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Socioeconomic, access-related, and periodontal factors associated with oral health-related quality of life among pregnant women in primary health care: a cross-sectional study

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Abstract

Background Periodontal disease affects not only clinical status but also oral-health-related quality of life (OHRQoL). Socioeconomic context, pregnancy-related systemic changes, hygiene habits, service access/use, and unmet periodontal needs may shape OHRQoL in pregnancy. This cross-sectional study aimed to identify factors associated with worse OHRQoL among pregnant women receiving care in the Brazilian Unified Health System (SUS).

Methods OHRQoL was assessed using the OHIP-14 questionnaire by standardized interview, and participants were categorized into: moderate/high impact (G1 = 56; OHIP-14 > 9) and no impact (G2 = 48; OHIP-14 = 0) on OHRQoL. Sociodemographic variables, systemic conditions, oral hygiene behaviors, access to prenatal dental care, and periodontal indicators were collected. Student's *t*-test, Mann-Whitney, chi-square, and Poisson regression with robust variance were adopted ($p < 0.05$).

Results G1 demonstrated lower educational attainment ($p = 0.036$) and frequency of daily toothbrushing ($p = 0.024$), with higher probing pocket depth ($p = 0.003$) and clinical attachment level ($p < 0.001$). Although 75% of the sample had a record of prenatal dental care, the absence of consultations was more prevalent in G1 (33.9%). The prevalence of periodontitis was also higher in this group (71.4% vs. 25.0%). In the multivariable analysis, three factors remained independently associated with worse OHRQoL: educational level, in which each additional year of schooling was associated with a lower prevalence of moderate/high OHRQoL impairment (PR = 0.96; 95% CI 0.92–0.99; $p = 0.025$), absence of prenatal dental care (PR = 1.49; 95% CI 1.11–1.99; $p = 0.008$), and greater severity of periodontitis in a dose-response gradient, with stage III showing the highest prevalence (PR = 2.93; 95% CI: 1.91–4.48; $p < 0.001$).

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Conclusions Social, access-related, and clinical vulnerabilities were associated with worse OHRQoL among pregnant women in primary health care. These findings reinforce the most recent Brazilian epidemiological data in dentistry (SB Brasil 2023) and support the need for integrated strategies in primary health care to expand effective prenatal dental care and prioritize periodontal disease prevention during pregnancy.

Keywords Oral health, Periodontitis, Pregnancy, Prenatal care, Primary health care, Quality of life, Social determinants of health, Social vulnerability

Background

Pregnancy is a period of intense biochemical, hormonal, and immunological changes that promote maternal adaptation and fetal growth. However, part of these alterations may negatively affect oral health. Elevated progesterone and estrogen heighten gingival inflammatory responses to dental biofilm by modulating innate immunity, including neutrophil function [1, 2]. These hormones influence processes such as chemotaxis, activation, and degranulation, favoring the production of reactive oxygen species (ROS) and the formation of neutrophil extracellular traps (NETs). This reflects not only local inflammatory changes but also the systemic modulation of immune responses during pregnancy. Consequently, pregnant women are at higher risk of developing periodontal diseases [1–3].

Periodontal diseases include gingivitis, characterized by inflammation of the gingiva while the connective tissue remains attached to the tooth, and periodontitis, a chronic inflammatory condition of multifactorial nature, directly associated with dysbiotic dental biofilm and the host immune response [4, 5]. A recent systematic review and meta-analysis estimated that about 40% of pregnant women have periodontitis, with wide variability driven by heterogeneous diagnostic definitions, study quality, and settings [6]. During pregnancy, periodontitis assumes additional relevance due to potential adverse maternal and infant outcomes, such as preeclampsia, preterm birth, and low birth weight [7, 8].

In addition to clinical repercussions, periodontal diseases affect subjective dimensions of health, being associated with pain, discomfort, functional limitations, and social embarrassment. Evidence indicates that unfavorable periodontal conditions and poor oral hygiene are linked to lower oral-health-related quality of life (OHRQoL) scores, with tooth loss representing an additional aggravating factor [9–11]. Recent studies further support this relationship, reporting a high prevalence of oral problems in pregnant women and a consistent association between periodontitis and poorer OHRQoL scores, particularly among women with lower hygiene frequency or lacking regular dental care [12, 13].

Access to prenatal dental care, including the provision of periodontal interventions during pregnancy, has been associated with better OHRQoL [14]. However, structural and organizational barriers continue to limit the utilization of these services in the context of public

health, and even when access exists, it does not always result in effective care, with unmet oral health needs persisting [15].

In Brazil's Unified Health System (Sistema Único de Saúde, SUS), care is organized through Health Care Networks coordinated by primary health care (PHC). These networks aim to expand access, improve quality, and prevent service fragmentation. Within this context, the "Stork Network" (*Rede Cegonha*, 2011–2024) and its successor, the "Alyne Network" (established in 2024), were implemented to enhance maternal and child care by promoting comprehensiveness, humanization, and reducing ethnic-racial and regional inequalities [16]. Also in 2024, the Oral Health Care Network was established to integrate dental services with other health networks, including the "Alyne Network", thereby strengthening oral health care for pregnant women [17]. Despite recent gains in prenatal dental care utilization in Brazil, a system-level gap persists whereby preventive visits rise without a corresponding increase in comprehensive periodontal management, highlighting the need to qualify care rather than merely broaden access. This picture is consistent with the most recent national oral-health survey (SB Brasil 2023), which shows that periodontal conditions remain highly prevalent among women of reproductive age, with marked regional and social inequalities [18]. Addressing these inequities requires strengthening and qualifying the Alyne Network and the Oral Health Care Network, as well as ensuring coordination between maternal-child and oral-health networks to avoid fragmentation.

