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Association between sociodemographic factors and noncavitated and cavitated caries lesions in 8- to 12-year-old Mexican schoolchildren

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Abstract

The aim of this study was to evaluate the association between sociodemographic factors and noncavitated and cavitated caries lesions in Mexican schoolchildren.

This cross-sectional study was conducted in 2020 on 8-to-12-year-old schoolchildren of different socioeconomic status (SES). The caries was evaluated using ICDAS II, SES was evaluated using three categories—a high, middle, or low-income level—of the CONAPO. Multinomial logistic regression analyses were performed in order to ascertain the associations between socioeconomic factors and noncavitated and cavitated caries lesions.

The prevalence of noncavitated lesions was 38.0% and cavitated lesions was 43.4% in permanent dentition. In all the samples, 50.6% of schoolchildren had poor oral hygiene. About 52.5% of the mothers and 64.7% of the fathers had less than 9 years of education. Schoolchildren with a low-income level have more cavitated lesions (ICDAS II 4–6) than schoolchildren with high-income level (56.3% vs 15.8%, $P = .009$). The multinomial logistic regression models showed that mother's level of education <9 years and low-income level were significantly associated with cavitated caries lesions (ICDAS II 4–6), [odds ratio = 1.79 (1.17 – 2.75); $P = .007$], [OR = 2.21 (1.23 – 3.97); $P = .008$], respectively. The socioeconomic level was not associated with noncavitated caries lesions (ICDAS II 1–3).

An association was found between the presence of cavitated caries lesions and the subject's mother's level of education and a low-income level. Socioeconomic factors were found to be associated with inequalities in caries distribution in the age group studied.

Abbreviations: CI = 95% confidence interval, CONAPO = Consejo Nacional de Población (CONAPO or National Population Council), DMFT = Decayed, Missing and Filled, ICDAS II = International Caries Detection and Assessment System, INEGI = Instituto Nacional de Estadística y Geografía (INEGI, or the National Institute for Statistics and Geography), OHI-S = Simplified Oral Hygiene Index, OR = odds ratio, SES = Socioeconomic Status, SiC = Significant Caries Index.

Keywords: dental caries, mother's education, school children, socioeconomic factors

1. Introduction

Social inequalities in health are influenced by economic, political, and cultural factors, as well impact of aspects of health systems. Health inequalities are linked to social determinants and result from differences in living conditions, education, socioeconomic status (SES), employment, and social development.[1] These inequalities mark differences between social groups and geographic areas within a country and are reported using the following health indicators: life expectancy; tobacco and alcohol consumption; access to health services; mortality and morbidity; and, chronic diseases such as diabetes.[2,3]

Such inequalities affect not only general health but also oral health, and negatively impact the population. One of the oral diseases with the highest prevalence and incidence is dental caries,

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which affects approximately 60% to 90% of the school population and the vast majority of adults [4,5] and occurs in rural and urban populations in both developed and underdeveloped countries. [6,7] This multifactorial disease begins with a process of enamel demineralization and can progress into a cavitated lesion involving all the tissues of the tooth, culminating in its destruction. This process causes pain, discomfort when chewing, difficulty sleeping, and early tooth loss, which can have a negative impact on both children and adolescents' quality of life.[8,9]

For many years, various indices, such as the Decayed, Missing and Filled (DMFT) and the Significant Caries Index (SiC), have been used to evaluate the pattern of caries distribution in different population groups. One of the disadvantages of these indices is that they only include cavitated caries lesions, making it necessary to include noncavitated caries lesions in epidemiological studies in order to contribute to the planning of early interventions and preventive treatments.[10] This objective is served by the International Caries Detection and Assessment System (ICDAS II) index,[11] which considers the degree of progress of the lesion and identifies noncavitated and cavitated caries lesions.

