Incidence and causes of dental trauma in children living in the county of Värmland, Sweden

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Abstract – Aim: The aims of this study were to determine the incidence of injuries to permanent incisors in 2011–2013 in children aged 8–10 years living in the county of Värmland, Sweden, and to compare it with the incidence rates in 1989/1990 in the county of Västmanland, as well as to determine the cause of dental trauma in relation to time and place.

Method: The study analysed the patient records from dental visits (2011–2013) of trauma to the permanent incisors in children aged 8–10 years. The incidence rates were the incidence per 1000 children at risk. Standardized incidence rates were calculated for the comparison between different years. Information about month, location where the trauma occurred as well as cause of trauma was recorded. Results: A total of 2.2% of 21,721 children aged 8–10 years had experienced at least one trauma. The incidence rate in Värmland increased from 18.9 in 2011 to 21.3 in 2012 to 28.5 in 2013. The standardized incidence rate in Värmland in 2011 and 2012 was not significantly different than in Västmanland in 1989/1990 ($P > 0.05$), but the standardized rates in 2013 were significantly higher than in 1989/90 ($P < 0.001$). Dental trauma occurred most often outdoors, followed by sports arenas/sports fields, and more often at school than at home. Falling and slipping was the most common cause of trauma, followed by accidents during leisure activities, playing and sports. Conclusion: The incidence rate for dental trauma has not decreased in the past 20 years, and there is an indication that parents and teachers should be more aware of the risks of dental trauma at leisure times and at school as well as during sports and exercise.

Dental trauma during childhood and adolescence can have an effect on oral health throughout life. The prevalence of dental trauma was reported to be similar in children from all socio-economic status (1–4). Trauma to the facial area may create mild damage to teeth such as concussion or subluxation, or more severe damage such as tooth fractures, root fractures, lateral luxations, intrusions, extrusions or avulsions. The initial impact on pulp may be reversible or may create a latent effect on the vitality of pulp some years after the incident (5–7).

Traumatic dental injuries in both primary and permanent dentitions mostly involve maxillary incisors (8). The incidence of injury is higher between the ages of 1–3 years for primary dentitions and 8–9 years for permanent dentitions, and the incidence is higher in boys for both dentitions. Children with dental malocclusion anterior open bite are reported to have a significantly increased risk for dental damage after a trauma to the facial areas compared to other children (9–13). Diseases such as epilepsy, cerebral palsy and attention deficit hyperactive disorder have also been shown to increase the incidence rate (14–16).

The prevalence of dental traumatic injuries across the world has been reported to be approximately 15–30% in primary teeth in children aged 1–5 years old and between 16–40% in permanent teeth in children aged 6–12 years old (8). In Sweden, the incidence per 1 year among children aged 0–19 years living in the county of Västmanland was reported to be 13.2 injury episodes per 1000 children between October 1989 and September 1990 (17).

A review reports oral injury to account for approximately 5% of all injuries with 92% of these involving damage to the teeth (18). Treatment was considered to be time-consuming, while costs for the injured teeth were reported to be moderate. A trauma to a permanent tooth was reported to require more than one dental visit (19). A Swedish study that collected data from the insurance company Folksam and from telephone interviews with the patients or parents on dental injuries in children aged 0–19 years during a 2-year period in 1993 estimated the total direct and indirect cost of a dental trauma to be SEK 1746 (EUR 188) for trauma to primary teeth and SEK 4569 (EUR 492) for permanent teeth (20). These figures might be underestimated.
as some injuries required treatment longer than the 2-year period, and dental implant was not a common treatment choice as at current time.

The World Health Organization has highlighted a safe physical environment, that reduces risk for accidents and dental trauma, as one of the components of the oral health programme through health-promoting schools (21). In Sweden, injuries and death in children due to accident and trauma are among the lowest in the world due primarily to many prevention programmes (22, 23). However, studies of programmes that aim to reduce dental trauma are limited, compared to prevention and promotion programmes for dental caries among children.

The national database for accidents and injuries in children lacks statistics on dental trauma and injuries. The most recent study on incidence and prevalence was the study in the county of Västmanland between October 1989 and September 1990, but the current incidence rate of dental trauma is not known (17). Therefore, this study aims to determine the incidence of injuries to permanent incisors, in 2011–2013, in children aged 8–10 years living in the county of Värmland and to compare the finding with the county of Västmanland study in 1989/1990. The study also aims to determine the cause of dental trauma in relation to time and place, factors that are crucial in implementing prevention and promotion programmes.

