Prevalence, etiology, and types of dental trauma in children and adolescents: systematic review and meta-analysis

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Abstract

Background: Dental traumas are common among children and adolescents in many societies posing health and social problems. The aim of this study was to conduct a systematic review and meta-analysis on prevalence, etiology, types, and other epidemiologic aspects of dental trauma in children and adolescents (0-18 years old).

Methods: In this systematic meta-analytical review, data were collected searching for key words including traumatic dental injuries, dental trauma, dental injury, dental trauma, tooth injuries, tooth trauma, traumatized teeth, dental-veolar trauma, oral trauma, epidemiology, etiology, prevalence, incidence, occurrence, child*, and adolescence in the following databases: Scopus, CINAHL, Science Direct, PubMed and Google scholar.

Results: From the total of 3197 articles, 44 completely relevant papers were included in the study. The prevalence of dental trauma was variable based on geographical area and was estimated 17.5% in the population, with higher prevalence in boys. Falling was the major cause for dental trauma, and the most frequent location was home. The most frequent type of trauma was enamel fracture.

Conclusion: A relatively high prevalence was detected for dental trauma, which calls for effective planning and intervention to prevent the occurrence in children and adolescents. These may include special care for children, eliminating fall-prone areas, installing safety measures at homes, using protective appliances in sports, education, and raising the knowledge and availability of services to address enamel fracture. Region-specific criteria should be taken into account in programs and interventions.

Keywords: Dental Trauma, Prevalence, Etiology, Type, Children and Adolescents, Systematic Review, Meta-analysis.

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Introduction

Traumatic injuries not only pose a health risk worldwide, but are also regarded among serious social problems (1). One important category is dental trauma (2), accounting for a major part of health problems in children and adolescents (3-6). Studies conducted in different countries report various prevalence rates for traumatic dental injuries among children and ado-

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lescents (7-10). Dental trauma occurs in children mainly because of their weak balance and just having learnt to walk (11).

Demographic evaluations indicate a higher prevalence for trauma in males compared to females (12-14). Falling, fight, sports, accidents, and hitting items or people are among common etiologic factors (15-18). Home setting, school and street are places with the highest frequency of dental traumatic injuries (19,20), which most importantly include enamel fracture and enamel and dentin fracture without pulp exposure (21-24).

According to the heterogeneity among the individual study results and the importance of preventing dental trauma, it is of importance to accurately determine the prevalence of dental trauma using appropriate research methodology. Also identifying the influencing factors is essential for better planning, decision-making and intervention.

Therefore, the present study aimed to conduct a systematic review and meta-analysis on the prevalence of dental trauma among children and adolescents in different countries and other related variables.

**Methods**

This study was a systematic and meta-analytical review. The required date were collected searching for key words including traumatic dental injuries, dental trauma, dental injury, dental trauma, tooth injuries, tooth trauma, traumatized teeth, dentoalveolar trauma, oral trauma, epidemiology, etiology, prevalence, incidence, occurrence, child*, and adolescence in Scopus, CI-NAHL, Science Direct, PubMed, Google scholar. Manual journal searching and an extensive hand search of the Gray Literature were also conducted. Articles from the reference list of the studies which were found to be relevant were also considered. Article publication time limit was set 1995 onward.

Articles in English and Persian that reported dental trauma (injury to the teeth and/or periodontium, and nearby soft tissues) and those studies (2) that were conducted on children and adolescents with age range of 0-18 years and cross-sectional studies were also included. Exclusion criteria were as follows: studies on trauma from sport activities, studies on trauma from medical interventions such as endoscopy, studies on individuals with medical or special conditions, conference presentations, case reports and interventional studies (such as randomized controlled trials). Two reviewers evaluated the articles according to the checklist of strengthening the Reporting of Observational Studies in Epidemiology (STROBE) (Appendix. 1) and controversies were referred to a third party. First, articles with non-relevant titles to the subject of this review were excluded. Then, the abstracts and the full texts of the articles were reviewed respectively to exclude those articles that matched the exclusion criteria of the study, or had a weak relevance to the subject of the study. Computer software for reference management (Endnote X5) was used for organizing and assessing the titles and abstracts as well as recognizing the repetitive items.