To our knowledge, there is little information currently available that examines the link between socioeconomic factors and different ICDAS II categories in the permanent dentition of schoolchildren. The use of this index would enable a more detailed analysis of the association between socioeconomic factors and the distribution of noncavitated and cavitated caries lesions, which would be of great relevance to public health, improving the targeting of caries-prevention strategies for at-risk populations. Therefore, in light of the hypothesis that schoolchildren with a low SES will present more severe caries, the present study aimed to evaluate the association between sociodemographic factors and noncavitated and cavitated caries lesions in Mexican schoolchildren. Given that different risk factors have been reported to be associated with noncavitated and cavitated caries lesions in permanent teeth.

2. Materials and methods

2.1. Ethical approval

This cross-sectional study's research protocol was reviewed and approved by the Ethics Committee of the Faculty of Higher Studies Iztacala at the National Autonomous University of Mexico (CE/FESI/072020/1347). Both local authorities and the participants parents were informed of the study's objectives and the procedures to be undertaken during the research, with those parents who agreed for their children to participate signing the informed consent form, while the children were also asked to give their verbal consent to participate.

2.2. Sample

A cross-sectional study was performed in the municipality of Naucalpan de Juarez, in the state of Mexico, between January and March 2020. According to the *Instituto Nacional de Estadística y Geografía* (INEGI, or the National Institute for Statistics and Geography), the municipality has 833,779 inhabitants, with 119,976 children aged from 6 to 14 years, of whom 86.2% can read and write.[12] Three public schools were randomly selected from a list of 16 (public schools) in the municipality, with all those pupils aged between 8 and 12 invited to participate, private schools were not considered.

The sample size was designed to detect an odds ratio (OR) of 2.0, with 80% power, an alpha of 0.05, 95% level of confidence, 10% of expected data loss, and a probability of 0.30 for caries, based on the prevalence of caries found in schoolchildren.[13] The minimum sample size to satisfy these requirements was estimated to be 598, while a nonresponse rate of 10% was estimated, requiring a minimum of 658 participants. A total of 800 informed consent forms were distributed, of which 770 were signed by parents, corresponding to a nonresponse rate of 3.8%. On the basis of the exclusion criteria, 42 children were not included in the study, meaning that the data pertaining to 728 schoolchildren was analyzed. The inclusion criteria were as follows: children aged between 8 and 12 years; both genders; and, written authorization to participate in the study. The exclusion criteria were that the child had lived in a different residence for more than 6 months during the first 7 years of life or had an orthodontic appliance fitted.

2.3. Variables

The independent variables were as follows: age; sex; SES; toothbrushing frequency (number of times a day) dichotomized into < 2 or ≥ 2 times a day; use of fluoride toothpaste (yes/no); the Simplified Oral Hygiene Index (OHI-S) dichotomized into poor and good (OHI-S ≥ 2 and < 2, respectively); dental and medical visits < 6 months (yes/no); soft drink consumption (seldom/sometimes each week /> once per day); consumption of sweets (seldom/a few times per week/at least once per day); the employment status of the head of the family; and, the mother's and/or father's level of education. The variable of educational level was intended to compare those parents who had completed 9 years of formal education or more with those who had completed less than 9 years, which, in Mexico, corresponds to primary and secondary school combined. According to the *Consejo Nacional de Población* (CONAPO or National Population Council) definition of SES, a *high-income level* corresponds to the average purchasing power of families characterized by parents with well-paying jobs, high income levels, and high levels of education, and is a group comprising professionals, entrepreneurs, and business people. A *middle-income level* corresponds to the average purchasing power of families characterized by parents with well-paying jobs, middle-income levels, and medium levels of education. A *low-income level* corresponds to larger families characterized by parents receiving a low level of income from temporary jobs in construction and other informal sectors and who have little education.[14,15]

The dependent variable of noncavitated and cavitated caries lesions was assessed via ICDAS II grouped into three categories: ICDAS II = 0; ICDAS II 1–3; and ICDAS II 4–6, while a questionnaire was used to explore the sociodemographic variables of the present study's participants. The questionnaire was answered by the parents of the participants.

