

# Does the School Environment Exert Influence on Quality of Life Related to the Occurrence of Traumatic Dental Injuries in School Children?

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## Research Article

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# Abstract

**Purpose:** To assess whether favourable factors related to school characteristics have a positive effect on the impact on OHRQoL related to occurrence TDI.

**Methods:** An epidemiological survey of oral health was conducted with 12-year-old scholars from Quito, Ecuador. Children were examined regarding TDI, dental caries, and malocclusion. Individual socioeconomic data was collected. Information on the physical environment, health practices and occurrence of negative episodes in the schools were collected with the school's coordinators. The Child Perceptions Questionnaire 11-14 (CPQ<sub>11-14</sub>) was answered to evaluate the OHRQoL (outcome variable). Multilevel Poisson regression analysis was conducted.

**Results:** Occurrence of severe TDI was associated with higher CPQ<sub>11-14</sub> scores, even in the multiple model adjusted for oral health conditions, sex, individual socioeconomic variables, and school-related variables. Children from schools that had an appropriate tooth brushing environment for their students exhibited a lower impact on OHRQoL, even when adjusted for occurrence of TDI and other variables.

**Conclusion:** A favourable school environment may exert a positive effect on the OHRQoL, independently of the occurrence of TDI.

## Introduction

Traumatic dental injuries (TDIs) of permanent teeth are highly prevalent worldwide [1, 2], and most of these injuries occur in children and adolescents [1–3]. Therefore, since children at this age group spend a considerable part of their active time at school, a substantial proportion of these injuries may occur in the school environment [4–6]. Occurrence of TDIs have a negative impact on quality of life among children and adolescents [7–9]. However, it is unclear if schools with a favourable environment and that promote health practices could have a positive impact on oral health-related quality of life (OHRQoL) related to TDI.

Previous studies have demonstrated that the implementation of health-promoting schools is associated with a decrease in the prevalence of dental trauma [10, 11]. Moreover, schools with episodes of bullying and vandalism are associated with a higher prevalence of other oral health conditions among their students [12, 13]. With regard to quality of life, a more negative impact on OHRQoL was demonstrated in Brazilian children registered at public schools [8, 14], but this might be due to socioeconomic factors [15].

The influence of school environmental characteristics on OHRQoL has been studied. Authors have observed that children attending schools with more positive indicators related to bullying occurrence and lack of security at the schools had lower impact on OHRQoL [16]. A further study investigated the influence of the Basic School's Development Index (IDEB), a Brazilian index that comprises the school flow and the average performance of the students, on scores related to OHRQoL [17]. The authors observed that children from the highest rated schools presented lower impact on OHRQoL [17]. Another

study compared children's OHRQoL after the implementation of a health promoting school model in Malaysia. Although the improvements were generally discrete, the health promoting school model had some positive impacts on children's OHRQoL [18].

Nevertheless, none of those previous studies was focused on the occurrence of TDI and its impact on schoolchildren's OHRQoL. Our working hypothesis is that factors related to school physical conditions, promotion of health practices, and the absence of negative episodes in the schools could favour a positive impact on students' OHRQoL, regardless of the occurrence of TDI. Therefore, the aim of this cross-sectional study was to evaluate if school environmental characteristics exert an influence on the negative impact of TDI on OHRQoL in 12-year-old schoolchildren from Quito, Ecuador.

## **Material And Methods**

### **Study Design, setting and ethical considerations**

This cross-sectional study is part of an epidemiological survey called "QUITO Oral Health Survey" (QUITO-OH Survey). It is a population-based survey with 12-year-old children studying in public schools in the urban area of Quito, the capital city of Ecuador. The study protocol was approved by the Local Committee for Ethics in Research of both the School of Dentistry of University of São Paulo and the Central University of Ecuador (CAAE # 61903416.8.0000.0075 and # 399-CE-UCE-2016, respectively). All the subjects assented to participate, and a written informed consent form was obtained from all parents or guardians. This study was written following the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines.

The children were examined for several oral health conditions, including TDIs, dental caries, malocclusion, gingival bleeding, presence of calculus, and fluorosis. The oral conditions were evaluated according to the recommendations of the World Health Organization (WHO) [19]. The evaluations were performed by 6 examiners from March to May, 2017. Prior to the survey, training and calibration sessions of the 6 examiners were conducted by 2 benchmark examiners. Details of the methodology used in the survey, training and calibration of the examiners, and the observed prevalence of all oral health problems collected in the QUITO-OH survey were previously published [20].

