

Prevalence of Traumatic Dental Injuries to Anterior Teeth of 12-Year-Old School Children in Kashmir, India

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Abstract

Background: Traumatic dental injuries to anterior teeth are a significant public health problem, not only because their prevalence is relatively high, but also because they have considerable impact on children's daily lives. Traumatic dental injuries (TDIs) cause physical and psychological discomfort, pain and other negative impacts, such as tendency to avoid laughing or smiling, which can affect social relationships.

Objectives: This study aimed to assess the prevalence of traumatic dental injuries to anterior teeth among 12-year-old school children in Kashmir, India.

Patients and Methods: A cross-sectional study was conducted in private and government schools of India among 1600 schoolchildren aged 12 years. In addition to recording of the type of trauma (using Ellis and Davey classification of fractures, 1970), over jet, Angle's molar relation and lip competence were also recorded. The socioeconomic status and academic performance of the study subjects were registered. The data obtained were compiled systematically and then statistically analyzed. The statistical significance for the association between the traumatic injury and the variables was analyzed using the chi-square test. Logistic regression was used to identify potential risk predictors of TDIs.

Results: The overall prevalence of TDI to anterior teeth was found to be 9.3%. The TDI to anterior teeth in male was more than female, but the difference was statistically nonsignificant ($P < 0.01$). Falls and sports were the most common causes of trauma in the present study. The highest potential risk factor for the occurrence of trauma was over jet. Academic performance was found to be significantly associated to TDI to anterior teeth, when analyzed in a multiple regression model.

Conclusions: It was concluded that the prevalence of traumatic dental injuries was 9.3%. Traumatic dental injuries among children exhibit complex interaction between the victims' oral conditions and their behavior. Therefore, prevention should consider a number of characteristics such as oral predisposing factors, environmental determinants and human behavior. It is recommended that specific and proper public places for leisure and sports activities, with impact-absorbing surfaces around the items on which children are most likely to fall, should be provided.

Keywords: Traumatic Dental Injuries, Schools, Risks

1. Background

Injuries during childhood have been considered a global public health problem and injuries have become the primary cause of death and disability of human beings (1). It has been estimated that in 2000, 12% of the burden of disease and 9% of deaths worldwide were due to injuries (2).

The prevalence of traumatic dental injuries (TDIs) to anterior teeth among schoolchildren has been studied in different parts of the world by many researchers, and a wide range of variation has been found. In Asia and Africa, the prevalence of TDI to anterior teeth among adolescents ranges from 4% to 35% and 15% to 21%, respectively.

In America and Europe, the prevalence varied from 15% to 23% and 23% to 35%, respectively (3). These figures represent the burden of TDI on the community, affecting the populace of various age groups. Hence, traumatic dental injuries to anterior teeth have become a significant public health problem, by having a considerable effect on a child's day to day life, in addition to its high prevalence (4). Most of these injuries cause adverse impact on physical, psychological, educational, social and economic aspects of the affected individual and their family (5, 6). Moreover, researchers have found an association between dental problems and academic achievement and

learning in affected children (7). Hence, such a negative impact of TDI cannot be underestimated, and it becomes the role of health professionals to elucidate the causes and risk factors of TDI, so as to prevent its occurrence.

To allow or implement the application of adequate preventive actions for traumatic injuries, the knowledge of its risk factors is of utmost importance (8). Prevention of traumatic dental injuries will be possible only if it is based on reliable data relating to its prevalence, causes and risk factors. However, it is unfortunate that people are not aware of the risk factors and the ways to avoid traumatic dental injuries. Also, some dentists and health professionals do not give much importance to the prevention of dental trauma and are more concerned about the treatment aspects (9).

In most of the previous studies, increased over jet, incompetent lip coverage and maxillary incisor protrusion have been reported to have an association with the occurrence of traumatic dental injuries (8, 10). There are complex interactions of these oral risk factors with the environmental factors and individual behaviors. All these risk factors together highlight the complexity of the etiology of dental trauma.