2.4. Clinical oral examination

Dental caries were evaluated in the participants permanent dentition via the application of the ICDAS II criteria, which include the identification of noncavitated lesions (white spots and microcavities on the enamel) and cavitated caries lesions, with the highest category corresponding to the destruction of more than half of the tooth surface. The ICDAS II index classifies caries with

a score ranging from 0 to 6, with higher values indicating an increase in the severity of the caries lesion.[11]

The clinical oral evaluations were conducted inside selected schools by two dentists using dental mirrors, a WHO probe, and artificial light, with regular toothbrushing undertaken before the procedure. Wet gauze pads and toothbrushes were used to remove the dental plaque present on the tooth surfaces. The first step in the evaluation of the facial surface involved the examination of the wet teeth to differentiate between ICDAS II scores of 1 and 2, with the teeth subsequently dried with compressed air for five seconds and then reexamined. This procedure was used because ICDAS II assesses both the first visual change observed in the enamel after prolonged air drying and the distinct visual changes observed in the enamel without air drying. The ICDAS II categories were registered if confirmed and grouped into three categories: ICDAS II = 0; ICDAS II 1–3; and, ICDAS II 4–6.

The examination of the participants oral cavity adhered to the corresponding infection control standards. Two examiners participated in a pre-study calibration exercise using the ICDAS II index; a sample of 30 participants was used for calibration, with intra and inter-examiner reliability assessed and a Cohen kappa coefficient of >0.88 calculated.

2.5. Statistical analysis

Comparisons were made for age, sex, SES, toothbrushing frequency, use of fluoride toothpaste, the Simplified Oral Hygiene Index (OHI-S), soft drink consumption, sweet consumption, the participant's parents' level of education, the employment status of the head of the family, and the dental visits undertaken by participants both with and without caries. The Pearson Xi-square test and the Kruskal–Wallis test were used for categorical and continuous variables, respectively, while the variables were not normally distributed.

A multinomial regression analysis was performed to analyze the association between all independent variables (age, sex, toothbrushing, oral hygiene, the participant's mother's level of education, the employment status of the head of the family, dental visits <6 months, and SES) and dental caries, with the association expressed as an OR with a 95% confidence interval (CI). The possible interactions between variables were also analyzed. The participants were categorized into 3 groups based on the following categories for their dental caries experience: null presence of caries (ICDAS II = 0); noncavitated lesions (ICDAS II = 1–3); and, cavitated lesions (ICDAS II 4–6). Values of $P \leq .05$ were considered statistically significant, with plausible interactions also explored. The analysis was performed using the Stata 15 program (Stata Corp, College Station, TX).

3. Results

3.1. Population characteristics

The mean age was 9.89 (±1.23) years, while the percentage of girls and boys examined was 51.0% (371) and 49.0% (357), respectively. The study revealed that 59.6% of the participants brushed their teeth once per day or less. According to the OHI-S evaluation, 50.6% of participants had poor oral hygiene, while the survey revealed that 95.0% used fluoride toothpaste daily. About 52.5% of the participant's mothers and 64.7% of their fathers had less than 9 years of education, with 55.0% of participants reporting to have not visited the dentist in the last 6 months.

3.2. Noncavitated and cavitated caries lesions (ICDAS II)

The prevalence of noncavitated and cavitated caries lesions in permanent dentition was 38.0% and 43.4%, respectively. No permanent tooth was recorded as lost and no significant difference was found for caries by sex ($P = .748$). The prevalence of caries (ICDAS II 4–6) was higher in participants with poor hygiene than in those with good hygiene (57.9% vs 42.1%, $P = .001$). Moreover, toothbrushing frequency, dental visits, and the consumption of sweets were associated with ICDAS II scores of 4 to 6. No association was found between the consumption of

Table 1

Associations between demographic and oral health determinants, and severity of caries by ICDAS (n = 728).

