

Risk factors for injuries to maxillary permanent incisors and upper lip among schoolchildren in Dar es Salaam, Tanzania

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Background. Dental trauma is common among children, and the maxillary permanent central incisors are the most often affected teeth.

Aim. This study aimed to investigate the risk factors for injury to maxillary permanent incisors and the upper lip among Tanzanian schoolchildren aged 8–14 years.

Design. A cross-sectional study involving 1119 children. The risk variables investigated included age, gender, lip competence, and overjet. The corresponding proportions of injuries and the relative risk (with 95% confidence interval) were calculated and tested by Fisher's exact test. Logistic regression was applied to ascertain the strength and direction of the association of the risk variables to injuries, and backward selection was used to test significant risk factors.

Results. About 24% of the children had trauma to maxillary incisors, 45% had incompetent lip whereas 31% had increased overjet. Age, gender, overjet, and lip competence showed significant association with injuries to upper lip and maxillary incisors. Boys had sustained more injuries than girls, with a higher relative risk for luxation injuries. Enamel fracture was associated with overjet combined with lip competence, whereas enamel dentine fracture without pulp involvement was related to gender. Luxation injuries were associated with gender, tooth avulsion with overjet, and lip competence. Injury to the upper lip was associated with age.

Conclusion. Male gender, increased overjet, and lip incompetence were the main risk factors of getting trauma to maxillary incisors, whereas age was the risk factor for injury to the upper lip.

Introduction

Substantial evidence is available asserting that dental trauma is common among children and that the maxillary central incisors are the most often affected teeth^{1–6}. With respect to the situation in Tanzania, Kahabuka *et al.*³ reported untreated trauma of permanent teeth ranging from 8% to 36% among Tanzanian schoolchildren aged 8–15 years. Furthermore, studies show that the prevalence of dental trauma increases with increasing overjet^{5–7}. More explicitly, increased overjet and inadequate lip coverage are reported to be significant predisposing factors to dental trauma of the maxillary incisors^{7–12}. Other studies report high percentage of dental trauma among subjects

with postnormal occlusion, short upper lip, and mouth breathing^{9,11}.

Even though few studies did not detect significant gender differences in dental trauma experience^{10,13}, most studies report that boys sustain dental trauma about twice as much as girls^{2,4–6,11,14}. Others report ethnic and racial differences such as significantly higher percentage of incisor injury in non-Caucasians² or more incisal trauma and two teeth injuries among Hispanics and all minorities combined than among whites, although these differences were not statistically significant¹⁵. The risk to injuries is reported to increase in children exhibiting multiple factors. For instance, Kania *et al.*² stated that the prevalence of incisor injury was higher for male children who had a prognathic maxilla, and a larger overjet, whereas Bauss *et al.*⁶ stated that children with increased overjet in combination with inadequate lip coverage revealed the highest prevalence of dental trauma. Moreover,

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Dearing¹⁶ stated that children who have an increased overjet of more than 6.0 mm and less than one-half of their maxillary central incisors covered by the upper lip at rest may be regarded as 'at risk' especially if they are males.

On the other hand, a few studies did not find these associations. Stokes *et al.*¹⁷ reported that overjet was not a positive correlate with traumatic dental injuries. Marcenes *et al.*¹⁸ found that children with incisor overjet greater than 5 mm and inadequate lip coverage were not more likely to experience dental injuries. Considering these contradicting findings and the fact that children of African background have more bimaxillary protrusion compared to Caucasians and other racial groups^{19,20}, this study was conducted aiming to investigate the risk for injury to the maxillary permanent incisor teeth and upper lip among children in Dar es Salaam, Tanzania.

Materials and methods

The study was carried out in primary schools in Ilala, Kinondoni, and Temeke Municipalities of Dar es Salaam city. Lists of primary schools in the three Dar es Salaam municipalities were obtained from respective education offices. Thereafter, 18 primary schools were randomly selected: Ilala (six schools), Temeke (five schools), and Kinondoni (seven schools). All schoolchildren aged 8–14 years were eligible to take part in the study. Pre-investigation calculation of the required sample size was done to find a difference of 10% in risk at $\alpha = 0.05$ and a power of 90%. The results indicated that at least 1040 children should be enrolled. A random sample of the children from the selected schools was taken, and 1349 children were chosen to participate in the study. None of the children refused to take part in the study. The study participants were of the same ethnic but a wide range of social background representative of different Dar es Salaam city social strata.

For 230 (17%) children, overjet could not be obtained for various reasons including missing maxillary incisors, having an open bite, or Angle's class III incisal relationship. Consequently, they were excluded from the

analyses. Therefore, the current report is based on the total sample of 1119 children of whom 49.2% were boys. Children aged 8–12 years constituted 50.8% of the study participants.