In addition to oral health problems previously described, we gathered data on access to dental services, socioeconomic variables and school performance and OHRQoL. Besides those individual variables (variables related to the children), data related to the school environment (contextual variables) were also obtained. Data related to the prevalence of TDI and the association of these scholar contextual variables were published recently [21].

### **Participants**

The epidemiological survey was designed to evaluate oral health outcomes in a representative sample of 12-year-old schoolchildren from the urban area of Quito. Thus, the eligibility criteria were children born

between April 2004 and March 2005 attending one of the randomly selected public schools from the urban area of Quito. The exclusion criteria were children whose parents did not sign the consent form, or children who did not agree to participate. Moreover, children presenting or reporting systemic diseases and children who did not attend at the days of the examinations were excluded.

First, we selected the public schools of urban area of Quito with students aged 12 years ( $n = 156$  schools). From these schools, we randomly selected 33 schools, stratified by city area and proportion of students. After this procedure, the students who filled the eligibility criteria were randomly selected. The number of students per school was proportional to the total number of enrolled students.

The sample size was calculated based on the epidemiological survey of oral health. Details of the sample size calculation for the QUITO-OH survey can be found elsewhere [20]. The minimum sample size was estimated to be 928 children, and we invited 1,100 children to account for the non-respondents.

For the Poisson regression analysis, and considering this sample of 928 children, we calculated the statistical power to detect a minimum Rate Ratio (RR) of 1.2 considering a dichotomous explanatory variable and the total CPQ<sub>11-14</sub> scores as outcome. Acknowledging an unfavourable scenario of ratio between exposed and unexposed of 1 to 9, the calculated minimum sample would have a power of 99.9% for an alpha error probability of 5%. With the addition of explanatory variables in the multiple model, considering a correction factor of 0.7, this power would be 90.7%.

## **Explanatory and Outcome Variables**

Individual and contextual explanatory variables were evaluated. The individual variables were related to socioeconomic and demographic characteristics and oral health conditions. The socioeconomic variables were obtained through a structured questionnaire sent to the parents or guardians.

The following sociodemographic variables were collected: child's sex (male and female), household income, parent's level of education, and number of persons per room. Household income was calculated considering the Ecuadorian Minimum Wage (EMW - around U\$ 375.00/month during the period of data gathering). Children were categorized in families receiving up to 1 EMW and more than 1 EMW. Mother's and father's level of education was classified as those who finished primary school (up to 8 years of formal education) and those who attended beyond primary education (more than 8 years of attendance at the school). Number of persons per room was categorized by the median in children living in a house with up to 1.7 persons per room, and children living in houses with more than 1.7 persons per room.

TDIs and other oral health problems were evaluated by 6 trained and calibrated examiners. Details of the calibration procedures have previously been described.<sup>20</sup> Children were examined in their school environment, under artificial light, using sterilized dental mirrors and ball-point dental probes. Gauze pads were used to dry the teeth surfaces when necessary.

TDIs were identified through the evaluation of the upper and lower incisors, according to the method described by O'Brien [22], as recommended in by the WHO.<sup>19</sup> Children were categorized in three groups,

according to the most severe situation in the incisors, as follows: (i) children without TDI, (ii) children with mild TDI (presence of enamel fractures), and (iii) children with severe TDI (occurrence of TDI reaching the dentin, with or without pulp involvement, or avulsion).

Analysis was adjusted for dental caries and malocclusion. Dental caries was assessed according to the World Health Organization (WHO) recommendation, and the number of decayed, missing and filled teeth (DMFT) was calculated [19]. Children were categorized as caries-free (DMFT = 0), children with DMFT between 1 and 4, and with DMFT higher than 4. Malocclusion was collected using the Dental Aesthetics Index (DAI) and children were categorized as children with normal occlusion, definite malocclusion, severe malocclusion, and handicapping malocclusion [23].

