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Gender differences in tooth loss among Chilean adolescents: Socio-economic and behavioral correlates

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Abstract

Objective. To investigate gender differences in tooth loss among Chilean adolescents and its association with selected socio-economic indicators and oral-health-related behaviors. ***Material and methods***. Data on 9,163 Chilean adolescents obtained using multistage random cluster procedures. Clinical recordings included information on missing teeth and the participants provided information on socio-demographic factors and oral-related behaviors. Two eruption-time-adjusted logistic regression analyses were used to investigate the associations between gender, tooth loss and socio-economic position/oral-health-related behaviors. ***Results***. The association between gender and tooth loss remained after adjusting for age, eruption times in both the socio-economic position regression model and the oral-health-related behaviors model. Tooth loss followed social gradients for the variables paternal income and achieved parental education, with students reporting a paternal income $<$\$100,000 (OR = 2.0), and having a father (OR = 1.8) and a mother (OR = 2.0) who achieved only primary school education being more likely to experience tooth loss. The adjusted regression model for behavioral indicators revealed that students who reported brushing their teeth once a day (OR = 1.6) were more likely to have experienced tooth loss than those who reported more frequent toothbrushing. Students who visited a dentist rarely (OR = 0.8) or never (OR = 0.5) were less likely to have lost first molars and/or incisors. ***Conclusions***. The results demonstrate that gender differences in tooth loss among young Chileans are related to socio-economic position; and selected oral-health-related behaviors after adjusting for eruption time variation.

Key Words: *Adolescence, gender, health behavior, socio-economic factors, tooth loss*

Introduction

The consequences of early loss of permanent teeth have not been investigated, but a current line of thinking suggests that early tooth loss is particularly important because it can favor more receptive attitudes towards tooth extraction and promote an accelerated pattern of tooth loss in adulthood [1]. Although many reports contain data on tooth loss among the young [2] and isolated studies have been conducted of the distribution of tooth loss in adolescent populations [3], the causes of early tooth loss are not well understood. The events leading to extractions in adolescence are complex and involve factors in addition to the presence of dental disease [3–13].

The most consistent findings of studies addressing the issue suggest that subjects from lower socio-economic (SEC) strata [11,13] and girls [3–6,13,14] experience earlier tooth loss than do persons from higher SEC strata and boys. Earlier tooth eruption among girls implies longer exposure of teeth to disease and to extraction [5], just as gender-associated oral-health-behavior differences other than oral hygiene practices (e.g. dental attendance) [15] may have influenced the results of those studies. Using data generated in a cross-sectional study on periodontal conditions in a large group of randomly selected Chilean adolescents, we confirmed the gender differences previously reported and speculated to what extent the predominance of tooth loss among the girls might be confounded by differences in the eruption times; oral-health-related behaviors; and socio-economic position of the subjects.

The aim of this analysis was to explore how gender differences in tooth loss among adolescents relate to selected socio-economic indicators and oral-health-related behaviors.

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Material and methods

The data used originated from a cross-sectional study of periodontal diseases conducted among Chilean high school students [16,17]. Briefly, the target population was sampled using a multistage random cluster procedure resulting in a study group of 9,203 students aged 12–21 years, distributed in 310 classes from 98 high schools of the Province of Santiago. Details on the sampling methods can be found in a previous publication [16]. All 9,203 students were invited to participate and they all accepted filling out a questionnaire on oral-health-related behaviors and a questionnaire that included the questions: How often do you brush your teeth? (More than once a day/once a day/less than once a day); When was the last time you visited a dentist? (Less than 6 months ago/between 6 and 12 months ago/more than a year ago); Do you smoke? (No/yes, sometimes/yes, daily); and if you smoke daily, how many cigarettes do you smoke? [16]. Only 40 students refused to participate in the clinical examinations, and 9,163 students were therefore included in the analyses. The clinical data used for the present analysis are based on data on the presence (yes/no) of the 1st and 2nd molars; and all incisors, i.e. a partial recording involving 16 teeth in total.

All students who participated in the clinical examination also filled out an additional questionnaire on their socio-economic position. The information collected included: Household size (number of subjects living in the same residence); housing status (owned and paid; owned paying for; rented; living in others' residence; living in a borrowed residence); number of cars owned by the family (none; 1 car; 2 cars; 3 or more cars); monthly paternal, maternal and other sources of the monthly family income in thousands of Chilean pesos (no income; <$100; $100–299; $300–499; $500–999; and ≥$1.000); and the level of paternal and maternal education attained (no education; incomplete primary school; primary school completed; incomplete high school; high school completed; incomplete technical education; technical education completed; incomplete university education; university education completed).

