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Prevalence and factors associated with traumatic dental injuries (TDI) to anterior teeth of 11-13 year old Thai children

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Objective: The objective was to assess the prevalence and factors associated with Traumatic Dental Injuries (TDI) to anterior teeth of 11-13 year old Thai children. ***Methods:*** A cross sectional survey was carried out in a sample of 2,725 children from 52 primary school classes in the Chiang Mai urban area of Thailand. The children were clinically examined for TDI and interviewed. ***Results:*** 35.0% of children experienced TDI. Males (45.3%) had TDI levels approximately twice as high as females (25.2%), and the prevalence of TDI increased with age. TDI were more common amongst children living in more disadvantaged households and whose parents were less educated. Children with an overjet greater than 5mm were also more likely to have TDI. Most of the affected children (20.6%) had trauma to 1 tooth, 10.3% to 2, 2.6% had 3 teeth affected. The proportion of damaged teeth was 4.6 per 100 anterior teeth. Central incisors were the most common teeth with TDI, both in the upper and lower jaws. Enamel fracture was the major type of TDI. Most of the TDI occurred at home and school. Running was the major activity leading to TDI. 'Falls' was the most common manner causing TDI (24.8%). Ground surfaces (22.4% of all cases), particularly concrete surfaces (14.6% of all cases), were the most common vectors which directly contacted or injured children. Biting hard material was the most common activity leading to TDI. ***Conclusion:*** Traumatic dental injuries are common and are an important dental public health problem in Thailand.

Key words: children, prevention, strategy, traumatic dental injuries

Introduction

The epidemic of general injuries is among the most neglected health problems of the 21st century (Murray and Lopez, 1996). The burden of all injuries is expected to be equal to that of all communicable diseases worldwide by 2020, and to exceed it in China, Latin America, and the Caribbean. In 'Other Asia and Islands' (OAI), including Thailand, the burden has increased from 14.4% of all deaths in 1990 to 17.2% expected in 2020 (Murray and Lopez, 1996). The death rate from injuries and poisonings in Thailand has been ranked second to coronary diseases, and the trend is increasing (Division of Health Statistics, 1995). Despite being a worldwide major public health problem, limited attention has been paid to the prevention of injuries (Berger and Mohan, 1996).

As with general injuries, the importance of traumatic dental injuries (TDI) has attracted little attention. Few if any national oral health strategies include plans for the control and prevention of TDI, as there are for dental caries and periodontal diseases. This may be a reflection of the poor knowledge and understanding among dental health professionals of TDI. However TDI are relatively common in children. In Europe and in many other continents they affect about one in five schoolchildren (Andreasen and Andreasen, 1994). Most of the traumatized teeth are untreated and affect the quality of life of children. Cortes *et al*., (2002) showed that the presence of untreated fractured teeth was directly related to the impacts on appearance of the children and affected their emotional state. Children with fractured teeth also experienced difficulties with "eating and enjoying food", significantly more than for those without any traumatic injury. Children with untreated fractured teeth were frequently teased about their appearance.

The treatment of a TDI is relatively expensive. In Denmark the estimated cost of treating TDI was about 2 to 5 million US dollars per 1 million inhabitants (Borum and Andreasen, 2001). Indeed the treatment cost per tooth is estimated to be more than the cost for treating a carious lesion (Glendor *et al*., 2001). Therefore as the prevalence of TDIs is about 15-20% in children, in countries with moderate to low levels of caries, the cost of treating TDI may exceed that for treating caries.

Most studies on the epidemiology of TDIs do not provide planners with sufficient details of the causes of TDIs to prioritize which factors should be addressed. Haddon's matrix can be used to assess the underlying determinants of injuries (Haddon, 1980). Despite the importance of TDIs, there are few detailed reports on their epidemiology. Most of the papers on causes, focus on clinical risk factors such as incisal overjet and inadequate lip coverage. Falls are commonly reported as the main cause of dental injuries. However the causes and circumstances of the falls are not fully explored. They may be due to collisions, sporting activities, violence

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and traffic accidents (Gutmann and Gutmann, 1995). The lack of specificity and of the contribution that each cause makes to the injury burden are not provided. For example, whereas considerable efforts have been made to reduce TDIs in contact sports through the provision of mouth guards, other more common and important causes have not been addressed.

