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Socioeconomic and clinical aspects related to caries experience in schoolchildren treated at a Colombian university clinic

Camilo A. Romo Pérez[1, a, b, c],
Claudia Villafañe Aguilar[2, c, d],
Valentina Charris Almentero[2, e],
Stefanny Campo Vizcaino[2, e],
Andrés Sierra Ramos[2, e]

[1] Institución Universitaria Colegios de Colombia, Dental College Research Center. Bogota, Colombia.

[2] Fundación Universitaria San Martín. Puerto Colombia, Atlantico, Colombia.

[a] MSc in Epidemiology.

[b] Specialist in Pedagogy and Teaching.

[c] Dentist.

[d] Specialist in Pediatric Dentistry.

[e] Dentistry Student.

ABSTRACT

Objective: To evaluate the relationship between caries experience and socioeconomic and clinical factors in children aged 5 to 12. **Materials and methods:** A cross-sectional study was conducted with a sample of 103 children aged 5 to 12 from Puerto Colombia (Colombia) between 2022 and 2023. Clinical, socioeconomic, and demographic data were obtained from medical records. Poisson generalized linear models with robust standard errors were fitted to evaluate the relationship between caries experience and both socioeconomic and clinical variables. Incidence rate ratios (IRR) and their 95% confidence intervals were presented for crude and adjusted models. **Results:** Caries experience was 94.85% (n = 98), with a median of 8 affected teeth (IQR = 5-11). Additionally, it was significantly higher in stratum 2 (IRR = 1.4; 95% CI: 1.042-1.956) in children without access to water and gas services (IRR = 2.29; 95% CI: 1.172-4.472), and in those with developmental defects of enamel (IRR = 1.188; 95% CI: 1.003-1.406), with poor oral hygiene (IRR = 1.68; 95% CI: 1.147-2.459), and in those who toothbrushed less than three times a day (IRR = 1.244; 95% CI: 1,027-1,507). **Conclusion:** Children with socioeconomic disadvantages, poor oral hygiene, and irregular toothbrushing practices exhibited a higher caries experience. It is necessary to address not only clinical, but also social and behavioral aspects in the prevention of childhood caries.

Keywords: oral health; child health; dental caries susceptibility; epidemiology.

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INTRODUCTION

Dental caries is one of the most prevalent pathological conditions among the infant population, according to the Global Burden of Disease Study 2019 (1), mainly related to frequent sugar consumption, low levels of oral hygiene, and enamel developmental defects (2). Although some risk factors for the development of dental caries during childhood are considered modifiable, it is now recognized that wide socioeconomic disparities exist both within and between countries. As a result, even though the prevalence and severity of dental caries in children have decreased in developed nations, an unfavorable contrast persists in many low- and middle-income countries (3).

In Colombia, dental caries has shown a slight decline over the past decades, as evidenced by the four National Oral Health Surveys (ENSAB) conducted in Colombia between 1965 and 2014. However, it continues to be a public health concern due to its high prevalence among adults and children. According to the Fourth National Oral Health Survey (ENSAB IV, 2013-2014), the Atlantic region of Colombia reported one of the highest prevalences of dental caries in schoolchildren (67.80%). This figure exceeded that of other regions, such as the Eastern (61.16%) and Central (49.00%) regions. Among five-year-old children, the prevalence in this region was 52.38%, indicating that more than half had already developed dental caries. Although the study does not provide specific data for the department of Atlántico, its inclusion in the Atlantic region suggests that its figures are similar. These results reveal a critical situation regarding children's oral health in the Colombian Caribbean region (4).

According to the World Oral Health Status Report published by the World Health Organization (WHO) in 2022, the global average number of dental caries cases in the deciduous dentition increased by only 6%. However, increases of up to 87% were reported in low-income countries and 17% in lower-middle-income countries—approximately double the proportions observed in high-income countries (5). This disproportionate impact on socioeconomically disadvantaged populations exposes children, adolescents, older adults, ethnic minorities, disabled individuals, and victims of armed conflict to a higher risk of disease. Among these groups, children are particularly vulnerable due to the social costs and negative consequences associated with dental caries, such as pain, which compromises quality of life, affects school performance, and impacts family well-being (6). Therefore, a prevention-centered approach that focuses on modifying risk factors provides a more comprehensive and effective strategy for managing dental caries (7, 8).