The explanatory contextual variables were collected using a questionnaire containing information regarding the physical conditions of the school, the health practices promoted by the school, and the occurrence of negative episodes. The questions were elaborated based on earlier studies [10, 11, 13]. The school coordinators answered the questionnaire and the examiners checked the information provided. The contextual explanatory variables related to the physical conditions of the school were the average number of students per classroom ( $\leq 30$  students per room and  $> 30$  students per room), the patio area ( $\leq 600\text{m}^2$  and more than  $600\text{ m}^2$ ), and patio and court floor conditions (poor conditions, with cracks and/or holes, and good conditions).

Considering the health practices promoted by the school, we evaluated if the students were allowed to brush their teeth in an adequate environment (yes or no), if the schools offer healthy meals for the students (yes or no), and if sports practice after the regular class time was allowed (yes or no). With regard to the occurrence of negative episodes, the coordinators reported whether the school experienced episodes of vandalism, theft episodes or physical violence among the students in the last year (response options: yes or no).

The outcome variable in our study was related to OHRQoL. The OHRQoL was assessed using the translated and validated Spanish version [24] of the short-form Child Perceptions Questionnaire 11–14 (CPQ<sub>11-14</sub>) [25]. The short-form of the CPQ<sub>11-14</sub> is responded by the children and it comprises 16 questions with answers that range from 0 to 4 on a Likert scale. The sum of the answers results in a final score ranging from 0 to 64. The higher the scores, the worse the OHRQoL. The 16 questions of the instrument are divided into four domains (4 items per domain): oral symptoms, functional limitations, emotional well-being and social well-being.

The main outcome variable was obtained considering the total CPQ<sub>11-14</sub> scores. The scores obtained in each domain separated were also analysed as outcome variables in additional analyses.

To avoid selection bias, children were randomly selected before the clinical examination. Dentists who were not involved in the clinical examination applied the questionnaire; hence, they were not aware of the oral health conditions of the children. Likewise, the examiners who performed the clinical evaluations were unaware of the child's responses to the CPQ<sub>11-14</sub>.

# Statistical Analysis

Descriptive statistics were performed to demonstrate the proportion of children distributed according to individual and contextual explanatory variables. The mean and standard deviation (SD) values of the total CPQ<sub>11-14</sub> scores according to the explanatory variables were also calculated.

Multilevel Poisson regression was used to evaluate the association between individual and contextual explanatory variables and the main outcome variable (CPQ<sub>11-14</sub> scores). The analysis was performed using robust variance to correct for a possible overdispersion. With this approach, we derived the RR and respective 95% confidence intervals (95%CI).

After univariate analysis, multiple multilevel Poisson regression analyses were performed by the gradual incorporation of explanatory variables according to the purpose of the study and the adjustment of the regression model. In the first step, a null model without variables was used. The first model included only the occurrence of TDI as an independent variable, which is the main exposure of this study. In the second model, we included variables related to other oral health conditions (dental caries and malocclusion). In the third multiple model, individual demographic and socioeconomic variables were included, and then, in the final model, the contextual variables were also added.

Univariate and multiple multilevel Poisson regression analyses were also used to assess the association between TDI and scores of the different domains of CPQ<sub>11-14</sub>, unadjusted or adjusted for other explanatory variables. All analyses were conducted using the statistical package Stata 13.0 (Stata Corporation, College Station, TX, USA), and the significance level was set at 5%.

## Results

The kappa values for interexaminer agreement ranged from 0.79 and 0.98 for evaluation of TDIs. These values varied from 0.75 to 0.96 for malocclusion, and from 0.92 to 0.95 for dental caries.

Of the 33 schools from the urban zone of Quito that were randomly selected to participate, 31 schools were enrolled in this study. Two school coordinators did not allow the schools' participation because they claimed that the examinations would disrupt the routine of the schools. From the 31 schools included, 1,100 children were randomly selected and invited to participate in the study. Among these students, a total of 997 children (90.6% response rate) were examined and responded to the CPQ<sub>11-14</sub>. The reasons for non-participation were: not returning the consent form (n = 96), absence on the day of examination (n = 4), the refusal to be examined (n = 2), and the non-response of the CPQ<sub>11-14</sub> (n = 1).