The searches returned 3197 articles, but those articles that were non-relevant, and repetitive between databases, with weak relevance to the study or matched the exclusion criteria were excluded; finally, 44 relevant articles were selected (Fig. 1). These articles were fully read, and the required data for the systematic review were extracted into the extraction table designed for the purpose of the study in spreadsheet computer software (Excel, Microsoft Office; Microsoft, US). SPSS 17 was used to analyze some of the quantitative data.

To determine the overall prevalence of dental traumatic injuries and perform the meta-analysis, computer software (CMA-Comprehensive Meta-Analysis; Englewood, NJ, USA) was employed. The results were reported using forest plots, in which the size of each square indicates the sample size and the lines drawn on each side of the square indicate the confidence interval (CI) of approximately 95% for den-
The overall prevalence of dental traumatic injuries was estimated using the random model. Either all or some of the variables were treated as if they were random. Random model was in contrast with the fixed model that demonstrates the observed quantities with respect to the explanatory variables which are treated as if the variable were not random.

**Results**

From a total of 3197 relevant articles, 44 completely relevant articles were included in the study. Most studies were conducted in Brazil (16 articles), and the oldest was conducted in Jordan (1995); most of the studies were done in dental clinics, and only two out of the 44 (4%) studies were conducted in Iran. The overall number of participants was 69502 children and adolescents aged 0-18 years (mean, 1579 each study). The mean±SD prevalence of dental trauma was 10.2% ± 4.70 among boys and 6.5% ± 3.40 girls, which was statistically significant (p< 0.001).

The mean of falling was the most frequent cause of dental trauma. The most important etiological factors of traumatic dental injuries are shown in Fig. 1.

Places with the highest frequency of traumatic dental injuries are demonstrated in Table 1.

The mean of enamel fracture had the highest frequency (55%) among the types of dental trauma in children and adolescents (Fig. 3).

To perform the meta-analysis, the heterogeneity index was determined within the articles using the heterogeneity I² test. After confirmation of heterogeneity of the
Table 1. Extraction table for Prevalence, etiology, and types of dental trauma in children and adolescents