For data analysis the variables were re-categorized as follows: For housing status the categories 'Living with others' and 'borrowed residence' were collapsed into 'other'; for parental income the categories '$500,000–999.000' and '≥$1.000.000' were collapsed into ≥$500.000; for parental education the categories 'No education; incomplete primary school; 'primary school completed', and 'incomplete high school' were collapsed into 'Up to primary school completed'. The categories 'high school completed', 'technical incomplete', and 'university incomplete' were collapsed into 'High school completed'. The categories 'Technical education completed' and 'University education completed' were collapsed into 'Technical/university completed', respectively.

Logistic regression analyses

Two age and eruption time adjusted logistic regression models were built in. One assessed whether the socio-economic variables investigated were associated with having lost teeth (Table III); the other whether the selected oral-health-behavior-related variables 'toothbrushing frequency', 'time since last visit to dentist', and 'cumulative number of packs of cigarettes smoked' were associated with having experienced tooth loss (Table IV).

Using the dates of birth and the function 'mdy' in Stata version 9.0 [18], the chronologic age of the participating subjects at the time of examination was calculated. In order to adjust for the longer exposure among the girls due to earlier eruption times, the age of girls was adjusted (increased) by 0.2 years, corresponding to the average difference between girls and boys in the mean eruption of first molars [19–22].

Second molars were excluded from the regression analyses because the pattern of missing teeth found in this study [16] suggests that missing 2nd molars may reflect eruption delay rather than real tooth loss among the younger participants.

The association between tooth loss and each of the eight social and three behavioral variables was investigated using age and eruption-time-adjusted bivariable logistic regression analyses to select relevant variables for multivariable logistic regression models [23]. Variables for which the association was statistically significant at a p-value <0.25 were selected to be included as covariates in the age and eruption time multivariable logistic regression analyses. The option 'robust cluster' for the procedure 'logit' in Stata [18] was used to account for the clustering of subjects in school classes. Model-building used forced entry of variables followed by consecutive exclusion of non-significant variables using the likelihood ratio test as described by Hosmer & Lemeshow [23]. Once the final model was built, the variables that had been excluded after the bivariable analysis were added back into the model, one at a time, and the analyses repeated to identify variables that may add to the model in the presence of other variables. Non-significant variables were retained in the model as confounders if their removal would result in a change of the estimates by more than 15%. Once the best-fitting and most parsimonious model was identified, the possibility of interaction between gender and socio-economic and behavioral indicators remaining in the model was evaluated as described by Hosmer & Lemeshow [23].

Results

Girls were more likely to have lost teeth and had lost more teeth than had boys and this applied whether 2nd molars were included or not (Table I). About 18% of the girls had lost 1st, 2nd molars or incisors while this applied only to 14.7% of the boys (Table I). The response rates for the different indicators of socio-economic position and for the selected behavioral indicators ranged from 82.8% for the variable 'other sources of the family income' to 100% for the three behavioral indicators (Table II).

Students in lower socio-economic position categories and those smoking more packs of cigarettes had lost teeth more often than students in higher socio-economic positions and those reporting less smoking. Socio-economic gradients were evident for the variables 'household size'; 'number of cars owned by the family'; 'income of the father'; 'income of the mother'; 'education of the father'; and 'education of the mother' (Table II).

Logistic regression analyses

The multivariable logistic regression analyses confirmed that even when the differences between boys and girls in the timing of eruption were adjusted, girls were more likely to have had experienced tooth loss than had boys (Tables III and IV). The regression analyses confirmed the social gradients for the variables paternal income and achieved parental education. Hence, students reporting a paternal income $<$\$100,000 (OR = 2.0), or who had a father (OR = 1.8) or a mother (OR = 2.0) with no more than primary school education, were more likely to have experienced tooth loss than those reporting a parental income $\geq$\$500,000 and parental achieved technical or university education (Table III). Owing to collinearity between the variables, it was impossible to assess the occurrence of interactions between gender and the indicators of socio-economic position. Therefore, two independent models were built, one for boys and one for girls. However, the resulting models were not significantly different and we decided therefore to report the original final model without attempting to introduce interaction terms.