To overcome some of the shortcomings of previous studies on the causes of TDIs, this study sets out to gain more detailed insights into the contexts and factors associated with TDIs in a population where injuries were relatively common (Division of Health Statistics, 1995). The objective of this study was to assess the prevalence and factors associated with Traumatic Dental Injuries (TDI) to anterior teeth of 11-13 year old Thai children. On the basis of the findings, strategies for prevention will be suggested.

Materials and Methods

The study population was all 4,720 Level 6 primary school children attending 53 of the 58 primary schools in Muang district, Chiang Mai province, Thailand. Five schools were excluded because they had many children from ethnic minorities whose culture and lifestyle are very different from the majority of Muang residents, or they had no children in class level 6 and one private school did not respond.

The estimated sample size was based on a 'TDI' prevalence rate of 20 per cent. At the confidence level of 99% (1-α), the required minimal sample size was 1,699 children. However, 2,725 children were included in the study because the examiners were also interested in assessing levels of dental caries and gingivitis and required a larger sample for this purpose. The local university Ethics Committee approved the study and parents signed positive consent forms for their children to participate in the study.

Three trained examiners examined children for TDI to anterior permanent teeth (12 teeth) using the Cortes classification (Cortes, 2000) (Table 1). The study was limited to anterior teeth as other teeth are seldom affected. Discoloured teeth were recorded as injured when there was a homogeneous discolouration compared to the adjacent permanent tooth and the child had a positive history of traumatic dental injury. An enamel crack was diagnosed when an incomplete fracture of the enamel was present without loss of tooth substance. A fracture was considered to be limited to the enamel if it was small and of homogeneous colour, when observed from the incisal angle with the aid of a mouth mirror. If the central area of the fracture surface was a darker yellow than the surrounding enamel, and there was no evidence of pulpal involvement a dentine fracture was recorded. Pulpal involvement was considered when direct contact of the pulp horns or pulp chamber with the oral cavity were seen. Injuries to the crown and root, such as fractures involving the cementum and root fractures were not accounted for in the classification used in this study. Avulsion was recorded if a tooth was missing and there was a positive history of traumatic dental injury given by the child. It is essential to include a measurement of the

Table 1. Diagnostic criteria used in assessment of traumatic injuries to teeth (Cortes, 2000)

Score	Criteria	Description
Code 0	No trauma	No observed injury to the incisors
Code 1	Discoloration due to trauma	Discoloration ranging from yellow to dark grey when compared to the other teeth
Code 2	Enamel crack	An incomplete fracture of the enamel without loss of tooth substance
Code 3	Enamel fracture	Loss of a small portion of the crown, including only the enamel
Code 4	Enamel and dentine fracture	Loss of enamel and dentine without pulp exposure
Code 5	Fracture with pulp exposure	Loss of enamel and dentine and / or cementum, exposing the pulp
Code 6	Missing tooth due to trauma	Absence of the tooth due to a complete ex-articulation
Code 7	Composite restoration	Restoration provided due to crown fracture and/or located in the palatal surface of the crown
Code 8	Bonded fragment	Bonding of the tooth fragment due to crown fracture
Code 9	Permanent crown provided	Jacket or post crown or any kind of restoration involving all the whole crown
Code 10	Semi-permanent crown provided	Any kind of crown or denture or bridge (pontic) placed provisionally
Code 11	Denture or bridge provided (pontic)	Denture or bridge (pontic) provided
Code 12	Fistulous tract and/or presence of swelling	Presence of fistula and / or swelling in the labial or lingual vestibule without evidence of caries
Code 99		Signs of trauma cannot be assessed due to appliances or absence of any of the incisors

treatment provided as repair of the injuries. The presence of a restoration, if accompanied by a positive history of traumatic dental injury, was recorded as traumatic dental injury as were a fistulous tract and swelling related to teeth without evidence of caries. Children were seated on portable dental chairs, and examined with plane mouth mirrors and explorers under light from portable lamps. No tooth vitality test and radiographs were used. Approximately 16% of the children were re-examined by each examiner. The intra- and inter-examiner Kappa scores showed almost perfect agreement, ranging from 0.85 to 0.96.

Subjects who had clinical evidence of TDI were interviewed for details of the injury event by a trained interviewer using a structured questionnaire. Evidence of tooth position in the arches and types of tooth damage were recorded and the proportions of damaged teeth were calculated and stratified by types of tooth damage and tooth positions. The proportions of children, according to number of traumatised teeth, were calculated and the chi-square test was used to assess any differences on the distribution of TDI by the child's characteristics. A pilot study was undertaken prior to the main study to assess the feasibility of the study methodology.

