Scientific Research Report

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

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ARTICLE INFO

Article history:
Available online 30 January 2021

Key words:
Hypertension
Obesity
Quality of life
Periodontitis
Pregnancy

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 χ^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.

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.[4,5]

Obesity is a chronic disease that has increased worldwide because of sedentary lifestyle and excessive consumption of processed and caloric food.[6] 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

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https://doi.org/10.1016/j.identj.2020.12.012

end, there is ample scientific evidence highlighting the association between obesity and periodontitis.[10] 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 diagnosis criteria for periodontitis and overweight and obesity.

Caracho et al[22] 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/m^2) and overweight (BMI 25-29.99 kg/m^2); requiring absolute rest; drug or alcohol users; smokers; with any kind of infection during pregnancy; using drugs that could adversely affect oral health; having a history of clinical attachment loss before pregnancy; and under orthodontic treatment or any kind of dental treatment with other professionals.

Initially, we evaluated 73 pregnant women; however, 9 of them did not meet our eligibility criteria: antibiotic use because of urinary infection ($n = 1$), systemic impairments before pregnancy (diabetes = 2 and hypertension = 1), and orthodontic patients ($n = 5$). Therefore, we had a sample of 30 and 34 pregnant women with obesity and normal BMI, respectively. After delivery, 6 women did not return for follow-up without justification (GO = 28 and GN = 30) and, thus, 2 other obese pregnant women were recruited for this study.

Therefore, the sample was composed of 60 women stratified int: pregnant women with obesity (GO = 30) and with normal BMI (GN = 30) according to prepregnancy BMI, which was considered because our main aim was to understand the influence of high BMI on women's health status throughout the pregnancy. Pregnant women with BMI of 30.0 kg/m^2 and above were included into GO, and women with BMI 18.5-24.99 kg/m^2 were included into GN.[26]

For maternal BMI calculation, the women's weight was obtained from prenatal obstetric records, and their height was assessed with a stadiometer. Unlike previous studies, this study did not include women classified as overweight (BMI 25-29.99 kg/m^2) 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 Medicine[27] 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

Table 1 – Institute of Medicine protocol for GWG during pregnancy according to prepregnancy nutritional status.[27]

Nutritional status before pregnancy	BMI (kg/m^2)	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 inter-examiner = 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.[20]

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 ($0 < \text{OHIP-14} \leq 9$), moderate impact ($9 < \text{OHIP-14} \leq 18$), and high impact on the quality of life ($18 < \text{OHIP-14} \leq 28$).[22]

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 analysis[33] was considered to determine the sample size, according to previous studies.[19–22] 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 χ^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 ($P = .146$). 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,

