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Systemic Condition, Periodontal Status, and Quality of Life in Obese Women During Pregnancy and After Delivery

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ABSTRACT

Objective: To evaluate the systemic condition, periodontal status, and quality of life of obese women during pregnancy and after delivery.

Methods: This prospective cohort consisted of 60 women examined in the third trimester of pregnancy (32nd-36th gestational week [T1]) and after delivery (T2) and were divided into elevated body mass index (BMI; GO = 30) and normal BMI (GN = 30) according to the World Health Organization. The variables assessed were: (1) gestational weight gain, arterial hypertension (AH), and diabetes mellitus; (2) oral hygiene behaviour (frequency of dental floss using and toothbrushing); (3) probing pocket depth (PPD), clinical attachment loss (CAL), bleeding on probing (BOP), and dental biofilm; and (4) quality of life (Oral Health Impact Project [OHIP]-14). Analysis of variance (ANOVA), Friedman, Cochran’s Q and $\chi^2$ tests, and logistic regression model were adopted ($P < .05$).

Results: GO showed a higher frequency of AH in T1 ($P < .001$). Both groups decreased the frequency of dental floss use ($P = .013$) and toothbrushing ($P < .001$) and increased the percentage of dental biofilm in T2 ($P < .001$). GO presented a greater PPD and CAL in T1 and T2 and higher BOP in T1 ($P < .001$), demonstrating a negative impact in the following dimensions of Oral Health Impact Project-14 during T1 functional limitation ($P = .020$), physical disability ($P = .020$), and handicap ($P = .021$).

Conclusion: Obese women presented higher prevalence of AH during pregnancy and higher prevalence of periodontitis in both periods. They showed a poor quality of life in T1 regarding functional limitation, physical disability, and handicap.

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Introduction

Because of hormonal and immunological changes during pregnancy, women can present an exacerbated inflammation of gingival tissues, even due to the presence of a small amount of dental plaque.1 Previous evidence shows a significant increase of gingivitis and ratio of anaerobic to aerobic bacteria during pregnancy.1,2 Periodontitis during pregnancy can be associated with adverse pregnancy outcomes, such as preterm birth, low birthweight, and preeclampsia.3 Consequently, oral impairments during pregnancy may impact an individual’s well-being.5,6 Obesity is a chronic disease that has increased worldwide because of sedentary lifestyle and excessive consumption of processed and caloric food.5 Obesity during pregnancy is related to adverse gestational consequences, such as preeclampsia, gestational diabetes mellitus, caesarean section, and placental and foetal dysfunction.7 The adipose tissues of obese patients secrete tumour necrosis factor alpha (TNF-α), adipokines, adipocytokines, and interleukins that cause a generalised inflammation in the patient’s body.8,9 To this
end, there is ample scientific evidence highlighting the association between obesity and periodontitis. Obesity-related oral changes and other nutritional disorders may negatively influence patients' well-being, including functional, physical, psychological, and social disabilities and handicap.11,12

Previous studies that have investigated the occurrence of periodontal disease during pregnancy in overweight women have suggested a positive association between periodontitis and obesity.13–24 Nonetheless, they presented methodological differences such as study design, sample size, and diagnostic criteria for periodontitis and overweight and obesity.

Caracho et al22 evaluated the periodontal status and oral health-related quality of life (OHRQoL) in pregnant women with excessive weight, nonetheless, the aforementioned study had a cross-sectional design, recruited only pregnant women from a Brazilian public health care system with low socioeconomic condition, and included women both with overweight and obesity in the same group.

Considering the heterogeneity of previous studies, lack of a longitudinal study that adopts standardised diagnostic criteria for periodontitis, obesity, and assessment of individuals' well-being, this study aimed to assess the systemic condition, periodontal status, and quality of life in women with obesity during pregnancy and after delivery.

Material and methods

This prospective cohort study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.25

Ethical approval

According to the Declaration of Helsinki (1964 and its amends), this study was previously approved by the Ethics Committee on Human Research (CAAE 58339416.4.0000.5417). All women submitted a written informed consent prior to participation.

