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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, dentoalveolar 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, CINAHL, 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) (Appendex. 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-

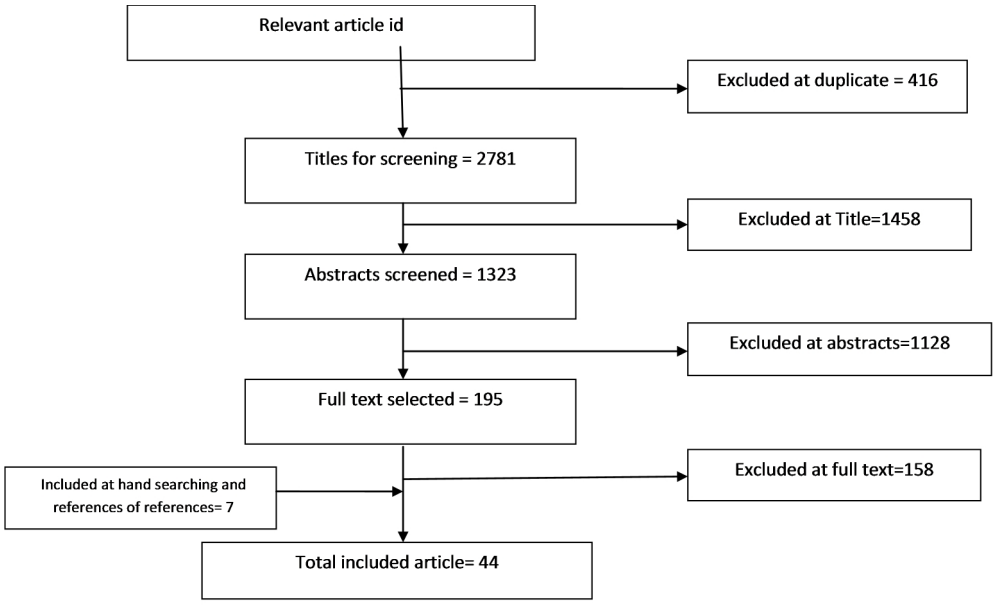

Fig.1. Literature review and retrieval flow diagram

tal trauma.

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 I^2 test. After confirmation of heterogeneity of the

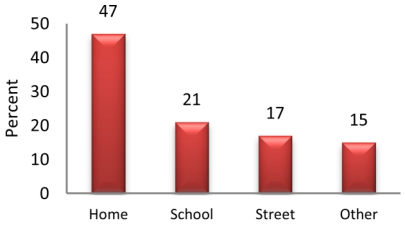

Fig. 2. Trauma place of occurrence

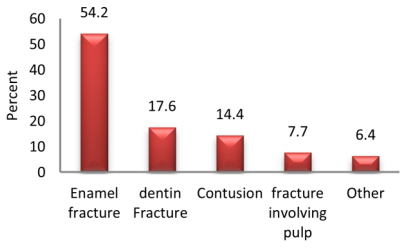

Fig. 3. Type of dental trauma

Table 1. Extraction table for Prevalence, etiology, and types of dental trauma in children and adolescents

Au-Cu-Ye	Sample	prevalence	Gender	Etiology	place	Type/teeth affected
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)	Enamel fracture (10.6), dentin Fracture (3.2), other (.5)
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)	-	-	fracture of enamel only (86.91), fracture of enamel and dentin(4.20),fracture involving pulp(3.27),other (5.69)
Dame´-Teixeira et al[27]. Brazil,2012	1528-12-year-old	34.8%	-	-	-	Enamel fracture only(71.16),Enamel-dentin fracture (25.84), other (2.99)
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 (15.46%), sports (11.08%), collision against objects or people (10.60%), violence (.7%), traffic accidents (.5%), other causes (7.98%)	Home (22.32%), school (8.52%) elsewhere (15.50%)	
Piovesan et al [29], Brazil, 2011	792 12-yearold schoolchildren,	9.7%				Crown fracture of enamel only (94.5), Crown fracture of enamel and dentin (4.4), Crown fracture involving pulp (1.1)
Jorge et al [30], Brazil, 2011	891Adolescents 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)	Enamel fracture (63.6), Enamel-dentin fracture (15.3), Complicated crown fracture (1.8), Lateral luxation (0.4), Avulsion(0.7), Restoration (23.3)
Dıaz 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)