Material and method

This study analysed data from a database owned by Värmland Public Dental Health in Sweden. The database contains documentation of dental visits to all public dental clinics in the county. Information includes dental status codes, diagnostic codes and treatment codes according to The Dental and Pharmaceutical Benefits Agency (TLV). The database also includes descriptions of findings from X-ray and laboratory test as well as performed treatments. Of the total number of children aged 0–19 years in the county, 89.6–90.9% were registered in the public dental clinics. Records of dental visits of children aged 8–10 years (born in 2001–2005) between 1 January 2009 and 31 December 2013 were included in the study.

Data collection method

As dental injuries mostly concern front teeth, data collection was limited to dental injuries to the four maxillary and the four mandibular permanent incisors. Some children did not seek dental care directly after a dental trauma but came after signs or symptoms appeared. Some signs and symptoms were also detected during other dental visits. Therefore, the records of all acute dental visits and the non-acute dental visits that related to treatment of permanent incisors within the 3-year study period were reviewed to select trauma to permanent incisors. The review was carried out by a dental hygienist, and the selection of patients was reviewed by a dentist. Another dentist went through the selected records, and any unclear issues or disagreements with the records were discussed by two dentists to ensure the quality of data. A total of 746 entries from acute visits and 31 entries from non-acute visits were identified, and data analysis was carried out with IBM SPSS Statistics Version 22.0 (Armonk, NY, USA).

The selected records were coded for patient identification and record identification, and one investigator who did not take part in the data analysis kept the codes. The study was reviewed and approved by the Karlstad University Ethics Committee (Dnr C2014/44).

Data analysis

Data were analysed by descriptive analysis. The incidence rates were defined as the 1-year cumulative incidence per 1000 children, where the 1-year cumulative incidence per 1000 children was the number of dental injuries divided by the total number of children at risk per 1 year. The numbers of children at risk were the number of children registered in all public dental clinics in the county of Värmland per year or per age group.

Due to differences in population distribution, the comparisons between the incidence per 1000 in the county of Värmland (2011–2013) and in the county of Västmanland (1989/1990) were carried out by the indirect standardization method. Incidence per 1000 and numbers of children aged 8, 9 and 10 years living in the county of Västmanland were obtained from a previous study (17). The incidence per 1000 in children aged 8, 9 and 10 years in 1989/1990 was used as the standard age-specific rates for the calculation of expected incidences per 1000 for the corresponding ages in 2011, 2012 and 2013. The incidence per 1000 in children aged 8, 9 and 10 years in the county of Värmland in 2011 was used as a baseline for the analysis of incidence trend in the county of Värmland during the 3 years. The statistical significance between the expected and observed incidence per 1000 was tested at 95%, 99% and 99.9% confidence intervals.

The trend for seasonal variation was calculated from a moving average of the incidence per 1000 of a 3-month period to minimize the effect of outliers. The average incidence per 1000 in January 2011 and March 2011 was set as the first point of the trend line. The linear trend was also calculated using the simple linear regression with the least square method.

To identify locations and activities at risk, the locations where trauma occurred were categorized into outdoor, indoor, at school, at sports arenas/fields and gyms and at swimming pools. Traumas occurring at school that were related to sports and exercise were included in the category ‘at sports arenas/fields and gyms’. The causes of injury were categorized into falling and slipping, sports and exercise, leisure activities, other accidents and accidents while playing, violence and fighting, and misusing of teeth or biting into something other than foods.

Any missing or unclear information on locations and causes was categorized as not reported. The chi-square test was carried out to compare age and sex dif-
ferences between trauma episodes with missing data to reported data.

Results

A total of 478 of 21,721 (2.2%) children aged 8–10 years old, who were registered in public dental clinics in the county of Värmland during 2011–2013, had at least one trauma to maxillary or mandibular incisors during the study period. Among these, 465 (97.3%) sought acute dental care after the trauma and 13 (2.7%) sought dental care some time later. The number of children who needed acute care due to dental trauma corresponds to 13.0% of the total 3664 children who sought acute dental care of any kind at all public dental clinics during that period.

