



Impact of untreated dental caries severity on the quality of life of preschool children and their families: a cross-sectional study

Patrícia Corrêa-Faria¹ · Anelise Daher¹ · Maria do Carmo Matias Freire^{1,2} · Mauro Henrique Nogueira Guimarães de Abreu³ · Marcelo Bönecker⁴ · Luciane Rezende Costa^{1,3}

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Abstract

Purpose Untreated dental caries is a persistent oral problem among preschool children. Although there is vast evidence regarding the impact of dental caries on oral health-related quality of life (OHRQoL) in this age group, evidence on the impact of untreated caries severity is scarce. The purpose of this study was to investigate the impact of untreated caries severity on the OHRQoL of preschool children and their families.

Methods A cross-sectional study was conducted with 563 individuals in the city of Goiania, Brazil. Data were collected through interviews with parents/caregivers and clinical examinations of their children. The OHRQoL was measured by the Brazilian version of the Early Childhood Oral Health Impact Scale. Untreated dental caries severity was assessed using validated indices. Other independent variables were socioeconomic, toothache prevalence, and the questionnaire respondent. Statistical analysis involved bivariate comparisons and Poisson regression analyses.

Results A higher prevalence of impact on OHRQoL was found among preschool children with untreated dental caries with clinical consequences (PR 1.31; 95% CI 1.01–1.70) compared to those without caries; those aged 5 years (PR 1.47; 95% CI 1.18–1.82), compared to those aged two; and those with a toothache (PR 1.54; 95% CI 1.34–1.76), compared to those without toothache. Moreover, fathers (PR 0.71; 95% CI 0.55–0.92) and other respondents (PR 0.70; 95% CI 0.52–0.96) perceived less impact on the OHRQoL in comparison to mothers.

Conclusions Severe untreated dental caries with clinical consequences had a negative impact on the children's OHRQoL, regardless of toothache and socioeconomic factors.

Keywords Quality of life · Dental caries · Child · Preschool

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✉ Patrícia Corrêa-Faria
patriciafaria.faria09@gmail.com

¹ Dentistry Graduate Program, Faculdade de Odontologia, Universidade Federal de Goiás, Av. Universitária Esquina com 1ª Avenida s/n, Setor Universitário, Goiânia, GO 74605-220, Brazil

² Department of Oral Health, Faculdade de Odontologia, Universidade Federal de Goiás, Goiânia, GO 74605-220, Brazil

³ Department of Community and Preventive Dentistry, Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil

⁴ Department of Pediatric Dentistry, School of Dentistry, University of São Paulo, São Paulo, Brazil

Introduction

Untreated dental caries is a public health problem that affects a large percentage of children throughout the world [1]. In the primary dentition, caries is the 10th most prevalent oral problem, affecting approximately 9% of the global population [1]. In Brazil, a national survey conducted in 2010 found that approximately 48% of 5-year-old children had at least one primary tooth with untreated caries [2]. This condition can affect growth and development [3] and is associated with a negative impact on oral health-related quality of life (OHRQoL) [4–8].

Children with untreated dental caries have a poorer perception of OHRQoL, which is related to the occurrence of toothache [9], problems eating certain foods [5, 10], sleeping difficulty and changes in behavior [9, 11–14], and tend to worsen with the progression of the dental caries [8, 15,

16]. Children with caries lesions in the early stages tend to experience less impact on quality of life than those with moderate and extensive caries lesions [15, 16].

Despite the importance of this topic, a small number of studies have investigated the relationship between increased levels of severity of dental caries and the worsening of OHRQoL among preschool children. Most studies report the impact of dental caries without distinguishing treated and untreated caries or the stages of progression [11–14]; this discrimination is relevant considering the current approach of cariology and minimal intervention [17, 18].

Considering the high prevalence of untreated dental caries in young children, it is important to investigate its impact on OHRQoL taking into consideration different levels of severity and using methods that are easily applied and understood on a population level. In this context, we propose the evaluation of dental caries by combining the dmft and pufa indices that are easy to apply and understood by dentists. This combination may be useful for determining the severity of the lesions, especially in epidemiological surveys with large numbers of participants. Thus, the aim of the present study was to evaluate the impact of untreated caries severity, assessed through the combination of dmft and pufa index, on the quality of life of preschool children and their families.