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 (18.9), 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%		Falls (29.8%), collisions (6.8%)	Home (32%), street (1.7%), day care centers (0.8%)	Enamel fractures (37.2%), enamel–dentin fractures (5.7%),
Fakhruddin et al [39], Canada, 2008	242212- to 14-year-old Ontario schoolchildren	11.4%		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), Sports(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%				
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%)			
Vanderas and Papagiannoulis [4], Greece, 1999	199 children aged 8 to 10 years	16.6%	M (11.5%) F (5.1%)			Enamel fractures (75.8) Infractions (24.2)
Marcenes and et al, Syria[45],1999	1087 children aged 9 to 12 years,	8%	M (5.3%) 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),	Home (63.7), School (23.8), other (12.4)	
Petti et al [47], Italy,1997	938, 6- to I 1-year-old children	21.3%		Indoor play (31.5), Outdoor play (31), Sport (9), Fall (8), Traffic accident (1.5), Chewing (1),Unknown (18)		

Huang et al [17], Taiwan, 2009	6312 15- to 18-year-old senior high school	19.9%	M (12.4%) F (7.5%)	Sports(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	24.8%	M (14.6%) F (10.2%)	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)
Govindarajan et al [49], India, 2012	3200 school children in the age 3-13 years	10.13	M (6.03%) F (4.1%)	Fall (41.9), Sports(19.1), accidents (8.64), violence (5.8), Collision (.3), Unknown(24.07)		
Dua and Sharma [50], India, 2012	880 children in the age 7-12 years	14.5%				Enamel fracture (50%), crown fracture without pulpal involvement (20.3), crown fracture with pulpal involvement (13.2), avulsion (4.6), fracture unspecified(11.9)
Abdulaziz and et al[51], 2010, Kuwait	500 preschool children(2–6 years)	11.2%		Fall (94.6%),	Home (87.5%), street (7.1%), school (5.4%).	Enamel fractures (29.4), enamel- dentin fractures (26.5), crown fractures (14.7),
Malikaew et al [52], Thailand, 2006	2,725 of 11-13 year old Thai children.	35.0%	M (22.1%) F (12.9%)	Fall (24.8%), Collision(21.1), Traffic accident(1), Misuse of teeth(18.7), Unknown(21.7) , other (12.7)	Homes (31.7), schools (28.0), street (4.7), swimming pool (1.2), other (10.7)	Enamel fracture (83), enamel- dentin fractures (4.8)
-Hamdan and Rock[53], Jordan, 1995	459 schoolchildren aged 10-12 years	17.3	M (10.4%) F (6.9%)			
Vejdani. And Mohammad Alizadeh, Iran [54]; 2006	700 fifth and sixth grade schoolchildren	10.3	M (5.4%) F (4.9%)	Falls (37.5), Collision (22.2), Traffic accident (4.2), Sports (19.4), other (17.7),		Enamel fracture(76.4), Enamel and dentine fracture(19.4)، Enamel, dentin and exposure of the pulp (4.2)
Vejdani et al [55], Iran; 2011	1042 fifth and sixth grade schoolchildren	15.2	M (9.6%) F (5.6%)			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	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	20.4%	M (13.7%) F (6.7%)	Falls (24.1) collisions (15), traffic accidents (10.5), misuse of the teeth (6), sports (2.3) violence (1.5).		
Rajab [57], Jordan,2003	2751 children	14.2%	M (9.2%) F (5%)	Falls (49.9) collisions (30), sports (8.7) violence (7.2). traffic accidents (3)	Homes (63.17), schools (25.5), street (11.25)	Enamel and dentine fracture (43.8), Enamel, dentin and exposure of the pulp (37.5), Enamel fracture (14.6)
Soriano et al [58], Brazil, 2007	1046 boys and girls aged 12	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)	Homes (25.5), schools (13.6), street (23.6), Do not remember (20.9), other(16.4)	Enamel fracture(47.3), Enamel and dentin fracture without pulp exposure (34.5), Crown fracture without pulp exposure (10), other(8.2)
Sgan-Cohen et al [59], Israel, 2008	453 5th and 6th grade	33.8%		Falls (29.1), sports (16.4) violence		

	schoolchildren			(20), playing (20)
David et al [60], South India,2009	838 12-year-old school children	6.1%		
Wendt et al [61], Brazil, 2010	571 preschool children	36.6%	M (19.7%) F (16.9%)	
Thelen and Ba°rdsen, Albania[62], 2010	2789, adolescents aged 16–18 years	9.9%	M (5.8%) F (4.1%)	Collision (27.5), Falls (13.4), sports (14.1) violence (4.0), Traffic accidents (4.7), Do not remember(10.5), other(25.8)
Livny et al [63], Israel, 2010	804 sixth grade Children of ages 11 and 12 years.	17.7%	M (11.1%) F (6.6%)	

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.

