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Trends in the prevalence of traumatic dental injuries in Brazilian preschool children

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Abstract – *Objective*: The aim of this paper was to report trends in traumatic dental injuries (TDI) in preschool children in Brazil between 2002 and 2006, and assess whether gender, family structure, and socio-economic differences in TDI are significant, and confirm the relationship between TDI and anatomic predisposing factors such as overjet and lip coverage. *Methods*: Three cross-sectional surveys were conducted in 2002, 2004 and 2006 in Diadema using the same protocol. It was estimated that a minimum sample size of 778 5–59 months old children was required to achieve a level of precision with a standard error of $<2\%$ Participants were systematically selected from all children attending the National Day of Children's Vaccination carried out in the city of Diadema. The criteria used to assess TDIs were a modified version of Ellis' classification. *Results*: There was a significant increase in TDIs between 2002 and 2006 (47.9%, $P = 0.002$). The prevalence of TDIs was 9.4% (95% CI 7.63, 11.42) in 2002, 12.9% (95% CI 11.06, 14.96) in 2004, and 13.9% (95% CI 12.03, 15.84) in 2006 in 5–59 months old children and the treatment of TDI was seriously neglected. There was no significant gender, family structure, and socio-economic differences in the prevalence of TDIs. The relationship between TDI and anatomic predisposing factors such as overjet, lip coverage, and anterior overbite was highly statistically significant ($P < 0.01$). *Conclusion*: The prevalence of TDIs in preschool children in Diadema increased between 2002 and 2006, the treatment of TDIs was neglected, thus it is crucial to generate considerable efforts to implement health promotion strategies to reverse the observed trends and to provide treatment to TDIs to prevent their biologic and psychologic consequences.

Traumatic dental injuries (TDI) have become a relative serious dental public health problem in children (1, 2) since a remarkable and well documented decline in the prevalence and severity of dental caries in many countries (3–7).

There is evidence that the prevalence of TDI is relatively high in many countries (8). The majority of published studies reported the prevalence of TDI in permanent teeth (8), while the prevalence of TDI in primary teeth has been reported to a less extent (9–11). A review of literature published in 1995 reported the prevalence of TDI on primary teeth worldwide ranged from 4% to 30% (12). Similarly, our up-to-date review of literature of studies identified the prevalence of TDI in preschool children in Brazil ranged from 9.4% to 36% (13–17). Furthermore, treatment of TDIs in primary (13) and permanent dentition (18) tends to be neglected.

To our knowledge there are no published methodologically sound reports on trends in the prevalence of TDI in primary teeth worldwide. The assessment of disease trends is essential to address oral health needs effectively, thus to plan and structure health services. Despite its importance, the epidemiology of TDI provides only scarce information on trends in the prevalence of TDI, in particular when compared to epidemiological data on dental caries. Therefore, it is relevant to assess trends in TDI and this paper will address this gap on the dental literature.

A body of knowledge exists on anatomical predisposing factors to TDI. It is well known that increased incisal overjet of the teeth in primary and permanent dentition, and inadequate lip coverage in children all ages are significant predisposing factors to TDI (8, 13). The literature on TDIs in the primary dentition showed consistently there is no gender differences (13, 14, 16, 17, 18), contrary to most studies in the permanent dentition that reported boys experienced significant more TDI than girls (8). Association between family structure and TDI in preschool children has been reported (19, 20, 21) and the children from non-nuclear families had higher prevalence of TDIs (20).

The role of socio-economic factors on TDI in permanent and primary teeth is ambiguous, and nearly all studies concentrated in the permanent dentition. Previous studies that included indicators of socio-economic status reported that they were not related to the occurrence of TDI in permanent teeth (10, 13, 22–24), while other studies reported that TDI is more prevalent

in affluent populations (25, 26) or contrary in deprived populations (18, 27–29). In the primary dentition studies either failed to demonstrate a significant association between TDI and socio-economic factors (10, 13), or showed a higher prevalence of TDI in the upper socio-economic group (20, 30). These contradictory findings in studies and the scarce information on the epidemiology of TDIs in primary teeth suggest more research need to be carried out.

The aim of this paper was to report trends in TDI in preschool children in Brazil at three distinct time periods 2002, 2004 and 2006 and assess whether gender, family structure, and socio-economic differences in TDI are significant, and confirm the relationship between TDI and anatomic predisposing factors such as overjet and lip coverage.