| Au-Cu-Ye et al [25], Brazil, 2012 | Sample | prevalence | Gender | Etiology | place |
|-----------------------------------|--------|------------|--------|----------|-------|
| Schuch et al [25], Brazil, 2012   | 1210 children aged 8–12 | 12.6% | M (6.8), F(5.8) | Fall (35), Assault (40), Accident (8), Sport (10), other (7) | Home (55), School (18), Street (15), other (12) |
| Martins et al [26], Brazil, 2012 | 590 children aged 7-14 years | 12.7% | M (7.9), F(4.8) | - | - |
| Piovesan et al, Brazil, 2012      | 441 children-of 12- to 59-month-old | 31.7% | M(18.6), F(13.1) | - | - |
| Dame’-Teixeira et al [27], Brazil, 2012 | 1528-12-year-old | 34.8% | - | - | - |
| Teixeira et al [28], Brazil, 2012 | 1528-12-year-old Schoolchildren. | 34.79% | M(40.8), F(28.6) | Not remember the cause (53.64%), Falls (15.64%), sports (11.08%), collision against objects or people (10.60%), violence (7%), traffic accidents (5.82%), other causes (7.83%) | Home (22.32%), school (8.52%) elsewhere (15.50%) |
| Piovesan et al [29], Brazil, 2011 | 792 12-year-old schoolchildren, | 9.7% | - | - | - |
| Jorge et al [30], Brazil, 2011    | 891 Adolescents from schools. | 24.7% | M(27.6), F(22.8) | Unknown (33.2), Falls (17.7), Playing(12.7), Collision (10), Violent incident (7.3), Sports(6.4), Use of teeth for functions other than eating (5.9), Chewing (5), Traffic accidents (1.8), | - |
| Aldrigui, et al [31], Brazil, 2011 | 260 children aged from 2 to 5 years | 33.5% | - | - | - |
| Norton and O’Connell [32], Ireland, 2012 | 839- children between 9 and 84 months | 25.6% | M(26.7), F(24.6) | Most injuries occurred within and around the home, 46.9% and 35.7%. | Enamel fracture (39.4%), discoloration of the crown (20.2%) |
| Bendoand et al [33], Brazil, 2010 | 1612 children aged 11 to 14 | 17.1% | M (19.9%), F (15%) | Falls (43.6), Sports (20.4), Unknown (25.5), Others (10.5) | Home (41.8), School (14.2), Street (10.5), Unknown (24.4), Others (9.1) |
| Diaz et al [34], Chile, 2010      | 1719 from 1 to 15 years of age, | 37.9% | - | - | - |
| Altun et al, Turkey [35], 2009    | 4956 children aged 6–12 years | 9.5% | M (5.4%), F (4.1%) | Fall (40.3), Impact with a hard object (30.5), Bicycle/tricycle accident (25.4), Other 18 (3.8) | Enamel fractures (44.6), Enamel/dentin fracture (19.0), Intrusive luxation (13.4), Lateral luxation (7.3), Subluxation (6.1), Enamel/dentin/pulp fracture (5.5), Crown discoloration (5.2), other (7.1) |
| Study                      | Participants                          | Enamel fractures | Enamel-dentine fractures | Enamel & dentine | Other原因 | Site | Cause | Other细节 |
|----------------------------|---------------------------------------|------------------|-------------------------|------------------|-----------|------|-------|-----------|
| Noori and Al-Obaidi [36], Iraq, 2009 | 4015, 6- to 13-year-old children     | 6.1%             | M (3.7%)                | F (2.4%)         | Falls (60.9), Playing (21.4), Impact with a hard object (9.1), other (8.6) | At home (69.9), school (17.7), on street (18.6), Unknown (2.5) | Enamel fracture (36.6%), enamel-dentine fracture (35.4%), and concussion (11.5%). Other (16.5) |
| Avsar and Topaloglu [37], Turkey, 2009 | 563- children 0–3 years              | 17.4%            | M (10.3%)               | F (7.1%)         | Falls (73.5), Striking objects (14.2), Traffic accident (1), Child abuse (2), Unknown (9.2) |  |
| Naidoo and et al [38], South Africa, 2009 | 1665 children aged 11–13 years      | 6.4%             | M (4.2%)                | F (2.2%)         | Falls (43.4%), Sport (13.2%), collision with objects (9.4%), Unknown (8.5%) | Homes (46.3%), schools (35.8%), on a street (5.7%) | Enamel fracture (69.1%), enamel and dentine (22.8%), enamel, dentine and pulp (5.7%) |