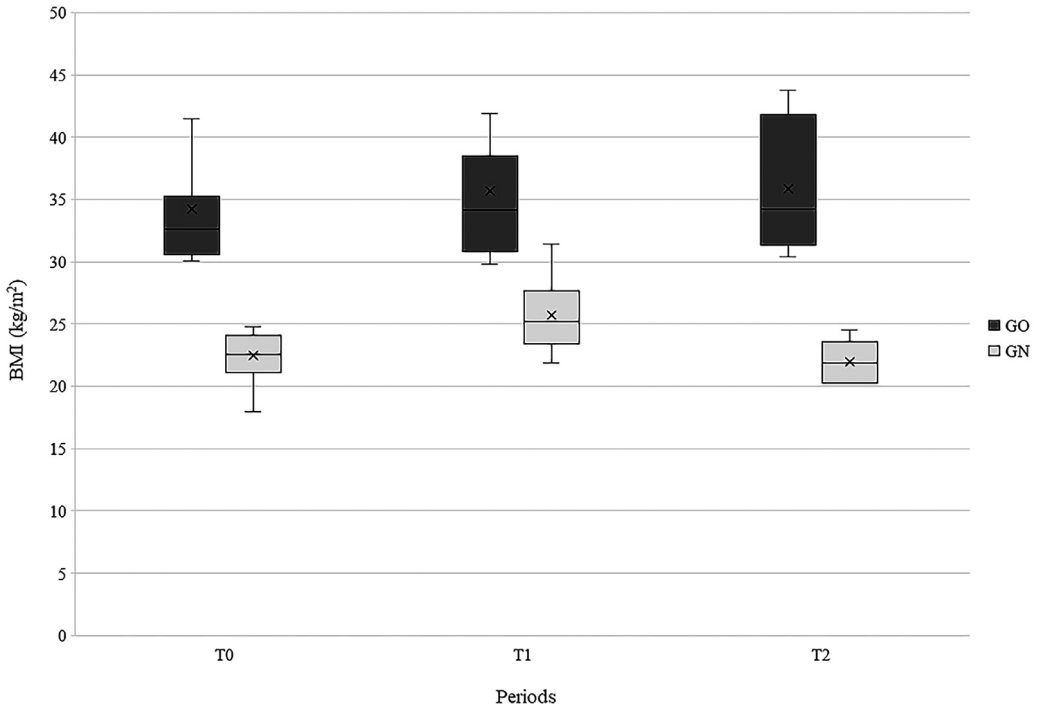

Fig. 1 – Comparison of women's body mass index (BMI) changes over time.

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 χ^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

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

	T1		T2		P
	GO ($n = 30$)	GN ($n = 30$)	GO ($n = 30$)	GN ($n = 30$)	
AH* (n)	**Aa**	**Ab**	**Ba**	Aa	
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 ≥ 140 × 90 mm Hg.
† Cochran's Q test.
‡ Friedmann.

Table 3 – Periodontal parameters compared between groups and periods.

	T1		T2		P
	GO (*n* = 30) Median [1st-3rd quartiles] Mean (95% CI)	GN (*n* = 30) Median [1st-3rd quartiles] Mean (95% CI)	GO (*n* = 30) Median [1st-3rd quartiles] Mean (95% CI)	GN (*n* = 30) Median [1st-3rd quartiles] Mean (95% CI)	
PPD (mm)	2.23 [1.94-2.57] **Aa**	1.93 [1.84-2.03] **Ab**	2.14 [2.06-2.29] **Aa**	1.97 [1.89-2.09] **Ab**	**<.001***
CAL (mm)	2.23 [2.04-2.39] **Aa**	1.95 [1.86-2.03] **Ab**	2.16 [2.10-2.32] **Aa**	2.01 [1.91-2.11] **Ab**	**<.001***
Dental plaque (%)	21.98 [11.53-61.53] **Aa**	32.14 [14.28-50.00] **Aa**	62.25 [42.85-75.00] **Ba**	57.14 [42.85-67.85] **Ba**	**<.001***
BOP (%)	37.45 (30.58-44.32) **Aa**	26.18 (20.94-31.41) **Ab**	45.14 (38.87-51.41) Aa	39.11 (34.88-43.35) **Ba**	**<.001†**
Periodontitis (*n*)					**<.001‡**
No	8 (26.6%)	26 (86.7%)	13 (43.3%)	29 (96.7%)	
Yes	22 (73.7%)	4 (13.3%)	17 (56.7%)	1 (3.3%)	
	Aa	**Ab**	**Aa**	**Ab**	
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%)	
	Aa	**Ab**	**Aa**	**Ab**	

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.

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 Negelkerke = 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 χ^2 value for the final model of 4.93 for 8 degrees of freedom ($P = .764$) was obtained.

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

Model	Variables	β	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		**.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		**.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.