Results

2,725 children, 1,394 females (51.2%) and 1,331 males (48.8%), were examined. Their mean age was 11.8±0.7; most of them (64.3%) were 12 years old. 954 children (35.0%) had a TDI. Almost twice as many males (45.3%) as females (25.2%) had a TDI. The prevalence of TDI increased with age and was inversely related to the educational and socio-economic status of child's parents. Children with an excessive overjet were more likely to have a TDI (Table 2). Most of the children (20.6%) had trauma to 1 tooth, 10.3% to 2, 2.6% had 3 teeth affected and less than 1.5%, more than 3 teeth traumatised.

Each child was examined for TDI to the 12 upper and lower anterior permanent teeth. The expected number of teeth to be examined was 32,700 teeth. However, 1,242 were missing not from trauma, leaving 31,458 teeth; 15,468 upper anterior teeth and 15,990 lower anterior teeth. The proportion of TDI teeth was based on the teeth already erupted. There was evidence of TDI to 1,517 anterior teeth (4.8%); 1,112 teeth (7.2%) of upper, and 405 (2.5%) of lower anterior teeth. Central incisors were the most common teeth with TDI, both in the upper and lower jaws. Of the 1,517 teeth affected by TDI,

Table 2. The prevalence of traumatic dental injuries, by gender, age, socio-economic status and overjet

Children's characteristics	Traumatic dental injuries (%)		Total (%)	P-value*
	No	Yes		
Gender				
Males	728 (54.7)	603 (45.3)	1,131 (100)	
Female	1,043 (74.8)	351 (25.2)	1,394 (100)	<0.001
Age				
< 12 years old	531 (67.0)	262 (33.0)	793 (100)	
12 years old	1,138 (65.0)	613 (35.0)	1,751 (100)	
> 12 years old	102 (56.4)	79 (43.6)	181 (100)	0.030
Martial status of parent				
Not married or single parent	327 (57.7)	240 (42.3)	567 (100)	
Married parents	1,444 (66.9)	714 (33.1)	2,158 (100)	<0.001
Employment status of parent				
Unemployed	51 (38.1)	871 (33.6)	134 (100)	
Employed	1,720 (66.4)	83 (61.9)	2,591 (100)	<0.001
Educational status of parent				
Compulsory level or lower	707 (61.3)	446 (38.7)	1,153 (100)	
Above compulsory level	1,064 (67.7)	508 (32.3)	1,572 (100)	0.001
Family income				
5,000 Baht or less per month	625 (59.6)	424 (40.4)	1,049 (100)	
Above 5,000 Baht per month	1,146 (68.4)	530 (31.6)	1,676 (100)	<0.001
Anterior tooth protrusion (overjet)				
> 5mm	132 (57.1)	99 (42.9)	231 (100)	
< 5mm	1,639 (65.7)	855 (34.3)	2,494 (100)	0.009
Total	1,771 (65.0)	954 (35.0)	2,725 (100)	

* Chi-square test.

34.1% were upper right incisors, 30.4% upper left, 10.3% lower left and 10.2% lower right central incisors. Only 11 canines were affected.

Enamel fracture was the main type of TDI (83%), both in upper and lower anterior teeth. Only 4.8% of fractures involved dentine and 1.4% involved the pulp or the tooth was avulsed. Overall, only 2.7% of TDI cases affected had evidence of enamel cracks.

The majority of dental injuries occurred between 12.00 p.m. to 18.00 p.m. (49.8%) and on weekdays (44.0%); 23.6% occurred on weekends; the remainder could not be classified because children could not remember the day. Homes (31.7%) and schools (28.0%) were the most common places where TDI occurred; 4.7% and 1.2% of traumatised cases occurred in the street/road and swimming pool, respectively and 10.7% occurred at other places such as supermarkets, shops, waterfalls, hot water springs, public playgrounds, and other public places.