Sample conformation

This study adopted the following inclusion criteria: good neuromotor health, regular gestational follow-up, being in the third trimester of pregnancy, presenting with obesity or normal body mass index (BMI), a schooling level of being at least at graduate of college, and a monthly income of at least R$3500.00 (corresponding to about USD$680.00). Exclusion criteria were women with diabetes or hypertension, anaemia, or diagnosed with anxiety or depression; underweight (BMI <18.5 kg/m²) and overweight (BMI 25.0-29.9 kg/m²); requiring ambulatory care; with excessive weight, nonetheless, the aforementioned study did not include women classified as overweight (BMI 25-29.9 kg/m²) because they could present an inflammatory response similar to patients of both normal and obese weights. Therefore, the inclusion of overweight patients in the same group of obese patients could mask the differences that could be seen between eutrophic and obese patients, biasing the results.

Women were recruited from Bauru, São Paulo, Brazil, and were assessed between the 32nd and 36th gestational week (T1) and, at least, 2 months after delivery (T2). The recruitment of women and data collection during pregnancy and after delivery occurred from February 2019 to November 2019. All women were paired by age and socioeconomic status (education and income levels).

Anthropometric measurements, systemic condition, and oral hygiene habits

The weight and BMI of women in T1 and T2 were documented and were classified as excessive or normal gestational weight gain (GWG) according to their prepregnancy weight and weight at the end of T1. Weight was calculated using an automatic scale, and the protocol of the Institute of Medicine27 for recommended GWG was adopted (Table 1).

The presence of arterial hypertension (AH) and diabetes mellitus during T1 and T2 was collected from medical records. AH in pregnancy was considered when blood pressure levels were ≥140/90 mm Hg,28 and gestational diabetes mellitus was considered when maternal hyperglycaemia >92 mg/dL (fasting level).29 Hyperglycaemia values greater than 99 mg/dL in T2 (after pregnancy) were considered abnormal (presence of diabetes mellitus).

With respect to women’s oral hygiene habits, daily use of dental floss and frequency of toothbrushing were assessed

| Nutritional status before pregnancy | BMI (kg/m²) | Recommended GWG (kg) |
|-----------------------------------|------------|----------------------|
| Underweight                       | <18.5      | 12.5-18              |
| Normal                            | 18.5-24.9  | 11-16                |
| Overweight                        | 25.0-29.9  | 7-11.5               |
| Obesity                           | ≥30.0      | 5-9                  |

BMI = body mass index; GWG = gestational weight gain.
during pregnancy and after delivery. These data were self-reported by patients.

**Periodontal examinations**

One trained dentist conducted the oral examinations (κ interexaminer = 0.92; intraexaminer = 0.95). For the diagnosis of periodontitis, probing pocket depth (PPD) and clinical attachment loss (CAL) were assessed in 6 sites (mesial, centre, and distal, both buccal sides, and both the palatal and lingual surfaces) of all teeth, excluding the third molars. The PPD corresponded the distance between the free gingival margin and the bottom of the periodontal pocket, and CAL corresponded the distance from the cementoenamel junction to the base of the periodontal pocket.30

According to Tonetti et al.,30 periodontitis was present if interdental clinical attachment loss was detectable on 2 or more nonadjacent teeth or buccal or oral clinical attachment loss of ≥3 mm with pocketing of >3 mm was detectable on 2 or more teeth and the observed clinical attachment loss was not ascribed to nonperiodontal causes.22,23 Afterward, periodontitis was classified in stages between I and IV as described by Tonetti et al.30

The prevalence (in percentage) of bleeding on probing (BOP) from each assessed site and the prevalence of dental surfaces (buccal or lingual surfaces) with visible dental biofilm (visible dental biofilm index)31 were documented for each group. Both BOP and visible dental biofilm indexes were proposed by Ainamo and Bay.31 The percentages of BOP and dental plaque were obtained based on total assessed sites and assessed dental surfaces, respectively.