During the 3-year study period, 315 of 11,309 boys (2.8%) and 163 of 10,412 girls (1.6%) who were registered with public dental clinics had dental trauma (Table 1). The ratio of boys to girls who had experienced dental trauma was 1.9:1.0. Of 478 children who experienced dental trauma, 15 boys and four girls had two unrelated visits, and one boy had three unrelated visits. The incidence per 1000 of dental trauma for boys was 29.3 (95% CI: 26.3, 32.5), much higher than 16.0 (95% CI: 13.8, 18.6) for girls.

The percentage of children with dental trauma to permanent incisors was highest in 8-year-old children during all years; 2.1–3.1% (Table 1), compared to 9- and 10-year-old children. The percentages of 9- and 10-year-old children who experienced dental trauma were about the same.

The total trauma incidence in children aged 8–10 years, registered with public dental clinics in the county of Värmland during the 3-year study period, was 498. The incidence per 1000 increased from 18.9 (95% CI: 15.9, 22.3) in 2011 to 21.3 (95% CI: 18.2, 24.9) in 2012 to 28.5 (95% CI: 24.9, 32.6) in 2013 (Fig. 1). The incidence rate in 2012 was not significantly higher than in 2011 \((P > 0.05)\), but the incidence rate in 2013 was significantly higher than in 2011 \((P < 0.000)\) and in 2012 \((P < 0.001)\).

Compared to the incidence rate among children registered with both public and private dental clinics in the county of Västmanland in 1989/1990, the incidence in children registered with public dental clinics in the county of Värmland in 2013 was much higher in 8- and 10-year-old children (31.2 vs 21.7 and 27.9 vs 17.1), and in 2011, the incidence was lower in 9-year-old children (15.4 vs 22.3). When adjusted for population distribution, the standardized age-specific incidence rate in the county of Värmland in 2011 and 2012 was not statistically different \((P > 0.05)\) than in the county of Västmanland in 1989/1990, but the standardized rate was 39.4% higher in 2013 than in 1989/1990 \((P < 0.000)\).

The occurrence of dental trauma showed seasonal variation during 2011–2013. Apart from January and May 2013, the variation was similar in all 3 years (Fig. 2). The moving trend of trauma incidence increased from November to the highest point in February–March, to then decrease from March to April and the lowest rates were observed in July–Au-

Table 1. Number and percentage of children aged 8–10 years with dental trauma to permanent incisors, public dental clinics in the county of Värmland, Sweden, 2011–2013

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (%)</th>
<th>Boys (%)</th>
<th>Girls (%)</th>
<th>8-year (%)</th>
<th>9-year (%)</th>
<th>10-year (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>135 (1.9)</td>
<td>91 (2.5)</td>
<td>44 (1.3)</td>
<td>52 (2.1)</td>
<td>36 (1.5)</td>
<td>47 (2.0)</td>
</tr>
<tr>
<td>2012</td>
<td>145 (2.0)</td>
<td>83 (2.2)</td>
<td>62 (1.8)</td>
<td>59 (2.5)</td>
<td>53 (2.1)</td>
<td>33 (1.4)</td>
</tr>
<tr>
<td>2013</td>
<td>198 (2.7)</td>
<td>141 (3.7)</td>
<td>57 (1.6)</td>
<td>77 (3.1)</td>
<td>59 (2.5)</td>
<td>62 (2.5)</td>
</tr>
<tr>
<td>2011–2013</td>
<td>478 (2.2)</td>
<td>315 (2.8)</td>
<td>163 (1.6)</td>
<td>188 (2.6)</td>
<td>148 (2.1)</td>
<td>142 (2.0)</td>
</tr>
</tbody>
</table>

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The linear regression showed an increasing trend during the study period with $R^2 = 0.0486$.

Of all 498 cases, 230 (46.2%) dental records did not report location or they were unclear where the trauma occurred. The remaining 268 reported that the dental trauma for both boys and girls occurred most often outdoor (Fig. 3). The second most common place was at sports arena or sports field such as ice hockey, floorball, basketball, handball arenas and football field as well as gym. Dental trauma occurred more often at school than at home or inside building.

Causes of trauma were not reported in 139 (27.9%) cases. Table 2 shows the reported causes of dental trauma during the 3-year study period. Of the reported causes, falling and slipping was the most common cause, accounting for 109 (30.4%). Playing with playground equipment such as swings, slides, rocking horses, climbing structures and jumping on trampolines accounted for 48 (13.4%) of cases. Sport and exercise accounted for 74 (20.6%) of the reported cases; with physical exercise, gymnastics, floorball and football being the most common causes. Violence accounted for only 11 (3.1%) cases of dental trauma in this age group.