In this context, socioeconomic and cultural factors, pregnancy-related systemic changes, oral hygiene habits, access to and use of health services, and unmet periodontal needs may be associated with OHRQoL among pregnant women. Although prior studies have reported associations between periodontal disease and OHRQoL in pregnancy, many were conducted in heterogeneous settings and typically report OHRQoL in the full spectrum, without explicitly examining periodontitis severity gradients alongside modifiable service-related factors under routine public-sector prenatal care. Evidence therefore remains limited on how periodontal disease severity and modifiable service-related factors (such as prenatal dental attendance), together with social vulnerability, jointly relate to OHRQoL in

real-world primary care settings within the SUS. Clarifying whether periodontal disease severity follows a gradient in OHRQoL and whether modifiable access-related factors are associated with worse OHRQoL may support risk stratification and inform targeted strategies in prenatal care. We hypothesized that worse OHRQoL would be associated with greater periodontal disease severity and with social and access-related vulnerabilities. Therefore, this study aimed to identify factors associated with worse OHRQoL among pregnant women receiving care in the Brazilian Unified Health System (SUS), with particular attention to social, clinical, and service-related vulnerabilities that remain relevant despite recent policies.

Methods

This clinical, observational, cross-sectional, and analytical study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [19].

Ethical consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (1975, updated in 2013) and was approved by the Ethics Committee of the Bauru School of Dentistry, University of São Paulo (CAAE 79324624.2.0000.5417). Participation was voluntary, and women were included only after providing written informed consent.

Sample selection

The sample of this study was consecutively recruited from ten primary health care units (PHC units) in Bauru, São Paulo, Brazil, between July 2024 and August 2025. PHC units were selected based on operational feasibility. All PHC units in the municipality were contacted, and we included those in which a dental chair was available on the same days as scheduled prenatal medical appointments, allowing coordination of interviews and periodontal examinations with routine prenatal visits. The selected units covered central and peripheral areas across different regions of the municipality (north, south, east, and west). Eligible participants were consecutively approached during routine third-trimester prenatal medical appointments in the participating PHC units. Women waiting for scheduled prenatal consultations were invited by trained researchers using a standardized script. After eligibility screening and written informed consent, participants underwent the interview and periodontal examination in the unit's dental office. Recruitment followed the service workflow and was not designed to ensure proportional sampling by PHC unit.

Inclusion criteria consisted of pregnant women in their third trimester (from the 27th week of gestation); aged between 18 and 40 years; under regular follow-up with an

obstetrician; and without any systemic condition requiring absolute rest during pregnancy. Additionally, participants were required to exhibit adequate cognitive and neuromotor function, allowing for proper understanding of the study ethical aspects and sufficient ability to perform regular oral hygiene. Each participant received an oral hygiene kit (toothbrush, fluoridated toothpaste with 1450 ppmF and dental floss) and instructions on proper oral hygiene. The sample was restricted to women in the third trimester of pregnancy for both operational and methodological reasons. In primary health care, third-trimester prenatal follow-up is typically more frequent, which facilitated recruitment during routine visits and enabled coordination of interviews and periodontal examinations within the service workflow. In addition, periodontal inflammatory changes related to pregnancy may be more clinically evident later in gestation, after a longer period of exposure to pregnancy-related hormonal and immunological modulation [1–3]. Finally, restricting the sample to a single gestational stage reduces heterogeneity, as earlier pregnancy is often characterized by marked systemic symptoms and initial adaptation processes that could influence self-reported outcomes and introduce additional variability in OHRQoL assessment [1, 2].

Participants were excluded if they: (i) required absolute rest for medical reasons (to ensure maternal safety); (ii) were currently or previously using, during pregnancy, antibiotics or medications known to affect periodontal status, such as immunosuppressants, anticonvulsants, or calcium channel blockers (e.g., cyclosporine, phenytoin, nifedipine); (iii) had multiple missing teeth (> 2 per quadrant), which could compromise the reliability of periodontal assessment; (iv) experienced tooth loss prior to pregnancy attributable to periodontitis; (v) were undergoing orthodontic, periodontal, or other dental treatment with a predefined treatment plan; (vi) had a history of periodontal surgery, which could alter periodontal findings; (vii) had a medical history of pre-gestational psychological disorders (e.g., depression) documented in the PHC medical records, given their potential influence on OHRQoL outcomes; or (viii) reported receiving dental care in the private sector at any time during pregnancy, in order to maintain homogeneity regarding follow-up within the public health system.

Participants were divided into two groups based on the Oral Health Impact Profile (OHIP-14) score, which captures perceived OHRQoL: moderate/high OHRQoL impairment (OHIP-14 > 9; G1 = 56) and no OHRQoL impairment (OHIP-14 = 0; G2 = 48). The validated OHIP-14 questionnaire was administered through a standardized face-to-face interview by a trained and calibrated interviewer to standardize interpretation across participants and reduce differential misclassification.

Calibration consisted of didactic sessions and group discussions on instrument specifics, with scripted prompts and mock interviews to harmonize administration. OHIP-14 is an adapted version of the OHIP-49, evaluating the following dimensions: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap, with two questions applied for each dimension [20, 21]. Response codes were based on a Likert scale: 0 = never; 1 = rarely; 2 = sometimes; 3 = often; 4 = always. The mean of the two questions for each dimension was calculated, and then the means of the seven dimensions were summed. Scores were computed using the dimensional mean approach to maintain equal weighting across domains. Thus, the total score ranged from 0 to 28, where a score of zero (0) was classified as “no OHRQoL impairment”; $0 < \text{OHIP-14} \leq 9$ was classified as “low OHRQoL impairment”; $9 < \text{OHIP-14} \leq 18$ was classified as “moderate OHRQoL impairment”; and $18 < \text{OHIP-14} \leq 28$ was classified as “high OHRQoL impairment” [22, 23].