The adjusted regression model for behavioral indicators demonstrated that students who reported brushing their teeth once a day (OR = 1.6) were more likely to have experienced tooth loss than those who reported more frequent tooth-brushing. Those who visited a dentist rarely (OR = 0.8) or never (OR = 0.5) were less likely to have lost molars and/or incisors (Table IV).

Discussion

The findings of this study demonstrate the existence of strong social gradients in the prevalence of tooth loss early in life and confirm the tendency for girls to be more likely to have lost permanent teeth. It is well known that apart from being a result of disease, tooth loss among adults also reflects access to dental care [24], dental treatment philosophies [25] and patients and dentist attitudes [5,26–28]. Plausible explanations for the socio-economic gradients therefore include a higher risk of caries among the disadvantaged [29]; social differences in access to health care [13,30]; and differences in the relation between dentists and patients depending on the socio-economic position of the patients [28]. The socio-economic inequalities in health-care access and tooth loss outcome can operate in opposite directions [5,7,31] because cost-sharing may be an influential factor for tooth extraction [32] given the same extent and severity of disease [31]. In some populations, deprived people may retain more teeth than the less deprived because it is simply impossible for them to access any kind of dental treatment including extractions [7]; while in other populations individuals from low socio-economic position may be able to afford basic dental treatment, which actually places them at higher risk of receiving tooth extractions. The latter is likely to be the case for this young Chilean population because the dental public

Table I. Distribution of girls and boys according to the number of missing teeth in the study population (n = 9,163)

No. of teeth missing	All teeth				Excluding 2nd molars			
	Girls		Boys		Girls		Boys	
	n (4,510)	%	n (4,653)	%	n (4,510)	%	n (4,653)	%
0	3,692	81.9	3,971	85.3	3,906	86.6	4,187	90.0
1	513	11.4	434	9.3	430	9.5	337	7.2
2	233	5.2	173	3.7	146	3.2	108	2.3
3	49	1.1	43	0.9	23	0.5	15	0.3
4	22	0.5	27	0.6	5	0.1	6	0.1
5	0	–	4	0.1	0	–	0	–
6	1	0	0	0	0	–	0	–
8	0	–	1	0	0	–	0	–

– Not determined due to no cases.

Table II. Prevalence of loss of permanent 1st molars and incisors according to the demographic and socio-economic characteristics of the study population ($n = 9{,}163$)

Determinant (distribution in population) Overall% in population (100%)	%	95% CI
Age (years)		
12–14 (22.5%)	8.9	[7.8;10.2]
15–17 (69.5%)	11.5	[10.7;12.3]
18–21 (8.0%)	21.1	[18.3;24.2]
Gender		
Boys (50.8%)	10.0	[9.2;10.9]
Girls (49.2%)	13.4	[12.4;14.4]
Smoking packs		
0 (75.4%)	11.0	[10.3;11.8]
1–250 (13.3%)	12.7	[10.9;14.7]
251–500 (6.1%)	14.2	[11.6;17.4]
More than 500 (5.2%)	15.7	[12.7;19.2]
Toothbrushing		
More than once a day (70.7%)	10.9	[10.1;11.7]
Once a day (25.6%)	14.1	[12.7;15.5]
Less than once a day (3.7%)	10.8	[7.9;14.5]
Last visit to a dentist		
Less than 6 months ago (33.3%)	12.9	[11.7;14.1]
6–12 months ago (19.6%)	12.8	[11.3;14.4]
More than a year ago (39.8%)	11.0	[10.0;12.0]
Never seen a dentist (7.3%)	7.0	[5.3;9.2]
Household size		
1–3 persons (14.6%)	10.5	[9.0;12.3]
4–6 persons (68.2%)	11.0	[10.3;11.8]
7 or more persons (15.7%)	15.1	[13.4;17.1]
Not answered (1.5%)	16.3	[11.0;23.4]
Type of housing		
Owned, paid (47.6%)	11.3	[10.4;12.3]
Owned, paying (26.8%)	11.2	[10.0;12.5]
Rented (15.9%)	11.9	[10.4;13.4]
Other (8.9%)	14.7	[12.4;17.3]
Not answered (0.8%)	10.8	[5.6;19.9]
No. of cars owned		
2 or more cars (21.2%)	7.0	[6.0;8.3]
1 car (35.0%)	9.8	[8.8;10.9]
No car (39.0%)	15.7	[14.5;16.9]
Not answered (4.8%)	13.5	[10.6;17.4]

health-care system ensures everybody access to free emergency dental treatment including extractions while access to conservative restorative procedures is more difficult [33].