In Kashmir, being a hilly area, there is an additional risk of traumatic dental injuries due to falls on uneven terrain. Moreover, the climatic conditions, such as snowfall, can increase the probability of trauma, as children may fall while walking or playing on the slippery roads and playgrounds. A review of the literature reveals that there are no previous studies conducted regarding traumatic dental injuries in Kashmir, India.

2. Objectives

Therefore, a cross-sectional study was conducted to estimate the prevalence of traumatic dental injuries to anterior teeth among 12-year-old schoolchildren in Kashmir, India.

3. Patients and Methods

A cross-sectional survey was carried out in private and public schools of Kashmir, India to assess the prevalence of traumatic dental injuries to anterior teeth among 12-year-old schoolchildren.

The sample size calculation was done on the basis of a prevalence of 50% in order to obtain the largest sample size (mentioned in Health Research Methodology, WHO; 2nd Edition, 2001), as there were no previous studies conducted in the state. At a confidence interval level of 95% and with an allowable error of 5%, the sample size was estimated to be 1600.

A multistage sampling was adopted for selection of students so that they represented the population of 12-year-old schoolchildren of Kashmir, India. In the first stage, the Kashmir division was divided into four zones; Northeast, Northwest, Southeast and Southwest. From each zone, one district was selected in which two private

and two public schools were chosen randomly, using the criteria of a minimum number of 100 students of age 12 years old studying in each school. In the second stage, all 12-year-old children in these schools who fulfilled the eligibility criteria, were examined to make the final sample of 1600 subjects. All those students who were 12 years old, willing to participate and were permanent residents of Kashmir, India were included in the study. Students, who were mentally or physically disabled and those who were not present on the days of oral examinations were excluded from the study.

A single examiner was calibrated in the department of Public Health Dentistry, Kothiwal Dental College and Research Centre, Moradabad. Kappa statistics were applied to compute the intra-examiner reliability and it was found to be satisfactory at a Kappa coefficient of 0.81.

Subjects were asked about their demographic data by the investigator, and the responses were recorded in a pre-structured proforma. To categorize the subjects based on their socioeconomic status, they were interviewed to determine the education and occupation of the family head, monthly family income and total number of members in their family. Their responses were cross-verified with school records. An updated Kuppaswami's Classification 2012 was used for determining the socioeconomic status. The student's teacher was asked about the academic performance and as to how they rated the student's performance in academics. The ratings were categorized on 5-point Likert scale as excellent, good, fair, poor or very poor. Students were examined by one calibrated examiner for traumatic dental injuries using a mouth mirror and explorer. The Ellis and Davey classification of fractures (1970) was used to assess the type of tooth fracture. Subjects who were found to have traumatic dental injury were interviewed for details of the injury event. Subjects were checked for overjet using the Community Periodontal Index (CPI) probe, as mentioned in the 1997 WHO basic oral health survey guidelines. Lip seal was examined by visual inspection to categorize children as having competent or incompetent lips. Angle's molar relationship was recorded to classify the subjects as having Class I, Class II and Class III molar relation.

Data analysis included descriptive statistics (frequency distribution). The statistical significance for the association between the traumatic injury and gender, socioeconomic status, academic performance, malocclusion, overjet and lip competence was obtained using the Chi-Square test. The level of significance was set at $P \leq 0.05$. Logistic regression was used to identify potential risk predictors of traumatic dental injuries at a level of significance of $P < 0.15$.

3.1. Ethical Consideration

Prior to conducting the survey, ethical approval was obtained from the Institutional Ethics Committee, Kothiwal Dental College and Research Centre, Moradabad. Permis-

sion for carrying out the study in the public and private schools of Kashmir was obtained from the Directorate of School Education, Kashmir.