Participants within the low OHRQoL impairment range (OHIP-14=1–9) were excluded to minimize outcome misclassification and increase interpretability, as small OHIP-14 values may reflect transient, non-specific, or minor impairments that are common during pregnancy and may not represent a stable or meaningful impairment. Including this intermediate range could dilute group contrasts and introduce heterogeneity by mixing women with minimal symptoms and those with marked functional and psychosocial burden, potentially attenuating associations and obscuring gradients across periodontal severity. This conservative categorization was adopted to improve discriminatory capacity when the objective is to identify factors associated with a more substantial OHRQoL burden. To address potential information loss from this approach, we conducted a sensitivity analysis modeling OHIP-14 as a continuous outcome.

Systemic assessments

In addition to pre-pregnancy body mass index (BMI) and gestational weight gain, the presence of Gestational Diabetes Mellitus (GDM) and arterial hypertension during pregnancy was assessed.

Diagnostic criteria for GDM proposed by the International Association of Diabetes and Pregnancy Study Groups Consensus Panel (2010), also adopted by the

World Health Organization (WHO), were considered [24]. Fasting and 1- and 2-hour post-load glucose levels during the Oral Glucose Tolerance Test (OGTT) were evaluated, which was performed between the 24th and 28th weeks of gestation through the oral administration of 75 g of glucose. GDM was diagnosed when participants presented at least one value meeting the following cut-off points: 92–125 mg/dL (fasting); ≥ 180 mg/dL (1-hour post-load); 153–199 mg/dL (2 h post-load). This analysis was part of the routine mandatory examinations performed in primary health care, particularly when fasting glycemia was altered. Data were collected from the participants' gestational care booklet or electronic health records. Regarding blood pressure (BP), participants were classified as having arterial hypertension during pregnancy if systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg [25].

Finally, participants were classified according to pre-pregnancy nutritional status, based on the classification proposed by the World Health Organization and previous studies [26, 27]. Participants were considered obese when their pre-pregnancy BMI was ≥ 30.00 kg/m². Pre-pregnancy BMI was prioritized over gestational BMI in these cases, since weight gain during pregnancy is physiological and could introduce bias in the interpretation of results. In addition to pre-pregnancy BMI, total gestational weight gain was also analyzed, following the guidelines of the Institute of Medicine and National Research Council Committee to Reexamine Pregnancy Weight Guidelines [28] (Table 1).

Contextual variables

Age, number of pregnancies, educational level, and monthly household income were considered as contextual variables potentially associated with OHRQoL during pregnancy. Educational attainment was recorded as the highest educational level completed at the time of the interview and also as years of schooling. For descriptive purposes, education and income were categorized to reflect commonly used socioeconomic strata in Brazilian epidemiological research [29–31] and aligned with national benchmarks reported by the Brazilian Institute of Geography and Statistics (IBGE). The following educational levels were considered: 0 = illiterate; 1 = incomplete elementary; 2 = complete elementary; 3 = incomplete high school; 4 = complete high school; 5 = incomplete higher education; 6 = complete higher education. Monthly household income was classified as follows: 1 – up to 1 minimum wage (MW); 2–1 to 2 MW; 3–2 to 3 MW; 4–3 to 4 MW; 5–4 to 5 MW; 6 – above 5 MW. Minimum wage values were based on official federal decrees (BRL 1,412.00 in 2024; BRL 1,518.00 in 2025).

Table 1 Recommended gestational weight gain according to pre-pregnancy maternal BMI

Pre-pregnancy nutritional status	Gestational weight gain (kg)
Underweight (< 18.5 kg/m ²)	12.5–18
Normal weight (18.5–24.9 kg/m ²)	11–16
Overweight (25.0–29.9 kg/m ²)	7–11.5
Obesity (≥ 30.0 kg/m ²)	5–9

Oral hygiene habits were assessed, including daily toothbrushing frequency and flossing. Access to public-sector prenatal dental care was considered present when there was a record of at least one dental appointment during pregnancy with the oral health team of the PHC unit in which the participant was registered. This information was primarily obtained from electronic health records/PHC system records and also confirmed with participants during the consultation to minimize potential bias due to incomplete or inaccurate records. Emergency dental visits were not considered as access to prenatal dental care, nor were visits conducted in the private sector, in accordance with the exclusion criteria.

Periodontal outcomes

A calibrated and experienced researcher in epidemiological surveys ($\kappa = 0.95$; ICC = 0.88) performed a full-mouth periodontal examination (six sites per tooth) to obtain the following periodontal parameters: probing pocket depth (PPD), clinical attachment level (CAL), bleeding on probing (BOP), and visible dental biofilm. The prevalence of sites and tooth surfaces with BOP and visible biofilm, respectively, was recorded based on the index proposed by Ainamo and Bay [32]. Participants with an intact periodontium (without pockets associated with attachment loss) were classified as “gingivitis cases” when presenting a BOP score $\geq 10\%$, and were further categorized as localized (BOP score $\geq 10\%$ and $\leq 30\%$) or generalized (BOP score $\geq 30\%$), according to the definition proposed by Trombelli et al. [33].

Periodontitis was diagnosed if: (1) interdental attachment loss was detectable at ≥ 2 non-adjacent teeth; or (2) buccal or oral attachment loss ≥ 3 mm with probing pocket depth > 3 mm was detectable at ≥ 2 teeth; and the observed attachment loss could not be ascribed to non-periodontal causes. Subsequently, patients diagnosed with periodontitis were classified according to stages I, II, III, and IV of the disease [34].

