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# Tooth brushing frequency in Mexican schoolchildren and associated socio-demographic, socioeconomic, and dental variables

Authors' Contribution:  
Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

**ABDEF 1 Alejandro José Casanova-Rosado**  
**ACDEF 2 Carlo Eduardo Medina-Solís**  
**ADE 1 Juan Fernando Casanova-Rosado**  
**ADE 1 Ana Alicia Vallejos-Sánchez**  
**ADE 1 Mirna Minaya-Sánchez**  
**ADE 2 Martha Mendoza-Rodríguez**  
**ADE 2 Sonia Márquez-Rodríguez**  
**ADEF 3,4 Gerardo Maupomé**

1 School of Dentistry, Autonomous University of Campeche, Campeche, Campeche, Mexico  
2 Academic Area of Dentistry, Health Sciences Institute, Autonomous University of State of Hidalgo, Pachuca, Hidalgo, Mexico  
3 Indiana University/Purdue University at Indianapolis School of Dentistry, Indianapolis, IN, U.S.A.  
4 Regenstrief Institute, Inc. Indianapolis, IN, U.S.A.

**Corresponding Author:** Carlo Eduardo Medina Solís, e-mail: [cemedinas@yahoo.com](mailto:cemedinas@yahoo.com)

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**Background:** Tooth brushing (with fluoridated toothpaste) is the most cost-effective intervention in dentistry and it is widely recommended to preserve good oral health. We aimed to determine the frequency of tooth brushing and the variables associated with this practice in schoolchildren living in southeast Mexico.

**Material/Methods:** A cross-sectional study was carried out in 1644 schoolchildren, 6 to 13 years old. Questionnaires with socio-demographic, socioeconomic, and dental variables were administered to mothers/guardians of children. The dependent variable was the frequency of tooth brushing, which was categorized as 0 = tooth brushing less than once a day and 1 = tooth brushing at least once a day. A logistic regression model was used to evaluate the final results.

**Results:** Mean age was 9.06±2.02 years and 49.1% were girls. The prevalence of tooth brushing at least once a day was 49.8%. In the multivariate model, characteristics related to tooth brushing frequency ( $p<0.05$ ) were: older age (OR=1.11), being female (OR=1.64), having a larger family (OR=0.87), having had a visit to a dentist during the year preceding the study (OR=1.37), and having had fluoride applications by a professional (OR=1.39).

**Conclusions:** The results suggested that different variables (demographic, socioeconomic and dental) are associated with the frequency of tooth brushing. Family size (proxy variable for socioeconomic status) may indicate certain oral health inequalities in this population.

**MeSH Keywords:** Oral Health • Tooth Brushing • Oral Hygiene Practices • Schoolchildren • Mexico

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## Background

Prevention is considered the cornerstone of modern dental practice; effective control of dental plaque is usually proposed as the key element of preventive dentistry for prevention of oral diseases. Intraoral cleaning devices have been part of human civilization and have been used in oral hygiene practices for a long time [1]. Since dental caries is a disease in which a cariogenic biofilm leads to dental tissue demineralization [2] and periodontal diseases are a group of chronic conditions associated with specific pathogenic bacteria that colonize subgingival tissues [3,4], both share common characteristics as they depend on a dental biofilm and an ecological disruption [5]. Although being theoretically preventable through hygiene habits that modify the mouth environment by mechanically removing dental plaque, both are still major oral diseases in Mexico [6–11]. Preventive activities, early diagnosis, and therapeutic treatment are the means available for management [12]. With regard to preventive activities, tooth brushing (with fluoridated toothpaste) is the most cost-effective intervention in dentistry and it is widely recommended to preserve good oral health [13]. This behavior should be instituted at an early age, as it removes and mechanically disorganizes the dental biofilm, limiting its ability to cause diseases [14–16].