	ICDAS II = 0 n = 135	ICDAS II = 1–3 n = 277	ICDAS II = 4–6 n = 316	*P*
Age mean (Standard deviation)	9.57 (±1.20)	10.22 (±1.22)	9.75 (±1.19)	<.001
Sex				
Male	71 (52.6)	144 (52.0)	156 (49.4)	.748
Female	64 (47.4)	133 (48.0)	160 (50.6)	
Toothbrushing frequency				
< 2 times a day	65 (48.2)	167 (60.3)	202 (63.9)	.007
≥ 2 times a day	70 (51.8)	110 (39.7)	114 (36.1)	
Oral hygiene (OHI-S)				
Poor hygiene	54 (40.0)	131 (47.3)	183 (57.9)	.001
Good hygiene	81 (60.0)	146 (52.7)	133 (42.1)	
Dental visits <6 months				
No	61 (45.2)	146 (52.7)	187 (59.2)	.020
Yes	74 (54.8)	131 (47.3)	129 (40.8)	
Consumption of soft drink				
Seldom/Sometimes per week	60 (44.4)	105 (37.9)	140 (44.3)	.232
> Once per day	75 (55.6)	172 (62.1)	176 (55.7)	
Consumption of sweets				
Seldom/ Sometimes per week	75 (55.6)	111 (40.1)	125 (39.6)	.004
> Once per day	60 (44.4)	166 (59.9)	191 (60.4)	

Table 2

Associations between socioeconomic variables and caries level by ICDAS (n = 728).

	ICDAS II = 0 n = 135	ICDAS II = 1–3 n = 277	ICDAS II = 4–6 n = 316	*P*
Medical visits <6 months				
No	73 (54.1)	153 (55.2)	159 (50.3)	.466
Yes	62 (45.9)	124 (44.8)	157 (49.7)	
Mother's level of education				
≥ 9 yr	77 (57.0)	132 (47.6)	137 (43.3)	.029
< 9 yrs	58 (43.0)	145 (52.4)	179 (56.7)	
Father's level of education				
≥ 9 yrs	49 (36.3)	99 (35.7)	109 (34.5)	.918
< 9 yrs	86 (63.7)	178 (64.3)	207 (65.5)	
Father's employment status				
Employed	125 (92.6)	259 (93.5)	292 (92.4)	.867
Unemployed	10 (7.4)	18 (6.5)	24 (7.6)	
Socioeconomic level (SES)				
High-income	31 (23.0)	49 (17.7)	50 (15.8)	.009
Middle-income	53 (39.2)	94 (33.9)	88 (27.9)	
Low-income	51 (37.8)	134 (48.4)	178 (56.3)	

soft drinks and the severity of caries ($P = .232$). The results for the sample population are presented in Table 1.

Table 2 summarizes the relationship between socioeconomic variables and the distribution of noncavitated and cavitated caries lesions (ICDAS II). The prevalence of caries (ICDAS II 4–6) was higher in participants whose mother's level of education was <9 years than in those participants whose mother's level of education was ≥9 years (56.7% vs 43.3%, $P = .029$). Participants from a low-income household presented more cavitated lesions (ICDAS II 4–6) than those from a high-income household (56.3% vs 15.8%, $P = .009$).

3.3. Socioeconomic and oral health indicators and caries

Table 3 summarizes the results of the multinomial logistic regression models. The participant's mother having an education <9 years and a low household income were variables significantly associated with cavitated caries lesions (ICDAS II 4–6), with results of [OR = 1.79] and [OR = 2.21], respectively. In addition, adjusting for the other indicators, such as toothbrushing frequency (< 2 times a day) [OR = 1.99], dental visits <6 months (No) [OR = 1.58], poor oral hygiene [OR = 2.27], and the consumption of sweets (> once per day) [OR = 2.18], revealed a significant association with ICDAS II scores of 4 to 6 in permanent dentition. On the contrary, poor oral hygiene [OR = 1.69], toothbrushing frequency (< 2 times a day) [OR = 1.56], and the consumption of sweets (> once per day) [OR = 2.38] were associated with noncavitated caries (ICDAS II 1–3). The participant's SES was not associated with noncavitated caries lesions (ICDAS II 1–3) and, finally, the interaction between the participant's mother's level of education and SES was evaluated, with no statistically significant differences found.