| Jorge et al [30], Brazil, 2009 | 519 infants and toddlers between 1 and 3 years of age | 41.6%            | M (9.6%)                | F (6.4%)         | Falls (29.8%), collisions (6.8%) | Home (32%), street (1.7%), day care centers (0.8%) | Enamel fractures (37.2%), enamel-dentine fractures (5.7%), |
| Fakhruddin et al [39], Canada, 2008 | 242212- to 14-year-old Ontario schoolchildren | 11.4%            | M (11.7%)               | F (7.2%)         | Falls (24.8%), Sport (23.7%), collision with objects (10%), violence (5.9%), other (35.6) | School (24.4), Home (21.1), street (7.4) |  |
| Pattussi et al, Brazil [40], 2006 | 1302 14- to 15-year-old adolescents | 16%              | M (9.6%)                | F (6.4%)         | Playing (48.1), Sport (13.3), Teeth misuse (9.0), Violence (5.7), Other causes (14.8), Don’t know (9.0) | Home (44.3), Street/walkway (26.7), School (10.0), Other places (10.0), Don’t know (9.0) |  |
| Locker[41], Canada, 2005 | 3010 grade 8 children                 | 18.5%            | M (11.7%)               | F (7.2%)         | Fall (47.9), Collision (37.5), Traffic accident (2.1), Eating (2.1), Unknown (10.4) | Home (60.4), School (18.4), street (18.6), Swimming pool (2.4) |  |
| Traebert et al [42], Brazil, 2003 | 307, 12-year-old school children     | 18.9%            | M (11.7%)               | F (7.2%)         | Fall (47.9), Collision (37.5), Traffic accident (2.1), Eating (2.1), Unknown (10.4) | Home (60.4), School (18.4), street (18.6), Swimming pool (2.4) |  |
| Nicolau et al [43], UK, 2001 | 652 , 13-year-old adolescents        | 20.4%            | M (13.9%)               | F (6.5%)         | Fall (24.1), Collisions (15.0), Traffic accidents (10.5), Misuse of teeth (6.0), Sports (2.3), Violence (1.5), Unknown (40.6) |  |
| Cortes et al [44], Brazil, 2001 | 3702-schoolchildren aged 9–14 years | 12%              | M (7.2%)                | F (4.8%)         | Fall (47.9), Collision (37.5), Traffic accident (2.1), Eating (2.1), Unknown (10.4) | Home (60.4), School (18.4), street (18.6), Swimming pool (2.4) | Enamel fractures (75.8), Infractions (24.2) |
| Vanderas and Papagiannoulis [4], Greece, 1999 | 199 children aged 8 to 10 years | 16.6%            | M (11.5%)               | F (5.1%)         | Fall (9.1), Collision (32), Traffic accidents (24.1), Violence (42.5), Other (3.4), Missing information (4.6) | Home (63.7), School (23.8), other (12.4) |  |
| Marcenes and et al, Syria[45], 1999 | 1087 children aged 9 to 12 years,    | 8%               | M (5.5%)                | F (2.7%)         | Fall (9.1), Collision (32), Traffic accidents (24.1), Violence (42.5), Other (3.4), Missing information (4.6) |  |
| Chen et al [46], Taiwan, 1999 | 1200 second grade students           | 16.5%            | M (10.2%)               | F (6.3%)         | Collision (65.3), Fall (26.9), Violence (2.6), Sport (3.6), Other (1.6), Indoor play (31.5), Outdoor play (31), Sport (9), Fall (8), Traffic accident (1.5), Chewing (1), Unknown (18) | Home (63.7), School (23.8), other (12.4) |  |
| Petti et al [47], Italy, 1997 | 938, 6- to 11-year-old children      | 21.3%            | M (3.7%)                | F (2.4%)         | Falls (60.9), Playing (21.4), Impact with a hard object (9.1), other (8.6) | At home (69.9), school (17.7), on street (18.6), Unknown (2.5) | Enamel fracture (36.6%), enamel-dentine fracture (35.4%), and concussion (11.5%). Other (16.5) |