Although the etiology of dental caries is clear, previous studies have suggested that low parental education levels and low household income are associated with an increased risk of caries in children (9). This may explain the variability in the distribution of dental caries among populations in the same country. Therefore, identifying the factors associated with caries experience and high-risk groups within their specific context is a crucial step toward broadening the understanding of the disease's dynamics.

On Colombia's Caribbean coast—a region with social inequalities and limited access to healthcare services—it is essential to understand the relationship between childhood caries and socioeconomic factors to design effective prevention strategies. From a clinical perspective, untreated caries causes pain, infections, and negatively affects child development. However, factors such as caregiver education, access to a healthy diet, and the availability of dental care directly influence its prevalence. In this context, investigating these factors within university dental clinics—where vulnerable populations are treated—will help identify epidemiological patterns and strengthen the training of future dentists.

Therefore, this study aims to assess the relationship between caries experience and socioeconomic and clinical factors among children aged 5 to 12 who were treated at the dental clinic of a higher education institution located on Colombia's Caribbean coast.

MATERIALS AND METHODS

An analytical cross-sectional observational study was conducted. The study population consisted of clinical records from 166 children, from which a non-probabilistic census sample was selected, including only those who met the inclusion criteria. This resulted in a final sample of 103 records of children aged 5 to 12 who were treated between 2022 and 2023 at the Pediatric Comprehensive Clinic of the Dentistry Program at Fundación Universitaria San Martín, located in Puerto Colombia, Atlántico, Colombia.

The study included cases of patients aged 5 to 12 with deciduous or mixed dentition, complete clinical records, with no erasures, and signed by the supervising faculty member of the Pediatric Comprehensive Clinic I, II, or III. Clinical records of patients undergoing orthopedic treatment with fixed appliances, children diagnosed with Sjögren's syndrome, and those with neoplasms undergoing radiotherapy were excluded.

The dependent variable was caries experience, measured using the DMF index, which consists of three components: D (decayed teeth), M (missing teeth due to caries), and F (filled teeth). The sum of these components provides the total DMF value, reflecting the caries burden in an individual or population group.

It is important to note that this index includes only teeth affected by caries and excludes those lost due to other causes, such as trauma or periodontal disease. For primary dentition, the DEF index (decayed, extracted, and filled) was used, with E indicating teeth recommended for extraction (10).

The independent variables obtained from the clinical records included: age, sex, level of education, daily sugar intake (25 grams or 6 teaspoons), presence of enamel developmental defects (fluorosis) according to Dean's Index (none, moderate, severe), dental malposition, and the O'Leary Plaque Index (good: 0-15%, fair: 16-30%, poor: 31-100%). Information was collected from the children's caregivers regarding their relationship to the patient, occupation, and educational level. Other variables considered included access to basic household services, type of housing, socioeconomic status, and family structure.

Statistical analysis

The distribution of caries experience was assessed using the Shapiro–Francia test. Additionally, Q-Q plots, violin plots, and histograms were examined. Quantitative variables were described using medians and interquartile ranges. Absolute and relative frequencies were calculated to describe qualitative variables. The median caries experience was stratified according to socioeconomic and clinical variables. Differences between the strata of each variable were examined using Welch's t-test for two-group comparisons, and the Kruskal-Wallis H test or Jonckheere-Terpstra test for variables with more than two groups. In all contrast tests, rejection of the null hypothesis was accepted with a significance level of $p < 0.05$.