4. Discussion

The present study found that participants from a low-income household were 2.21 times more likely to present cavitated caries

Table 3

Multinomial logistic regression models for the association between socioeconomic and oral health indicators and noncavitated (ICDAS II 1–3) and cavitated caries lesions (ICDAS II 4–6).

Variables		ICDAS II codes 1–3 Odds ratio (95% CI)	*P*	ICDAS II codes 4–6 Odds ratio (95% CI)	*P*
Age		1.65 (1.36–1.99)	<.001	1.19 (0.99–1.43)	.065
Sex	Male	*Reference*		*Reference*	
	Female	1.09 (0.70–1.68)	.694	1.21 (0.79–1.86)	.370
Oral Hygiene (OHI-S)	Good hygiene	*Reference*		*Reference*	
	Poor hygiene	1.69 (1.08–2.63)	.020	2.27 (1.46–3.51)	<.001
Toothbrushing frequency	≥ 2 times a day	*Reference*		*Reference*	
	< 2 times a day	1.56 (1.01–2.42)	.045	1.99 (1.29–3.07)	.002
Dental visits <6 months	Yes	*Reference*		*Reference*	
	No	1.24 (0.80–1.92)	.327	1.58 (1.03–2.43)	.036
Consumption of sweets	Seldom/Sometimes per week	*Reference*		*Reference*	
	> Once per day	2.38 (1.53–3.71)	.001	2.18 (1.41–3.37)	<.001
Mother's level of education	≥ 9 yrs	*Reference*		*Reference*	
	< 9 yrs	1.38 (0.89–2.13)	.144	1.79 (1.17–2.75)	.007
Socioeconomic level (SES)	High-income	*Reference*		*Reference*	
	Middle-income	1.09 (0.60–1.99)	.757	1.07 (0.59–1.95)	.804
	Low-income	1.54 (0.86–2.80)	.148	2.21 (1.23–3.97)	.008

Model adjusted for age, sex, OHI-S, Toothbrushing frequency, Dental visits <6 months, Consumption of sweets, Mother's level of education, SES.
CI = confidence Interval, OR = odds ratio.

lesions than those from a medium or high-income household; in addition, the mother's level of education was associated with the presence of cavitated caries lesions. Therefore, the hypothesis that schoolchildren with a low SES have more caries is confirmed. Inequalities were observed for variables such as the participant's mother's level of education, SES, and dental visits <6 months, in the prevalence of cavitated caries lesions at different socioeconomic levels in the sample population.

Although income and education have been shown to be increasingly related to health, one of the most commonly used indicators in studies evaluating health inequalities in children is parents level of education, as people with a low income and a low educational level are at a higher risk of poor oral health in terms of dental caries. In a study carried out on 6-year-old children, van der Tas et al[16] found an association between low income and dental caries, also reporting that the participant's mother's education was an important indicator in said association. Schwendicke et al [17] conducted a meta-analysis, reporting that the probability of caries increased with the presence of a low educational level and concluding that a low income was associated with an increased risk of caries lesions.

As observed in the present study, there was a relationship between the participant's mother's low educational level and the presence of cavitated caries lesions (ICDAS II 4–6) in the participant, suggesting that the mother's education plays an important role in decision making.[18] Likewise, parental education determines employment opportunities, family income, and participation in social protection programs.[19] Therefore, it is found that these factors influence access to health services and that families with a low educational level are more likely to have poor health outcomes.