Socioeconomic and demographic individual characteristics and variables related to oral health disorders of all children are presented in Table 1. The majority of children which experienced dental trauma had mild TDI (16.2%), while 2.2% of the children had severe TDI (Table 1). The mean (SD) of the total CPQ<sub>11-</sub>

$_{14}$  scores of the 997 participating children was 12.2 (8.7). The CPQ $_{11-14}$  scores according to the individual explanatory variables are displayed in Table 1.



Table 1

Descriptive analysis of all participants (n = 997) according to the individual explanatory variables and Child Perceptions Questionnaire 11–14 (CPQ<sub>11–14</sub>) scores

Explanatory variables	N (%)	CPQ <sub>11–14</sub>	Unadjusted RR
		Mean (SD)	(95%CI)
Traumatic Dental Injuries (TDI)			
Without TDI	814 (81.6)	12.2 (8.7)	1.00
Mild TDI	161 (16.2)	11.4 (8.2)	0.92 (0.81–1.07)
Severe TDI	22 (2.2)	18.4 (10.5)	1.37 (1.04 to 1.78) *
DMFT			
Without caries	413 (41.4)	11.9 (8.9)	1.00
DMFT between 1 and 4	523 (52.5)	12.3 (8.4)	1.00 (0.96–1.04)
DMFT higher than 4	61 (6.1)	14.7 (10.6)	1.25 (1.16–1.35) *
Dental Aesthetics Index			
Normal occlusion	390 (39.1)	11.3 (7.7)	1.00
Definite malocclusion	352 (35.3)	11.8 (8.7)	1.04 (0.95 to 1.13)
Severe malocclusion	175 (17.6)	13.8 (9.9)	1.22 (1.11 to 1.34) *
Handicapping malocclusion	80 (8.0)	14.6 (9.6)	1.31 (1.12 to 1.52) *
Sex			
Female	554 (55.6)	13.3 (9.3)	1.00
Male	443 (44.4)	11.1 (7.8)	0.85 (0.75–0.96) *
Household income **			
≤ 1 EMW	433 (45.2)	12.9 (9.3)	1.00
> EMW	526 (54.8)	11.8 (8.2)	0.94 (0.83–1.06)
Mother's education level **			
≤ Primary school	342 (34.3)	13.0 (9.1)	1.00
> Primary school	654 (65.7)	12.0 (8.6)	0.93 (0.85–1.03)
Father's education level **			
≤ Primary school	342 (34.5)	13.8 (9.8)	1.00
> Primary school	650 (65.5)	11.5 (8.1)	0.85 (0.77–0.95) *

Explanatory variables	N (%)	CPQ <sub>11-14</sub>	Unadjusted RR (95%CI)
		Mean (SD)	
Number of persons per room **			
≤ 1.7 persons per room	602 (60.8)	11.5 (8.4)	1.00
> 1.7 persons per room	389 (39.2)	13.6 (9.1)	1.14 (1.05–1.24) *
DMFT = number of decayed, missing and filled permanent teeth			
EMW = Ecuador's Minimum Wage at the time of data gathering (U\$ 375.00).			
SD = Standard Deviation. RR = Rate Ratio; 95%CI = 95% Confidence interval			
* Statistically significant at 5%			
** Variables did not sum 997 participants due to missing data			

The association between the individual explanatory variables and the OHRQoL measured through the CPQ<sub>11-14</sub> scores, presented as RR values and respective 95% CIs, are shown in Table 1. We observed that children with severe TDI presented significantly higher CPQ<sub>11-14</sub> scores than children with no signs of TDI. Likewise, children with DMFT > 4 and children that presented severe or handicapping malocclusion also exhibited higher CPQ<sub>11-14</sub> scores (Table 1). On the other hand, males and children of fathers with higher levels of scholarship were significantly associated with lower CPQ<sub>11-14</sub> scores. Additionally, children living in houses with more persons per room exhibited a more negative impact on OHRQoL (Table 1).

Table 2 shows the distribution and mean of total CPQ<sub>11-14</sub> scores according to the schools and the contextual variables evaluated in our study. Children from schools that provided an adequate environment for tooth brushing had a significant lower impact on OHRQoL (Table 2). Moreover, children from schools with episodes of vandalism during the last year presented significantly higher total CPQ<sub>11-14</sub> scores than children from schools that did not experience these events (Table 2).