Methods

Three cross-sectional surveys were conducted in 2002, 2004 and 2006 on representative samples of 5–59 months old children in Diadema using the same protocol (16). Ethical clearance was obtained from the Ethical Committee of the School of Dentistry of São Paulo, University of São Paulo.

It was estimated that a minimum sample size of 778 children was required to achieve a level of precision with a standard error of $< 2\%$ in each study in 2002, 2004 and 2006. The calculation of size of the sample used the formulae to calculate precision of a single proportion according to Kirkwood (31). This study adopted the 95% confidence interval level and assumed a prevalence of TDIs of 50% according to the prevalence found in a Brazilian study (17). This methodology was used in a previous study carried out by the same authors (13, 32).

Participants were systematically selected from all children attending the National Day of Children's Vaccination carried out in the city of Diadema. All the fifteen health centers in the city were used as sampling points in all three surveys because the city is administratively divided into regions and each region has a public health center that is responsible for the vaccination of those living in that area. Each fifth child in the queue in each health center for vaccination was invited to participate. Quota sampling was adopted because the population was equally distributed in all regions (33). Refusals were replaced by the next child in the queue. The uptake rate of the vaccination programmer in Diadema is very high and in 2002, 2004, and 2006 was above 95% among 5–59 months old children.

All dental examinations were carried out by 15 qualified dentists, and each one was randomized allocated in the 15 health centers in all surveys. All dentists participated in a training and calibration exercise in a total of six sessions. They were trained by two experienced researchers in carrying out clinical examinations for recording TDI and were selected according to their kappa values. They were almost the same fifteen dentists in all three surveys. Kappa coefficient was obtained using a sample of 20 clinical pictures of different dental injuries.

Children were examined, seated on a dental chair under a standard conventional dental light. The dental examination for TDIs included incisors and canines primary teeth. Before the clinical examination, wet gauze pads were used to clean the tooth surfaces (34) and a visual examination with a plane dental mirror was conducted. The criteria used to assess TDIs were a modified version of Ellis' classification (35) which includes: (i) fracture of the crown involving only enamel, (ii) fracture of the crown involving both enamel and dentine and fracture of the crown involving pulp, tooth missing due to trauma, and treated TDIs were included using the criterion of tooth discoloration. Pulp involvement was assessed by the presence of discoloration and presence of fistulous tract without signs of caries. Root fractures and pulp status recorded in Ellis' classification (35) were not recorded in this study because dental radiographs and pulp sensibility tests are not considered appropriate. The presence of anterior open bite was assessed based on the criteria of lack of vertical overlap of the incisors in the occlusal position (36).

A parent or care person provided information on family structure and socio-economic indicators. Socio-economic indicators included level of education, income, employment status, house ownership, whether moved to different address in the last year, and overcrowding.

Data analysis

Data were entered into Epi Info 6.14 software and then converted to SPSS software for data analysis. Next, the proportions of TDI were calculated. The statistical significance of trends in TDI was tested using the Chi-square test for trend, and the significance of differences in the prevalence of TDIs between genders, socio-economic groups, and anatomic features were assessed using the simple Chi-square test and logistic regressions. The level of significance was set at 5%.

Results

Both examiner agreement and response rate were very good in all surveys (Table 1). Kappa values for the presence of TDIs were calculated on a tooth by tooth basis and the values for intra- and inter-examiner agreement ranged between 0.69 and 0.91. The response rates in 2002, 2004 and 2006 were above 95%.

There was a significant increase in TDIs between 2002 and 2006 (47.9%, $P = 0.002$). The prevalence of TDIs was 9.4% (95% CI 7.63, 11.42) in 2002, 12.9% (95% CI 11.06, 14.96) in 2004, and 13.9% (95% CI 12.03, 15.84) in 2006 among 5–59 months old children (Table 1). There was an increase of 37.2% between 2002 and 2004 ($P = 0.012$) and 7.8% between 2004 and 2006 ($P = 0.500$). The three cross-sectional studies show that the treatment of TDI tends to be neglected (Table 1).

