema (mm) ☐
5. Largest anterior maxillary irregularity (mm) ☐
6. Largest anterior mandibular irregularity (mm) ☐
7. Anterior maxillary overjet (mm) ☐
8. Anterior mandibular overjet (mm) ☐
9. Vertical anterior open bite (mm) ☐
10. Antero-posterior molar relation
    - 0-Normal ☐
    - 1-Half cusp
    - 2-Full cusp
11. Lip posture ☐
    - 0-Competent
    - 1-Incompetent

Malocclusion and Traumatic Dental Injuries in relation to over-jet and lip posture in 12–15 year olds in Nairobi.

APPENDIX 2: Questionnaire on Trauma

1. Do you feel any discomfort associated with your tooth, which was hurt?

   1.Yes ☐

   2.No

If yes proceed to question 2 and if no proceed to question 3.

2. Which kind of discomfort does your tooth feel?

   1.Sensitive to hot or cold ☐

   2.Pain

   3.Swelling

3. When was your tooth hurt?

   1.In the last one month

   2.Between 1 to 6 months ago ☐

   3.6months to 1 year ago

   4.more than 1 year ago

   5.I do not remember

4.What was the cause of injury to your tooth

   1.A fall

   2.A bicycle or car accident

   3.Hurt during games or P.E ☐

   4.Hurt in a fight

   5.Hurt by a stationary object

   6.Others (specify)_____

4. When you were injured where were you?

   1.At home ☐

   2. In school

   3.Other (specify)_____

5. Have you been to see a dentist for treatment of your injured tooth?

   1.Yes ☐

   2.No

Malocclusion and Traumatic Dental Injuries in relation to over-jet and lip posture in 12–15 year olds in Nairobi.

APPENDIX 3: Clinical examination form for registration of TDI

A: DEMOGRAPHIC DATA

ID NO ☐☐☐☐ Date of examination _____

Gender 1.Male ☐ Age in years _____

2.Female

Name of Division _____

Name of Zone _____

Name of school _____

B. EXAMINATION FOR TRAUMA

	13	12	11	21	22	23
MAX						
MAND						
	43	42	41	31	32	33

Other teeth affected (specify teeth) _____

Tooth Status	Code
No trauma	0
Enamel infraction	1
Enamel fracture	2
Enamel-dentin fracture	3
Complicated crown fracture	4
Luxation injuries	5
Avulsion	6
Discoloration	7
Restored	8

Malocclusion and Traumatic Dental Injuries in relation to over-jet and lip posture in 12–15 year olds in Nairobi.

APPENDIX 4: Parental Consent Form

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

I am a postgraduate student at the University of Nairobi Dental School pursuing studies specializing in treating children's dental problems.

I wish to request for your permission for your child to participate in a study that will form part of my Masters Degree work.

The study will involve examination of your child's mouth to check for the arrangement of their teeth and inspect if they have broken or injured teeth. I shall perform the examination and also ask them questions regarding their broken or injured teeth. All this will be recorded and analyzed for research purposes only. No invasive or harmful procedure will be performed on your child during the study. Should any problem be detected in your child, an advisory note shall be sent to you through your child for action. The findings of the study shall be used to find out the frequency of injured teeth in children and their causes. Once these are known then the information shall be useful in advising both you and the children on how to prevent injuries to teeth.

I would therefore appreciate your consent by signing below:

Dr Marjorie K Muasya

I agree to have my child participate in the study:

Name.....

Signature.....

I do not agree to have my child participate in the study:

Name.....

Signature.....

Malocclusion and Traumatic Dental Injuries in relation to over-jet and lip posture in 12 -15 year olds in Nairobi.

APPENDIX 5: Ethical approval letter.

KENYATTA NATIONAL HOSPITAL
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Tel: 726300-9
Fax. 725272
Telegrams "MEDSUP", Nairobi
Email KNHplanC@Ken.Healthnet.org

Ref: KNH-ERC/01/3593
Date: 29th June, 2006

Dr.Mamore Kaswii Musaya
Dept. of Paediatric Dentistry,
School of Dental Science
University of Nairobi

Dear Dr Musaya ,

RESEARCH PROPOSAL"TRAUMATIC DENTAL INJURIES IN RELATION TO MALOCCLUSION IN 12-14 YEAR OLDS IN NAIROBI (P100/5/2006)

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and **approved** revised version of your above cited research proposal for the period 29th June 2006 – 28th June, 2007

You will be required to request for a renewal of the approval if you intend to continue with the study beyond the deadline given.

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

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

Yours sincerely

PROF A N GUANTAI
SECRETARY, KNH-ERC

c.c. Prof. K.M.Bhatt, Chairperson, KNH-ERC
The Deputy Director CS, KNH
The Dean School of Dental Sciences
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