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

Variables	T1		T2		*P*
	GO (*n* = 30) Median [1st-3rd quartiles]	GN (*n* = 30) Median [1st-3rd quartiles]	GO (*n* = 30) Median [1st-3rd quartiles]	GN (*n* = 30) Median [1st-3rd quartiles]	
Functional limitation	0 [0-2]	0 [0-0]	0 [0-0]	0 [0-0]	**.020***
	Aa	**A**b	A**a**	A**a**	
Physical pain	1.5 [0-3]	1 [0-2]	1 [0-2]	0.5 [0-3]	.289*
	Aa	Aa	Aa	Aa	
Psychological discomfort	2 [0-4]	1 [0-2]	0 [0-2]	0 [0-1]	**<.001***
	Aa	**A**a	**B**a	**B**a	
Physical disability	0 [0-3]	0 [0-0]	0 [0-0]	0 [0-0]	**.020***
	Aa	**A**b	**B**a	A**a**	
Psychological disability	0 [0-2]	0 [0-1]	0 [0-1]	0 [0-0]	.097*
	Aa	Aa	Aa	Aa	
Social disability	1 [0-2]	0 [0-2]	0 [0-1]	0 [0-1]	**.020***
	Aa	Aa	**B**a	Aa	
Handicap	0 [0-2]	0 [0-0]	0 [0-0]	0 [0-1]	**.021***
	Aa	**A**b	Aa	Aa	
Overall OHIP-14					**<.001***
No impact	8.50 [2-14]	3.25 [1-8]	0.75 [0-6]	0.25 [0-4.5]	
Low impact	3 (10%)	14 (46.7%)	6 (20%)	15 (50%)	
Moderate impact	14 (46.7%)	10 (33.3%)	18 (60%)	10 (33.3%)	
High impact	9 (30%)	6 (20%)	5 (16.7%)	5(16.7%)	
	4 (13.3%)	0 (0%)	1 (3.3%)	0 (0%)	
	Aa	**A**b	**B**a	A**a**	

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.

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 vasodilation 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.

It is expected, therefore, that obese pregnant women are even more prone to periodontal inflammation because the gestational hormones and inflammatory mediators released by the fat tissue act synergistically in the immune response and, consequently, in the inflammatory response of individuals.[1,2] Nonetheless, other factors, such as oral hygiene habits must be considered to understand the occurrence of

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		.132
Model 2	Maternal BMI	0.083	1.087	0.98-1.20	.089
	Periodontitis	-0.633	0.531	0.14-1.95	.341
	Constant	-2.837	0.059		.080
Final Model	Maternal BMI	0.105	1.111	1.02-1.22	**.018**
	Constant	-3.790	0.023		**.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.[20] In view of that, as stated by Martínez-Beneyto et al,[41] 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[13–23] and negative[24] 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[20] 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[22] 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[24] 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 ($P = 0.020$), social disability ($P = .020$), and psychological discomfort ($P < .001$) dimensions. Our results are supported by Caracho et al[22] 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[22] 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.[22] 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, prepregnancy 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/m^2) 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.

Funding

The authors thank the São Paulo Research Foundation (FAPESP; grant n°. 2015/25421-4; grant n°. 2018/13990-2; grant n°. 2018/20626-5; grant n°. 2018/25934-0) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES - Finance Code 001) for supporting this study. It is important to highlight, however, that FAPESP and CAPES had no role in the study design, data analysis, or manuscript drafting/approval.

