

Periodontal disease during pregnancy: assessment of determinants of health and quality of life in pregnant women with periodontitis

Doença periodontal durante a gestação: avaliação dos determinantes de saúde e da qualidade de vida em gestantes com periodontite

Enfermedad periodontal durante el embarazo: evaluación de determinantes de salud y calidad de vida en mujeres embarazadas con periodontitis

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Abstract

Periodontitis in pregnancy may be associated with several determinants of health and knowing these determinants makes possible an integral approach of the patients. The aim of this study was to evaluate the determinants of health and periodontitis-related quality of life in pregnant women. Sample was composed by 128 patients divided into two groups: pregnant women with periodontitis (GP = 64) and without periodontitis (GWP = 64) during the third trimester of pregnancy. They were evaluated regarding: a) socioeconomic level; b) anthropometric parameters; c) systemic conditions - presence of arterial hypertension and diabetes mellitus; d) behaviors regarding oral hygiene; and e) oral health impact profile (OHIP-14). T-test, Mann-Whitney U-test, chi-square and logistic regression were applied, considering a significance level of 5%. GP showed low socioeconomic level ($P = 0.0008$), high maternal body mass index (BMI) ($P = 0.0002$) and excessive gestational weight gain ($P = 0.008$). No intergroup differences were observed in systemic conditions. Patients with periodontitis presented low daily dental floss use ($P = 0.021$) and strong impact on quality of life for all evaluated dimensions ($P < 0.05$). Periodontitis in pregnancy was associated with high BMI, excessive gestational weight gain, low socioeconomic level, poor oral hygiene behaviors and negative impact on quality of life.

Keywords: Periodontitis; Pregnancy; Quality of life; Socioeconomic analysis.

Resumo

A periodontite na gravidez pode estar associada a diversos determinantes de saúde e o conhecimento desses determinantes possibilita uma abordagem integral das pacientes. O objetivo deste estudo foi avaliar os determinantes de saúde e qualidade de vida de gestantes com e sem periodontite. A amostra foi composta por 128 pacientes, divididas em dois grupos: gestantes com periodontite (GP = 64) e sem periodontite (GSP = 64) durante o terceiro trimestre de gestação. Eles foram avaliados quanto a: a) nível socioeconômico; b) parâmetros antropométricos; c) condições sistêmicas - presença de hipertensão arterial e diabetes mellitus; d) comportamentos em relação à higiene bucal; e e) impacto da saúde bucal na qualidade de vida (OHIP-14). Foram aplicados os testes t, Mann-Whitney, Qui-quadrado e regressão logística, considerando um nível de significância de 5%. GP apresentou menor nível socioeconômico ($P = 0,0008$), alto índice de massa corporal materna (IMC) ($P = 0,0002$) e excessivo ganho ponderal na gestação ($P = 0,008$). Não foram observadas diferenças entre os grupos nas condições sistêmicas. Pacientes com periodontite apresentaram baixo uso diário de fio dental ($P = 0,021$) e forte impacto na qualidade de vida em todas as dimensões avaliadas ($P < 0,05$). A periodontite na gravidez esteve associada a alto IMC, excessivo ganho ponderal na gestação, baixo nível socioeconômico, piores comportamentos de higiene bucal e impacto negativo na qualidade de vida.

Palavras-chave: Periodontite; Gravidez; Qualidade de vida; Análise socioeconômica.