Methods

A cross-sectional study was conducted with a population-based sample of children aged 2–5 years in the city of Goiânia-GO, which is located in the central western region of Brazil. The city has an estimated population of 1,302,001 inhabitants, including 67,160 preschool children aged 1–4 years [19]. The city Human Development Index is 0.799 [20]. For administrative purposes, the city is divided into seven health districts. The study population included children aged 2–5 years who attended the local primary healthcare units during a national child immunization campaign.

The sample size was calculated considering a 50% estimated prevalence of negative impact of untreated caries on OHRQoL, since the actual prevalence among children aged 2–5 years in Goiânia was unknown and this prevalence rate gives the largest sample size. Other parameters were considered: a 95% confidence interval, 5% standard error, and 1.2 design effect. A sample of 461 participants was determined, to which an additional 20% was added to compensate for possible refusals to participate, giving a total of 554 preschool children.

To ensure representativeness, the distribution of the sample was according to the expected number of children on the immunization day in the local health districts, which was based on the proportional distribution of preschool children throughout the primary healthcare units involved in the

vaccination campaign performed in the previous year. Lists provided by the Municipal Secretary of Health were consulted and the percentage distribution of children in each one of the seven health districts (Central, East, Northeast, North, West, Southeast, and South) was calculated. In each district, health units with the largest number of children expected in the target age group were selected, totaling 14 primary healthcare units.

In the date of the national child immunization campaign, one team (an examiner and two assistants) was installed in each primary healthcare unit. As parents/children were organized into lines, one assistant addressed them following a systematic random sampling: for every two children waiting in the vaccination line, one was invited to participate; if he/she did not meet the eligibility criteria, the next child in line was invited. Parents and children who agreed to participate in the study were advised to wait for data collection after vaccine administration. To be included in the study, the children had to be between 2 and 5 years of age and have no systemic diseases. Moreover, parents/caregivers should be the ones who stayed or looked after the child during most of the day and who were fluent in Portuguese.

Data collection included dental examinations of the children and interviews with the parents/caregivers using a structured questionnaire, carried out by researchers (public health dentists, post graduation students, and undergraduate students) who had undergone previous training and calibration exercises. An experienced specialist in pediatric dentistry coordinated the theoretical and practical steps. The theoretical step involved a discussion on the criteria for the diagnosis of the dental caries (decayed missing and filled teeth caries index—dmft index) [21] and the clinical consequences of untreated caries (pufa index) [22]. To determine inter-examiner and intra-examiner agreement, 15 dentists examined a total of 15 images of expected clinical conditions using the dmft and pufa (*in lux* calibration) [23]: decayed, missing and filled teeth caries, teeth with pulpal involvement, ulceration, fistula, and abscess, as well as sound teeth. This procedure was repeated after a 7-day interval. The Kappa statistic was used for the determination of inter-examiner and intra-examiner agreement and revealed a high level of agreement (Kappa > 0.8 and Kappa > 0.7, respectively). There was also a theoretical training for the application of the instruments for assessment of quality of life and toothache. For this training, the principal investigators read and discussed the instruments with the other members of the research team. The research assistants were instructed to read, slowly, each question from the instruments to the respondents and clarify questions when necessary.

After children being vaccinated, parents were interviewed, and children examined in specific rooms designated for this purpose, out of the agitation of the immunization procedures. This prevented the presence of other people

during the application of the questionnaires and clinical examination would interfere with the results. Children who did not cooperate with the dental exam were excluded as already foreseen in the calculation of sample size.

The clinical examination was performed with the aid of a mouth mirror and a ball-pointed dental probe (WHO model) under natural light with the child either standing up in front of the examiner or in the knee-to-knee position. The teeth were cleaned and dried with gaze and all procedures complied with biosafety norms. Dental caries was assessed using the criteria established by the WHO [21] and calculated based on decayed, missing due to caries and filled primary teeth (dmft index). The decayed (d) component was used as an indicator of untreated carious teeth. The consequences of untreated dental caries were evaluated using the pufa index [22].

A combination of decayed component of dmft and pufa was used in this study to measure severity of untreated dental caries. The following categories were considered: absence of dental caries experience (dmft = 0), untreated carious lesions without clinical consequences (d component ≥ 1 , pufa = 0), and untreated dental caries with clinical consequences (d component ≥ 1 , pufa ≥ 1).

The following data were collected through interviews with parents/caregivers (mother, father or other): mother's schooling (categorized as lower than high school, high school and university degree), child's age, sex, OHRQoL, and presence of toothache.