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| Reference                                      | Location          | Sample Size                       | Gender | Prevalence | Etiology | Trauma Type | Location | Type of Dental Trauma                                                                 |
|------------------------------------------------|-------------------|-----------------------------------|--------|------------|----------|-------------|----------|-------------------------------------------------------------------------------------|
| Huang et al [17], Taiwan, 2009                 |                   | 6312 15- to 18-year-old          | M (12.4%) F (7.5%) | 19.9%       | Falls (30.8), Eating (20.5), Falls (19.4), Traffic Accidents (10.2), Collisions (7.1), Other (12) | Home (29.1%), school (23.7%), street (11.1%) |
| Kovács et al [48], Romania, 2012              |                   | 4638 children and adolescents aged between 1 and 18 years | M (14.6%) F (10.2%) | 24.8%       | Fall (42.5), Sports (23.5), accidents (9.5), violence (7.5), Collision (5.5), Other (6.5), Unknown (4.7) | Uncomplicated coronal fracture (26.1), Enamel fracture (12.5), Lateral luxation (11.2), Contusion (7.7), other (42.5) |
| Govindanjan et al [49], India, 2012           |                   | 3200 school children in the age 3-13 years | M (6.03%) F (4.1%) | 10.13%      | Fall (41.9), Sports (19.1), accidents (8.64), violence (5.8), Collision (.3), Unknown (24.07) | Enamel fracture (50%), crown fracture without pulpal involvement (20.5), crown fracture with pulpal involvement (13.2), avulsion (4.6), fracture unspecified (11.9) |
| Dua and Sharma [50], India, 2012              |                   | 880 children in the age 7-12 years | M (22.1%) F (12.9%) | 14.5%       | Fall (24.8%), Collision (21.1), Traffic accident (1), Misuse of teeth (18.7), Unknown (21.7), other (12.7) | Enamel fractures (29.4), enamel-dentin fractures (26.5), crown fractures (14.7) |
| Abdulkaziz et al [51], 2010, Kuwait            |                   | 500 preschool children (2-6 years) | M (10.4%) F (6.9%) | 11.2%       | Fall (94.6%), | Home (87.5%), school (5.4%) | Enamel fracture (83), enamel-dentin fractures (4.8) |
| Malikaew et al [52], Thailand, 2006           |                   | 2,725 of 11-13 year old Thai children. | M (22.1%) F (12.9%) | 35.0%       | Fall (24.8%), Collision (21.1), Traffic accident (1), Misuse of teeth (18.7), Unknown (21.7), other (12.7) | Enamel fractures (31.7), schools (28.0), street (4.7), swimming pool (1.2), other (10.7) |
| -Hamdan and Rock [53], Jordan, 1995           |                   | 459 schoolchildren aged 10-12 years | M (10.4%) F (6.9%) | 17.3%       | Fall (94.6%), | Home (87.5%), school (5.4%) | Enamel fracture (76.4), Enamel and dentine fracture (19.4), Enamel, dentin and exposure of the pulp (4.2) |
| Vejdani. And Mohammad Alizadahe, Iran [54], 2006 |                   | 700 fifth and sixth grade schoolchildren | M (5.4%) F (4.9%) | 10.3%       | Falls (37.5), Collision (22.2), Traffic accident (4.2), Sports (19.4), other (17.7), | Enamel fracture (8.3), Enamel and dentine fracture (16.9), Enamel, dentin and exposure of the pulp (2.1) |
| Vejdani et al [55], Iran, 2011                 |                   | 1042 fifth and sixth grade schoolchildren | M (9.6%) F (5.6%) | 15.2%       | Falls (37.5), Collision (22.2), Traffic accident (4.2), Sports (19.4), other (17.7), | Enamel fracture (8.3), Enamel and dentine fracture (16.9), Enamel, dentin and exposure of the pulp (2.1) |
| Sgan-Cohen et al [56], Israel, 2005           |                   | 1195 fifth and sixth grade schoolchildren | M (13.7%) F (6.7%) | 29.6%       | Falls (30.3), violence (30.3), Sports (27.3), | Homes (31.4), schools (32.2), street' outside (36.4) |
| Nicolau et al [43], Brazil, 2001              |                   | 652 13-year-old adolescents       | M (9.2%) F (5%) | 20.4%       | Falls (24.1) collisions (15), traffic accidents (10.5), misuse of the teeth (6), sports (2.3) violence (1.5). | Enamel and dentine fracture (43.8), Enamel, dentin and exposure of the pulp (37.5), Enamel fracture (14.6) |
| Rajab [57], Jordan, 2003                      |                   | 2751 children                     | M (9.2%) F (5%) | 14.2%       | Falls (49.9) collisions (30), sports (8.7) violence (7.2), traffic accidents (3) | Enamel and dentine fracture (47.3), Enamel and dentin fracture without pulpal exposure (34.5), Crown fracture without pulpal exposure (10), other (2.2) |
| Soriano et al [58], Brazil, 2007              |                   | 1046 boys and girls aged 12       | M (9.2%) F (5%) | 10.5%       | Falls (27.3) collisions (18.2), sports (8.2) violence (6.4), traffic accidents (2.7), Non-specified accidents (22.7), other (14.5) | Enamel and dentine fracture (43.8), Enamel, dentin and exposure of the pulp (37.5), Enamel fracture (14.6) |
| Sgan-Cohen et al [59], Israel, 2008           |                   | 453 5th and 6th grade             | M (12.4%) F (7.5%) | 33.8%       | Falls (29.1), sports (16.4) violence | |
studies, the best estimation of the prevalence of trauma was determined based on the random effect model (Fig. 4).