Studies have shown that proper tooth brushing improves hygiene levels [17] and significantly reduces dental caries in preschool and school children [18,19]. Studies on tooth brushing have been focused primarily on their effectiveness to remove plaque, either with manual or electric toothbrushes, or with some kind of modification [20,21]; other studies have focused on its role as an independent variable in oral disease [6,12,18,19,22]. However, few studies have explored the patterns of tooth brushing and even fewer looked into factors modifying this behavior. In terms of prevalence of tooth brushing behavior, studies report 40% and 44.4% in China [23,24], 36% in Burkina Faso [25], and 31% in Jordan [26]. Other countries report higher prevalence, with figures between 51.6% and 99.4% [27–33]. Data published for industrialized countries, including European countries, USA, and Canada, vary between 16–80% in boys and 26–89% in girls [12,34,35], to 47% in socially disadvantaged groups in New Zealand [36]. In Mexico, some differences have been observed in the prevalence reported among preschool and school age children, ranging from 56% to 81% [37–40]. A wide variability in prevalence can be found in both less developed and in developed countries.

From the perspective of social epidemiology – the field of study that attempts to understand the social determinants of health and the dynamics between societal settings and health – considerable evidence has been generated that socioeconomic circumstances, living and working conditions, and social and psychological factors are strong influences on well-being and

health across the lifespan [41]. It is crucial to identify and assess those factors that determine tooth brushing patterns to effectively promote oral health [14]. There is some data about factors such as girls brushing their teeth more than boys [27,34,35,37–39]; among school-age children, the oldest children brushing more frequently than the younger [27,37]; those people who use dental services have higher frequency of tooth brushing [27,37,39]; certain parental characteristics modifying tooth brushing [37–39]; and economic status variables (regardless of the indicator used) are positively associated with more frequent tooth brushing [27,37,39].

To delineate more specifically the profiles of tooth brushing in sparsely investigated high-risk populations, the objective of the present study was to determine the frequency of tooth brushing and the variables associated with this practice among schoolchildren living in southeast Mexico.

## Material and Methods

This work is a part of a larger project that measured various indicators related to the oral health of schoolchildren in Campeche, Mexico. Some methodological aspects and findings have been published previously about the use of dental services, dental caries, and associated factors in both dentitions, loss of permanent first molars, comparison of indicators of socioeconomic inequality and dental caries, combination of oral hygiene indicators and associated factors, and developmental enamel defects in permanent teeth and primary teeth, and dental fluorosis [42–46].

### Population, sample and study design

We performed a cross-sectional study in children attending 7 public elementary schools. The mothers of the children were contacted and were informed in a letter about the design and oral examination proposed for their children; if they accepted to have their children being part of the study, a signed letter of informed consent was requested. Schoolchildren who met the inclusion and exclusion criteria were selected. Children were excluded from the study for any of the following reasons: a) they were younger than 6 years old or over 13 years old, b) they had any kind of systemic disease that would compromise oral function or health, c) children refusing to undergo the oral examination, and d) children who had fixed orthodontic appliances. A total of 1644 individuals were included in the final sample.

### Data collection, variables of the study, and conformation of indicators

Using a questionnaire administered to the mothers, a series of variables were collected, including socio-demographic variables,

socioeconomic status, and oral health behaviors. The dependent variable was tooth brushing frequency, which was categorized as 0 = tooth brushing less than once a day and 1 = tooth brushing at least once a day. The independent variables included were gender, age, family size, any dental care of the child in the 12 months preceding the survey, at least 1 topical fluoride application by a professional in the past year, and schooling and occupation of both parents.

Schooling and occupation of both parents were the variables constructed and validated specifically for the environment in which the research was carried out; once these variables were created, children were assigned to a socio-economic position group (SEP). To create these indicators, the methodology of principal components analysis (polychoric correlation) was used [47] because it allows incorporating categorical variables. Two indicators were generated, one for parental schooling (SEP1) and another for parental occupation (SEP2). With the generated variables, 70.9% and 56.8% of the variability was explained, respectively. Tertiles were calculated for the generated variables: the first group was the one with poorest socio-economic status and the third group represented the highest socio-economic status.