The dependent variable in this study was OHRQoL of children and their families, was assessed using the validated Brazilian version of the Early Childhood Oral Health Impact Scale (B-ECOHIS) [24–26], which has 13 items divided into two sections. The child section comprises nine items related to the impact of oral health on the child's quality of life. The family section comprises four items on the impact of the child's oral health on the family. Each item is scored using a simple five-point scale, with responses ranging from "never" to "very often." The total score ranges from 0 to 52, with higher scores denoting a greater negative impact on OHRQoL.

Toothache was evaluated using the Brazilian version of the Dental Discomfort Questionnaire (DDQ-B) [27] administered to the parents/caregivers. The DDQ-B has seven items addressing daily behaviors of the child related to toothache. The response options are "never," "sometimes," and "often." The final score ranges from 0 to 14 points, with higher scores indicating greater pain. For statistical purposes, the scores were dichotomized as absence (< 3 points) or presence (≥ 3 points) of toothache [28].

Data analysis was performed using the Statistical Package for Social Sciences (SPSS for Windows, version 22.0, SPSS Inc., Chicago, IL, USA) and involved a description of the frequencies and central tendencies of the variables as well as

association tests. The Kolmogorov–Smirnov test was used to determine the normality of the data distribution. Non-parametric tests were used to compare the scores of each domain and the overall B-ECOHIS between categories of untreated dental caries. Associations between the dependent variable (OHRQoL as measured by B-ECOHIS) and the clinical variable (untreated dental caries and clinical consequences) were investigated using the Chi-square, Mann–Whitney, and Kruskal–Wallis tests. Poisson regression with robust variance was performed to test association between the overall B-ECOHIS scores and the independent variables (severity of untreated caries, prevalence of toothache, sociodemographic characteristics of the participants and respondent of the B-ECOHIS). Variables with a p value $\leq .20$ in the bivariate analysis were selected to compose the multivariate model. Independent variables were selected for the final multiple model only if they had a p value $< .05$ after adjustment [29]. In this analysis, the outcome was stated as a count outcome and prevalence ratios (PR) and 95% confidence intervals (CI) were calculated.

Sensitivity analysis was performed to assess the impact of severity of the need for dental caries treatment in OHRQoL. The severity of the need for dental caries was categorized in the absence of needs, need for treatment in 1 tooth, 2 or 3 teeth and 4 or more teeth. The cutoff points of the number of teeth in need of treatment were obtained from the values of the quartiles (Supplement Table 1) and median (Supplement Table 2) obtained for the number of teeth with component d of the dmft.

This study was conducted in accordance with the Declaration of Helsinki and approved by the local human research ethics committee under protocol number 39914414.7.0000.5083. After receiving clarifications regarding the objectives and procedures of the study, parents/caregivers agreed to their children's participation by signing a statement of informed consent.

Results

A total of 563 children aged 2–5 years and their parents/caregivers participated in the study. Table 1 displays the characteristics of the participants. Age ranged from 24 to 70 months (median: 43.0 months) and 52.0% of the children were female. More than half of the mothers had a high school as the highest level of education (52.6%). Most of the respondents of the questionnaire were mothers of the participating children (76.0%). About the clinical variables, 29.0% of the children had dental caries (dmft ≥ 1). Among children with dental caries, 91.2% had untreated lesions (d component ≥ 1), and 13.1% had clinical consequences. Only 14.6% had received restorative treatment (f component of

Table 1 Characteristics of the study participants

Sociodemographic characteristics, clinical variables, and OHRQL	
Median age in months (minimum–maximum) (<i>n</i> = 563)	43.0 (24–70)
Sex <i>n</i> (%) (<i>n</i> = 563)	
Male	270 (48.0)
Female	293 (52.0)
Mother's schooling <i>n</i> (%) (<i>n</i> = 530)	
Lower than high school	151 (28.5)
High school	279 (52.6)
University degree	100 (18.9)
Dental caries <i>n</i> (%) (<i>n</i> = 548)	
Absence	389 (71.0)
Presence	159 (29.0)
Median dmft (minimum–maximum) (<i>n</i> = 548)	0.0 (0–14)
Untreated dental caries (d component of dmft) <i>n</i> (%) (<i>n</i> = 159) ^a	
Absence	14 (8.8)
Presence	145 (91.2)
Treated caries (m and f component of dmft) <i>n</i> (%) (<i>n</i> = 159) ^a	
Absence	135 (84.9)
Presence	24 (15.1)
Clinical consequences of untreated dental caries (pufa) (<i>n</i> = 145) ^b	
Absence	126 (86.9)
Presence	19 (13.1)
Untreated dental caries and clinical consequences <i>n</i> (%) (<i>n</i> = 548)	
Without dental caries	389 (71.0)
Untreated dental caries without clinical consequences	140 (25.5)
Untreated dental caries with clinical consequences	19 (3.5)
Toothache <i>n</i> (%) (<i>n</i> = 563)	
Absence	460 (81.7)
Presence	103 (18.3)
B-ECOHIS respondent <i>n</i> (%) (<i>n</i> = 563)	
Mother	406 (76.0)
Father	83 (15.5)
Other	45 (8.5)