Resumen

La periodontitis en el embarazo puede estar asociada a varios determinantes de la salud y el conocimiento de estos determinantes permite un abordaje integral de las pacientes. El objetivo de este estudio fue evaluar los determinantes de salud y calidad de vida de mujeres embarazadas con y sin periodontitis. La muestra estuvo conformada por 128 pacientes, divididas en dos grupos: gestantes con periodontitis (GP = 64) y sin periodontitis (GSP = 64) durante el tercer trimestre de gestación. Fueron evaluados según: a) nivel socioeconómico; b) parámetros antropométricos; c) condiciones sistémicas: presencia de hipertensión arterial y diabetes mellitus; d) comportamientos en relación con la higiene bucal; y e) impacto de la salud bucal en la calidad de vida (OHIP-14). Se aplicaron las pruebas t, Mann-Whitney, Chi-cuadrado y regresión logística, considerando un nivel de significancia del 5%. GP tenía un nivel socioeconómico más bajo ($P = 0,0008$), un índice de masa corporal (IMC) materno alto ($P = 0,0002$) y un aumento de peso excesivo durante el embarazo ($P = 0,008$). No se observaron diferencias entre los grupos en condiciones sistémicas. Los pacientes con periodontitis tuvieron un uso diario de hilo dental bajo ($P = 0,021$) y un fuerte impacto en la calidad de vida en todas las dimensiones evaluadas ($P < 0,05$). La periodontitis en el embarazo se asoció con un IMC alto, aumento excesivo de peso durante el embarazo, bajo nivel socioeconómico, peores conductas de higiene bucal e impacto negativo en la calidad de vida.

Palabras clave: Periodontitis; Embarazo; Calidad de vida; Análisis socioeconómico.

1. Introduction

Periodontitis is characterized by loss of periodontal attachment due to a microbial-associated, host-mediated inflammation (Tonetti, Greenwell & Kornman, 2018), which is initiated in the gingival tissues upon bacterial biofilm formation. The initiation and progression of periodontitis depend not only on microbiome changes resulted by tissue breakdown products, but also on anti-bacterial mechanisms that effort to contain the bacteriological challenge in gingival tissue (Tonetti, Greenwell & Kornman, 2018). Hence, periodontitis can be caused due to dysbiotic ecological changes in the local microbiome. Current evidence supports that smoking, among other multifactorial diseases, can cause some alterations on the multiple immunoinflammatory responses and interfere on the severity periodontitis for some patients (Tonetti, Greenwell & Kornman, 2018).

Due to several metabolic and physiological changes that are noticed during pregnancy, oral changes can also be perceived during gestation (Silva de Araujo Figueiredo, et al., 2017). From the second trimester of pregnancy, gingival status is aggravated by variations in estrogen and progesterone levels, which may negatively impact the patients' immune response, thereby contributing to the presence of *Bacteroides melaninogenicus* ss. *intermedius* and *Aggregatibacter actinomycetemcomitans*. Previous studies indicated that the subgingival microbiota becomes more anaerobic as gestation progresses (González-Jaranay, et al., 2017). Therefore, the third trimester of gestation is a critical period, and pregnant women should be instructed to improve their oral hygiene, especially through regular tooth brushing and use of dental floss.

The oral alterations during pregnancy can negatively influence the quality of life of individuals. Previous evidence

that evaluated quality of life and well-being in women during pregnancy found a negative impact in the physical and psychological dimensions of quality of life (Archarya & Bhat, 2009), once periodontal health and quality of life of pregnant women was poorer than non-pregnant women (Geevarghese, Baskaradoss & Sarma, 2017).

Besides the influence on the quality of life, periodontitis during pregnancy can produce recurrent bacteremia that indirectly activates an acute hepatic response phase, resulting in the production of inflammatory mediators such as prostaglandins, cytokines and interleukins (i.e. IL-6 and IL-8), which in turn may harm women and infants' health (Silk, et al., 2008). Several scientific studies pointed out that periodontal inflammation during pregnancy is associated with preterm birth and low weight at birth (Turton & Africa, 2017; Udagawa, et al., 2018).

Considering that periodontitis in pregnancy can negatively impact the maternal and newborn health and well-being, and considering the absence of studies that have evaluated the quality of life of pregnant women with and without periodontitis and the several associated risk factors, this study aimed to evaluate the factors associated with periodontitis and their association with oral health-related quality of life in women during pregnancy. Therefore, knowing these determinants makes possible an integral approach of the patients and an interdisciplinary action of the professionals during the gestation, ensuring a better health condition to the pregnant women and their children.

2. Methodology

This observational study followed the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines (Vandenbroucke, et al., 2014).

2.1 Ethical aspects

According to the Declaration of Helsinki guidelines of 1964 and its later amendments or comparable ethical standards, this study received approval from the Ethics Committee on Human Research of the Bauru School of Dentistry, University of São Paulo (CAAE 06624519.3.0000.5417; CAAE 58339416.4.0000.5417). All patients provided written informed consent prior to participating in the study.