### Statistical analysis

Baseline characteristics of the study subjects were expressed as frequencies and percentages for categorical variables, and as means  $\pm$  standard deviations for numeric variables (Table 1). According to the scale of measurement of the variables to be tested in the bivariate analysis, Mann-Whitney and chi-square test were used. Finally, we fitted a multivariate binary logistic regression model to estimate the strength of association between tooth brushing frequency and the independent variables, which is expressed as odds ratios with 95% confidence intervals (95% CI), as well as reporting the p values that were considered statistically significant (p-value  $<0.05$ ). To control for confounding, the final model included those variables that had a p-value  $<0.25$  in the bivariate analysis. We performed a variance inflation factor analysis (VIF) to detect and prevent multicollinearity between independent variables. The specification error test (link test) was used to test the assumption that the *logit* of the response variable is a linear combination of the independent variables. Confidence intervals were calculated with robust standard errors. Since data were from children attending elementary schools that shared common characteristics (*cluster*), we assumed that observations within these clusters would be correlated and observations between clusters would not. The model was fitted with the Hosmer-Lemeshow goodness-of-fit test, using a cutoff of  $p < 0.10$  considered an appropriate adjustment [48]. The analysis was performed using STATA 9.0 statistical software.

**Table 1.** Socio-demographic, socioeconomic and dental characteristics of schoolchildren included.

Variable	Mean $\pm$ SD	
Age (years)	9.06 $\pm$ 2.02	
Father's schooling (years)	7.00 $\pm$ 4.10	
Mother's schooling (years)	6.46 $\pm$ 3.67	
Number of children in the family	3.65 $\pm$ 1.83	
	n (%)	
Sex		
Men	836	(50.9)
Women	808	(49.1)
Use of dental care (preceding 12 months)		
Not in the last year	884	(53.8)
Yes, at least once	760	(46.2)
Application of topical fluoride (preceding 12 months)		
Not in the last year	1455	(88.5)
Yes, at least once	189	(11.5)
Socio-economic position (schooling)		
1 <sup>st</sup> tertile (lowest)	549	(33.4)
2 <sup>nd</sup> tertile	560	(34.1)
3 <sup>rd</sup> tertile (highest)	535	(32.5)
Socio-economic position (occupation)		
1 <sup>st</sup> tertile (lowest)	679	(41.3)
2 <sup>nd</sup> tertile	428	(26.0)
3 <sup>rd</sup> tertile (highest)	537	(32.7)
Tooth brushing		
Less than once a day	826	(50.2)
At least once a day	818	(49.8)

### Ethics statement

This study complied with the stipulations to protect research participants and with the ethics regulations in place at the Autonomous University of Campeche, Mexico, and the principles of the Declaration of Helsinki. Informed consent was obtained from the mothers/guardians of the participants in the study and data were analyzed anonymously.

## Results

### Descriptive results

The study sample consisted of 1644 schoolchildren 6–13 years of age, with an average age of 9.06 $\pm$ 2.02 years (mean age 9.15 $\pm$ 2.09 for boys and 8.96 $\pm$ 1.94 for girls). The father's education was higher than the mother's education ( $p < 0.0001$ ).

**Table 2.** Bivariate analyses between brushing frequency (categorized as occasionally/never vs. at least once a day) and the independent variables included.

Variable	Occasionally/never	At least once a day	p value
Age (years)	8.91±2.00	9.20±2.03	0.0035*
Father's schooling (years)	6.43±3.59	6.49±3.75	0.9649*
Mother's schooling (years)	6.85±4.07	7.13±4.11	0.1252*
Number of children in the family	3.83±1.93	3.45±1.69	<0.0001*
	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>
Sex			
Men	468 (56.0)	368 (44.0)	<0.001**
Women	358 (44.3)	450 (55.7)	
Use of dental care			
Not in the last year	489 (55.3)	395 (44.7)	<0.001**
Yes, at least once	337 (44.3)	423 (55.7)	
Application of topical fluoride			
Not in the last year	751 (51.6)	704 (48.4)	0.002**
Yes, at least once	75 (39.7)	114 (60.3)	
Socio-economic position (schooling)			
1 <sup>st</sup> tertile	283 (51.5)	266 (48.5)	0.565**
2 <sup>nd</sup> tertile	284 (50.7)	276 (49.3)	
3 <sup>rd</sup> tertile	259 (48.4)	276 (51.6)	
Socio-economic position (occupation)			
1 <sup>st</sup> tertile	333 (49.0)	346 (51.0)	0.652**
2 <sup>nd</sup> tertile	222 (51.9)	206 (48.1)	
3 <sup>rd</sup> tertile	271 (50.5)	266 (49.5)	

\* Mann-Whitney; \*\* Chi square.