^aFrequency calculated considering the total of 159 children with dental caries (dmf-t ≥ 1)

^bFrequency calculated considering the total of 145 children with untreated dental caries

dmft) and 0.5% had missing teeth due to caries. Approximately 18% of children had a history of toothache.

To determine whether the missing data exerted an influence on the results, children with and without information on dental caries were compared. No statistically significant differences were found considering sex ($p = .673$), age ($p = .489$), B-ECOHIS respondent ($p = .973$), mother's schooling ($p = .184$), toothache ($p = .238$), and impact on OHRQoL ($p = .191$).

A total of 56.8% of the parents reported impact on OHRQoL (score ≥ 1). B-ECOHIS scores ranged from 0 to 28. The distribution of the responses to each item is in Table 2. The item related to pain was the most frequent on the child impact section. Being upset was frequently reported on the family impact section. Comparing the median values

of each domain and overall score of the B-ECOHIS among the degrees of severity of untreated dental caries, significant differences were found for most of the items (Table 3).

In the bivariate analysis with Chi-square tests, children with untreated dental caries and clinical consequences ($p = .008$) and those with a history of toothache ($p \leq .001$) had a higher prevalence of negative impact on OHRQoL, when compared to those without untreated dental caries and without toothache. Higher prevalence of impact was also found when mothers answered the B-ECOHIS ($p = .004$), compared to the cases in which the respondents were fathers and other caregivers.

In the unadjusted analysis, OHRQoL was associated to untreated caries severity, toothache, age, and the questionnaire respondent. The final adjusted model showed that

Table 2 Frequency distribution of B-ECOHIS responses

Impacts	Never or hardly ever <i>n</i> (%)	Occasionally, often or very often <i>n</i> (%)	Don't know <i>n</i> (%)
Child impact section			
Symptoms domain			
Oral/dental pain <i>n</i> = 561	490 (87.3)	69 (12.3)	2 (0.4)
Child function domain			
Difficulty drinking <i>n</i> = 563	499 (88.6)	61 (10.8)	3 (0.6)
Difficulty eating <i>n</i> = 563	523 (92.9)	40 (7.1)	0 (0.0)
Difficulty pronouncing words <i>n</i> = 559	490 (87.6)	62 (11.1)	7 (1.3)
Missed preschool or school <i>n</i> = 465	448 (96.3)	10 (2.2)	7 (1.5)
Child psychological domain			
Trouble sleeping <i>n</i> = 563	548 (97.3)	15 (2.7)	0 (0.0)
Irritable or frustrated <i>n</i> = 562	515 (91.6)	45 (8.0)	2 (0.4)
Child self-image/social interaction			
Avoided smiling or laughing <i>n</i> = 558	551 (98.7)	6 (1.1)	1 (0.2)
Avoided talking <i>n</i> = 558	550 (98.5)	8 (1.5)	0 (0.0)
Family impact section			
Parental distress domain			
Been upset <i>n</i> = 555	475 (85.6)	80 (14.4)	0 (0.0)
Felt guilty <i>n</i> = 557	478 (85.8)	79 (14.2)	0 (0.0)
Family function domain			
Time off from work <i>n</i> = 558	518 (92.9)	40 (7.1)	0 (0.0)
Financial impact <i>n</i> = 556	513 (92.2)	43 (7.8)	0 (0.0)