75.4% of the TDIs were from unintentional causes. Three percent were intentional TDI from pushing and being struck by objects (Table 3). Falls were the main cause of TDI (24.8%); falls from tripping/slipping (14.9%) was the major type among the causes from falling. The next most frequent cause of falls was unintentional pushing (6.7%) and the remainder from intentional pushing and falls from a height (Table 3). Misuse of teeth (18.7%) was the second most common cause of TDI. The third most common was collision or hitting objects (10.7%) and the fourth, accidentally biting hard materials (9.8%). The other causes were being unintentionally struck by objects (9.1%), cycling (2.9%), intentionally struck by objects (1.3%) and traffic accidents (1.0%).

The most common vector causing tooth damage was the ground (22.4%) (Table 4). Among types of ground surface, concrete surfaces were the major vector (14.6%) whereas asphalt gravel and soil accounted for 7.8%. The second most common vector was an object causing tooth damage due to misuse of teeth (18.7%) (Table 4). Ice (3.2%), bottle caps (2.7%) and pens and pencils (2.4%) were the common vectors that caused dental trauma in those who misused their teeth. Tamarind seeds caused 1.8% of cases. Interestingly, plastic milk containers, which contain milk provided to children every day at school, caused 1.0% of cases. The other common types of vector

Table 3. Percentage of traumatic dental injuries, classified according to manner of the injury events

Manner of injury events	(%)
Fall, unintentional pushing	6.7
Fall, intentional pushing	1.7
Fall, tripping/slipping	14.9
Fall, from height	1.5
Subtotal	24.8
Collision, obstructed by objects	10.7
Struck by objects, unintentionally	9.1
Struck by objects, intentionally	1.3
Traffic accident	1.0
Cycling	2.9
Misuse of teeth*	18.7
Accidentally bit hard material	9.8
Do not know	21.7
Total	100.0

*opening bottle caps, biting metal wire/rope/pen/pencil/necklace/parts of toy/finger nail.

Table 4. Percentage distribution of types of vectors that directly injured children

Vectors	%
Ground surfaces	22.4
Objects causing trauma from misuse of teeth	18.7
Objects causing tooth damage due to accidentally biting	9.8
Human bodies	7.6
Other obstructing or hitting objects	6.7
Objects parts of buildings	5.1
Sports equipment	3.8
Furniture/home equipment	3.2
Playground equipment	0.6
Unknown	21.7
Total	100.0

were objects which children unintentionally bit (9.8%). Of this type of vector, animal bones were the major objects that caused tooth damage (6.1%). Stones in rice and snacks accounted for 1.6% and 0.4%, respectively. The human body caused 7.6% of cases; head of other child was the main part of body that caused tooth damage (6.0%). Other obstructing or hitting objects caused 6.7% of traumatised cases; the most common object was metal/wooden barrier (2.6%). Parts of buildings caused 5.1% of cases. Concrete walls, wooden doors, and concrete posts were common vectors of this vector type. Sport equipment caused 3.8% of cases. The number of TDIs caused by football was equal to that caused by swimming pool walls (1.3%). Furniture/home equipment caused 3.2% of cases. The major furniture/home equipment causing tooth damage was table/cabinet (1.8%). Playground equipment caused the lowest percentage (0.6%) of TDIs.

The most common type of activity that children were doing when the injury occurred was biting hard materials (18.7%). The other activities leading to TDI were running (12.8%), eating (9.9%) and playing sports (6.9%). Football (soccer) and swimming were the major sports leading to injuries. Playing games caused 5.6% of cases. Chasing games were the main game type that caused the highest number of injury cases. General play accounted for 4.2% of cases. It is noticeable that opening bottle cap caused 2.7% whereas boxing, a popular sport in Thailand caused only 1.3% of TDI cases. 21.7% of children said they did not know what activity lead to the TDI.

Discussion

The prevalence of TDI to permanent anterior teeth (35%) and the proportion of damaged teeth in this Thai population were much higher than in other studies, including those using the same criteria for TDI (Cortes, 2000). However a very similar pattern was evident in relation to the prevalence of TDI by age, gender, socio-economic and educational status of parent and extent of overjet. Boys who were older and living in socially disadvantaged circumstances were far more likely to have TDI than girls from more privileged households. Children with an excessive overjet were also more likely to have TDI. These findings support the existing TDI literature from both developed and developing countries (O'Brien, 1994; Hamilton *et al*., 1997; Marcenes *et al*., 1999).