**Oral health-related quality of life**

The Oral Health Impact Project (OHIP)-14 was applied to assess the influence of oral health on women's well-being.32 To avoid possible different interpretations among women and, thus, minimise their subjectivity, the questionnaire was applied through a standardised interview. Women were asked how often (0 = never, 1 = rarely, 2 = occasionally, 3 = often, and 4 = very often) they had experienced oral health symptoms listed in the questionnaire during and after pregnancy. Each 2 questions from the questionnaire corresponded to 1 of the following dimensions of OHIP-14: functional limitations; physical pain; psychological discomfort; physical, psychological, and social disabilities; and handicap. The total score was obtained by adding the mean of each dimension, and it varied from 0 to 28. The scores were categorised into no impact (0), low impact (0 < OHIP-14 ≤ 9), moderate impact (9 < OHIP-14 ≤ 18), and high impact on the quality of life (18 < OHIP-14 ≤ 28).32

**Statistical analysis**

IBM SPSS (Released 2017, Version 25.0; IBM Corp.) was used to perform the analysis. The Hosmer and Lemeshow protocol for logistic regression analysis33 was considered to determine the sample size, according to previous studies.13−22 That protocol allows the inclusion of 20 cases for each independent variable inserted in logistic regression models. In this study, the dichotomisation of outcomes (periodontitis and quality of life) was performed, and subsequently, binary logistic regression models with these outcomes were adopted, in which, at maximum, 3 independent variables were included. Therefore, this study was representative because we collected data from 60 women. Moreover, according to previous evidence in the same field,20 the power test was calculated considering a difference between the mean of CAL of the groups during pregnancy of at least 10%, with a standard deviation of 10%. Based on mean of CAL and standard deviations of the 2 groups, an effect size of 0.82 was obtained, resulting in a power of 93% with the sample size used.

In bivariate analysis, after Shapiro-Wilk and Bartlett tests were applied, the following tests were considered: analysis of variance (ANOVA; % BOP); Friedman (BMI, daily toothbrushing, daily dental floss use, PPD, CAL, % dental plaque, functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, handicap, and overall OHIP-14 score); Cochran Q test (arterial hypertension, diabetes mellitus, and periodontitis classification); and $\chi^2$ (GWG classification). Bonferroni test was applied to identify intergroups and interperiods differences.

Binary logistic regressions (stepwise backward - likelihood ratio) were performed. According to the standardised statistical criteria, all independent variables with $P < .20$ in bivariate analyses were included in the initial model of logistic regression. Hosmer–Lemeshow, collinearity, and residual analyses were implemented to explain the results obtained through logistic regression. A significance level of 5% was adopted.

**Results**

The mean age of the sample was 29.66 years, with 30.46 and 28.86 for GO and GN, respectively ($P = .266$). Approximately 80% ($n = 24$), 13.3% ($n = 4$), and 6.7% ($n = 2$) of GO indicated a schooling level of graduated college, masters, and PhD, respectively. While 73.3% ($n = 22$), 16.7% ($n = 5$), and 10% ($n = 3$) of GN were classified as having graduated college, masters, and PhD, respectively ($P = .545$). Similarly, 70% ($n = 21$) and 30% ($n = 9$) of GO had monthly income of R$3500.00-6000.00 and higher than 6000.00, respectively. In contrast, 60% ($n = 18$) and 40% ($n = 12$) of GN presented the same monthly income classification, respectively ($P = .420$).

Figure 1 shows the change in women’s BMI over time ($P < .001$). GO and GN had a mean GWG of 5.71 and 7.62, respectively (Figure 1). GO and GN had a mean GWG of 5.71 and 7.62, respectively ($P = .146$). Nevertheless, a higher percentage of women in GO presented excessive GWG (26.66% and 6.66% in GO and GN, respectively; $P = .039$).