Statistical analysis

Statistical analyses were performed using IBM SPSS (version 25.0; IBM Corp., Armonk, NY, USA) and Jamovi (version 2.6.2; The Jamovi Project, Sydney, Australia).

The target sample size was planned a priori based on regression modeling requirements and previous studies from our research group conducted in similar settings and populations, which adopted the Hosmer–Lemeshow approach for multivariable models (15 participants per independent variable) [23, 29–31]. Considering that the present study intended to include up to five independent variables in the final multivariable model, a minimum sample of approximately 75 participants was considered adequate. Therefore, we aimed to recruit ≥ 100 pregnant women to account for exclusions and missing data. The

final analytical sample ($N = 104$) exceeded the minimum planned sample size. As a complementary assessment, we computed a post hoc power estimate for one key periodontal parameter, using G*Power 3.1 and considering a two-tailed Mann–Whitney test ($\alpha = 0.05$). The reference variable was the percentage of sites with CAL > 3 mm. In the comparison between groups ($n_1 = 56$; $n_2 = 48$), the observed U value ($U = 691$) was converted into the Vargha–Delaney stochastic superiority measure (A), which expresses the probability that a randomly selected observation from one group has higher values than those from the other group. The resulting value was $A = 0.743$. Since G*Power requires a parametric effect size, this value was converted to an equivalent Cohen’s d ($d = 0.923$). With these parameters, the achieved statistical power was 0.994 (99.4%).

For bivariate comparisons between groups, quantitative variables were tested for normality and homogeneity of variances using the Shapiro–Wilk and Levene tests, respectively. Student’s *t*-test was applied to continuous variables with normal distribution and homogeneity of variances; the Mann–Whitney U test was used for continuous variables without normal distribution/homogeneity and also for ordinal variables; and the chi-square test was applied to nominal qualitative variables. A significance level of 5% was adopted.

Furthermore, Poisson regression with a log-link function and robust variance was used to model OHRQoL impairment as a binary outcome (0 – no OHRQoL impairment, OHIP-14 = 0; 1 – moderate/high OHRQoL impairment, OHIP-14 > 9). Multivariable modeling followed a theory-driven approach based on a conceptual framework including contextual, access-related, behavioral, systemic, and periodontal variables. Candidate predictors were initially screened in bivariate analyses, and variables showing evidence of association with the outcome ($p < 0.20$) were considered for entry into the multivariable model. In addition, age and number of pregnancies were treated as potential confounders and were evaluated in the multivariable modeling regardless of their bivariate significance and retained if they materially changed the main estimates or improved model fit. Because educational attainment and household income capture overlapping dimensions of socioeconomic position and may be correlated, we did not include both variables simultaneously in the same multivariable model to reduce the risk of multicollinearity and unstable estimates. Educational attainment was prioritized as the main socioeconomic indicator a priori due to its greater stability over time and reduced susceptibility to short-term fluctuations compared with income. The final model was obtained using a purposeful selection strategy, retaining variables that remained independently associated with the outcome ($p < 0.05$) and/

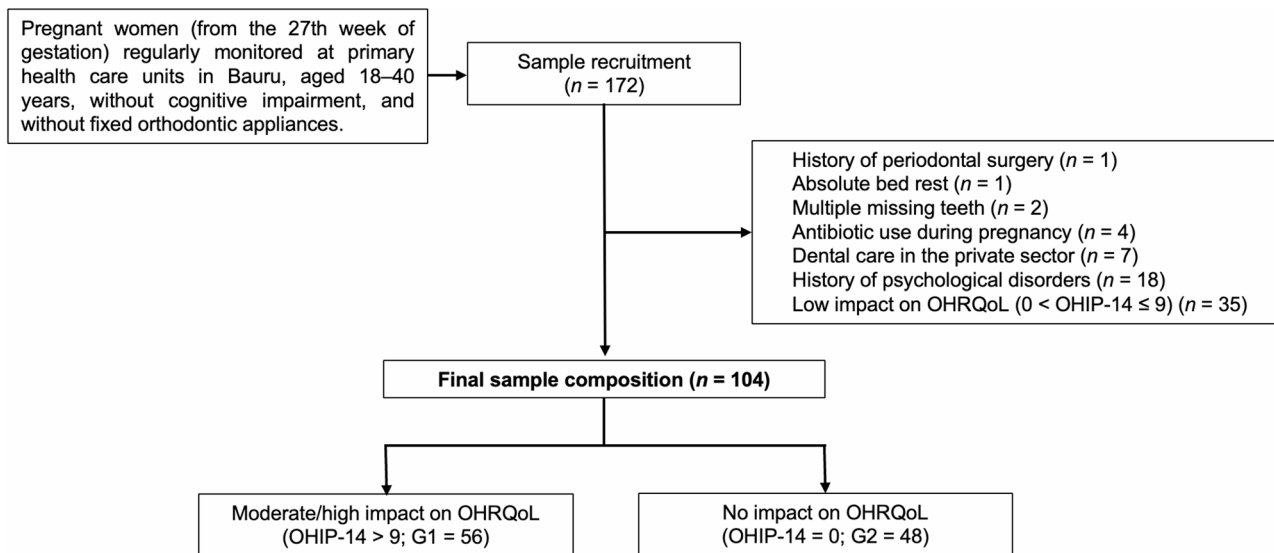


Fig. 1 Participant flow diagram for sample selection

Table 2 Dimensions and total score of the OHIP-14 in G1

Variables	G1 (n = 56) Median [1st – 3rd quartile]
Functional limitation	1 [0–2]
Physical pain	3.50 [2–4]
Psychological discomfort	3.75 [3–4]
Physical disability	2.50 [1–4]
Psychological disability	2 [2–3.63]
Social disability	2 [1.38–3.50]
Handicap	1.50 [1–2]
Total OHIP-14	15.50 [12.40–18.50]
Moderate impact– n (%)	42 (75)
High impact– n (%)	14 (25)