The average number of children per family was 3.65±1.83. The use of dental services in the preceding year was 46.2%. As reported by the mother, only 11.5% of children received topical application of fluoride by a professional in the past year. SEP variables (occupation and schooling of both parents) were divided into tertiles (Table 1). Prevalence of tooth brushing at least once a day was 49.8%.

### Bivariate results

Table 2 shows the results of the bivariate analysis. Mean age was older among those who brushed more frequently ( $p < 0.01$ ). No differences were observed in the schooling level of the father or the mother ( $p > 0.05$ ) between groups with higher and lower frequency of tooth brushing. Families with more members brushed less frequently ( $p < 0.0001$ ). Girls brushed more frequently than boys (55.7% vs. 44.0%,  $p < 0.001$ ). Children who had visited the dentist in the last year before the study brushed more often (55.7%) than those who did not (44.7%) ( $p < 0.001$ ). We observed more tooth brushing among those who had had a professional fluoride application in the preceding 12 months than in those who had not (60.3% vs. 48.4%,  $p < 0.01$ ).

No differences in the frequency of tooth brushing across SEP levels were observed.

### Results of the multivariate model

The logistic regression model is shown in Table 3, which presented an adequate fit (goodness of fit: Hosmer & Lemeshow  $\chi^2(8) = 9.29$ ,  $p = 0.3181$ ).

Features associated with tooth brushing frequency (at least once a day) were older age (OR=1.11, 95% CI=1.04–1.18): for each year of increasing age the likelihood of tooth brushing at least once a day increased 11%. The odds for tooth brushing at least once a day for girls were 64% higher than the odds for boys. In families with more members, the likelihood to brushing at least once a day decreased (OR=0.87, 95% CI=.83 to .92). Among children who had had a dental visit in the year preceding the study, the likelihood of tooth brushing at least once a day increased by 37% compared with those who had not had a dental visit. Finally, if subjects had received at least 1 fluoride application by a professional in the preceding 12 months, the odds of tooth brushing at least once a day increased by 39%.

**Table 3.** Results of the multivariate logistic regression analysis for tooth brushing frequency in Mexican schoolchildren.

Variable	OR (95% CI)	p value
Age	1.11 (1.04–1.18)	0.002
Sex		
Men	1*	<0.001
Women	1.64 (1.26–2.14)	
Number of children in the family	0.87 (0.83–0.92)	<0.001
Use of dental care		
Not in the last year	1*	<0.001
Yes, at least once	1.37 (1.17–1.62)	
Application of topical fluoride		
Not in the last year	1*	0.038
Yes, at least once	1.39 (1.02–1.90)	

\* Reference category.

Adjusted odds ratios for the variables in the table plus father's schooling. Confidence intervals were calculated with robust standard errors (adjusted for school clustering).

Goodness of fit: Hosmer & Lemeshow  $\chi^2$  (8)=9.29, p=0.3181.

Specification Error: estimator =0.000; estimator<sup>2</sup> =0.921.

## Discussion

This study characterized the frequency of tooth brushing in a sample of Mexican schoolchildren, together with the variables associated with this practice, from an epidemiological point of view. Tooth brushing is considered the most accepted mechanical self-care maneuver for effective oral hygiene. In terms of prevalence, we observed a rate of 49.8%, which is comparable with other studies around the world. This figure is higher than that reported in Jordan by Rajab et al., which was 31% [26], or similarly reported in China by Peng et al. [23] and Zhu et al. [24], which was about 44%, or the 36% observed in Burkina Faso by Varenne et al. [25]. Other countries reported percentages above ours, as in Nicaragua, which was 51.6% [27], 52.1% in Nigeria [31], 64% in Poland [28], 69% in Jordan [29], 72% in Spain [12], 88% in Thailand [30], close to 100% in Brazil [33], or in Sweden, where data have varied between 84% and 94% in several age groups [32]. Similarly, for various European countries, the USA, and Canada, reports ranged between 16–80% in boys and 26%–89% in girls [34,35], or 47% in socially disadvantaged groups in New Zealand [36]. In Mexico, Villalobos et al. [39] observed a 56.3% prevalence of daily tooth brushing in schoolchildren from northwest Mexico, while in southeast Mexico community figures vary from 72% [40] to 82% [37,38] – percentages far higher than that observed in the present study. These variations in the frequency of daily tooth brushing around the world and even within Mexico may be due to some methodological differences between studies; for example: a) the age ranges included, b) the way daily frequency was measured (1, 2, or 3 times/day),

and even c) socio-economic conditions between countries and within the same country.