Since the outcome variable represented a discrete count measured over the same period and within a population with a fixed susceptibility across all subjects under observation, a generalized linear model was fitted using Poisson regression with robust variance. This approach allowed for determining the adjusted effect of each independent variable on the caries experience rate (outcome variable), that is, the probability of being at risk of an increase in the mean count of caries experience within the susceptible subgroup (those with lower socioeconomic status and theoretically more prone to caries). To assess the adequacy of using Poisson regression analysis, the difference between the likelihood ratio test (Pearson's chi-square) and deviance was examined. Subsequently, the ratio between the likelihood ratio test and the degrees of freedom of the proposed model was calculated, and, complementarily, the ratio between deviance and the degrees of freedom was also estimated.

In the crude analysis, incidence rate ratios (IRR) were examined for each covariate. Subsequently, a multivariate analysis was performed, including variables that were marginally associated with an increase in the caries experience rate, considering a positive IRR, a Wald test p-value <0.1, and 95% confidence intervals that did not include the null value of one. In addition, the following main independent variables were retained: socioeconomic status, parental education, and those theoretically relevant to dental caries in children. The fit of the model was evaluated using general goodness-of-fit indices: pseudo-R^2, the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC) for parsimony. Clinical and socioeconomic data were entered into an online form, and all analyses were performed using STATA v. 14 (StataCorp LLC).

Ethical considerations

Written authorization and permission were obtained from the Audit Office of Fundación Universitaria San Martín to conduct the inspection and data extraction from the clinical records. Confidentiality of personal data was maintained in accordance with the provisions of Statutory Law 1581 of 2012 in the Republic of Colombia. Parents or guardians signed informed consent forms before the initiation of treatment. Since the ethical risk for participants in this study was classified as "minimal risk", in accordance with Resolution 008430 of 1993 issued by the Ministry of Health of Colombia, this project was reviewed and approved by the Research Coordination Office of Fundación Universitaria San Martín, located in Puerto Colombia, Atlántico, Colombia, on May 25, 2024.

RESULTS

A total of 166 clinical records were reviewed, of which 103 met the inclusion criteria. Most children were between 5 and 7 years old (50.50%; n = 52), with a median age of 7 years (IQR = 6-9). In addition, a higher proportion of the sample was male (55.3%; n = 57). The most common level of education among patients was primary school (89.3%; n = 92), and among parents or guardians, it was secondary school (47.6%; n = 49). The most frequent occupations among the parents were self-employment (44.7%; n = 46) and paid employment (43.7%; n = 45). Most participants had access to basic utilities such as water, electricity, and gas (93.2%; n = 96) and lived in their own homes (61.2%; n = 63). In addition, 62.1% (n = 64) belonged to socioeconomic stratum 1 (Table 1).

Regarding the oral clinical characteristics of the patients, caries experience was observed in 94.85% (n = 98), with a median of 8 affected teeth (IQR = 5-11). Most of the population showed poor oral hygiene (63.1%; n = 65), a

condition that may also be associated with the fact that 69.9% (n = 72) reported a high sugar intake, and 56.3% (n = 58) brushed their teeth twice a day. At the same time, most participants did not present dental malposition (58.3%; n = 60) (Table 1).

On the other hand, statistically significant differences were observed in the median caries experience according to the patients' oral hygiene status. Children with an O'Leary index of 31-100% had a significantly higher caries experience (Mann-Whitney U test: p = 0.008) (Table 1).

Table 1. Percentage distribution of sociodemographic and clinical variables.