or acted as confounders ($\geq 10\%$ change in PR estimates). This approach allowed adjustment for key contextual and clinical covariates, including educational level, access to prenatal dental care, and presence/severity of periodontitis, thereby improving precision of the estimates. Multicollinearity was assessed using tolerance and variance inflation factor (VIF) computed from an auxiliary linear model including the same set of predictors; VIF ≥ 5 or tolerance ≤ 0.20 were prespecified as concerning. Although logistic regression is commonly used in cross-sectional studies with binary outcomes, it can overestimate effect measures (odds ratios) when outcomes are highly prevalent. Therefore, Poisson regression with robust variance was considered more appropriate in this context, as it directly estimated prevalence ratios (PR), a more interpretable and suitable metric for cross-sectional designs [35].

We also conducted a sensitivity analysis modeling OHIP-14 as a continuous outcome in the full sample, using a robust linear model (HC3 standard errors). BCa bootstrap confidence intervals (1000 resamples) yielded

similar conclusions (Supplementary Material; Table S1), supporting the robustness of the primary extreme-group strategy.

Results

Figure 1 shows the sample recruitment. The final sample comprised 104 participants (G1 = 56; G2 = 48), with a mean age of 28.4 years (± 6.32). Among the subjects in G1, 75% reported a moderate impact on OHRQoL, while 25% reported a high impact (Table 2). Among the OHIP-14 dimensions (Likert scale 0–4), psychological discomfort showed the greatest impact (3.75 [3–4]), followed by physical pain (3.50 [2–4]) and physical disability (2.50 [1–4]). The median total OHIP-14 score was 15.50 [12.40–18.50], representing approximately 55% of the maximum possible OHIP-14 score.

There were no significant differences between groups regarding age, number of pregnancies, pre-pregnancy BMI, gestational weight gain, or prevalence of GDM and systemic arterial hypertension during pregnancy ($p > 0.05$). However, G1 showed lower educational levels ($p = 0.036$), although no significant differences were observed in monthly family income ($p = 0.454$) (Table 3).

G1 showed a lower frequency of toothbrushing ($p = 0.024$). No significant differences were observed between groups regarding the frequency of dental floss use ($p = 0.156$), prevalence of sites with BOP ($p = 0.302$), or surfaces with visible biofilm ($p = 0.979$). Regarding periodontitis classification, 71.4% ($n = 40$) of G1 were diagnosed with periodontitis, with 14.3% ($n = 8$), 42.8% ($n = 24$), and 14.3% ($n = 8$) classified as stage I, II, and III, respectively. In contrast, 25% ($n = 12$) of the women in G2 presented periodontitis, with 14.6% ($n = 7$) and 10.4% ($n = 5$) classified as stage I and II, respectively (Table 4).

Table 3 Comparison of contextual variables between groups

Variables	G1 (n = 56) Mean ± SD Median [1st – 3rd quartile]	G2 (n = 48) Mean ± SD Median [1st – 3rd quartile]	p
Age	28.40 ± 6.48	28.40 ± 6.21	0.983 [*]
Number of pregnancies	3 [2–3]	2 [1–3]	0.149 [†]
Educational level – N (%)	4 [2–4]	4 [4–4]	0.036[‡]
Illiterate (0)	0 (0)	0 (0)	
Incomplete elementary (1)	9 (16.10)	5 (10.40)	
Complete elementary (2)	6 (10.70)	0 (0)	
Incomplete secondary (3)	8 (14.30)	5 (10.40)	
Complete secondary (4)	28 (50)	31 (64.60)	
Incomplete higher education (5)	1 (1.80)	3 (6.30)	
Complete higher education (6)	4 (7.10)	4 (8.30)	
Monthly income – N (%)	2 [2–3]	2 [2–3]	0.454 [†]
Up to 1 MW	11 (19.70)	9 (18.70)	
1–2 MW	26 (46.40)	20 (41.70)	
2–3 MW	14 (25)	10 (20.80)	
3–4 MW	4 (7.10)	6 (12.50)	
4–5 MW	0 (0)	2 (4.20)	
> 5 MW	1 (1.80)	1 (2.10)	
Pre-pregnancy BMI (kg/m ²) – N (%)	27.10 [24–30.80]	26.50 [23.20–31.10]	0.582 [†]
Normal (18.5–24.99 kg/m ²)	22 (39.30)	23 (47.90)	
Overweight (25–29.99 kg/m ²)	16 (28.60)	8 (16.70)	
Obesity grade 1 (30–34.99 kg/m ²)	11 (19.70)	11 (22.90)	
Obesity grade 2 (35–39.99 kg/m ²)	4 (7.10)	4 (8.30)	
Obesity grade 3 (> 40 kg/m ²)	3 (5.30)	2 (4.20)	
Gestational weight gain – N (%)	9.04 ± 7.12	8.57 ± 5.88	0.719 [‡]
Adequate	39 (69.60)	38 (79.20)	
Above recommended	17 (30.40)	10 (20.80)	
GDM – N (%)			
No	44 (78.60)	41 (85.4)	0.368 [‡]
Yes	12 (21.40)	7 (14.6)	
SAH – N (%)			
No	48 (85.70)	45 (93.70)	0.184 [‡]
Yes	8 (14.30)	3 (6.30)	

SD standard deviation, p significance level, MW minimum wage, BMI Body Mass Index, GDM Gestational Diabetes Mellitus, SAH Systemic Arterial Hypertension; * t-test; † Mann-Whitney U test; ‡ Chi-square test; Bold values represent statistical significance (p < 0.05)

Regarding access to prenatal dental care, 75% of the total sample had at least one non-urgent dental consultation within PHC during pregnancy. However, the prevalence of no prenatal dental visit was higher in G1: 33.9% (n = 19) had no record of a dental consultation in the system, and this was consistent with participants' self-report that they had not been scheduled for a dental appointment during pregnancy (Table 4).