4. Results

Out of total 1600 students, 767 (47.9%) were male and 833 (52.1%) were female. The prevalence of TDI was found to be 9.3% (5.06% male and 4.25% female). It was slightly higher in male than female, but the difference was found to be statistically non-significant ($P < 0.10$). The most common cause of trauma was falls (42.2%) followed by sport injuries (22.81%) (Table 1). Type I (68.45%) fracture was the most common type of tooth fracture found (Ta-

ble 2) and among all anterior teeth, the most commonly involved teeth were right maxillary central incisors (Table 3). Among those children with > 3 mm overjet, 17.1% were affected by trauma, while 3.6% of children with ≤ 3 mm overjet showed TDI to anterior teeth (Table 4).

In multiple logistic regression analysis, it was observed that the highest potential risk factor for occurrence of TDI, was overjet followed by molar relation and lip incompetence. These three variables showed a highly significant association to TDI. Academic performance and socioeconomic status also showed a statistically significant association to traumatic dental injuries when analyzed in the multiple logistic regression model (Table 5).

Table 1. Distribution of Traumatized Subjects According to Cause^a

| Serial No. | Cause of Trauma | Percentage of Children |
|------------|-----------------|------------------------|
| 1 | Falls | 63 (42.2) |
| 2 | Sports | 34 (22.81) |
| 3 | Unknown | 24 (16) |
| 4 | Accidents | 15 (10.06) |
| 5 | Collisions | 7 (4.69) |
| 6 | Violence | 3 (2.01) |
| 7 | Biting | 3 (2.01) |

^aData are represent as No. (%).

Table 2. Traumatic Dental Injuries According to Type of Trauma^a

| Serial No. | Type (Ellis and Davey classification of fractures) | Affected Children |
|------------|--|-------------------|
| 1 | Type I | 102 (68.45) |
| 2 | Type II | 37 (24.8) |
| 3 | Type III | 7 (4.6) |
| 4 | Type IV | 1 (0.67) |
| 5 | Type V | 1 (0.67) |
| 6 | Type VIII | 1 (0.67) |

^aData are represent as No. (%).

Table 3. Traumatic Dental Injuries According to Tooth/Teeth Fractured^a

| Tooth/Teeth Fractured | Involved Students |
|--|-------------------|
| Right Maxillary Central Incisors | 91 (61.07) |
| Right and Left Maxillary Central Incisors | 15 (10.06) |
| Left Maxillary Central Incisors | 40 (26.84) |
| Left Maxillary and Mandibular Central Incisors | 1 (0.67) |
| Left Mandibular Central Incisors | 1 (0.67) |
| Right and Left Mandibular Central Incisors | 1 (0.67) |

^aData are represent as No. (%).

Table 4. Traumatic Dental Injuries According to Overjet, Lip Coverage, Molar Relation, Socio-Economic Status and School Type^{a,b}

| Risk Factor | Examined | Affected by | Fracture | P |
|-----------------------------|------------------------|-------------|------------|---------|
| Overjet, mm | | | | 0.001 |
| | Less than 3 mm | 921 (57.6) | 33 (3.6) | |
| | ≥ 3 mm | 679 (42.4) | 116 (17.1) | |
| Lip coverage | | | | 0.001 |
| | Competent | 1301 (81.3) | 71 (5.45) | |
| | Incompetent | 299 (18.7) | 78 (26.08) | |
| Molar relation | | | | 0.001 |
| | Class I | 1262 (78.5) | 69 (5.46) | |
| | Class II | 306 (19.1) | 80 (26.14) | |
| | Class III | 3 (2) | 0 (0) | |
| Socioeconomic status | | | | ≤ 0.024 |
| | Upper (I) | 342 (21.5) | 35 (10.2) | |
| | Upper Middle (II) | 476 (29.8) | 28 (5.9) | |
| | Middle Lower (III) | 236 (14.8) | 25 (10.6) | |
| | Lower Upper Lower (IV) | 350 (21.9) | 35 (10.2) | |
| | Lower (V) | 196 (12.2) | 26 (13.3) | |
| School type | | | | ≤ 0.82 |
| | Public | 844 (52.8) | 80 (9.5) | |
| | Private | 756 (47.2) | 69 (9.1) | |