The age and sex distribution between trauma episodes with missing cause and reported cause and missing location and reported location was not significantly different ($P > 0.05$).

**Discussion**

This study analysed dental records, between 2011 and 2013, of children aged 8–10 years, registered with the public dental clinics (89.6–90.9% of total children living in the county of Värmland). A total of 478 (2.2%) children had experienced at least one trauma incident, and boys had almost two times higher incidence rate than girls (incidence per 1000 = 29.3 vs 16.0). The gender difference at these ages was similar to findings from other previous studies (8).

Dental trauma is a rare event, causing difficulty in carrying out an extensive study on prevalence and incidence rate. Existing studies in various populations are insufficient to clearly demonstrate a national trend. In

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**Fig. 2.** Month of dental trauma in children aged 8–10 years registered in the public dental clinics in the county of Värmland (2011–2013).

**Fig. 3.** Location of dental trauma occurrence in children aged 8–10 years registered in the public dental clinics in the county of Värmland, Sweden, during 2011–2013. ($N = 268$). *Trauma at school which were not related to sports and exercise.*
Sweden, a 1-year population-based study in the county of Västmanland in 1989/1990 reported incidence rate per 1000 of 21.7, 22.6 and 17.1 among children aged 8, 9 and 10 years (17). In a more recent study in seven public dental clinics in the Västra Götaland county and five public dental clinics in Örebro county, the incidence rate per 1000 during 2008–2012 was about 33.0 (24). Whether the incidence rate has increased or not could not be determined from these two studies due to differences in the population profiles in different counties and the differences in the study design. The 2008–2012 study classified children into age groups and used combined data from a selected number of public dental clinics in the two counties, while the 1989/1990 study included all children living in the county of Västmanland.

To compare incidence rates across various populations at various times, the crude incidence rates in this study were adjusted using the indirect method. The findings show that the standardized incidence rates in 2011 and 2012 were not significantly different than the standardized rate in 1989/1990, but the standardized rates in 2013 were significantly higher than in 1989/1990, 2011 and 2012. Although the least square regression showed a weak upward line over the study period, the linear regression model can explained only about 4.9% of variation, underlining an increasing linear trend. This suggests that the upward trend may be a result of a high rate in one particular year in 2013 rather than a trend. Therefore, it cannot be determined whether there is a linear increasing trend during 2011–2013 or between 1989/1990 and 2013. More studies such as retrospective registration studies on incidence rates in children at various years are required to determine the forecasting model for incidence trend.

The trend analysis did not take into account any intervention effect because there was no substantial intervention programme for dental trauma prior to the study in the county of Västmanland in 1989/1990 or in the county of Värmland in 2011–2013. The lack of sufficient prevention to dental trauma might partially explain the higher standardized incidence rates in 2013. In contrast, dental caries in children and child injuries in Sweden had a clear downward trend since the 1980s. This is due to comprehensive preventive care such as dietary advice and oral hygiene education, and additional fluoride for caries risk patients and the Swedish National Safety Promotion Program for preventing child injuries (25–28).

The finding from this study confirms that dental trauma has a seasonal variation. The incidence rate was highest in winter (February–March), second highest in spring (April–June) and lowest in summer (July–August). The seasonal variation was similar to the study in 1989/1990 (17). The highest incidence in winter months corresponds to the highest incidence episodes of trauma from falling and second highest from engaging in outdoor leisure activities such as playing in the playground, biking, kickboarding and rollerblading. Therefore, trend analysis should take into consideration the seasonal variation component.

The two most common causes of dental trauma in this study are falls (30.4%) and trauma from being hit with playground equipment such as swings, slides and trampolines (13.4%). Similar to earlier studies in Sweden and other countries (13, 29, 30), falling was found to be the most common cause of dental trauma. These two causes agree with the finding that dental trauma among boys and girls occurred most often outdoor.

The results also confirm the significance of the safety environment in playgrounds. Playground injuries are extensively studied and many injuries prevention programmes have been implemented in other countries (31, 32). In the United States, a study that analysed data from the National Electronic Injury Surveillance System reports playground injuries to rank as number two of the most common causes of unintentional injuries among children aged 8 and 9 years who visit emergency departments in 2010–2018 (33). The American Academy of Pediatrics has studied injuries from trampolines in relation to safety measurements and recommendations and strongly discouraged the home use of trampolines (34). Dental trauma from playgrounds has not been addressed in the studies of playground safety, presumably, because most children with dental trauma go to dental clinics and there is no link between dental trauma records to trauma surveillance databases.