Table 2

Descriptive analysis of all participants (n = 997) enrolled at the 31 participating schools, according to the contextual explanatory variables and Child Perceptions Questionnaire 11–14 (CPQ<sub>11–14</sub>) scores

Explanatory variables	Schools	Children	CPQ <sub>11–14</sub> scores	Unadjusted RR (95%CI)
	N	N (%)	Mean (SD)	
<b>Physical conditions of the school</b>				
N° of students per classroom				
≤ 30 students/classroom	17	400 (40,1)	11,8 (8,8)	1.00
> 30 students/classroom	14	597 (59,9)	12,4 (8,6)	1.09 (0.91 to 1.31)
Patio area				
≤ 600 m <sup>2</sup>	23	581 (58.3)	12.1 (8.5)	1,00
> 600 m <sup>2</sup>	8	416 (41.7)	12.3 (9.0)	0.94 (0.77 to 1.14)
Patio floor conditions				
Poor condition	5	130 (13,0)	14.0 (9.2)	1,00
Good condition	26	867 (87,0)	11.9 (8.6)	0.83 (0.62 to 1.09)
Sports court floor conditions				
Poor condition	4	92 (9.2)	14.1 (9.8)	1.00
Good condition	27	905 (90.8)	12.0 (8.6)	0.80 (0.59 to 1.09)
<b>Health practices promoted by the school</b>				
Appropriate tooth brushing environment				
No	27	861 (86.4)	12.6 (8.8)	1.00
Yes	4	136 (13.6)	9.8 (7.8)	0.78 (0.66 to 0.93) *
School offers healthy meals				
No	5	110 (11.0)	11.8 (8.4)	1.00

Explanatory variables	Schools	Children	CPQ <sub>11-14</sub> scores	Unadjusted RR (95%CI)
	N	N (%)	Mean (SD)	
Yes	26	887 (89.0)	12.2 (8.7)	1.01 (0.89 to 1.14)
Sports Activities after regular class time				
No	22	638 (64.0)	11.9 (8.9)	1.00
Yes	9	359 (36.0)	12.7 (8.4)	1.16 (0.94 to 1.43)
<b>Occurrence of negative episodes</b>				
Episodes of vandalism				
No	12	499 (50.1)	11.3 (7.9)	1.00
Yes	19	498 (49.9)	13.3 (9.4)	1.20 (1.01 to 1.42) *
Theft episodes				
No	9	249 (25.0)	11.1 (7.5)	1.00
Yes	22	748 (75.0)	12.6 (9.0)	1.19 (0.99 to 1.41)
Physical violence among the students				
No	7	245 (24.6)	12.0 (8.5)	1.00
Yes	24	752 (75.4)	12.4 (8.8)	1.13 (0.91 to 1.40)
SD = Standard Deviation. RR = Rate Ratio; 95%CI = 95% Confidence interval				
* Statistically significant at 5%				

Children with severe TDI exhibited a mean of CPQ<sub>11-14</sub> scores approximately 37% higher than children with no TDI, as observed in the model 1 (Table 3). In the model 2, this association remained significant, even when adjusted for other variables related to oral health conditions (Table 3). With the inclusion of demographic and socioeconomic individual variables, again, children with severe TDI had a significantly higher impact on OHRQoL. Other variables significantly associated with OHRQoL were presence of severe or handicapping malocclusion, children's sex, father's level of education and number of persons per room

(Model 3, Table 3). In the final model, this association remained significant despite the incorporation of the contextual variables related to the school environment. Moreover, besides the same associations with individual explanatory variables found in the model 3, we observed that children studying in schools with an appropriate environment for tooth brushing had lower total CPQ<sub>11-14</sub> scores than children from schools that did not favour tooth brushing among the students (Model 4, Table 3).