GO showed a greater frequency of hypertension during pregnancy (36.6%), with a significant decrease after delivery ($P < .001$), without intergroup difference in T2. Concerning oral hygiene behaviours, there were no differences between groups in T1 and T2; nonetheless, GO and GN showed a decrease in the frequency of daily toothbrushing ($P < .001$) and daily dental floss use ($P = .013$) between periods (Table 2). Consequently, there was an increase in the percentage of dental plaque in both groups after delivery ($P < .001$).

For PPD, GO showed median values and interquartile ranges of 2.23 [1.94-2.57] and 2.14 [2.06-2.29] in T1 and T2,
respectively. For CAL, GO presented 2.23 [2.04-2.39] and 2.16 [2.10-2.32] in T1 and T2, respectively, being higher than the median values for GN ($P < .001$). Table 3 also highlights the prevalence and severity of periodontitis in both periods. Despite the intergroup difference in the prevalence of periodontitis in both periods, no differences between the periods were found (Table 3).

Dental plaque, hypertension, and maternal BMI were inserted in the initial logistic regression model related to presence of periodontitis in T1 (Table 4). The final model was significant ($X^2(1) = 18.29; P < .0001; R^2$ of Negelkerke = 0.352) and had an 80% accuracy. In the multicollinearity analysis, all variables had values of tolerance of $>0.90$ and variance inflation factor (VIF) values $<2$. “Maternal BMI” (odds ratio = 1.229; 95% CI 1.10-1.38; $P = .001$) remained on the final model, showing that high maternal BMI was associated with the occurrence of periodontitis during pregnancy. In the Hosmer–Lemeshow analysis, a $\chi^2$ value of 10.12 in the final model for 8 degrees of freedom ($P = .257$) was obtained.

GO had greater values for the overall score of OHIP-14 during T1, with improvement in the postpartum period. Among the dimensions of OHIP-14, T1 GO had the greatest impact on

![Fig. 1 – Comparison of women’s body mass index (BMI) changes over time.](image)

Table 2 – Comparison of systemic conditions and oral hygiene behaviours between groups and periods.

|                  | GO (n = 30) | GN (n = 30) | T1      | T2      | P      |
|------------------|-------------|-------------|---------|---------|--------|
| **AH** (n)       | Aa          | Ab          | Ba      | Aa      | <.001  |
| No               | 19 (63.3%)  | 28 (93.4%)  | 26 (86.7%) | 30 (100%) | <.001  |
| Yes              | 11 (36.7%)  | 2 (6.6%)    | 4 (13.3%) | 0 (0%)  |        |
| **Diabetes Mellitus** (n) | Aa         | Aa          | Aa      | Aa      |        |
| No               | 26 (86.7%)  | 28 (93.4%)  | 29 (96.7%) | 30 (100%) | .172   |
| Yes              | 4 (13.3%)   | 2 (6.6%)    | 1 (3.3%) | 0 (0%)  |        |
| **Daily toothbrushing** | Aa         | Aa          | Ba      | Ba      |        |
| Median [1st-3rd quartiles] | 3 [3-3]    | 3 [3-3]    | 2.5 [2-3] | 3 [2-3]  | <.001  |
| Daily dental floss using | Aa         | Aa          | Ba      | Ba      | .013   |
| Median [1st-3rd quartiles] | 1 [0-1]   | 1 [0-1]    | 0 [0-1] | 0 [0-1] |        |

To evaluate the differences between groups within a same period, lowercase letters should be evaluated (different lowercase letters correspond to difference between groups; Bonferroni $P < .05$). To evaluate the differences between periods for the same group, capital letters should be evaluated (different capital letters correspond to difference between periods; Bonferroni $P < .05$).

$P =$ significance level.

* Arterial hypertension $\geq 140 \times 90$ mm Hg.

† Cochran’s Q test.

‡ Friedman.
functional limitation \((P = .020)\), physical disability \((P = .020)\), and handicap \((P = .021)\). The comparison between periods shows that GO had lower values for physical disability \((P = .020)\), social disability \((P = .020)\), and psychological discomfort values \((P < .001)\), indicating an improvement in these dimensions related to individuals’ quality of life after delivery (Table 5).