The prevalence of dental trauma in children and adolescents based on the random effect was determined to be 17.5% (95% CI: 14.6%-20.4%); 95% CI for the prevalence was drawn for each study in the horizontal line format (Q = 3631.17, df= 43, p<0.001).

The frequency distribution for dental trauma based on the location variable (continent) is shown in Figs. 5-7.

To assess the publication bias, funnel plot was used (Fig. 8). The results of funnel plot revealed that there was publication bias among studies. The shape of funnel plots was not symmetrical.

**Discussion**

Dental trauma is a major health problem in many societies (26,29,30), with higher prevalence rates among children and adolescents (25,26,29,48,64). The present study revealed the prevalence of dental trauma in children and adolescents (under 18 years of age) to be 17.5%, but with variances among different geographic regions.

In the present study, the prevalence of dental traumas for all subjects was determined to be 17.5%, which necessitates efficient planning and intervention to prevent their incidence. Moreover, considering the negative influence of dental traumas on individuals’ quality of life (39,65), psychological and social problems (66,67), and direct and indirect costs of treatment (68), developing effective interventional strategies to deal with this issue is of prime importance. The difference in the prevalence of dental trauma among the studied geographic regions might be a reflection of their different cultural, sanitary, and economic conditions, type of activities and professions practiced, and ecological characteristics like the fluoride concentration of drinking tap water. For instance, the prevalence of dental trauma was found to be higher in the continent of America compared to Asia or Europe, and this could be the result of sports activities of youth, as most studies in the region pertained to Brazil. Furthermore, the fluoride concentration of water in regions with mild and humid weather condition is usually low (69), resulting in lower fluoride content in teeth which can render teeth more prone to dental trauma. This notion highlights the importance of local and regional considerations during planning and interventions by policy makers.

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The prevalence of dental trauma was higher in boys compared to girls (10.2 ± 4.7 vs. 6.5 ± 3.4). Previous studies also agree on the higher prevalence of dental trauma in boys than girls (27, 51, 70-72), which might be due to boys performing more activities like sports, bicycle riding, fighting, working, etc. compared to girls (73).

In the present study, the most important cause for dental trauma was falling, which is in agreement with previous literature (74-78). This can be explained by the imbalance of the newly walking children leading to falling accidents. Thus, children should be cared more prudently, reinforced by measures to eliminate the risk of falling. The other important cause of dental trauma in this study was sports, which is in line
Ensuring the existence of sound safety measures in sports venues accompanied by the use of protective athletic appliances such as mouth guards, and educating children and adolescents who engage in sports activities are among suggestions that can be effective in reducing the incidence of dental trauma in this age range (81,82). Fights and violence were also among the causes of dental trauma in children and adolescents in the present study, which is indicative of the behavioral characteristics of this age range, with dominant, violent, emotional, and illogical traits. In this regard, special attention should be given to social education at home and school, fostering a culture of self-control and social respect towards others.

The findings of this study revealed that dental traumatic accidents occurred most frequently at home, and this is in line with many previous studies (83-85). This is explainable by the fact that children and adolescents spend a significant part of their time at home; and therefore, special safety measures should be considered at houses in which families live with their children.

Based on the analysis of the study data, enamel fracture was the most frequent type of dental traumatic accidents, confirming the findings of other studies (34,42,56,86). Therefore, dentists and other health-care professionals as well as lay people should have adequate knowledge regarding the management of dental traumatic events (87-90).

The analyses performed in the present study were limited by age under 18 years. Thus, it is suggested to include adults in future studies. The study was also limited by the fact that it only included articles in English and Persian and only included studies conducted since 1995.

**Conclusion**

The results of this study indicated a significant prevalence for dental traumatic accidents among children and adolescents, which necessitates efficient planning and
interventions in order to prevent their incidence. Planning for reducing the risk of falling in children would be of utmost importance. Safety measures would be most effective when implemented at home where dental traumatic accidents occur most frequently.

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Med J Islam Repub Iran 2015 (10 July). Vol. 29:234.
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