In multivariable Poisson regression with robust variance, the included predictors were jointly associated with moderate/high OHRQoL impairment (Table 5). Age and number of pregnancies were evaluated as potential confounders in the multivariable modeling; however, they were not retained in the final model because their inclusion did not materially change the prevalence ratio estimates (≥ 10%) for the main exposures and did not

improve model fit. All predictors showed tolerance > 0.70 and VIF < 2.0, indicating low multicollinearity.

Education (years of schooling) was inversely associated with the outcome (PR per additional year = 0.96; 95% CI, 0.92–0.99; p = 0.025), indicating that each additional year of education was associated with a lower prevalence of moderate/high OHRQoL impairment. Access to prenatal dental care was also significantly associated with the outcome. Pregnant women who did not attend a dental consultation in the public healthcare system during pregnancy had a 48.7% higher prevalence of moderate/high OHRQoL impairment compared with those who had at least one consultation (PR = 1.49; 95% CI: 1.11–1.99; p = 0.008) (Table 5).

Regarding periodontal status, a dose-response association was observed between periodontitis and moderate/

Table 4 Comparison of oral hygiene behaviors and periodontal parameters between groups

	G1 (n = 56) Mean ± SD Median [1st – 3rd quartile]	G2 (n = 48) Mean ± SD Median [1st – 3rd quartile]	p
Daily toothbrushing frequency	3 [2–3]	3 [2–3]	0.024 [†]
Daily dental flossing frequency	0 [0–0]	0 [0–1]	0.156 [†]
BOP (%)	49.60 ± 22.40	45.40 ± 18.60	0.302 [*]
Visible biofilm (%)	63.50 [41.60–86.20]	69.10 [50–81.60]	0.979 [†]
PPD (mm)	2.38 [2.06–2.56]	2.11 [2.02–2.25]	0.003[†]
CAL (mm)	2.41 [2.07–2.54]	2.13 [2.03–2.28]	<0.001[†]
Gingivitis – n (%)			
No gingivitis	2 (3.60)	2 (4.20)	0.977 [†]
Localized	10 (17.80)	8 (16.70)	
Generalized	44 (78.60)	38 (79.20)	
Periodontitis – n (%)			
No periodontitis	16 (28.60)	36 (75)	<0.001[†]
Stage I	8 (14.30)	7 (14.60)	
Stage II	24 (42.80)	5 (10.40)	
Stage III	8 (14.30)	0 (0)	
Stage IV	0 (0)	0 (0)	
Access to prenatal dental care – n (%)			
Yes	37 (66.10)	41 (85.40)	0.023[‡]
No	19 (33.90)	7 (14.60)	

SD standard deviation, p significance level, BOP bleeding on probing, PPD probing pocket depth, CAL clinical attachment level; * t-test; † Mann-Whitney U test; ‡ Chi-square test; Bold values represent statistical significance ($p < 0.05$)

Table 5 Poisson regression with log-link function and robust variance for factors associated with moderate/high OHRQoL impairment (OHIP-14 > 9)

	β	PR	95% CI	p
Intercept	-0.76	0.47	0.26–0.85	0.012
Educational level	-0.05	0.96	0.92–0.99	0.025
Access to prenatal dental care				
Yes	REF	REF	REF	REF
No	0.40	1.49	1.11–1.99	0.008
Periodontitis				
No periodontitis	REF	REF	REF	REF
Stage I	0.49	1.64	0.91–2.97	0.102
Stage II	0.94	2.56	1.65–3.95	<0.001
Stage III	1.07	2.93	1.91–4.48	<0.001

All participants with complete data were included in the multivariable model ($N = 104$); no cases were excluded due to missing data. β regression coefficient (log(PR)), PR prevalence ratio, CI confidence interval, p significance level, REF reference category; Bold values represent statistical significance ($p < 0.05$)

high OHRQoL impairment. Although stage I did not reach statistical significance (PR = 1.64; 95% CI: 0.91–2.97; $p = 0.102$), pregnant women with stage II periodontitis exhibited a 2.56-fold higher prevalence of moderate/high OHRQoL impairment (PR = 2.56; 95% CI: 1.65–3.95; $p < 0.001$), whereas those with stage III showed an almost threefold higher prevalence (PR = 2.93; 95% CI: 1.91–4.48; $p < 0.001$), compared with pregnant women without periodontitis.

Discussion

The results of this study highlight that the assessment of prenatal care should extend beyond traditional clinical outcomes to include subjective dimensions such as

OHRQoL. Fewer years of schooling, lack of dental consultations during prenatal care, and greater periodontitis severity remained independently associated with moderate/high OHRQoL impairment. These findings are consistent with the most recent Brazilian oral-health survey (SB Brasil 2023), which indicates that, among women of reproductive age, periodontal conditions remain common and exhibit regional and social inequalities [18]. These factors serve as markers of social and clinical vulnerability during pregnancy, emphasizing the impact of social determinants of health on maternal well-being. In this context, our findings point out the need for integrated and interdisciplinary strategies within primary health care (PHC), centered on the prevention and

management of periodontitis by a multiprofessional team, and aligned with broader policies to reduce the socioeconomic inequalities that shape maternal health experiences.