Statistical analyzes of the data collected in 2006 confirmed that anterior open bite (OR = 3.18, 95% CI 2.27, 4.46), overjet (OR = 2.53, 95% CI 1.68, 3.79), and short upper lip (OR = 2.29, 95% CI 1.48, 3.54) were significant predisposing factors to TDI in primary teeth (Table 2).

Table 1. Sample size, response rate, intra- and inter-examiner agreement, prevalence of TDI, proportion of untreated TDI in three cross-sectional studies carried out in preschool children in Diadema in 2002, 2004, and 2006

	2002	2004	2006	*P*-value*
Sample size	808	1138	1265	
Response rate	95.3%	97.2%	98.0%	
Intra- and inter-examiner agreement[1]	>0.69	>0.77	>0.81	
Untreated	92.9% (90.2–95.0)	98.3% (96.5–99.6)	98.9% (95.8–99.9)	
Prevalence of TDI	9.4% (7.6–11.4)	12.9% (11.0–14.9)	13.9% (12.0–15.8)	<0.05
Prevalence of TDI (boys)	8.8% (6.5–10.9)	12.3% (10.0–14.1)	12.2% (10.2–14.5)	<0.05
Prevalence of TDI (girls)	10% (8.7–12.1)	12.6% (10.5–14.9)	15.3% (13.7–17.1)	<0.05

Values in parentheses represent the 95% confidence interval.
TDI, traumatic dental injury.
[1]All Kappa values for the presence of TDIs were calculated on a tooth by tooth basis.
*All differences in prevalence between boys and girls were not statistically ($P > 0.05$).

Table 2. Simple logistic regressions of explanatory biologic factors on TDI in a sample of preschool children, Diadema – SP, 2006

Variables	Categories	*n*	TDI *n* (%)	OR	95% CI	*P*-value
Anterior open bite	No	991	102 (10.3)	1.00		
	Yes	273	73 (26.7)	3.18	2.27–4.46	<0.01
Short upper lip	No	1135	143 (12.6)	1.00		
	Yes	129	32 (24.8)	2.29	1.48–3.54	<0.01
Overjet	No	1114	136 (12.2)	1.00		
	Yes	150	39 (26.0)	2.53	1.68–3.79	<0.01

The difference in prevalence of TDI between boys (15.3%) and girls (12.2%) was not statistically significant ($P = 0.11$). Similarly, the difference in prevalence of TDI in children from nuclear families (13.6%), living with either the father or the mother (16.1%), or living with other than their biologic parents (8.7%) were not statistically significant ($P = 0.33$) (Table 3).

The socio-economic indicators included in this study were not statistically significantly related to the occurrence of TDI. House ownership (OR = 0.77, 95% CI 0.56, 1.06), moved house in the last year (OR = 0.74, 95% CI 0.49, 1.13). Similarly, other socio-economic indicators such as family income, overcrowding, mother's and father's level of education, and mother's and father's employment status were not significantly related to the occurrence of TDI (Table 4).

Discussion

Despite its importance, to our knowledge there are no published methodologically sound reports on the trends in TDI in primary teeth. This study showed that there was a significant increase in the prevalence of TDIs in a representative sample of 5–59-month-old preschool children aged in a typical westernized Brazilian city.

The increase in prevalence of TDI in Diadema does not appear to be related to either systematic or random error. The methodology adopted was sound because data were collected during the National Day of Children's Vaccination, and >95% of the children at this age living in the city of Diadema were vaccinated. The three cross-sectional surveys adopted the same protocol and diagnostic criteria and almost the same well trained examiners carried out the examinations in all surveys.

The prevalence of TDI in Diadema is likely to be consistently higher in all surveys because epidemiological studies may underestimate the prevalence of TDI. Epidemiological surveys do not assess concussions and luxations, root fractures, and bone fractures. Because this is an epidemiological rather than a clinical study an epidemiological study classification was used. The classification used in this study was published in the textbook and color atlas of traumatic injuries to the teeth (8), and only included markers of TDI that are possible to assess in epidemiological surveys. They are treated dental injury, enamel fracture only (N 502.50), enamel and dentin fracture (N 502.51), pulp injury (N 502.52, N 502.54), and missing tooth due to trauma (N 503.22). Treated dental injury is not a disease but a

Table 3. Simple logistic regressions of explanatory variables on TDI in a sample of preschool children, Diadema – SP, 2006