Table 3

Multiple regression analyses for the association of individual and contextual exposure variables and the mean of the Child Perceptions Questionnaire 11–14 (CPQ<sub>11–14</sub>) total scores

Independent variables	Null model	Model 1	Model 2	Model 3	Model 4
		Adjusted RR (95%CI)			
<b>Fixed effects</b>					
Intercept	2.48 (0.05)	2.49 (0.05)	2.40 (0.05)	2.50 (0.07)	2.52 (0.07)
TDI (ref.: without TDI)					
Mild TDI		0.92 (0.80 to 1.06)	0.94 (0.82 to 1.09)	0.95 (0.82 to 1.09)	0.95 (0.82 to 1.09)
Severe TDI		1.37 * (1.05 to 1.78)	1.36 * (1.03 to 1.78)	1.34 * (1.04 to 1.74)	1.34 * (1.04 to 1.74)
DMFT (ref.: with no caries)					
DMFT between 1 and 4			0.99 (0.95 to 1.02)	0.98 (0.89 to 1.07)	0.98 (0.89 to 1.07)
DMFT higher than 4			1.11 * (1.03 to 1.21)	1.03 (0.79 to 1.34)	1.03 (0.79 to 1.34)
DAI (ref.: normal occlusion)					
Definite malocclusion			1.04 (0.96 to 1.14)	1.05 (0.97 to 1.14)	1.05 (0.97 to 1.14)
Severe malocclusion			1.23 * (1.12 to 1.34)	1.21 * (1.11 to 1.33)	1.21 * (1.11 to 1.32)
Handicapping malocclusion			1.30 * (1.12 to 1.52)	1.33 * (1.14 to 1.56)	1.33 * (1.13 to 1.56)
Sex (ref.: Female)					

Independent variables	Null model	Model 1	Model 2	Model 3	Model 4
		Adjusted RR (95%CI)			
Male				0.85 *	0.85 *
				(0.76 to 0.96)	(0.76 to 0.96)
Father's education level (ref.: ≤ primary school)					
> Primary school				0.89 *	0.89 *
				(0.81 to 0.98)	(0.81 to 0.98)
Number of persons per room (ref.: ≤ 1,7 persons per room)					
> 1,7 persons per room				1.13 *	1.13 *
				(1.04 to 1.22)	(1.04 to 1.22)
Appropriate tooth brushing environment (ref.: no)					
Yes					0.81 *
					(0.69 to 0.96)
<b>Random Effects</b>					
Variance of intercept (SE)	0.065 (0.016)	0.063 (0.015)	0.063 (0.016)	0.058 (0.014)	0.053 (0.014)
<b>-2 log likelihood</b>	9159.3	9113.8	9006.0	8778.5	8776.0
* Statistically significant at 5%					
TDI = Traumatic Dental Injuries; SE = Standard Error; DMFT = number of decayed, missing and filled teeth; DAI = Dental Aesthetics Index; RR = Rate Ratio; 95%CI = 95% Confidence Interval					

As regards the impact of TDI on the different domains of CPQ<sub>11-14</sub>, children presenting severe TDI had significantly higher CPQ<sub>11-14</sub> scores than those with no TDI in the domains: “functional limitations”, “emotional well-being”, and “social well-being” in both univariate and multiple analyses (Table 4). The exception was the domain named “oral symptoms”, where any significant association with occurrence of TDI was observed. Moreover, children who had suffered mild TDI presented similar scores to children that have not experienced TDI for all domains (Table 4).

Table 4

Association of occurrence of Traumatic Dental Injuries (TDI) and the mean of the different domains of Child Perceptions Questionnaire 11–14 (CPQ<sub>11–14</sub>) scores using multiple multilevel Poisson regression

CPQ <sub>11–14</sub> domains	Without TDI	Mild TDI	Severe TDI
<b>Oral symptoms</b>			
Mean (SD)	4.9 (2.7)	4.7 (2.5)	5.6 (2.8)
Unadjusted RR (95%CI)	1.00	0.95 (0.86 to 1.05)	1.10 (0.93 to 1.30)
Adjusted RR (95%CI) **	1.00	0.96 (0.87 to 1.06)	1.10 (0.93 to 1.30)
<b>Functional limitations</b>			
Mean (SD)	3.3 (2.8)	3.3 (2.7)	5.2 (3.3)
Unadjusted RR (95%CI)	1.00	0.96 (0.80 to 1.16)	1.43 * (1.12 to 1.83)
Adjusted RR (95%CI) **	1.00	1.00 (0.83 to 1.19)	1.44 * (1.12 to 1.85)
<b>Emotional well-being</b>			
Mean (SD)	2.3 (3.4)	1.9 (3.1)	4.3 (5.2)
Unadjusted RR (95%CI)	1.00	0.83 (0.64 a 1.08)	1.60 * (0.73 to 0.94)
Adjusted RR (95%CI) ***	1.00	0.84 (0.64 a 1.11)	1.55 (1.25 a 1.93)
<b>Social well-being</b>			
Mean (SD)	1.6 (2.5)	1.5 (2.2)	3.2 (3.3)
Unadjusted RR (95%CI)	1.00	0.92 (0.68 to 1.25)	1.74 * (1.36 to 2.23)
Adjusted RR (95%CI) ****	1.00	0.97 (0.84 to 1.12)	1.61 * (1.25 to 2.06)