Table 3 Median B-ECOHIS scores according to severity of untreated caries

	Severity of untreated caries			<i>p</i> Value
	Without untreated caries	Untreated caries without clinical consequences	Untreated caries with clinical consequences	
Child symptom domain	0.0 (0–3) ^a	0.0 (0–3) ^b	2.0 (0–4) ^c	≤ .001
Child function domain	0.0 (0–10) ^a	0.0 (0–8) ^{a,b}	2.0 (0–8) ^c	≤ .001
Child psychological domain	0.0 (0–7) ^a	0.0 (0–4) ^{a,b}	1.0 (0–5) ^c	≤ .001
Child self-image/social interaction	0.0 (0–4) ^a	0.0 (0–2) ^{a,b}	0.0 (0–4) ^c	.005
Overall child section	0.0 (0–17) ^a	0.0 (0–14) ^{a,b}	5.0 (0–18) ^c	≤ .001
Parental distress domain	0.0 (0–8) ^a	0.0 (0–8) ^b	1.0 (0–8) ^{b,c}	≤ .001
Family function domain	0.0 (0–6) ^a	0.0 (0–6) ^{a,b}	0.0 (0–8) ^c	.015
Overall family section	0.0 (0–12) ^a	0.0 (0–10) ^b	2.5 (0–12) ^c	≤ .001
Overall ECOHIS score	1.0 (0–22) ^a	2.0 (0–22) ^b	9.0 (0–28) ^c	≤ .001

Different superscript letters signify statistically different results (*p* < .05). *p* Values determined using Kruskal–Wallis and Mann–Whitney tests

all these four variables remained independently associated with a greater perceived impact on OHRQoL. Children with untreated dental caries and clinical consequences had a 1.31-fold (95% CI 1.01–1.70) greater probability of experiencing a negative impact on OHRQoL compared to those with untreated dental caries without clinical consequences (PR 1.16; 95% CI 0.99–1.35). Children aged 5 years (PR 1.47; 95% CI 1.18–1.82), compared to those aged 2, and those with a history of toothache (PR 1.54;

95% CI 1.34–1.76), compared to those without toothache, had a higher prevalence of impact on OHRQoL. Moreover, fathers (PR 0.71; 95% CI 0.55–0.92) and other respondents (PR 0.70; 95% CI 0.52–0.96) perceived less negative impact on the children's OHRQoL in comparison to mothers (Table 4). Sensitivity analyses showed similar associations between OHRQoL and covariates (Supplement—Tables 1, 2).

Table 4 Unadjusted and adjusted Poisson regression models for variables associated with impact on children and their families Oral Health Quality of life

Variables	Impact on OHRQoL (overall ECOHIS score)						
	Absence <i>n</i> (%)	Presence <i>n</i> (%)	<i>p</i> ^a	Unadjusted PR (95% CI)	<i>p</i>	Adjusted PR (95%CI)	<i>p</i>
Age in years			.180				
2	70 (42.2)	96 (57.8)		1		1	
3	81 (50.3)	80 (49.7)		0.85 (0.70–1.05)	.142	0.87 (0.71–1.06)	.169
4	90 (41.3)	128 (58.7)		1.01 (0.85–1.20)	.862	0.98 (0.82–1.16)	.822
5	2 (11.1)	16 (88.9)		1.53 (1.24–1.89)	≤.001	1.47 (1.18–1.82)	≤.001
Sex			.346				
Male	111 (41.1)	159 (58.9)					
Female	132 (45.1)	161 (54.9)					
Mother's schooling <i>n</i> (%)			.758				
Lower than high school	60 (39.7)	91 (60.3)					
High school	121 (43.4)	158 (56.6)					
University degree	43 (43.0)	57 (57.0)					
B-ECOHIS respondent			.004				
Mother	156 (38.4)	250 (61.6)		1		1	
Father	46 (55.4)	37 (44.6)		0.72 (0.56–0.93)	.012	0.71 (0.55–0.92)	.011
Other	24 (53.3)	21 (46.7)		0.75 (0.54–1.04)	.091	0.70 (0.52–0.96)	.028
Severity of untreated caries			.008				
Without dental caries	188 (46.5)	216 (53.5)		1		1	
Untreated dental caries without clinical consequences	47 (37.3)	79 (62.7)		1.17 (0.99–1.38)	.055	1.16 (0.99–1.35)	.065
Untreated dental caries with clinical consequences	4 (21.1)	15 (78.9)		1.47 (1.15–1.89)	.002	1.31 (1.01–1.70)	.040
Toothache			≤.001				
Absence	224 (48.7)	236 (51.3)		1		1	
Presence	19 (18.4)	84 (81.6)		1.59 (1.39–1.80)	≤.001	1.54 (1.34–1.76)	≤.001

Values in bold indicate statistical significance ($p < 0.05$)

^aChi-square test

Discussion

The present cross-sectional study offers evidence of the association between the severity of untreated dental caries and the negative impact on OHRQoL of preschool children and their families. Children with untreated dental caries and clinical consequences had higher overall B-ECOHIS scores in comparison to those with untreated caries, but no clinical consequences indicative of an aggravation of the condition and those without untreated caries. The negative impact of dental caries on OHRQoL is well established, but few studies have offered evidence of the relationship between caries severity and OHRQoL among children [5, 6, 30, 31]. In these studies, caries severity was determined by the number of cavitated lesions [31], presence of clinical consequences of untreated lesions [5, 6], and stage of development of lesions (absent, white spot, and cavitated lesions) [30].