Maternal BMI, presence of periodontitis, and hypertension were inserted in the regression model related to the impact on quality of life (Table 6). The final model was significant \([\chi^2(1) = 6.81; P = .009\); \(R^2\) of Nagelkerke = 0.151] and had a 71.7% accuracy. In the multicollinearity analysis, all variables had tolerance values of >0.90 and variance inflation factor (VIF) values <2. “Maternal BMI” (odds ratio = 1.111; 95% CI 1.02-1.22; \(P = .018\)) remained on the final model, showing that a high maternal BMI was associated with the impact on quality of life during pregnancy. In the Hosmer–Lemeshow analysis, a \(\chi^2\) value for the final model of 4.93 for 8 degrees of freedom \((P = .764)\) was obtained.

Discussion

This longitudinal study highlighted that obese women have a greater prevalence of gestational hypertension and worst periodontal status during pregnancy and also postpartum. Furthermore, high maternal BMI is associated with functional limitation, physical disability, and handicap during pregnancy.

Previous studies showed that the socioeconomic level is associated with periodontitis,11,14,17,20,23 obesity,11,14,17,20,23,34 and negative quality of life.11,35,36 Pregnant women with high BMI who showed the worst periodontal status also had a lower socioeconomic level.22 To minimise the influence of

**Table 3 – Periodontal parameters compared between groups and periods.**

|                | T1                      | T2                      | \(P\)     |
|----------------|-------------------------|-------------------------|-----------|
| **GO (n = 30)** | **GN (n = 30)**         | **GO (n = 30)**         | **GN (n = 30)** |
| **Median**     | **Median**              | **Median**              | **Median** |
| **[1st-3rd quartiles]** | **[1st-3rd quartiles]** | **[1st-3rd quartiles]** | **[1st-3rd quartiles]** |
| **Mean (95%) CI** | **Mean (95%) CI**       | **Mean (95%) CI**       | **Mean (95%) CI** |
| **PPD (mm)**   | 2.23                    | 1.93                    | 2.14      | 1.97 |
|                | [1.94-2.57]             | [1.84-2.03]             | [2.06-2.29]| [1.89-2.09]| <.001*|
| **CAL (mm)**   | 2.23                    | 1.95                    | 2.16      | 2.01 |
|                | [2.04-2.39]             | [1.86-2.03]             | [2.10-2.32]| [1.91-2.11]| <.001*|
| **Dental plaque (%)** | 21.98                  | 32.14                  | 62.25     | 57.14 |
|                | [11.53-61.53]           | [14.28-50.00]           | [42.85-75.00]| [42.85-67.85]| <.001*|
| **BOP (%)**    | 37.45                   | 26.18                   | 45.14     | 39.11 |
|                | (20.58-44.32)           | (20.94-31.41)           | (38.87-51.41)| (34.88-43.35)| <.001*|
| **Periodontitis (n)** | 8 (26.6%)              | 26 (86.7%)             | 13 (43.3%)| 29 (96.7%) |
|                | 22 (73.7%)              | 4 (13.3%)               | 17 (56.7%)| 1 (3.3%) |
| **Stage I**    | 6 (20%)                 | 2 (6.6%)                | 8 (26.6%) | 1 (3.3%) |
| **Stage II**   | 8 (26.6%)               | 2 (6.6%)                | 5 (16.6%) | 0 (0%) |
| **Stage III**  | 8 (26.6%)               | 0 (0%)                  | 4 (13.3%) | 0 (0%) |
| **Stage IV**   | 0 (0%)                  | 0 (0%)                  | 0 (0%)    | 0 (0%) |

To evaluate the differences between groups within a same period, lowercase letters should be evaluated (different lowercase letters correspond to difference between groups; Bonferroni \(P < .05\)). To evaluate the differences between periods for the same group, capital letters should be evaluated (different capital letters correspond to difference between periods; Bonferroni \(P < .05\)).