CPQ <sub>11-14</sub> domains	Without TDI	Mild TDI	Severe TDI
SD = Standard Deviation; RR = Rate Ratio; 95% CI = 95% Confidence interval			
* Statistically significant at 5%			
** adjusted by number of decayed, missing and filled teeth (DMFT), Dental Aesthetics Index (DAI), sex, number of persons per room, appropriate tooth brushing environment, and patio floor conditions.			
*** adjusted by DMFT, DAI, sex, number of persons per room, father's education level, and appropriate tooth brushing environment			
**** adjusted by DMFT, DAI, sex, number of persons per room, father's education level, and promotion of sports activities after regular class time			

## Discussion

The present study, nested in an epidemiological survey conducted with a representative sample of children from Quito, Ecuador, was designed to evaluate whether factors related to the school environment could influence the negative impact of TDIs on schoolchildren's OHRQoL. We found that children from schools that experienced vandalism episodes in the last year exhibited a more negative impact on OHRQoL. Furthermore, this trend was also observed for children studying in schools that did not provide an adequate environment for tooth brushing of their students, and this variable remained significant even when the model was adjusted for TDI and other individual variables. Therefore, the positive characteristics of the school environment favoured a lower impact on OHRQoL, regardless of the occurrence of TDI and oral health disorders, supporting our working hypothesis.

A potential explanation for these findings is that children studying in schools with a more negative environment are probably from families with low socioeconomic status. Socioeconomic conditions can partially explain the higher prevalence of dental caries [13], although these factors were not usually associated with the occurrence of TDI [26]. On the other hand, socioeconomic conditions have been associated with the OHRQoL [17]. In the multiple model adjusted for the socioeconomic indicators and the occurrence of TDI and other oral health problems, the variable "vandalism episodes" did not achieve statistical significance. Thus, this fact can suggest the influence of individual socioeconomic characteristics on our findings.

These findings may be also explained by the lower prevalence of oral health disorders in these schools. For example, the occurrence of negative episodes such as bullying, vandalism, theft, and violence among students in schools was associated with a higher prevalence of dental caries [13] or TDI [12]. In our study, schools that experienced vandalism episodes exhibited a higher prevalence of TDI compared to schools where their coordinators did not report any occurrence of vandalism in the last year (14.8% and 0.8% for mild and severe TDI, respectively). Moreover, schools that have experienced episodes of vandalism against the patrimony presented the mean of CPQ<sub>11-14</sub> scores approximately 20% higher than schools

that have not experienced negative episodes. We also observed that children from schools with a favourable school environment in other aspects experienced less episodes of TDIs [21].

In addition to the decrease in prevalence of health problems, a positive school environment may favour a higher resilience among their students [27]. This effect can be observed with variables that were not directly associated with the prevention of TDIs. In our study, another contextual variable significantly associated with lower CPQ<sub>11-14</sub> scores was the promotion of an appropriate tooth brushing environment at the schools. The mean of total CPQ<sub>11-14</sub> scores in children attending these schools were approximately 20% lower than in children studying in other schools that did not provide time and an environment for tooth brushing. However, different to the occurrence of vandalism, this variable remained significant even in the adjusted model including oral health conditions and socioeconomic indicators. Thus, even though the prevalence of TDI in the schools that promote a safe tooth brushing environment was lower (11.0% and 0.8% for mild and severe TDI, respectively) than in schools without this routine (17.0% for minor TDI and 2.4% for severe TDI), multiple analyses suggest that the lower impact on OHRQoL is also associated with the promotion of these healthy habits.