The very high prevalence of TDI in this Thai population is either due to the classification system used or different factors causing the problem. The criteria used in this study include most types of TDI identified from evidence of tooth damage (Cortes, 2000). They differ in that many other authors do not usually include enamel cracks (O'Brien, 1994; Hamilton *et al*., 1997). However the inclusion of enamel cracks in the classification only accounted for 2.7% of cases. Compared to other similar studies, in this population three factors 'misuse of teeth' (18.6%), 'accidentally bit hard material' (9.9%) and 'do not know' (21.7%) were identified as being important causes of TDI and accounted for half of how injury events occurred. In contrast Burton *et al* (1985) in an Australian study reported that 'bit into object' accounted for only 0.6 per cent of all causes according to manner of dental injuries. Although it is difficult to compare the 'misuse of teeth' with other populations because data are not available, visitors frequently comment upon the practice of using teeth for a wide variety of non-eating functions in Thai children. Cooking practices in Thailand may also explain these results. Animal bones are frequently chopped up in the preparation of foods in Thailand. Small fragments of bone therefore remain in foods and can be unexpectedly bitten. Biting on 'animal bones', 'stones in rice' and 'other hard materials' accounted for 9.9% of all vectors for TDI.

Most of the TDIs occurred at home and school. The levels of TDI occurring in these two locations were nearly equal. Most of TDI occurred on weekdays and between midday and 6 p.m. The higher incidence in the afternoon may be related to levels of supervision. Parents were more likely to be at work and afternoons are when children had lunch breaks and playtime. Running was the major activity leading to TDI.

Since the classifications of causes of TDI varied between studies, it is difficult to compare causes between the present study and previous studies. However, some of them can be compared. The most common cause of TDI was unintentional injuries. 'Fall' was the most common manner causing TDI (24.8%). This finding is similar to that reported by previous studies (Marcenes and Murray, 2000; Nicolau *et al*., 2001). The most common specific manner of 'fall' was tripping/slipping (Marcenes and Murray, 2000). A relatively common cause according to manner of TDI was misuse of teeth. Almost one in five cases of TDI were related to that cause. No previous study reported this as an important cause. The next most common causes according to manner was 'collision/obstructed by objects' (10.7%) and 'accidentally bit hard material' (9.8%), respectively. Burton *et al*. (1985) reported that 'ran into objects' as the major cause according to manner of injury. In fact, 'ran into objects' is the manner defined in the present study as 'collision, obstructed by objects'.

It is noticeable that intentional injuries accounted for only 2.9% of cases. They include 'fall, intentional pushing' and 'struck by objects, intentionally'. Other recent studies reported a higher prevalence of TDI caused by violence. Marcenes and colleagues reported that 16.4% of TDI cases were caused by violence, such as falls from pushing, collision due to pushing and other types of violence in Brazilian children (Marcenes *et al*., 2000). However, a study in 13 year-old Brazilian children found that the causes from violence were only 1.5% of cases whilst the unknown causes were 40.6% (Nicolau *et al*., 2001). The present study also shows a relatively high percentage of unknown causes (21.7%). This high percentage of unknown causes together with low levels of intentional cases may be related to under reporting damage due to violence. The victim may tend to report 'do not know', particularly if the violence is domestic (Marcenes *et al*., 2000; Nicolau *et al*., 2001).

This study indicates that the prevalence of TDIs in schoolchildren was high and shows that the major dental public health problems of concern in countries such as Thailand are not only dental caries, periodontal diseases and dental fluorosis but also TDI. The fact that most TDIs were untreated shows that oral health authorities have neglected this problem. TDIs have serious impacts on

the quality of life of Thai children (Gherunpong, 2004). They should not continue to be neglected. Preventive strategies need to address the underlying determinants of oral conditions to achieve sustainable improvements in oral health and reduce inequalities. The use of conventional clinical risk assessment and provision of mouth guards will only have a limited impact on TDI across the population. The results of this study highlight the need to target action particularly at older school boys from more deprived backgrounds. Most cases of TDI occurred in schools or the home. The role of the school environment as a determinant of TDI is well established. In schools which have a supportive social and physical environment TDI are less likely (Moyses *et al*., 2003). In this study detailed analysis of the impact of the school environment on TDI also revealed a positive association (Malikaew *et al*., 2003). The WHO Health Promoting Schools Network provides an ideal framework for developing effective action to promote oral health through the implementation of a range of policies and actions addressing common health risks and conditions. Adoption of health and safety policies, improvements in the physical environment and closer supervision of children are likely to have a positive impact on TDI.

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