Variable	n	%	Median CE	IQR	Statistic	p-value
Age			7	6-9		
5-7 years	52	50.50				
8-11 years	51	49.50				
Mother's age			32	27-37		
Father's age			37	32-42		
Patient's sex						
Female	46	44.70	8.00	6-11	1184.5	0.4
Male	57	55.30	7	5-11		
Patient's education level						
Nursery	1	1.0	14	14-14	459.000[1]	0.545
Primary school	92	89.30	8	5-11		
Secondary school	1	1.00	8	8-8		
Kindergarten	9	8.70	8	6-13		
Caregiver's education level						
No schooling	2	2.00	8.5	7.75-9.25	2.697[1]	0.441
Primary school	11	10.70	8	5.5-8.50		
Secondary school	49	47.60	8	6-13		
Technical studies	25	24.30	7	5-9		
Undergraduate education	16	15.5	6.50	4-10.5		
Family relationship with the child						
Mother	82	4.90	8	6-11		
Grandmother(s), father or other	21	2.90	6	3-10		
Father's occupation						
Unemployed	2	1.90	8	8-11	1.325[1]	0.516
Employed	45	43.70	7.50	5-10.75		
Self-employed	46	44.70	8.00	6-11		
Type of family						
Compound	4	3.90	4.5	4-6.75	1.597[1]	0.809
Extended	31	30.10	8	6-11		
Single-parent	11	10.70	10	7-11.5		
Nuclear	51	49.50	8	5-10.5		
Divorced parents	6	5.80	11.5	7.5-14.75		

CE: caries experience; IQR: interquartile range; DDE: developmental defects of enamel.
Test statistics: Mann-Whitney U; [1] Kruskal-Wallis H; [2] Jonckheere-Terpstra test.
*Statistically significant differences in CE (p < 0.05).

Table 1. (*Continuation*).

Variable	n	%	Median CE	IQR	Statistic	p-value
Basic household utilities						
Water, electricity, and gas	96	93.20	8	5-11		
Water and electricity	7	6.80	10.5	8.50-11.75	2.906[1]	0.234
Household socioeconomic status						
Status 3	11	10.70	6	4-8.5		
Status 2	28	27.20	9.50	5-12.25		
Status 1	64	62.10	8.00	6-11.25	1535.000[2]	0.375
Type of housing						
Own	63	61.20	8	5-11.5		
Rented	40	38.80	8.00	5-11	1227.5	0.825
Caries experience	98	94.85	8	5-11		
Presence of DDE					1013.5	0.41
Absent	74	72	8	5-10		
Moderate	24	23	10	7-14.25		
Severe	5	5	4	4-11		
O'Leary index						
Good (0-15%)	7	6.80	4	3.5-8	1450.500[2]	0.008*
Fair (16-30%)	31	30.10	7	4-9.5		
Poor (31-100%)	65	63.10	8	6-13		
Daily sugar intake						
<25 g	31	30.10	7	5-11	1023	0.502
<25 g	72	69.90	8	5.75-11.25		
Brushing frequency						
Three times a day	25	24.30	6	5-8.5		
Twice a day	58	56.30	8	5.5-11		
Once a day	20	19.40	8	5.5-14	1487.000[2]	0.143
Dental malposition						
Yes	43	41.70	8.00	5.0-11.25	992.5	0. 599
No	60	58.30	8	5.5-10.5		

CE: caries experience; IQR: interquartile range; DDE: developmental defects of enamel.
Test statistics: Mann-Whitney U; [1] Kruskal-Wallis H; [2] Jonckheere-Terpstra test.
*Statistically significant differences in CE ($p < 0.05$).

Regarding the explanatory analysis, the unadjusted analysis of the predictor variables for caries experience allowed the inclusion, in the multivariable model adjusted for confounding factors, of socioeconomic status, caregiver relationship, presence of advanced developmental defects of enamel (DDE), oral hygiene level according to the O'Leary Plaque Index, toothbrushing frequency, and availability of basic household services. The reference model yielded a deviance value of 211.685 and a Pearson chi-square of 191.58, with 77 degrees of freedom. Therefore, after *a priori* evaluation of the Poisson distribution assumption to detect overdispersion in the final model, it was determined to be acceptable, as no substantial difference was observed between the parameters.

Table 2 presents the final adjusted model, derived from a Poisson regression with robust variance, in which caries experience was analyzed as the dependent variable. In this model, socioeconomic status was identified as the main predictor variable. It was observed that children from socioeconomic status 1 had a 1.42 times higher probability of presenting an increased rate of caries experience compared to those from status 3 (95% CI: 1.011-1.953). Similarly, children from socioeconomic status 2 were 1.40

times more likely to exhibit a higher rate of caries experience compared to those from status 3 (95% CI: 1.042-1.956). Moreover, living in a household with incomplete basic utilities was also associated with worse caries experience: children residing in homes without access to water or gas had a 2.29 times higher rate of caries experience (95% CI: 1.172-4.472) compared to those with access to all basic utilities (water, electricity, and gas).