The Muhimbili University ethical committee granted ethical clearance. Written informed consent was requested from parents, whereas children gave verbal consent. Both parents and children had an option to withdraw from the study after giving consent if they so wished. Besides, the education and school authorities gave permission to conduct the study in the selected schools.

Methods

Interview was conducted in classrooms, and the purpose of the interview was to obtain children's demographic data including name, age, and gender, and to inquire on children's experience of injury to the maxillary incisors and upper lip. Furthermore, clinical examination was carried out to ascertain the evidence of traumatic injury to the maxillary incisors. Intra-oral examination of overjet, trauma of the maxillary incisors, and recording of lip competence was conducted in classrooms utilizing natural daylight with a child seated in an office chair. Two different examiners carried out clinical measurements independently. One examined injury to the maxillary incisors and the other determined and recorded overjet and lip competence.

Intra-examiner variability for lip competence, overjet, and dental trauma was checked basing on double measurements of 100 children within an interval of 10 days. The agreements for the variables were considered good with kappa values ranging from 0.67 to 0.80.

Injuries were scored according to Andreasen's classification¹ that was modified to suit the study conditions. Luxation injuries, namely extrusive luxation (peripheral dislocation, partial avulsion) and lateral luxation, were pooled together and called luxation injuries because it was thought that subjects were unable to describe different types of luxation injuries. Root fractures were not recorded as no radiographs were taken.

Overjet was measured in millimetres using a WHO periodontal probe with a scale in

millimetres held parallel to the occlusal plain and was recorded into two categories as follows: normal (0–3.5 mm) and increased (> 3.5 mm) according to the Index of Orthodontic Treatment Need (IOTN)²¹. Overjet was measured from the most prominent aspect of the maxillary incisors.

Determination of lip competence was done with a child seated without his/her awareness. A state of lip competence was recorded when the lips covered the teeth in relaxed position. A state of lip incompetence was recorded when the lips could not cover the teeth or did so with muscle strain.

Statistical methods

The independent variables in this study were age, ethnicity, gender, lip competence, maxillary incisors, and overjet, whereas the dependent variables were self-reported experience of injury to oral tissues, injury to upper lip, maxillary incisors, and total sum of all injuries to the maxillary incisors. An additional independent variable combining lip competence and overjet variables was created and included in the analyses as an independent variable. When five independent variables, namely age, gender, ethnicity, overjet, and lip competence were subjected to various descriptive and backward logistic regression analyses, ethnicity straight away showed no association with injury to upper lip or maxillary incisors. Hence, the variable was excluded from further analyses. Cross tabulations of injuries by independent variables were done to detect associations

using both χ^2 and Fisher's exact tests. The prevalence of injury to the upper lip and maxillary incisors was generated per gender with relative risks (RRs) for boys [95% confidence intervals (CIs)]. For variables that showed a significant relationship, backward logistic regression was applied to ascertain the strength and direction of the association at a significance level of $P < 0.05$. The rare injuries with prevalence of less or equal to 0.5% were also excluded from further analysis. These included enamel infraction and enamel dentine fracture with pulp involvement. Furthermore, backward logistic regression was applied to the following selected interactions: lip competence and overjet, gender and age, gender and overjet, gender and lip competence, gender versus combination of lip competence, and overjet variables to find possible effect modifiers. Interactions were tested at a significance level of $P < 0.01$ to compensate for multiple testing. The odds ratios (ORs) with 95% CI were generated.

Results

Out of 1119 participating children, 459 had lip incompetence and 421 had increased overjet. The proportions of children with lip incompetence and increased overjet according to sex and age are shown in Table 1. Lip incompetence was significantly higher in older boys ($P < 0.04$). The differences in increased overjet between subgroups were not statistically significant. On cross tabulating overjet and lip competence, only 19.3% of the children with normal overjet had incompetent lips, whereas

Table 1. Frequency of lip incompetence and increased overjet (> 3.5 mm) according to age and gender.

Variable	Boys		Girls		Total		P value
Lip incompetence	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
8–12 years	106	23.1	132	28.8	238	51.9	NS
12 ± 14 years	129	28.1	92	20	221	48.1	0.04
Total	235	51.2	224	48.8	459	100	NS
Increased overjet (> 3.5 mm)	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	
8–12 years	104	24.7	115	27.3	219	52.0	NS
12 ± 14 years	112	26.6	90	21.4	202	48.0	NS
Total	216	51.3	205	48.7	421	100	NS

NS, not significant.

Table 2. Experience of oral injuries among schoolchildren divided by gender.