Quantitatively, the OHRQoL burden among women with moderate/high impairment in this study was substantial (OHIP-14 > 9), with a median score of 15.50 (IQR 12.40–18.50), corresponding to ~ 55% of the maximum possible value under our scoring approach and indicating marked functional and psychosocial impact. In broader antenatal samples, mean OHIP-14 scores are typically lower (approximately 6–8) [9, 12, 36]. Although cross-study comparisons should be interpreted cautiously because OHIP-14 scoring and outcome operationalization vary, studies conducted in public-sector settings and those explicitly accounting for social vulnerability and barriers to care often report higher values (around ~ 10 or above) [10, 37, 38]. This is plausible because our analysis contrasted extreme outcome strata (OHIP-14 = 0 vs. > 9), excluded the low-impact range, and recruited women in the third trimester, increasing separation between groups and enriching the sample for clinically meaningful impairment. Additionally, recruitment within routine SUS prenatal care may have captured a higher baseline of structural vulnerability, which may amplify perceived impacts; thus, findings should be interpreted as contextual benchmarks, with cautious extrapolation to other settings, including high-income contexts with different health-system organization and social protection.

Educational level is recognized as one of the main social determinants of health, being associated in the literature with health literacy, greater understanding of preventive guidance, and adoption of self-care behaviors [37, 39]. In this study, educational level was inversely associated with moderate/high OHRQoL impairment, indicating that each additional year of schooling was associated with a lower prevalence of worse OHRQoL, a finding consistent with evidence that additional years of schooling promote better oral hygiene practices, increased utilization of dental services, and improved periodontal parameters [13, 15, 38]. This pattern was also reflected in our results, as G1 also demonstrated lower daily toothbrushing frequency, further reinforcing the role of education as a determinant of health behaviors, with both clinical and subjective implications [11, 40]. Thus, low educational attainment should be considered an independent marker of vulnerability during pregnancy, highlighting the need for health education strategies and targeted interventions for this group. Furthermore, our findings point out the importance of intersectoral public policies to reduce social inequalities and promote equitable health empowerment and autonomy. These actions align with the United Nations Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and

Well-Being) and SDG 10 (Reduced Inequalities), ensuring that pregnant women across diverse socioeconomic contexts have equal opportunities to achieve both oral and overall well-being.

Although most pregnant women in this study (75%) had at least one dental consultation during pregnancy, this finding should be interpreted with caution in the context of Brazilian maternal–child health policies. Investments in the Stork Network (*Rede Cegonha*) since 2011, reaffirmed and expanded in 2024 with the implementation of the Alyne Network (*Rede Alyne*), have been milestones in organizing prenatal, childbirth, and postpartum care, emphasizing comprehensiveness, humanization, and reduction of inequalities [16]. In oral health, the establishment of the Oral Health Care Network aims to integrate dental care into this system, strengthening follow-up through PHC [17]. These advances reflect investments in the structuring of primary care and partly explain the high proportion of women with at least one dental consultation [41, 42]. Nevertheless, in our dataset “prenatal dental care” was defined as ≥ 1 visit and did not capture the content of the appointment. In practice, many recorded visits are preventive-only and may not include periodontal diagnosis or therapeutic procedures, which limits inference about care quality and comprehensiveness.

Moreover, federal funding for health teams, including oral health teams, is tied to quantitative performance targets, among which prenatal care coverage is included. This arrangement may favor target-driven care at the expense of quality, with a risk of widening inequalities [41, 43]. Not all appointments coded as “prenatal dental care” represent effective or resolute care. Distinguishing preventive-only from resolute (therapeutic) consultations, and tracking whether periodontal diagnosis and treatment were performed, should be a priority for policy evaluation and routine monitoring. Consistent with national and municipal evidence from Brazil, prenatal dental care utilization has risen substantially [42], yet access remains uneven and strongly conditioned by municipal social and organizational factors [44]. Our findings reinforce this concern, as unmet oral health needs persisted despite high access, particularly among pregnant women with poorer OHRQoL. This suggests that mere numerical expansion of consultations does not guarantee effective care and may even overburden professionals without ensuring the comprehensiveness promoted by care networks. Therefore, it is essential that monitoring and funding strategies advance beyond the mere number of appointments, prioritizing professional recognition and support, and quality indicators that reflect meaningful improvements, thereby reducing the regional disparities still observed in access to dental care during pregnancy [41, 44, 45].

From a clinical standpoint, dental care during pregnancy is generally considered safe when appropriately indicated, including the use of local anesthetics, restorative procedures, and periodontal therapy [46, 47]. However, despite this evidence base, delivery of resolute dental care in routine public-sector settings may still be hindered by persistent misconceptions and risk-avoidance beliefs, not only among pregnant women, but also among dental professionals and the prenatal medical team. These factors represent implementation barriers rather than clinical contraindications and may reduce referrals, acceptance of treatment, and the prioritization of therapeutic interventions [47]. In addition, limitations in care coordination and fragmented referral pathways within health care networks can reinforce prevention-only encounters and delays in addressing caries, gingivitis/periodontitis, oral lesions and other symptomatic oral complaints, with potential downstream consequences for maternal well-being and increased demand on public services. Because we did not capture pre-pregnancy oral status or the content and timing of dental procedures delivered during prenatal care, we could not assess how prior disease burden versus care delivery patterns may have influenced current periodontal parameters and perceived OHRQoL. Future studies should incorporate preconception/early-pregnancy oral assessments and detailed recording of preventive and therapeutic interventions to disentangle baseline disease from care delivery across gestation.