The results of this study supported the findings observed in different parts of the world with regard to girls brushing their teeth more often than boys (or at least they report doing so) [27,34–39]. In this sense each culture has its own set of health beliefs – a collection of perceptions and ideas about what health is and what disease is that jointly support health-related behaviors. Thus, from a cultural point of view, it is possible that girls receive different messages from parents/guardians in terms of oral health concerns than boys. The understanding of the belief systems related to health matters in each culture is crucial for developing culturally sensible health promotion programs [49].

With regard to the age of the subjects included in the present study, other studies that considered the same age group also observed that the tooth brushing frequency was higher in older children [27,37]. This may be due to the psychomotor development of the subject, although the age at which children can manage their own tooth brushing is hard to accurately define. It has been suggested that the age at which parents should let their children brush their teeth on their own is 7–8 years [50]. Other authors have mentioned that any tooth brushing program must take into account not only the needs presented but also the age of the targeted subjects. Because brushing must be monitored in younger children, some children may not understand the importance of brushing every day for maintenance of oral health [51].

Tooth brushing seems to be a very complex behavior determined by a variety of factors. There is evidence to suggest that people not only brush their teeth due to reasons related to dental health, but this habit can be influenced by social and economic factors as well as cultural and living conditions [52]. In the present study we used the variable of family size as an indicator of socioeconomic status, which is associated with tooth brushing frequency. This is consistent with the findings of Herrera et al. in Nicaragua [27]. Similarly, other studies have associated the socio-economic position with various oral health indicators [53–55]. This is a methodological development insofar as the ‘family size’ variable has been sparsely utilized in prior oral health research studies. This variable has been considered by other researchers as an economic variable, as it leads to what they call “competitive needs at home” – more persons at home is related to greater competition for resources between them. Its value as a metric of socio-economic disadvantage must be accurately characterized in future research.

Other economic indicators have shown oral health inequalities moderating oral health indicators, in that people of

higher socioeconomic status brush their teeth more frequently [27,37,39]. Along the same lines of socio-economic considerations in the present study, we found that use of dental services and/or application of topical fluoride by a professional in the preceding 12 months were positively associated with frequency of tooth brushing. Such trends have been observed by other authors in Mexico [37,39] and elsewhere in the world [27]. Some authors mentioned that this link is due to the strengthening of the brushing habit reinforced during dental visits. We did not accurately establish the reasons for brushing patterns in the present study: the reasons for tooth brushing vary between cultures and may also reflect differences in the level of oral health care in a particular society. While it is one of the most effective ways of self-administering fluoride [55], the importance of tooth brushing also resides in being an efficacious preventive tool for dental public health problems worldwide: dental caries, periodontal disease, and tooth loss, all of which have effects on various aspects of life [56,57]. In addition to the professional preventive care performed by dentist or dental hygienist, the individual oral hygiene conducted at home is also of great importance. The individual daily oral hygiene necessitates the mechanical removal of the bacterial biofilm by tooth brushing [58].

There are certain methodological limitations in this study strategy that must be considered to place the value of the findings in an objective perspective. Although the opinion of the parents (especially the mother) is considered a valuable tool

for assessing children's oral conditions, it is necessary to note that all self-reported data are susceptible to a socially desirable behavior bias, in which the subjects reports what they believe to be socially acceptable. Another limitation is inherent to cross-sectional studies' designs, which measure the cause and effect at the same time, thus the relationships described are not necessarily causal.

## Conclusions

Self-reported tooth brushing was low compared to other Mexican studies. The results suggest that different variables (socio-demographic, socioeconomic, and dental) may influence the frequency of tooth brushing. Furthermore, family size (a proxy for socioeconomic status) may indicate certain oral health inequities in this population, which can influence oral self-care behaviors in populations of Mexican origin. Whether these trends have an impact on behavioral patterns in other populations of Mexican origin (in particular in the United States, of importance because of the large number of Mexican-born immigrants there), it is something that must be determined by future studies addressing patterns of socio-cultural behaviors in this specific group.

## Conflicts of interest

None.

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