BOP = bleeding on probing; CAL = clinical attachment loss; CI = confidence interval; P = significance level; PPD = probing pocket depth.

* Friedmann test.
† Analysis of variance (ANOVA).
‡ Cochran’s Q test.

Table 4 – Binary logistic regression models showing the independent variables related to maternal periodontitis.

| Model      | Variables               | \(\beta\) | Adjusted OR | CI 95% | \(P\)  |
|------------|-------------------------|-----------|-------------|-------|-------|
| Model 1    | Dental Plaque           | 0.008     | 1.01        | 0.98-1.03 | .478 |
|            | Hypertension            | 0.295     | 1.343       | 0.21-8.26 | .750 |
|            | Maternal BMI            | 0.214     | 1.238       | 1.08-1.42 | .002 |
|            | Constant                | -5.878    | 0.003       | .000-1.00 | .049 |
| Model 2    | Dental Plaque           | 0.008     | 1.01        | 0.98-1.03 | .490 |
|            | Maternal BMI            | 0.203     | 1.225       | 1.09-1.37 | .001 |
|            | Constant                | -5.310    | 0.005       | .000-1.00 | .025 |
| Final Model| Maternal BMI            | 0.206     | 1.229       | 1.10-1.38 | .001 |
|            | Constant                | -6.028    | 0.002       | <.001  |

BMI = body mass index; CI = confidence interval; OR = odds ratio; \(P\) = significance level.
socioeconomic level on outcomes, women in this study were paired by education and monthly income.

The hypothesis that best explains the higher inflammatory response of periodontal tissue during pregnancy is that these women have a reduced immune response because there is a reduction in the antimicrobial activity of peripheral neutrophils and increased levels of oestrogen and progesterone in the body.1–3,19–23

Obesity, in turn, is associated with periodontitis because the generalised inflammatory state of the patient’s body, a result of cytokines that are released by adipose tissue,10 Tumour necrosis factor alpha, interleukin-6, interleukin-8, and C-reactive protein, among others, also interfere negatively with the individuals’ immune response, making them more prone to exacerbated inflammation.8,9

These cytokines also have an impact on the systemic health of patients because they cause vascular inflammation and endothelial disturbance, leading to an imbalance between vasodilatation and vasoconstriction, which is clinically diagnosed as arterial hypertension.37,38 In this study, as well as in previous findings,18–24 obese pregnant women presented a higher prevalence of hypertension, but the condition was resolved after delivery (Table 2). Our hypothesis is that during pregnancy, women are more prone to the effects of obesity-related inflammatory mediators.20

Another condition that must be controlled during pregnancy is weight gain. In this present study, a greater frequency of women in GO had excessive GWG according to the recommendation, and that corroborates previous findings.19,20,23 Elevated BMI and GWG may result in pregnancy complications, for instance, gestational diabetes mellitus, preeclampsia, and pregnancy-induced hypertension,23,39,40 which may also explain the higher frequency of gestational hypertension for obese women.

Table 5 – Oral health-related quality of life between groups and periods.

| Variables          | GO (n = 30) | GN (n = 30) | GO (n = 30) | GN (n = 30) |
|--------------------|-------------|-------------|-------------|-------------|
|                    | Median      | Median      | Median      | Median      |
|                    | [1st-3rd quartiles] | [1st-3rd quartiles] | [1st-3rd quartiles] | [1st-3rd quartiles] |
| Functional limitation | 0 [0-2]    | 0 [0-2]    | 0 [0-0]    | 0 [0-0]    |
| Physical pain      | 1.5 [0-3]  | 1 [0-2]    | 1 [0-2]    | 0.5 [0-3]  |
| Psychological discomfort | 2 [0-4]   | 1 [0-2]    | 0 [0-2]    | 0 [0-1]    |
| Physical disability | 0 [0-3]    | 0 [0-0]    | 0 [0-0]    | 0 [0-0]    |
| Psychological disability | 0 [0-2]  | 0 [0-1]    | 0 [0-1]    | 0 [0-0]    |
| Social disability  | 1 [0-2]    | 0 [0-2]    | 0 [0-1]    | 0 [0-1]    |
| Handicap           | 0 [0-2]    | 0 [0-0]    | 0 [0-0]    | 0 [0-0]    |
| Overall OHIP-14    | 8.50 [2-14] | 3.25 [1-8] | 0.75 [0-6] | 0.25 [0-4.5] |