The findings suggest that trauma during sports and exercise should be addressed as an area for dental trauma prevention because the second most common location where dental trauma occurred is at sports arenas or gyms, and sports and exercise are the third most common cause of dental trauma in children in the county of Värmland. In terms of different sports, the

Table 2. Number and percentage of trauma episodes by causes of trauma (N = 359)

<table>
<thead>
<tr>
<th>Cause</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falling and slipping</td>
<td>109</td>
<td>30.4</td>
</tr>
<tr>
<td>Leisure activities</td>
<td>82</td>
<td>22.8</td>
</tr>
<tr>
<td>Playground equipment: swinging, slider, rocking horse</td>
<td>48</td>
<td>13.4</td>
</tr>
<tr>
<td>Biking</td>
<td>20</td>
<td>5.6</td>
</tr>
<tr>
<td>Ice skating</td>
<td>6</td>
<td>1.7</td>
</tr>
<tr>
<td>Kickboard, scooter, roller blade</td>
<td>5</td>
<td>1.4</td>
</tr>
<tr>
<td>Horse riding</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Playing and accidents</td>
<td>76</td>
<td>21.2</td>
</tr>
<tr>
<td>Collision, push, struck, playing with others</td>
<td>46</td>
<td>12.8</td>
</tr>
<tr>
<td>Run into door, bedframe, handrail, metal frame</td>
<td>16</td>
<td>4.5</td>
</tr>
<tr>
<td>Hitting by objects such as toys, glass, zipper, lashing strap, iPod, safety hook, plate, stick, spatade</td>
<td>13</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Not reported = 139 (27.9%).
results indicate that floorball should receive more attention. Dental trauma that occurred while playing floorball (4.5%) was more common than ice hockey (2.8%). Both floorball and ice hockey are fast moving sports with fast moving objects that can accidently hit the face. The awareness of using protection such as mouth guards and face guards may be more established among the ice hockey players than the floorball players. The mandatory use of mouth guard and face guard in ice hockey players aged 20 years or younger was introduced in Sweden since 1986. Use of face guard is not mandated while playing floorball. Using protection while playing floorball might not be a common practice. A survey among 308 Swiss and 300 Swedish floorball players in 2002/2010 showed that only one of the semiprofessional Swedish players used a mouth guard regularly and two used mouth guards sometimes during matches (35). Almost half of the players (47.0%) reported that they did not see any need to use a mouth guard, 26.1% had never thought about dental trauma, and 22.1% reported that there was never a discussion or recommendation to use mouth guards by officials. This would indicate that the use of mouth guards while playing floorball is not widely discussed among children either.

This study intended to investigate the incidence rate of dental trauma in Sweden after a study in 1989/1990 and explore the causes of dental trauma. The study was designed to be explorative for information as a base for further studies for planning intervention programmes and therefore has some limitations. One limitation is that data only includes dental records from public dental clinics, roughly 90% of all children in the county of Värmland. Some children with dental trauma might go to private clinics located in near vicinity to where the trauma occurred and dental traumas associated with facial trauma that required emergency hospital visits were not included in the study. A study at Helsinki University Central Hospital reported about 16% of patients with maxillofacial fractures had injuries to teeth and only about 0.5% of these were children aged 12 years or younger (36). Dental trauma associated with severe trauma in the county of Värmland can be expected to be very small because Sweden is similar to other Scandinavian countries with low levels of severe injuries due to accidents (23). Therefore, the incidence rate may not be substantial higher even if records from private clinics and hospitals were to be included in the study.

Lastly, dental records which were not constructed to collect data on dental trauma and dental injuries result in large percentage of missing or unclear information on cause and location of the trauma. Although chi-square test shows that there is no significant difference in gender and age among the missing data and reported data, the bias from missing data cannot be determined in this study. Therefore, interpretation of the findings must be made with caution.

These limitations of the study indicate a need for a registering system that links data from both private and public dental clinics as well as trauma centres at hospitals to limit the effect of missing data bias and misclassification bias as well as to provide information regarding the national trend and forecasting model for dental trauma.

In conclusion, this study indicates that the incidence rate for dental trauma has not decreased in the past 20 years. A surveillance system with data registering over time is required for a comprehensive analysis of dental trauma, which can increase the awareness of dental trauma.

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