Type of injury	Boys <i>n</i> = 551 (%)	Girls <i>n</i> = 568 (%)	Total <i>n</i> = 1119 (%)	<i>P</i> value	Relative risk for boys with 95% CI
Self-reported experience of injury to oral tissues	48.8	38.9	43.8	0.001	1.5 (1.2–1.9)
Injury to maxillary anterior teeth	26.3	20.8	23.5	0.03	1.4 (1.0–1.8)
Subluxation	9.8	9.2	9.5	NS	1.1 (0.7–1.6)
Enamel fracture	6.2	6.3	6.3	NS	1.0 (0.6–1.6)
Injury to the upper lip	6.2	4.0	5.1	NS	1.6 (0.9–2.7)
Enamel dentine fracture without pulp involvement	6.0	3.3	4.6	0.04	1.8 (1.0–3.3)
Luxation injuries	5.4	1.8	3.8	0.03	3.2 (1.0–9.7)
Tooth avulsion	1.8	1.2	1.5	NS	1.5 (0.6–3.9)
Enamel infractions	0.5	0.5	0.5	NS	1.0 (0.2–5.1)
Enamel dentine fracture with pulp involvement	0.4	0.2	0.3	NS	2.1 (0.1–22.8)

CI, confidence interval; NS, not significant.

Table 3. Multivariate analysis of the four considered risk factors of oral injuries as obtained by backward elimination in logistic regression.

Risk factors Type of injury	Gender	Age	Overjet	Lip competence	Overjet and lip competence
Self-reported experience of injury to oral tissues	0.001 OR = 1.487	NS	NS	NS	0.033 OR = 1.296
Enamel fracture	NS	NS	NS	NS	0.006 OR = 2.026
Tooth avulsion	NS	NS	0.004 OR = 4.954	0.019 OR = 0.245	NS
Enamel dentine fracture without pulp involvement	0.038 OR = 1.841	NS	NS	NS	NS
Subluxation	NS	NS	NS	NS	NS
Luxation injuries	0.043 OR = 3.168	NS	NS	NS	NS
Injury to upper lip	NS	0.003 OR = 0.398	NS	NS	NS
Injury to maxillary anterior teeth	0.035 OR = 1.349	NS	0.016 OR = 1.414	NS	NS

NS, not significant; OR, odds ratio.

77% with increased overjet (> 3.5 mm) had incompetent lips (< 0.001).

An overview of the prevalence of oral injuries experience per gender is presented in Table 2. Experience of injury to the oral tissues generally was reported by 43.8% of the participants being more common among boys ($P < 0.001$). Injury to the upper lip specifically was reported by 5% of the participants. Clinically, injuries to the maxillary incisors was observed and recorded in 23.5% of the participating children. Common injuries to the maxillary incisors were subluxation (9.5%), enamel fracture (6.3%), and enamel dentine fracture without pulp involvement (4.6%). Enamel–dentine fracture with pulp involvement and enamel infractions injuries were rare, occurring in 0.2–0.5% of the boys and girls. Often, boys had reported and were observed

to sustain more injuries than girls, with a RR ranging from 1.0 to 3.2.

The influence of the considered risk factors on the frequencies of the upper lip and maxillary incisor injuries is presented in Table 3. Self-reported experience of injury to oral tissues, enamel–dentine fracture without pulp involvement, luxation injuries, and total sum of all injuries to the maxillary incisors were significantly influenced by gender of the participants. Boys reported and/or experienced more injuries than girls did ($P < 0.001$; OR, 1.49; CI, 1.17–1.89). The frequency of injuries to the upper lip was significantly lower in older children ($P < 0.003$; OR, 0.40; CI, 0.22–0.73). Gender showed a significant influence on the occurrence of all injuries to the maxillary incisors ($P < 0.035$; OR, 1.35; CI, 1.02–1.78). Both lip competence ($P < 0.019$; OR, 0.25; CI,

0.08–0.80) and increased overjet ($P < 0.004$; OR, 4.95; CI, 1.66–14.76) had a significant influence on tooth avulsion injury. Injuries to the maxillary incisors in general were also significantly influenced by overjet ($P < 0.016$; OR, 1.41; CI, 1.07–1.87). A variable generated from the combination of overjet and lip competence had a significant influence on self-reported experience of injury to oral tissues ($P < 0.033$; OR, 1.30; CI, 1.02–1.64) and enamel fracture ($P < 0.006$; OR, 2.03; CI, 1.22–3.37).

Discussion

Interpretation of the findings in this study should bear in mind two limitations. First, some injuries could have been missed if signs and symptoms did not exist at the time of the study. Second, children's ability to recall the injury that occurred several months or years before the study or to correctly describe some injuries like subluxation, extrusion, and lateral luxation may present some reservations.