These parameters, when evaluated in isolation, quantify the lesions in need of treatment or indicate the natural evolution of the untreated lesions, but do not seem to indicate for the clinician the aggravation of the lesions. This fact limits the comparison with our results.

In the present study, data on untreated dental caries and clinical consequences were combined to gain a better understanding of the association between caries severity and OHRQoL. This approach revealed that untreated caries combined with clinical consequences (pulp involvement, ulceration, fistula, and abscess) had a greater potential to exert a negative impact on quality of life. In such cases, caries severity is greater, with considerable decay, pain and the progression of an infectious process. These clinical conditions may affect a child's willingness to eat and cause pain, which contribute to a poorer quality of life [6].

Besides severe untreated dental caries, toothache also had a negative impact on the participants' OHRQoL, which is in

agreement with the results reported in previous epidemiological studies involving representative samples [31–33]. In previous studies, toothache was investigated through a single question posed to parents/caregivers. In the present study, the Brazilian version of the Dental Discomfort Questionnaire (DDQ-B) was used, which enabled an accurate evaluation of toothache in the preschool children though the identification of pain-related behaviors [27, 34]. Despite the advantages of the DDQ-B, the questionnaire is composed of items that could be interpreted in a similar manner to those on the B-ECOHIS. The same could occur in other studies in which questions used to evaluate pain are similar to the ECOHIS items.

Mother's schooling was not significantly associated with a negative impact on OHRQoL, which agrees with results of previous studies in Brazilian preschool children [10, 13, 14]. Despite the lack of a statistically significant association, it is important to investigate the socioeconomic contexts of families, for which formal education is one of the variables, since children from more vulnerable families tend to be at greater risk for dental caries [35], which is related to a negative impact on OHRQoL.

In the present study, the quality of life was evaluated using the B-ECOHIS, which is answered by parents/caregivers. The secondary reports of these respondents have been used in research involving preschool children due to the fact that the underdeveloped cognitive capacity of young children limits their understanding of the questions and may compromise the responses [36, 37]. Although the B-ECOHIS has been validated for Brazilian parents and children [25], a pilot study should be performed prior to data collection in future studies, in order to identify the specificities of the sample. In this research, pilot study was not performed, this being a limitation of the study. This limitation was minimized by the clarifications given to the respondents by the researchers in the data collection. During the collection, the interviewers read the B-ECOHIS questions for the respondents and the doubts that arose were clarified.

The B-ECOHIS can be answered by any caregiver in close contact with the child; however, the present findings suggest that the perceptions of fathers and other respondents underestimate the impact of OHRQoL of children in comparison to the perceptions of mothers. Likewise, a previous study involving Brazilian 5-year-old children and their parents found that fathers underestimated the impact on OHRQoL and mothers were the preferred respondents [30].

Our study has some limitations. Other oral problems that can exert a negative impact on OHRQoL were not investigated, which may have led to an overestimation of the impact of untreated dental caries. However, as the B-ECOHIS is composed mainly of items related to pain or discomfort during the performance of routine activities and strong associations were found between dental caries and these items, this does not seem to have affected the results. The fact that socioeconomic context

was only investigated based on mother's schooling is another limitation and future studies should include other variables to enable a better understanding of the role of the social determinants of oral health and further comparisons with the literature.

The findings of this study confirm the association between untreated dental caries with clinical consequences, toothache and OHRQoL, emphasizing the physical and emotional impacts of poor oral health. We hypothesize that these oral health-related conditions could contribute to adverse childhood experiences, and it is already known that childhood adversity affects children development [38] and adult quality of life [39]. So, strategies to improve children's oral health quality of life should be incorporated in broader health promotion programs aiming to improve children's development during the early childhood. Specifically, family education on early childhood caries risk factors and their sensitization for the importance of oral health in the preschool years should be emphasized. Our results also emphasize the need to reinforce the importance of caries treatment in the deciduous dentition and the need to improve the provision of oral health services to the child population.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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