To evaluate the differences between groups within a same period, lowercase letters should be evaluated (different lowercase letters correspond to difference between groups; Bonferroni P < .05). To evaluate the differences between periods for the same group, capital letters should be evaluated (different capital letters correspond to difference between periods; Bonferroni P < .05).

OHIP = Oral Health Impact Project; P = significance level.

* Friedmann test.

and C-reactive protein, among others, also interfere negatively with the individuals’ immune response, making them more prone to exacerbated inflammation.8,9

Table 6 – Binary logistic regression models showing the independent variables related to the impact on quality of life.

| Model          | Variables          | β   | Adjusted OR | CI 95% | P       |
|----------------|--------------------|-----|-------------|--------|---------|
| Model 1        | Maternal BMI       | 0.095 | 1.099 | 0.98-1.23 | .105    |
|                | Periodontitis      | -0.627 | 0.534 | 0.14-1.97 | .346    |
|                | Hypertension       | 0.311 | 1.365 | 0.25-7.26 | .715    |
|                | Constant           | -3.410 | 0.033 | .01-1.08 | .940    |
| Model 2        | Maternal BMI       | 0.083 | 1.087 | 0.98-1.20 | .089    |
|                | Periodontitis      | -0.633 | 0.531 | 0.14-1.95 | .340    |
|                | Constant           | -2.837 | 0.059 | .01-0.67 | .080    |
| Final Model    | Maternal BMI       | 0.105 | 1.111 | 1.02-1.22 | .018    |
|                | Constant           | -3.790 | 0.023 | .01-0.72 | .004    |

BMI = body mass index; CI = confidence interval; OR = odds ratio; P = significance level.
periodontitis during pregnancy. There were no intergroup differences in these habits; however, both groups reported less frequent daily toothbrushing ($P < .001$) and flossing habits ($P = .013$) after delivery (Table 2). Consequently, both groups also showed a higher prevalence of dental plaque after delivery (Table 3). This can be explained by the change in the mothers’ routine because they spend more time on child care and, thereby neglect their own health. In view of that, as stated by Martínez-Beneyto et al., it is necessary to incorporate preventive oral health programs for pregnant women during pregnancy, reducing the adverse effects both during and after gestational period.

Regarding the prevalence and severity of periodontitis, we found worse periodontal status in obese pregnant women (Table 3). Logistic regression indicated that high maternal BMI was more determinant for periodontitis than daily toothbrushing (Table 4).

Previous findings reported a positive association between obesity and periodontitis during pregnancy. Nonetheless, some methodological differences must be carefully evaluated, mainly with respect to the study design and diagnostic criteria of periodontitis and nutritional status. Foratori-Junior et al. was the only prospective study that compared systemic and periodontal status throughout gestation (second and third trimesters) and postpartum, but included overweight and women in the same group and did not analyse the women’s quality of life and well-being. Caracho et al. sought to assess the general and periodontal status in addition to women’s OHRQoL; however, it had a cross-sectional design with no large sample, and overweight and obese women were grouped together. Gomes-Filho et al. conducted research with a representative sample, but their cross-sectional design did not find a positive association between maternal obesity and periodontitis during gestation, neither evaluated women’s OHRQoL.

This study reported a higher OHIP-14 overall score in obese pregnant woman ($P < .001$) (Table 5), which indicates a poor perception of quality of life related to oral health. Functional limitation ($P = .020$), physical disability ($P = .020$), and handicap ($P = .021$) were the OHIP-14 dimensions had a higher negative impact on oral health during pregnancy in GO. However, pregnant women with obesity had a great improvement in overall OHIP-14 score after delivery, as well as in the physical disability ($P = .020$), social disability ($P = .020$), and psychological discomfort ($P < .001$) dimensions. Our results are supported by Caracho et al. that also stated worst periodontal status and negative OHRQoL in pregnant women with excessive weight, mainly related to physical pain, psychological discomfort, physical disability, and psychological disability.