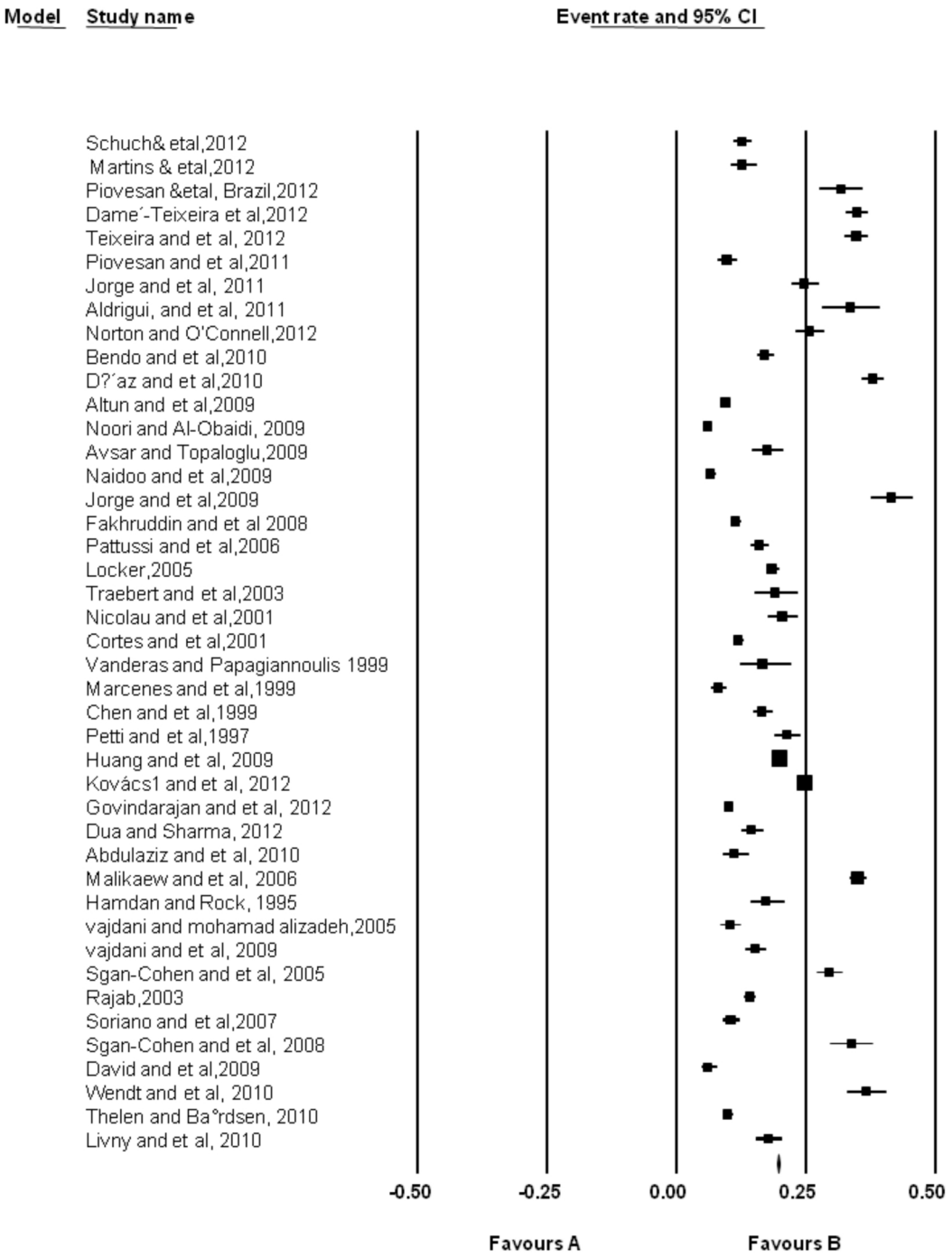

Fig. 4. The prevalence of dental trauma in children and adolescents based on the random effect model.