Sugar consumption plays an important role in the development of caries, with the present study finding that sugar consumption was related to the presence of noncavitated lesions and cavitated caries lesions in the study population. Despite the fact that consumption of sweets was the only variable related to sugar consumption considered in the present study and that eating habits were not taken into account, it is possible that the participant's diet, sugar consumption, and their mother's level of education have an important relationship with both the presence of cavitated caries lesions in the participant and the low level of income in their household. Quadri et al,[20] conducted research on 6- to 15-year-old participants, finding that those whose mothers had a low educational level were more likely to have caries, as were those presenting a higher level of consumption of sweet foods. Therefore, preventive measures and education on oral health and eating habits should focus on children's mother's education in an effort to prevent the development of caries. It is also important that healthy approaches to sugar and beverage consumption are promoted from childhood onwards, in order to prevent the negative effects of these behaviors on overall health.[21]

Of the participants examined in this study, 38.0% presented noncavitated and 43.4% cavitated caries lesions, with a strong positive association found between lack of toothbrushing and poor oral hygiene. A study carried out on Mexican schoolchildren aged 8 to 12 years reported that low brushing frequency and poor oral hygiene were associated with noncavitated and cavitated caries lesions, although one disadvantage of the study was that the participant's SES was not evaluated.[22] The lack of toothbrushing facilitates the accumulation of biofilm on all surfaces of the teeth, causing the development of noncavitated and cavitated caries lesions.

Participants from low-income households presented poor oral hygiene, which concurs with Oyedele et al,[23] who found that hygiene and oral health deteriorate as SES decreases. The relationship between oral hygiene and SES could be due to different factors occurring at an individual, family, and community level.[23] In addition, both SES and poor oral hygiene could have a negative impact on schoolchildren's quality of life.[24]

With the present study finding that over 90% of participants used fluoridated toothpaste, there is evidence that toothbrushing with fluoridated toothpaste is a likely explanation for the decreased prevalence of caries, further to the fact that toothpaste is an effective agent of remineralization.[25] In the present research, it was found that the majority of schoolchildren use toothpaste, as well as a relatively high prevalence of caries, so we could think that other socioeconomic variables are related to the increase in the prevalence of caries in this population.

Finally, the present study found that nearly 60% of the participants had not visited the dentist in the last six months and that the prevalence of cavitated lesions was higher in those participants reporting fewer dental visits than their peers who visited the dentist more often. Furthermore, dental visits were lower in participants from a low-income household than those from medium/high-income households. One method of providing dental services to schoolchildren from low-income households is to install a dental office in primary schools, with the aim of increasing the use of dental services and decreasing the prevalence of caries. Moreover, it is important to introduce new strategies and opportunities that help to reduce social determinants of health by improving household income and reducing health inequalities.[26]

Some of the limitations of the present study are related to its cross-sectional design and comparability with other research, given that most comparable studies have used the DMFT index, while the present study used the ICDAS II index, which evaluates noncavitated and cavitated lesions. Longitudinal designs would increase the knowledge on the sociodemographic inequalities of dental caries. Finally, as different studies use different indicators to evaluate SES, this could reduce the comparability of the present study.

5. Conclusion

The prevalence of noncavitated and cavitated lesions was found to be relatively high in the present study, which found that a low SES, the participant's mother having a low educational level, and poor oral hygiene practices were factors associated with the presence of cavitated caries lesions in permanent dentition. The SES was not associated with the presence of noncavitated caries lesions. The high prevalence of caries and the low SES found in children must be considered when designing health policies that include the social, economic, and environmental factors that surround the general and oral health of the child.

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Author contributions

A.G-P. designed the study, collected the data, led the writing, reviewed the manuscript, and contributed to discussion; A.E.G-A-P. reviewed the manuscript and contributed to discussion; R.R-I reviewed the manuscript and contributed to the discussion; J.A. R-C reviewed the manuscript and contributed to the discussion; J. C.C-G reviewed the manuscript and contributed to the discussion; N.G.P-P reviewed the manuscript and contributed to the discussion; T.V-G reviewed the manuscript and contributed to the discussion.

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Correction

When originally published, the "how to cite" in the footnote had incomplete author last names. This has since been corrected.

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