REFERENCES

1. Silva de Araujo Figueiredo C, Gonçalves Carvalho Rosalem C, Costa Cantanhede AL, Abreu Fonseca Thomaz EB, Fontoura Nogueira da Cruz MC. Systemic alterations and their oral manifestations in pregnant women. J Obstet Gynaecol Res 2017;43:16–22.
2. Gürsoy M, Pajukanta R, Sorsa T, Könönen E. Clinical changes in periodontium during pregnancy and post-partum. J Clin Periodontol 2008;35:576–83.
3. Daalderop LA, Wieland BV, Tomsin K, et al. Periodontal disease and pregnancy outcomes: overview of systematic reviews. JDR Clin Trans Res 2018;3:10–27.
4. Moimaz SA, Rocha NB, Garbin AJ, Garbin CA, Saliba O. Influence of oral health on quality of life in pregnant women. Influência da saúde bucal na qualidade de vida de gestantes. Acta Odontol Latinoam 2016;29:186–93.
5. Geevarghese A, Baskaradoss JK, Sarma PS. Oral health-related quality of life and periodontal status of pregnant women. Matern Child Health J 2017;21:1634–42.
6. Junior Foratori GA, FJ Andrade, Mosquim V, et al. Presence of serum ferritin before and after bariatric surgery: analysis in dentate and edentulous patients. PLoS One 2016;11:e0164084.
7. Catalano PM, Shankar K. Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. BMJ 2017;356:j1.
8. Gonçalves TE, Zimmermann GS, Figueiredo LC, et al. Local and serum levels of adipokines in patients with obesity after periodontal therapy: one-year follow-up. J Clin Periodontol 2015;42:431–9.
9. Borges MD, Franca EL, Fujimori M, et al. Relationship between proinflammatory cytokines/chemokines and adipokines in serum of young adults with obesity. Endocr Metab Immune Disord Drug Targets 2018;18:260–7.
10. Martinez-Herrera M, Silvestre-Rangil J, Silvestre FJ. Association between obesity and periodontal disease. A systematic review of epidemiological studies and controlled clinical trials. Med Oral Patol Oral Cir Bucal 2017;22:e708–15.
11. Yamashita JM, de Moura-Grec PG, de Freitas AR, et al. Correction: assessment of oral conditions and quality of life in morbid obese and normal weight individuals: a cross-sectional study. PLoS One 2015;10:e0137707.
12. Shay B, Ben Ami O, Levy Ianculovici D, Zini A, Ianculovici C, Almoznino G. Oral health-related quality of life in patients with disorders of nutrition. J Oral Rehabil 2019;46:355–68.
13. Chapper A, Munch A, Schermann C, Piacentini CC, Fasolo MT. Obesity and periodontal disease in diabetic pregnant women. Braz Oral Res 2005;19:83–7.
14. Piscoya MD, Ximenes RA, Silva GM, Jamelli SR, Coutinho SB. Periodontitis-associated risk factors in pregnant women. Clinics (Sao Paulo) 2012;67:27–33.
15. Vogt M, Sallum AW, Cecatti JG, Morais SS. Factors associated with the prevalence of periodontal disease in low-risk pregnant women. Reprod Health 2012;9:3.
16. Lee HJ, Jun JK, Lee SM, Ha JE, Paik DI, Bae KH. Association between obesity and periodontitis in pregnant females. J Periodontol 2014;85:e224–31.
17. Xie Y, Xiong X, Elkind-Hirsch KE, et al. Prepregnancy obesity and periodontitis among pregnant females with and without gestational diabetes mellitus. J Periodontol 2014;85:890–8.
18. Zambon M, Mandò C, Lissoni A, et al. Inflammatory and oxidative responses in pregnancies with obesity and periodontal disease. Reprod Sci 2018;25:1474–84.
19. Fusco NDS, Foratori-Junior GA, Missio ALT, Jesuino BG, Sales-Peres SHC. Systemic and oral conditions of pregnant women with excessive weight assisted in a private health system. Int Dent J 2019;69:472–9.
20. Foratori-Junior GA, da Silva BM, da Silva Pinto AC, Honório HM, Groppo FC, de Carvalho Sales-Peres SH. Systemic and periodontal conditions of overweight/obese patients during pregnancy and after delivery: a prospective cohort. Clin Oral Investig 2020;24:157–65.
21. Foratori-Junior GA, Jesuino BG, Caracho RA, Orenha ES, Groppo FC, Sales-Peres SHC. Association between excessive maternal weight, periodontitis during the third trimester of pregnancy, and infants' health at birth. J Appl Oral Sci 2020;28:e20190351.
22. Caracho RA, Foratori-Junior GA, Fusco NDS, Jesuino BG, Missio ALT, Sales-Peres SHC. Systemic conditions and oral health-related quality of life of pregnant women of normal weight and who are overweight. Int Dent J 2020;70:287–95.
23. Jesuino BG, Foratori-Junior GA, Missio ALT, Mascoli LS, Sales-Peres SHC. Periodontal status of women with excessive gestational weight gain and the association with their newborns' health. Int Dent J 2020;70:396–404.
24. Gomes-Filho IS, Batista JET, Trindade SC, et al. Obesity and periodontitis are not associated in pregnant women. J Periodontal Res 2020;55:77–84.
25. Vandenbroucke JP, von Elm E, Altman DG, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. Int J Surg 2014;12:1500–24.
26. World Health Organization (WHO). Obesity: preventing and managing the global epidemic. Report of a WHO consultation. Geneva, Switzerland: WHO; 2000 Organization Technical Report Series, vol. 894.

27. Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines. Weight gain during pregnancy: reexamining the guidelines. Washington, DC: National Academies Press; 2009.
28. Report of the National High Blood Pressure Education Program Working Group on High Blood Pressure in Pregnancy. Am J Obstet Gynecol 2000;183:S1–S22.
29. International Association of Diabetes and Pregnancy Study Groups Consensus Panel, Metzger BE, Gabbe SG, et al. International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes Care 2010;33:676–82.
30. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Clin Periodontol 2018;20:S149–61.
31. Oliveira BH, Nadanovsky P. Psychometric properties of the Brazilian version of the oral health impact profile-short form. Community Dent Oral Epidemiol 2005;33:307–14.
32. Ainamo J, Bay I. Problems and proposals for recording gingivitis and plaque. Int Dent J 1975;25:229–35.
33. Hosmer D, Lemeshow S. Applied logistic regression. 2nd ed New York, NY: John Wiley & Sons; 2000.
34. Benusic M, Cheskin LJ. Obesity prevalence in large US cities: association with socioeconomic indicators, race/ethnicity and physical activity. J Public Health (Oxf) [Preprint]. Available from: 10.1093/pubmed/fdz077.
35. Rocha V, Ribeiro AI, Severo M, Barros H, Fraga S. Neighbourhood socioeconomic deprivation and health-related quality of life: a multilevel analysis. PLoS One 2017;12: e0188736.
36. Höfelmann DA, Gonzalez-Chica DA, Peres KG, Boing AF, Peres MA. Chronic diseases and socioeconomic inequalities in quality of life among Brazilian adults: findings from a population-based study in Southern Brazil. Eur J Public Health 2018;28:603–10.
37. Saxton SN, Clark BJ, Withers SB, Eringa EC, Heagerty AM. Mechanistic links between obesity, diabetes, and blood pressure: role of perivascular adipose tissue. Physiol Rev 2019; 99:1701–63.
38. Shah S, Gupta A. Hypertensive disorders of pregnancy. Cardiol Clin 2019;37:345–54.
39. Goldstein RF, Abell SK, Ranasinha S, et al. Gestational weight gain across continents and ethnicity: systematic review and meta-analysis of maternal and infant outcomes in more than one million women. BMC Med 2018;16:153.
40. Gonzalez-Ballano I, Saviron-Cornudella R, Esteban LM, Sanz G, Castán S. Pregestational body mass index, trimester-specific weight gain and total gestational weight gain: how do they influence perinatal outcomes? J Matern Fetal Neonatal Med [Preprint]. Available from: 10.1080/14767058.2019.1628942.
41. Martínez-Beneyto Y, Montero-Martin J, Garcia-Navas F, Vicente-Hernandez A, Ortiz-Ruiz AJ, Camacho-Alonso F. Influence of a preventive program on the oral health-related quality of life (OHRQoL) of European pregnant women: a cohort study. Odontology 2019;107:10–6.