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

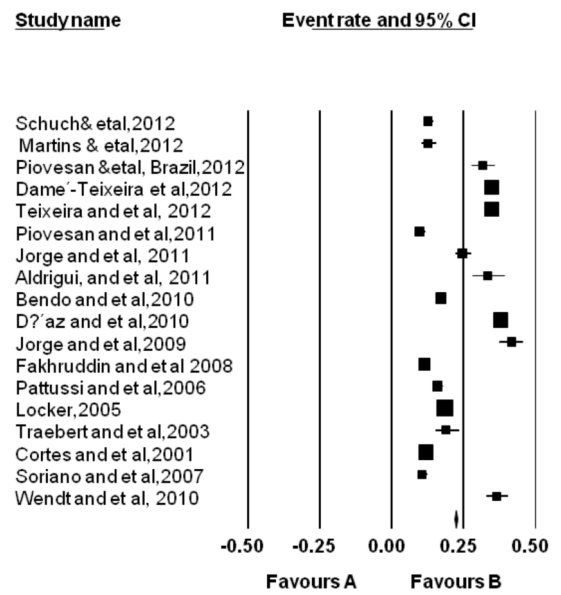

Fig.5. The prevalence of dental trauma in children and adolescents in the continent of America was estimated based on the random effect of 21.2% (95% CI:16.6%-26.7%); 95% CI was drawn for each prevalence in the horizontal line format ($I^2 = 98.7$).

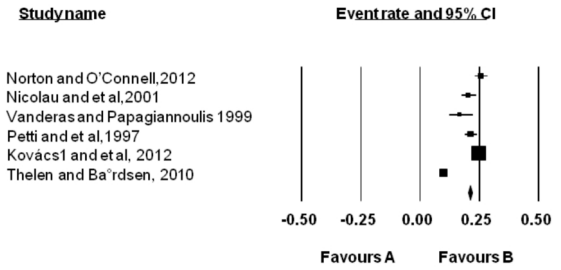

Fig. 6. The prevalence of dental trauma in children and adolescents in Europe was estimated based on the random effect of 19.1% (95% CI:13.7%-24.1%); 95% CI was drawn for each prevalence in the horizontal line format ($I^2 = 97.9$).

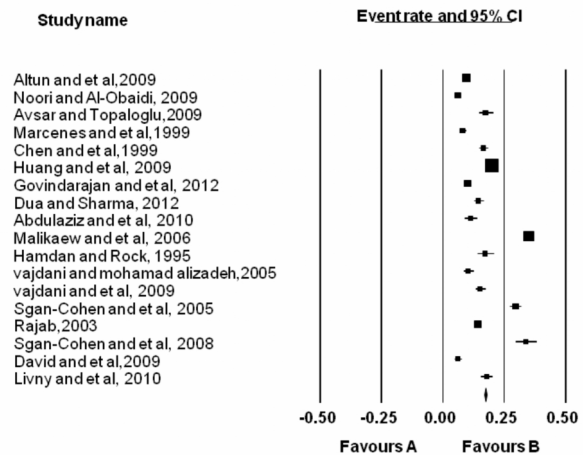

Fig. 7. The prevalence of dental trauma in children and adolescents in Asia was estimated based on the random effect of 14.7% (95% CI: 11.3%-19.0 %); 95% CI was drawn for each prevalence in the horizontal line format (I2 = 98.4).

with previous research (79,80). 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

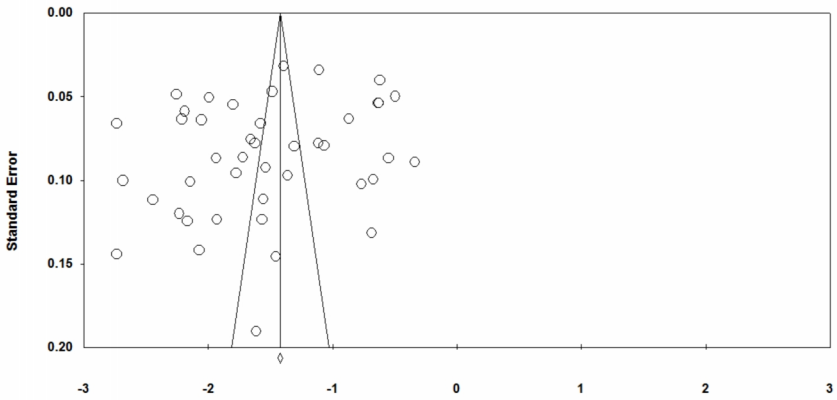

Fig 8. Funnel plot of standard error by event rate

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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