^aData are represent as No (%).^bLevel of significance at P ≤ 0.05.**Table 5.** Regression Analysis of Different Variables in Relation to Traumatic Dental Injuries to Anterior Teeth^a

| Effect | Model Fitting Criteria - 2 Log Likelihood of Reduced Model | Likelihood Ratio Tests Chi-square | Degree of Freedom | P Value |
|-----------------------------|--|-----------------------------------|-------------------|---------|
| Intercept | 366.6 | 0.00 | 0 | - |
| Gender | 367.5 | 0.84 | 1 | 0.36 |
| School Type | 368.9 | 2.25 | 1 | 0.13 |
| SES | 375.5 | 8.89 | 4 | 0.06 |
| Lips Competence | 371.1 | 4.48 | 1 | 0.03 |
| Molar Relation | 383.1 | 16.50 | 2 | 0.00 |
| Overjet | 386.7 | 20.03 | 1 | 0.00 |
| Academic Performance | 370.9 | 4.25 | 2 | 0.12 |

^aLevel of significance at P < 0.15.

5. Discussion

Out of a total of 1600 school children of 12 years of age examined in Kashmir, India, 149 (9.3%) subjects had traumatic dental injuries to anterior teeth. A review of the literature has shown that there is a wide variation in TDI to anterior teeth among children in Africa, Asia, Europe, the Middle East and America; ranging from 4% to 58% (11). This variation in the prevalence of TDI has been related to many factors such as the study design, sample size, sampling procedure, diagnostic criteria, limited age-groups, geographic differences and study locations (8).

Out of a total 149 children with traumatic dental injuries 81 (54.36%) were males and 68 (45.63%) were females. In most of the previous studies, the prevalence of TDI was found to be higher in boys than in girls. The reason for more traumas in boys was their participation in leisure activities or sports of a more aggressive nature than girls. In addition, the fact that pubertal growth rates are delayed in boys, so girls are more mature in nature at an earlier age than boys (10,12) could be a factor. However, in the present study there was no statistically significant dif-

ference found in TDI among girls and boys; this finding was similar to other previous studies (13, 14), which might be due to societal changes, including an increase in the participation of girls in sports, which can lead to trauma.

In the present study, children attending the public schools had more TDI to anterior teeth than those attending the private schools, but the difference was not found to be statistically significant ($P \leq 0.82$). More TDIs were reported in public schools than the private schools in several previous studies (15, 16). This might be due to the better facilities and more favorable socio-environmental conditions (especially for sports) at the private schools (17). Public schools probably have more children per classroom, resulting in overcrowding, and hence, a predisposition to TDIs. Moreover, the children studying in public schools are usually from poor families, so they lack appropriate supervision, which might be a risk factor for their TDIs. On the contrary, more traumatic dental injuries were seen in children attending private schools in the study conducted in San Domingo, Dominican Republic (18). This might be due to the fact that the students in private schools that were studied had more facilities, such as swimming pools, skates and skids, and different types of contact sports, and thus, they were more prone to traumatic dental injuries.

In the present study, the socioeconomic stratification was done based on Kuppaswamy's Socio-Economic Status Scale (revised in 2012). The socioeconomic status gives an idea of whether health services and facilities can be afforded or not. As Kuppaswamy's socioeconomic status is calculated by a summation of education, occupation and income, the value system for a particular level of education and occupation can be predicted. It is an important tool in hospital and population-based research in India, which was first proposed in 1971 (19). An updated version of the Kuppaswamy Scale was used because of the increase in the price index (this scale being consumer price index based) (20).