Regarding clinical characteristics, the presence of moderate DDE was associated with a higher likelihood of increased caries experience (IRR = 1.188; 95% CI: 1.003-1.406). Although the confidence interval of the point estimate may appear narrow and of limited precision, the association is considered significant not only from a statistical standpoint but also due to the clinical relevance of this condition. In terms of oral care aspects, poor oral hygiene was associated with a higher caries experience (IRR = 1.68; 95% CI: 1.147-2.459), and in those who brushed their teeth less than three times a day (IRR = 1.244; 95% CI: 1.027-1.507) (Table 2).

Table 2. Generalized linear Poisson regression model with robust variance for caries experience: crude and adjusted analysis for confounding factors.

Independent variable	Crude model			Final adjusted model		
	IRR	p-value	95% CI	IRR	p-value	95% CI
Patient's sex						
Male	1					
Female	1.051	0.649	0.847-1.304	1.053	0.499	0.907-1.223
Age	0.999	0.978	0.932-1.071	1.003	0.917	0.954-1.054
Patient's education level						
Nursery, Kindergarten	1					
Primary, secondary	1.115	0.461	0.835-1.489	-	-	-
Household socioeconomic status						
Status 3	1					
Status 2	1.506	0.016	1.078-2.104	1.405	0.043	1.011-1.953
Status 1	1.456	0.02	1.061-1.997	1.428	0.027	1.042-1.956
Type of family						
Nuclear	1					
Compound	0.984	0.889	0.784-1.235	-	-	-
Single parent, divorced parents	1.16	0.341	0.855-1.574	-	-	-
Caregiver's education level						
Undergraduate education	1					
No schooling	1.001	0.994	0.698-1.436	-	-	-
Primary school	1.206	0.274	0.862-1.687	-	-	-
Secondary school	0.997	0.989	0.656-1.516	-	-	-
Technical studies	1.097	0.639	0.746-1.613	-	-	-
Family relationship with the child						
Mother	1					
Father, aunt/uncle, grandparent, or other	1.327	0.109	0.938-1.878	0.869	0.169	0.712-1.061
Parents' occupation						
Employed	1					
Self-employed	1.052	0.66	0.84-1.317	1.066	0.412	0.915-1.241
Unemployed	1.162	0.314	0.867-1.558	0.999	0.996	0.59-1.692

IRR: incidence rate ratio; DDE: developmental defects of enamel.

Table 2. (*Continuation*).

Independent variable	Crude model			Final adjusted model		
	IRR	p-value	95% CI	IRR	p-value	95% CI
Presence of DDE (fluorosis)						
Absent	1					
Moderate	1.271	0.075	0.976-1.654	1.188	0.046	1.003-1.406
Severe	0.739	0.309	0.413-1.3	0.802	0.32	0.52-1.239
O'Leary index						
Good (0-15%)	1					
Fair (16-30%)	1.145	0.592	0.697-1.881	1.273	0.232	0.856-1.893
Poor (31-100%)	1.558	0.056	0.988-2.455	1.68	0.008	1.147-2.459
Brushing frequency						
Three times a day	1					
Twice a day	1.259	0.096	0.96-1.651	1.244	0.025	1.027-1.507
Once a day	1.314	0.102	0.947-1.825	1.238	0.068	0.985-1.556
Basic household utilities						
Water, electricity, and gas	1					
Water and electricity	1.235	0.099	0.961-1.588	1.127	0.395	0.855-1.486
Electricity	1.554	<0.001	1.385-1.744	2.29	0.015	1.172-4.472
Type of housing						
Own	1					
Rented	0.976	0.833	0.782-1.219	-	-	-
Sugar intake						
No	1					
Yes	1.082	0.489	0.866-1.351	1.012	0.885	0.856-1.197

IRR: incidence rate ratio; DDE: developmental defects of enamel.