In addition to socioeconomic and access-related factors, periodontal clinical measures in this study were consistently associated with OHRQoL. Pregnant women experiencing worse OHRQoL exhibited poorer periodontal parameters. Multivariable Poisson models confirmed a dose-response pattern: those with stages II–III periodontitis had more than twice the prevalence of impaired OHRQoL compared with women without periodontitis. These findings highlight the clinical relevance of periodontitis as a condition that not only compromises oral health but also directly affects the subjective experience of well-being during pregnancy, corroborating previous studies that identify periodontal disease as a significant determinant of OHRQoL in vulnerable populations [36, 48–50]. Moreover, literature links maternal periodontitis with maternal morbidity and adverse neonatal outcomes, including preterm birth and low birth weight, and suggests potential longer-term risks for offspring, underlining the intergenerational importance of prevention [3, 7, 8]. Taken together, these results suggest that periodontal severity may serve as a pragmatic risk-stratification marker in prenatal care, supporting timely periodontal screening and closer follow-up for women with higher disease stages and greater OHRQoL burden. To translate this risk-stratified approach into practice, timely and

resolute prenatal dental care is essential, since preventive and therapeutic interventions can reduce gingival inflammation, control periodontitis progression, and consequently improve perceived OHRQoL [14]. Therefore, monitoring and funding strategies should prioritize quality and resolutiveness, not only the number of consultations, to better align care with women's clinical and subjective needs.

This study has some limitations. First, the cross-sectional design precludes causal inferences; thus, the observed associations should be interpreted as associative rather than causal. There is also the possibility of reverse causality, whereby pregnant women with poorer perceived OHRQoL may engage less in self-care practices, which may be associated with worse periodontal status. Second, although OHRQoL was assessed using the OHIP-14 through standardized interviews conducted by calibrated researchers, the instrument remains susceptible to subjectivity and information bias. Third, access to prenatal dental care was operationalized dichotomously (≥ 1 consultation within the public health system), without distinction regarding the type (preventive only vs. preventive plus therapeutic) or quality of care, and heterogeneity may exist among units within the same municipality, implying potential residual confounding. In addition, we did not measure psychosocial factors that may influence OHRQoL in pregnancy, such as anxiety, depressive symptoms, stress, or perceived social support. These constructs may correlate with socioeconomic vulnerability, health behaviors, and the use of prenatal dental services; therefore, residual confounding from unmeasured factors cannot be excluded. Future studies should incorporate validated measures of maternal mental health and social support to better disentangle these relationships. Fourth, recruitment was restricted to SUS primary care units and was non-probabilistic (excluding women receiving prenatal care exclusively in the private sector); therefore, the study should be interpreted as a convenience sample from public-sector services, which may limit representativeness and generalizability. Refusal rates were not systematically recorded, which may have introduced selection bias. In addition, extrapolation to other Brazilian municipalities and to different cultural or health-system contexts (including in high- and low-income countries) should be made with caution, as local determinants (e.g., service organization, availability of oral health teams, and contextual inequalities) may vary across settings and modify effect sizes. Fifth, restricting the sample to women in the third trimester may reduce generalizability to earlier stages of pregnancy. Finally, self-reported behaviors (e.g., toothbrushing frequency) are subject to measurement error (social desirability bias). Prospective population-based cohort studies with larger samples and repeated measurements, ideally from

the preconception period through the gestational trimesters, could elucidate causality and provide more robust population-level inferences.

Despite the limitations, it can be concluded that greater negative impact on OHRQoL was independently associated with lower educational attainment, absence of prenatal dental care, and more severe periodontitis, indicating persistent social and clinical vulnerabilities despite advances in maternal–child health policies. These findings support an integrated and transdisciplinary approach in PHC that goes beyond prevention to include timely periodontal diagnosis and management, with standardized screening from the first trimester, strengthened health education for women with low schooling, and the prioritization of quality indicators (not merely consultation counts) in monitoring and funding. By aligning care with these priorities, the health system can enhance the effectiveness of the Alyne Network and the Oral Health Care Network, promoting equity in prenatal care and contributing to better maternal and neonatal outcomes.

Supplementary Information

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Supplementary Material 1.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI) for proof-reading and readability improvement. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

Authors' contributions

****Yasmim Zinezi:** ** Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review and editing. ****Amanda Borges Pirondi:** ** Investigation, Methodology, Resources, Validation, Visualization, Writing – review and editing. ****Luiz Renato Paranhos:** ** Formal analysis, Validation, Visualization, Writing – review and editing. ****Gilberto Alfredo Pucca Junior:** ** Formal analysis, Validation, Visualization, Writing – review and editing. ****Thais de Moraes Souza:** ** Formal analysis, Validation, Visualization, Writing – review and editing. ****Roosevelt da Silva Bastos:** ** Formal analysis, Validation, Visualization, Writing – review and editing. ****Marília Afonso Rabelo Buzalaf:** ** Formal analysis, Funding acquisition, Investigation, Visualization, Writing – review and editing. ****Gerson Aparecido Foratori-Junior:** ** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review and editing.

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Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Research Ethics Committee of the Bauru School of Dentistry, University of São Paulo (CAAE: 79324624.2.0000.5417, Brazil). Written informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable (no individually identifiable data are presented).

Competing interests

Gerson Aparecido Foratori-Junior is a member of the Editorial Board of *BMC Pregnancy and Childbirth*. He had no role in the editorial handling or peer review of this manuscript. All other authors declare that they have no competing interests.

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