Therefore, promotion of tooth brushing among the students, as well as other contextual variables related to health promotion measures (offering healthy meals and sports practices after regular class time), may be part of a general concept of health promotion for students. The concept of "Health Promoting Schools" comprises that broader health promotion measures are more effective than individual care [11, 28]. Previous studies have found a lower prevalence of oral health conditions in health-promoting schools [10, 11, 29, 30]. Moreover, positive effects related to health-promoting schools on OHRQoL have been observed [18]. Thus, in the present study, a possible explanation to the lower impact on OHRQoL in children from health-promoting schools, even in the adjusted model that incorporated the occurrence of TDI and other health conditions, may be the promotion of favourable healthy habits in these schools. These actions may favour healthier conditions [10, 11, 28–30], resilience [27], better quality of life [18], and other positive aspects [28].

However, these findings should be interpreted with caution. First, due to the nature of the study, it was not possible to collect where or how the TDIs occurred. Therefore, the direct relationship among the physical structure or occurrence of negative episodes in the schools and the occurrence of TDIs could not be evaluated. Nevertheless, authors have observed that many TDIs episodes in scholars occur in the school environment [4–6].

Other limitation is that other variables related to the promotion of healthy habits were not associated to lower CPQ<sub>11-14</sub> scores. Furthermore, there were only four schools promoting a tooth brushing friendly environment, and the sample was restricted exclusively to public schools in the urban area of Quito. Thus, studies in other cities and countries, preferentially involving public and private schools, are necessary to corroborate our findings.

Despite the limitations, our study presents some strengths. This is the first study that evaluates the influence of contextual school environmental characteristics, as well as health promotion measures, on the impact of TDI on children's OHRQoL. The occurrence of TDI, especially in the more severe stages, has been commonly associated with a negative impact on the OHRQoL of schoolchildren in primary studies [8, 9], as well as in a recent systematic review [7]. Despite of the low prevalence of children with severe TDI, this impact was confirmed in the present study, since children with severe TDI exhibited a greater impact on quality of life, even when adjusted for other variables.

In addition, this study demonstrated that even with the occurrence of TDI, schools that promote some health practices had a lower impact on OHRQoL. These findings favour the implementation of schools with supportive environments and that promote health measures. This effort could facilitate a reduction on the prevalence of oral health conditions and an improvement on OHRQoL. Besides, the implementation of health-promoting schools may favour other health conditions, as well as an improvement of the well-being and general quality of life of students, teachers, and staff of these schools [28]. However, the positive effect of these health-promoting schools on reducing health problems and improving health-related quality of life should be tested in cohort studies or cluster randomized clinical trials.

In conclusion, positive social environment and promotion of health practices in schools may reduce the impact of TDI on OHRQoL.

## **Declarations**

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### **Conflicts of interest/Competing interests**

The authors have no conflicts of interest to declare that are relevant to the content of this article.

### **Availability of data and material**

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### **Code availability**

Not applicable

### **Authors' contributions**

MDCQ-C, PLA-V, MCB-I substantially contributed with acquisition of data, revised critically the manuscript for important intellectual content and gave the final approval for the current version of the manuscript. RDF substantially contributed with the analysis and interpretation of data, drafted the article and gave the final approval for the current version of the manuscript. TMA substantially contributed with the analysis and interpretation of data, revised critically the manuscript for important intellectual content and gave the final approval for the current version of the manuscript. ACF substantially contributed with acquisition, analysis and interpretation of data, revised critically the manuscript for important intellectual content and gave the final approval for the current version of the manuscript. EM-C, CMP and DPR substantially contributed to the conception and design of the study, revised critically the manuscript for important intellectual content and gave the final approval for the current version of the manuscript. FMM substantially contributed to the conception and design of the study, analysis and interpretation of data, drafted the article and gave the final approval for the current version of the manuscript.

### **Ethics approval**

This study was performed in line with the principles of the Declaration of Helsinki. The study protocol was approved by the Local Committee for Ethics in Research of both the School of Dentistry of University of São Paulo and the Central University of Ecuador (CAAE # 61903416.8.0000.0075 and # 399-CE-UCE-2016, respectively).

### **Consent to participate**

All the subjects assented to participate, and a written informed consent form was obtained from all parents or guardians.

### **Consent for publication**

Patients signed informed consent regarding publishing their data

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