In the present study, the highest prevalence (13.3%) of traumatic dental injuries to anterior teeth was found in the children from the lowest socioeconomic status families. This finding was in agreement with some of the previous studies in which it was reported that lower socioeconomic groups were more prone to TDIs (15, 21), while few studies reported a higher prevalence of TDI among the highest socioeconomic groups (22, 23). One of the studies found a higher TDI prevalence in the middle class group (24). As the same socioeconomic pattern is not shared by different countries, this might explain the reason for the conflicting figures found by different researchers. Moreover, very few studies have included socioeconomic status in their reports.

In the present study, the most common cause of trauma was due to falls, followed by sports. This finding was in accordance with many previous studies, wherein they have mentioned that this is of special importance for health policy makers seeking to establish prevention strategies

to reduce traumatic or facial injuries (25, 26). The main activities that caused children to fall were playing, cycling, running and other leisure activities at home and at schools. As the present study was conducted in Kashmir, in which the snow-covered roads and playgrounds increase the chances for children to fall; hence, that might be the reason for falls being one of the most common cause for TDI. Moreover, the uneven terrain increases the likelihood of trauma among school children of Kashmir, it being a hilly area. The third most important cause was of unknown origin. The likely cause for this could be that the present study was retrospective in nature and several children could not recall the origin of their trauma. It might also be explained by the fact that as the trauma was not so severe, enamel fractures being more prevalent, it was possible that some children did not remember the circumstances of the traumatic event when they were interviewed. This finding was in accordance with the previous studies (26, 27). Contrary to this, in some of the previous studies (28), violence has been attributed to being the most common cause of dental trauma. This might be due to the fact that falls is a broad category and includes several causes such as falls due to pushing, which is a minor form of violence. So, in the present study this might be explained by the fact that minor forms of violence were not specified by the students, and hence, might have been categorized as falls.

The Ellis classification of fractures of anterior teeth has been used in many previous studies (29, 30) for recording dental trauma. Use of a simple classification, e.g., Ellis and Davey classification of fractures (1970) (31), was preferred over other classifications, as injuries to the alveolar socket and fractures of jaws or gingival lacerations were not evaluated in the present study. Using this classification was easy and allowed the rapid recording of reliable data.

The present study showed Type I (enamel fracture) as the most common type of fracture and accounted for 68.45% of the total fractures, followed by fractures involving enamel-dentine (Type II); the maxillary central incisors were the most commonly involved teeth. These findings were in accordance with most of the previous studies (12, 32). Severe impacts, such as those resulting from traffic accidents, may increase the number of teeth involved, which are better represented in hospital and institution-based studies (33). As the present study was conducted in schools and not in the hospitals, less severe cases involving only enamel fractures were more evident.

The most frequently affected teeth are the central incisors. This finding corroborated with previous studies (12, 13). The position of these teeth makes them more susceptible to trauma. In addition, these teeth are frequently protruding and may have insufficient coverage by the lips in Class II malocclusion cases. In the present study, it was found that students having Class II molar relation had more TDIs than those with Class I and Class III, which might be due to exposure of the central incisors in such

cases. Protrusion of maxillary anterior teeth is the most common feature in Class II Div1 malocclusion, so they are more vulnerable to traumatic dental injuries. These findings corroborate with earlier findings (10, 13).

In the present study, a higher prevalence of TDI was found in those children having an incisal overjet ≥ 3 mm ($P < 0.01$) and those with incompetent lip closure ($P < 0.001$), and the differences were found to be statistically significant. These findings corroborated with the findings of various previous studies (10, 12). In some studies (10), the overjet $> 3-3.5$ mm is believed to be the meaning of protrusion, but in others (12), it is considered when the overjet > 5.0 mm. Such differences in the explanation of overjet makes it difficult to compare the results of various studies. The results of the present study support previous findings in which it has been found that lip incompetence decreases the incisor protection, and thus, leaves the incisors more vulnerable to trauma (27). Children with inadequate lip coverage were found to be more prone to TDI to anterior teeth. This finding was in agreement with many previous studies (12, 13, 27, 34). Competent lips provide a cushion and protective effect, and hence, lip incompetence increases the likelihood of trauma (27).