Variables	Categories	*n*	TDI *n* (%)	OR	95% CI	*P*-value
Gender	Males	651	100 (15.4)	1.00		
	Female	614	75 (12.2)	0.77	0.56–1.06	0.11
Family struture	Nuclear family	994	135 (13.6)	1.00		
	Single father or mother	224	36 (16.1)	1.22	0.82–1.82	0.33
	Others	46	4 (8.7)	0.61	0.21–1.72	0.34

Table 4. Simple logistic regressions of explanatory socio-economic indicators on TDI in a sample of preschool children, Diadema – SP, 2006

Variables	Categories	*n*	TDI *n* (%)	OR	95% CI	*P*-value*
House ownership	No	512	81 (15.8)	1.00		
	Yes	742	94 (12.7)	0.77	0.56–1.06	0.11
Moved house in the last year	No	988	144 (14.6)	1.00		
	Yes	265	30 (11.3)	0.74	0.49–1.13	0.16
Family income	<1 BMW	147	19 (13.0)	1.00		
	1–1.9 BMW	487	60 (12.3)	0.83	0.58–1.18	0.30
	2–2.9 BMW	253	37 (14.6)	1.00	0.69–1.44	0.10
	3 - +BMW	378	59 (15.6)	1.09	0.77–1.55	0.62
Overcrowding	0–0.79	288	41 (14.2)	1.00		
	0.8–0.99	109	21 (19.3)	1.44	0.81–2.57	0.22
	1.0–1.49	497	68 (13.7)	0.95	0.63–1.45	0.82
	+1.5	368	45 (12.2)	0.84	0.53–1.32	0.45
Mother's level education	Fundamental (*years of formal education)	544	77 (14.2)	1.00		
	Medium (3 years of formal education)	628	88 (14.0)	0.99	0.71–1.37	0.94
	University degree	84	10 (11.9)	0.82	0.41–1.66	0.57
Mother's employment status	Full-time	460	57 (12.4)	1.00		
	Part-time	107	14 (13.1)	1.06	0.57–1.99	0.84
	Unemployed	689	104 (15.1)	1.26	0.89–1.78	0.20
Father's level education	Fundamental (*years of formal education)	557	78 (14.0)	1.00		
	Medium (3 years of formal education)	499	71 (14.2)	1.02	0.72–1.44	0.92
	University degree	83	9 (10.8)	0.75	0.36–1.55	0.44
Father's employment status	Full-time	957	136 (14.2)	1.00		
	Part-time	80	8 (10.0)	0.67	0.32–1.42	0.30
	Unemployed	108	14 (13.0)	0.90	0.50–1.62	0.72

BMW, Brazilian minimum wage.
*P < 0.05. Socio-economic indicators were not significantly related to the occurence of TDI.

marker of past occurrence of a TDI. Exclusion of this category would further underestimate the prevalence of TDI in surveys.

One of the limitations of this study is that one can only examine untreated TDI may be underestimate of the prevalence due to not examining luxation injuries. Further studies should identify the causes of the increase in prevalence of TDIs in Diadema, and assess whether the observed trend is confirmed in other westernized cities worldwide.

The findings of this study confirmed there is a strong relationship between TDI and anatomic predisposing factor such as overjet, anterior open bite, and short upper lip coverage. Also, this study confirmed the lack of significant gender differences in the occurrence of TDIs observed in most of previous studies. These findings were consistent in all three cross-sectional surveys, and they are in agreement with the dental literature.

The findings of this study corroborated previous studies that showed a lack of association between TDIs and socio-economic indicators (10, 13, 21, 23). The lack of a significant relationship does not seem to be due a lack of statistical power or lack of sensitivity of indicators of socio-economic position or deprivation. The study included a large sample and several validated socio-economic indicators.

Both the increase in prevalence of TDIs and treatment need requires urgent attention of health professionals. Cortes et al. (26) has demonstrated that TDI has a significant impact on quality of life of adolescents (26), and it may affect the quality of life of small children too. Untreated TDIs affect children's appearance, ability to eat and speak properly, socializing, and psychologic well-being (26). In addition, it may cause severe biologic sequels (8).

In conclusion, it is crucial to generate considerable efforts to implement health promotion strategies to reverse the observed trends and to provide treatment to TDIs therefore to prevent their biologic and psychologic consequences.

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