DISCUSSION

This study revealed a high caries experience among the participating children, which could be explained by the fact that the sample was drawn from a university dental clinic, where patients often seek care for existing oral diseases. This finding is comparable to a population-based study conducted by Ballo et al. (3), in which 71.1% of Libyan children presented with dental caries. Similarly, only a small proportion (17.1%) had filled or missing teeth.

Another study showing comparable results was conducted by Martínez-Pérez et al. (11) in Mexico, which reported that 86.4% of children aged 6 to 12 had at least one decayed tooth, indicating a high caries experience in both primary and permanent dentition. Support for these findings is also found in more recent reports, such as that of Márquez-Pérez et al. (12), whose systematic review on the prevalence of dental caries among Mexican children and adolescents showed rates of up to 88.5% between 2020 and 2021.

Low socioeconomic status and the lack of basic household utilities were associated with higher rates of dental caries. This finding is consistent with results observed in various populations. In Egypt, Eid et al. (13) reported that daily incomes below USD 3.20 were associated with a higher count of decayed teeth among children. This is consistent with the findings reported by Kotha (14) in 2022, who indicated in a systematic review that low socioeconomic status, parental education, low maternal education, and attendance at public schools are risk factors for higher early childhood caries experience.

Although in this research study maternal education was not associated with greater caries experience, other studies provide results that logically support the plausibility of this relationship, considering that maternal education is closely related to children's oral health. This

association is, in turn, influenced by unfavorable socioeconomic factors such as limited access to dental care, lack of knowledge regarding oral health practices, and inadequate family dietary habits (15-17).

From this perspective, the combination of low maternal education and socioeconomic disadvantages, particularly during the early stages of life (18), may increase the risk of dental caries in children by limiting access to preventive healthcare and promoting behaviors that favor its formation. Therefore, oral disease prevention programs for children should shift to a multifaceted approach that incorporates health literacy among parents, school instructors, and children themselves. Such initiatives aim to improve oral health indicators in the population and mitigate the negative effects that oral diseases, exacerbated by socioeconomic inequalities, have on children's quality of life.

However, to achieve a real impact, this approach must be complemented with interventions that address social, economic, and structural barriers, such as access to healthcare services, adequate living conditions, and effective public policies. Understanding a health message does not guarantee that individuals can act accordingly if they lack the necessary resources or the right environment to do so; therefore, a comprehensive approach is required.

Finally, limitations were found due to the selection of study subjects, given that, as it was a convenience sample, it lacks representativeness with respect to the population. Nonetheless, they do not compromise the comparability of the results obtained in similar populations attending university dental clinics, considering that these populations generally belong to a low socioeconomic level and face limitations in accessing dental treatments that are not covered by Colombia's Health Benefits Plan. Therefore, it is necessary to explore this relationship among variables in other Colombian populations beyond the Caribbean coast, to assess possible variations according to the socioeconomic context of the different regions of the country.

CONCLUSIONS

The study reveals that socioeconomic status, the availability of basic household utilities, clinical characteristics, and oral care habits are factors that influence the experience of dental caries in children. Similarly, children from lower socioeconomic status, those who lack basic household utilities, present moderate DDE, have poor oral hygiene, and brush their teeth less frequently, show a higher likelihood of experiencing dental caries. These findings highlight the importance of addressing not only clinical aspects but also social and behavioral factors in the prevention of dental caries among the children population.

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The authors declare no conflict of interest.

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Authorship contribution:
CARP: conceptualization, data curation, formal analysis, research, methodology, resources, software, project administration, supervision, visualization.
CVA: conceptualization, research, methodology, resources, project administration, supervision, visualization.
VCA, SCV: conceptualization, data curation, research, methodology, visualization.
ASR: conceptualization, research, methodology, project administration, visualization.

Corresponding author:
Camilo A. Romo Pérez
✉ camilo.romo.ow@gmail.com

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