The present study included the student's academic performance as per their class teacher. It was found that those students, who were rated as excellent for their academics by their teachers, experienced the least traumatic dental injuries, while those who were fair in their studies accounted for a greater number of traumatic dental injuries. In multiple logistic regression analysis, the academic performance of the children showed a significant association with traumatic dental injuries to anterior teeth.

Various researchers have found that the academic performance of the students is influenced by many factors such as their socioeconomic status, aggressive behavior, the environment of classrooms, the physical activity of child and so on (35). Warren et al. believed that social scenarios are responsible for the deviation of students towards using aggressive behavior. They indicated that if an individual utilizes their aggression in a constructive direction, then the negative impact of aggression, which includes physical acts of violence that lead to harming or injuring other person, may not be a cause of the harm (35). Loveland et al. found that higher levels of aggression may have a negative impact on academic performance as the students may remain absent, being unable to deal with the stressors of school life (36). Injuries, especially dental injuries, have been associated with behavioral and emotional risk factors (37).

According to DeGarmo et al., children's academic performance improves with good parenting, which has been in turn associated with socioeconomic status (37). Unfortunately, the converse is also true; children's school performance is hampered by negative parenting, which is related to the persistent stress of poverty. Parents who are struggling just to stay afloat tend to work extra hours, odd shifts, or multiple jobs, and hence, are not able to

provide proper supervision for their children as they are short of time and energy. These deficits have been linked with higher levels of externalizing behaviors and poor academic achievement by such children (38). Socioeconomic status and aggressive behavior has been correlated with academic performance. As the occurrence of traumatic dental injuries has been found to have an association with socioeconomic status and behavior, it can be assumed that academic performance and TDI are correlated to each other, as well.

The reviewed studies showed associations between dental problems of children and their school performance (3, 35). According to Pourat et al., students who are unable to attend school due to dental problems miss the prospect of learning, which impairs their academic performance (7). A study conducted in Kerala, India, showed a considerable correlation between TDI and whether or not the good marks achieved by students in school were important. Children, who considered that good marks at school were not important, experienced twice the risk of TDIs when compared to those children for whom achieving good marks was important (39).

Traumatic dental injuries among children exhibit a complex interaction between the victim's oral conditions and their behavior. Therefore, prevention should consider a number of characteristics such as oral predisposing factors, environmental determinants and human behavior. It is recommended that specific and proper public places for leisure and sports activities, with impact-absorbing surfaces around the items on which children are most likely to fall, should be provided. Moreover, proper monitoring and supervision by the parents and teachers is necessary to avoid TDIs among children.

The prevalence of TDI can be reduced if the potential risk factors are identified in time and strategies are directed at behavioral, environmental and societal changes and implemented by the health policy makers.

5.1. Sample Size Estimation

The sample size was calculated using the following formula:

$$(1) \quad n = \frac{pq}{\left(\frac{E}{1.96}\right)^2}$$

where, n = minimum sample size; p = maximum expected prevalence; q = 1 - p; E = Margin of sampling error tolerated (allowable error);

For this survey:

$$(2) \quad n = 4 \times \frac{0.5 \times 0.5}{2.5^2} = 1600$$

$$(3) \quad [P = \%50; q = \%50; E = \%5 \text{ of } P(\text{i.e. } 2.5)]$$

Footnotes

Authors' Contribution: Tasneem S. Ain, Ravishankar Lingesha Telgi and Saima Sultan have done the data collection in schools, created the study concept, and the 1st draft of the paper. Pradeep Tangade, Chaitra Ravishankar Telgi, Amit Tirth designed the study and contributed in preparation of recording the proforma. Sumit Kumar Pal, Owais Gowhar contributed to the final draft of the paper after critical evaluation. Vaibhav Tandon contributed in analyzing the data.

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