It is important to highlight that both pregnant women with normal and high BMI included in this study showed lower values of the OHIP-14 score during pregnancy (GO = 8.50, interquartile range: 2-14; GN = 3.25, interquartile range: 1-8) than those included in the study by Caracho et al. (GE = 13.5 ± 5.60; GN = 8.52 ± 6.05). This can be explained because Caracho et al. recruited only pregnant women from a Brazilian public health care system with low socioeconomic condition, and in our study the participants were paired by socioeconomic level. Despite this difference, it is possible to observe that the findings of OHRQoL in pregnant women with obesity are similar.

Quality of life is a subjective condition that is influenced by several factors besides oral health. Therefore, determinants of health, such as high maternal BMI and hypertension, should be considered for a better understanding of the relationship with quality of life and well-being. To this end, in this study, we performed a binary logistic regression in which maternal BMI, hypertension, and presence of periodontitis were the variables included in the initial model (Table 6). Only maternal BMI remained in the final logistic regression model; therefore, high maternal BMI seems to be a determinant for individuals’ well-being. Our hypothesis is that the presence of obesity was the initiating factor for exacerbated oral changes. Moreover, when these oral changes were associated with the personal and social impairments resulting from obesity, quality of life was more negatively impacted.

Our study has some limitations. Our data must be analysed with caution because our study did not have a large population-based sample. Moreover, this study did not evaluate women before the gestational period; thus, pre-pregnancy anthropometric data were collected from medical files. Monitoring women prior to pregnancy could allow a better understanding of the cause-and-effect relationship between the outcomes included in this study (pregnancy, obesity, periodontal disease, and OHRQoL). Moreover, women should have been evaluated in the same gestational week and at the same time after delivery to avoid interference from variable hormonal levels. However, in this study women were assessed during the third trimester of pregnancy and at least 2 months after delivery (not necessarily in the same week). Because breastfeeding has a hormonal influence on the body, it would be ideal if the postpartum evaluation were carried out after the breastfeeding period. In addition, although this study showed the prevalence of women with hypertension and diabetes mellitus, these data were collected from medical files, and therefore, glycaemic levels and blood pressure values were not assessed. Finally, our study did not take into account some variables that describe the level of oral health of pregnant women; thus, future cohorts should assess not only frequency of toothbrushing and use of floss but also variables as use of mouthwash, chlorhexidine, fluoride paste, and the concentration of these products.

Despite the limitations, this prospective study corroborates the literature because it shows that obesity during pregnancy is an important risk factor for hypertension, periodontal disease, and negative impact on quality of life. In addition, to our knowledge, this is the first longitudinal study that included only women diagnosed with obesity (BMI >30.0 kg/m²) in the same group, adopting a current diagnosis criterion for periodontitis and considering the systemic and periodontal status of pregnant women and their perception of quality of life. In view of the results of this study, we highlight the need for a comprehensive and interdisciplinary treatment in this group and also for public health policies to offer comprehensive care for obese women during the gestational period.

Conclusion

In conclusion, pregnant women with obesity have worse systemic and periodontal parameters and, consequently, a
negative impact on quality of life. However, after delivery, the systemic condition and quality of life improve, but periodontal disease persists. High maternal BMI was an important determinant for the occurrence of periodontitis and negative impact on quality of life during pregnancy.

Conflict of interest
None disclosed.

Authors contributions
GAFJ and SHCP worked on the conception and design of the study, analysis and interpretation of data; drafting the article; and approval of the version to be published. ALTM worked on data collection and analysis and interpretation of results; drafting the article; and approval of the version to be published. ESO worked on the analysis and interpretation of data; drafting the article; and approval of the version to be published.

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