In previous studies, the employed cut-off point for increased overjet varies from one study to another; the commonly used ones are 3 mm and 6 mm²². Thus, we had a challenge to choose a cut-off point for normal and increased overjet in our study. Ultimately, we decided to categorize overjet into normal (0–3.5 mm) and increased (> 3.5 mm) according to Dental Health Component (DHC) of the IOTN²⁰. The DHC of the IOTN measures the objective need for orthodontic treatment whereby overjet of > 3.5 mm with lip competence or lip incompetence falls in two different orthodontic treatment categories.

Upper lip incompetence occurred in 40.3% of the participating children and was significantly higher in older boys aged 12–14 years ($P < 0.04$). Although no published data from the Tanzanian population could be retrieved for comparison, this proportion is considered high. On the other hand, individuals of African origin are considered to have thicker and more prominent lips than Caucasians²³ which are expected to cover the anterior teeth adequately. The bimaxillary protrusion background for the African children may have influenced the proportion of the upper lip incompetence in this study sample^{19,20}.

Interestingly in this study, the increased overjet (> 3.5 mm) occurred in 31% of the children being higher than 12.2–19.3% reported previously in the Tanzanian population by Mugonzibwa and colleagues²⁴. Mugonzibwa *et al.*²⁴, however, used a higher cut-off point of 5 mm for normal overjet which may account for the difference observed.

The prevalence of injury to maxillary incisors of 23% in this study is comparable to 8–36% reported previously from the same population using similar methods³. Whereas initially, age was associated with some injuries, the absence of age effect in further analyses of most discrete injuries to maxillary anterior teeth suggests that the prevalence in younger children (8–12 years) is the same as in older children (12–14 years). However, injuries to upper lip were more frequent among younger boys and girls, whereas injuries to maxillary anterior teeth in general were more frequent in younger boys.

The findings of this study are in agreement with other studies reporting that boys have a higher risk of sustaining injury than girls, and their risk increases when a boy has either an incompetent lip, increased overjet, or both factors together^{2,4–6,11,14,25–28}. When someone has incompetent lips, some oral tissues are exposed to the surroundings, thus at risk for injury which may explain association of lip incompetence with more experience of injury to oral tissues. Moreover, they are different from few studies^{10,13} that did not find any association between gender and injury to maxillary incisor.

Whereas in previous studies, various types of injuries to maxillary incisors were grouped together and analysed for association with the risk factors, in this study analysis was done for individual discrete injuries to maxillary anterior teeth and these were shown to have diverse risk factors. Consequently, two rare injuries, enamel infraction and enamel dentine fracture with pulp involvement that had a prevalence of less than 1% were excluded from further analyses. Future studies using individual discrete injuries to maxillary anterior teeth may consider increasing the sample size to capture such rare injuries.

Similar to previous reports^{5–12}, increased overjet and incompetent lips separately or in

combination showed an influence on some dependent variables, namely self-reported experience to oral tissues, enamel fracture, tooth avulsion, and injury to maxillary incisors. This association is of general significance for starting and prioritizing orthodontic treatment for Tanzanian children. Furthermore, our observations are in agreement with those of Jarvinen⁷, Otuyemi²⁹, and of a systematic review by Nguyen *et al.*²² who concluded that children with an overjet larger than 3 mm are approximately twice as much at risk of traumatic dental injury on anterior teeth than those with a lesser overjet. This study showed that an overjet of more than 3.5 mm puts a child at risk of getting both injuries to maxillary anterior teeth and tooth avulsion. The findings are divergent from those of Burden¹⁰ who concluded that inadequate lip coverage is a better predictor of traumatic injury than increased overjet. Our results are also contrary to the two studies by Stokes *et al.*¹⁷, and Marcenes *et al.*¹⁸ who reported no relationship between injury to maxillary incisors and increased overjet or incompetent lips. The discrepancies of the Stokes and colleagues' findings¹⁷ could have been caused by a small sample size of 36 subjects and 36 control study groups, whereas that of Marcenes *et al.*¹⁸ may represent true differences that may prevail among Tanzanian and Brazilian children.

Conclusion

The findings in this study showed that being a boy, younger age, increased overjet, and co-existence of both lip incompetence and increased overjet are risk factors for trauma to the upper lip and maxillary incisors. Gender is, however, the main risk factor.

What this paper adds

- Additional evidence on risk factors for injury to maxillary incisors and upper lip
- Sheds light on the challenge of using discrete injuries of maxillary incisors to describe risk factors for injury
- Presents challenges for intervention and further research

Why this paper is important to paediatric dentists

- Oral facial trauma is one of the important oral health problems among children.

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