Little is known about how socio-economic position may affect the patient–dentist relationship, but the results of some studies suggest that the type of dental service provided is associated with patients socio-economic position [11,28,34]. Cangussu et al. [11], studying Brazilian adolescents, found that with the same level of caries and access to health care, adolescents from lower socio-economic position were more likely to receive extractions instead of dental fillings [11]. In a large study on service provision patterns in Australia Brennan et al. [34] found that after controlling for the main dental diagnosis, insured patients were more likely to receive preventive, endodontic and crown and bridge services and less likely to receive extractions than the uninsured. Correspondingly, check-ups were associated with higher odds for diagnostic, preventive and crown and bridge services and lower odds for extractions when compared to dental emergency visits [34]. This may occur because dentists offer different treatment options to people of lower socio-economic position and/or because subjects from lower socio-economic position are more likely to accept extractions as a solution to the problem [9,11]. Similarly, a significant role of the dentist's beliefs in the treatment decision-making process has been reported [28,35] with considerable variation in dental service rates being attributable to the dentist's practice beliefs.

The non-significance of smoking habits in the age and eruption time adjusted behavioral regression model in this study may appear surprising considering recent reports suggesting an association between tooth loss and smoking habits among young adults

Table II (*Continued*)

Determinant (distribution in population) Overall% in population (100%)	%	95% CI
Income – father ($)		
≥$500,000 (24.7%)	5.3	[4.4;6.3]
$300–$499,000 (14.4%)	8.7	[7.3;10.3]
$100–$299,000 (33.7%)	14.3	[13.1;15.5]
<$100.000 (12.4%)	18.3	[16.2;20.7]
No income (6.3%)	13.4	[10.9;16.4]
Not answered (8.6%)	14.3	[12.0;16.9]
Income – mother ($)		
≥$500.000 (8.1%)	4.7	[3.4;6.5]
$300–$499,000 (8.5%)	8.3	[6.6;10.4]
$100–$299,000 (21.7%)	11.1	[9.8;12.5]
<$100,000 (17.1%)	15.4	[13.6;17.2]
No income (40.6%)	12.8	[11.7;13.9]
Not answered (4.0%)	9.9	[7.3;13.5]
Income – other sources ($)		
≥$500,000 (2.4%)	6.0	[3.5;10]
$300–$499,000 (3.4%)	10.3	[7.4;14.2]
$100–$299,000 (14.0%)	15.7	[13.8;17.8]
<$100,000 (12.4%)	14.6	[12.7;16.8]
No income (50.6%)	10.3	[9.4;11.2]
Not answered (17.2%)	11.5	[10.0;13.2]
Education – father		
Technical/university completed (30.5%)	5.5	[4.7;6.4]
High school completed (32.3%)	11.1	[10.1;12.3]
Primary school completed (32.5%)	17.5	[16.2;18.9]
Not answered (4.8%)	15.1	[12.1;18.8]
Education – mother		
Technical/university completed (26.7%)	5.5	[4.7;6.5]
High school completed (34.2%)	9.8	[8.8;10.9]
Primary school completed (37.8%)	17.9	[16.6;19.2]
Not answered (1.4%)	8.1	[4.4;14.2]

95% CI = 95% confidence intervals.
$ = Chilean pesos.

[36,37]. However, the potential deleterious role of smoking for tooth loss is likely to be countered by socio-economic factors, owing to smoking being inversely related to socio-economic position among these adolescents [38–42]. Hence, in this adolescent group smokers are more likely to hold a higher socio-economic position, as this is precisely what allows them to smoke.

The gender difference confirmed in the occurrence of tooth loss in this population is striking because girls usually have a lower [43–45] or similar [14,46–52] caries experience as boys do. Moreover, girls in the present as well as in other populations [15,45] are more likely to practice oral hygiene procedures more frequently than boys. The absence of gender differences in the caries prevalence and extent previously reported for this population [52] and the higher tooth retention among the boys after adjusting for age; eruption times; social and behavioral factors suggest the existence of additional gender-related factors affecting tooth loss. The list of plausible factors includes gender differences in attitudes towards health care other than those investigated in this study; and gender differences on oral health awareness [13,15,53–55].

Interestingly, a gradient was clear in the association between tooth loss and the date of the last visit to the dentist, such that subjects who attended a dentist long ago or had never done so were significantly more likely to retain their permanent teeth than were those who reported having visited a dentist less than 6 months previously. This observation concurs with previous findings among adults showing that subjects visiting the dentist regularly are more likely to retain fewer teeth than subjects with irregular attendance patterns [56,57]. Potential explanations for this finding may be that healthy subjects who do not need dental extractions are less likely to attend the dentist more frequently or that dental extractions are a relatively common reason for visiting the dentist in this population. However, interpretation of the finding is not straightforward, because in this study the date of the last dental visit was used as a proxy variable for frequency of dental visits and this may be influenced by aspects of dental

Table III. Age and eruption time adjusted logistic regression analysis of socio-economic determinants of tooth loss among adolescents

Determinant	Missing ≥1 tooth			
	Bivariable		Multivariable	
	OR	95% CI	OR	95% CI
Gender				
Boy (ref.)	1	–	1	–
Girl	1.4	[1.2;1.5]	1.2	[1.0;1.4]
Income – father				
≥$500,000 (ref.)	1	–	1	–
$300–$499,000	1.6	[1.2;2.3]	1.3	[1.0;1.7]
$100–$299,000	2.8	[2.2;3.6]	1.7	[1.4;2.2]
<$100,000	3.7	[2.9;4.7]	2.0	[1.5;2.6]
No income	2.3	[1.7;3.2]	1.5	[1.1;2.0]
Not answered	2.7	[2.1;3.5]	1.8	[1.3;2.5]
Education – father				
Techn/univ. complete (ref.)	1	–	1	–
High school completed	2.0	[1.5;2.6]	1.5	[1.2;1.9]
Up to primary completed	3.0	[2.3;3.8]	1.8	[1.3;2.3]
Not answered	2.7	[1.9;3.7]	1.8	[1.2;2.7]
Education – mother				
Techn/univ. complete (ref.)	1	–	1	–
High school completed	1.9	[1.3;2.5]	1.4	[1.1;1.8]
Up to primary completed	3.3	[2.5;4.3]	2.0	[1.6;2.5]
Not answered	1.7	[0.8;3.8]	0.9	[0.5;1.9]

95% CI = 95% confidence interval.

attendance patterns other than the frequency of dental visits.

Although the use of partial recordings in the clinical examinations could be seen as a drawback, we are also aware that the inclusion of premolars and 2nd molars in the analyses may just introduce a different problem owing to the fact that premolars are frequently extracted for orthodontic reasons [3,57] among subjects in the affluent section of Chilean society and because 2nd molars may not have erupted in many of the younger participants [16]. The use of self-reported socio-economic indicators might be seen as a limitation of this study, but these self-reports have been found to hold adequate validity in previous investigations among adolescents [58–60].

In conclusion, the findings of the present study indicate that gender differences in tooth loss among Chilean adolescents are shaped by socio-economic factors and compound culturally determined patient/dentist values and attitudes, as has also been suggested for tooth loss among adults [5,6,32,61]. The results also demonstrate the existence of significant social gradients in tooth loss among adolescents with paternal income and parental education appearing as the most influential socio-economic dimensions. It is thus noteworthy that such differences are present already in adolescence.

Table IV. Age and eruption time adjusted logistic regression analysis of behavioral determinants of tooth loss among adolescents

Determinant	Missing ≥1 tooth			
	Bivariable		Multivariable	
	OR	95% CI	OR	95% CI
Gender				
Boy (ref.)	1	–	1	–
Girl	1.4	[1.2;1.5]	1.5	[1.3;1.7]
Toothbrushing frequency				
More than once a day (ref.)	1	–	1	–
Once a day	1.4	[1.2;1.3]	1.6	[1.4;1.9]
Less than once a day	1.1	[0.8;1.6]	1.3	[0.9;2.0]
Last visit to a dentist				
Less than 6 months ago (ref.)	1	–	1	–
6–12 months ago	1.0	[0.8;1.2]	1.0	[0.8;1.2]
More than a year ago	0.8	[0.7;0.9]	0.8	[0.7;0.9]
Never	0.5	[0.4;0.7]	0.5	[0.3;0.6]

95% CI = 95% confidence interval.
Interactions between gender and toothbrushing frequency; and between gender and last visit to dentist were not significant.

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