2.2 Examiner standardization

One previously calibrated dentist performed data collection. The examiner's calibration was conducted by a Gold Standard examiner in epidemiological surveys to ensure uniformity in interpretation, understanding and application of criteria for periodontal conditions. For Kappa coefficient calculation, approximately 10% (n=15) of the sample was recruited for periodontal evaluation. These patients were not included in the final sample of this study. The Kappa inter-examiner - between the calibrated dentist and Gold Standard examiner - was 0.92; and intra-examiner was 0.95.

2.3 Sample composition

Initially, the calibrated dentist consecutively recruited 132 pregnant women during the third trimester of pregnancy from Brazilian private and public healthcare systems for a dental triage. Both the public and private sectors allowed the calibrated dentist to attend the clinics on the days of prenatal appointments. Then an initial assessment was made and patients who met the inclusion criteria were invited to participate in the survey.

The inclusion criteria were as follows: satisfactory systemic health (without medical contraindication), regular medical visits (monthly follow-up), and mothers with singleton gestation. Patients who presented general health impairments (chronic hepatic, renal or cardiovascular disorders, type I or type II diabetes mellitus before pregnancy, anemia, coagulation abnormalities, hypertension before pregnancy, placenta abruption, uterine or cervical malformations, fetal anomalies),

smoking/drug/alcohol habits, gestational impairments that demanded absolute rest, or were using medications, mainly those that could harm oral health were excluded. The third trimester was chosen because the highest hormonal alterations that could be seen in that period (González-Jaranay, et al., 2017; Silva de Araujo Figueiredo, et al., 2017). Upon dental evaluation during the third trimester, 65 patients had healthy periodontal condition and 67 patients presented periodontitis. Nevertheless, one periodontally healthy patient presented with orthodontic braces and two periodontally compromised patients were on antibiotics due to urinary tract infection and bacterial vaginosis, respectively. Therefore, these patients were excluded from this study. Thus, the patients were divided according to their periodontal status: group with periodontitis (GP = 64) and without periodontitis (GWP = 64). The beginning of sample recruitment to evaluation during the third trimester occurred between April/2017 to June/2018.

For periodontal evaluation, six sites of each tooth, excluding the third molars, were assessed: mesial, center, distal, both on buccal and palatal/lingual surfaces. Periodontal analysis was performed according to the probing pocket depth (PPD) and clinical attachment level (CAL) (Caracho, et al., 2020; Foratori-Junior, et al., 2020a). Therefore, to calculate CAL, sites with recession and gingival hyperplasia were measured.

According to Tonetti, Greenwell and Kornman (2018), the following items were considered for periodontitis diagnosis, it was considered: 1) Interdental CAL at ≥ 2 non-adjacent teeth, or Buccal or oral CAL ≥ 3 mm with pocketing > 3 mm at ≥ 2 teeth. It is important to note the observed CAL could not be ascribed to non-periodontal causes. Specific non-periodontal causes were also described by Tonetti, Greenwell & Kornman (2018).

After, according to interdental CAL at site with greatest loss and complexity, periodontitis was classified in stages I, II, III and IV, as described in detail elsewhere (Tonetti, Greenwell & Kornman, 2018).

2.4 General measurements

Socioeconomic status was analyzed by schooling level and monthly income, which were self-reported by the patients.

Education level ranged from 0 (illiterate) to 9 (PhD), being that each patient's highest education level was registered. Similarly, household monthly income ranged from 1 - family receiving equal to or less than 1 minimum wage (MW) to 6 - family receiving higher than 5 MW. MW corresponded the amount R\$937.00 (approximately USD 242.00), previously approved by Brazilian government. Both education level and household monthly income categorization were previously described elsewhere (Caracho, et al., 2020).

In respect of systemic conditions during third gestational trimester, the diagnosis of arterial hypertension (AH) in pregnancy occurred when blood pressure levels were equal to or greater than 140/90 mmHg (Lenfant & National Education Program Working Group on High Blood Pressure in Pregnancy, 2001). On the other hand, for gestational diabetes mellitus diagnosis, it was adopted the International Association of the Diabetes and Pregnancy Study Group protocol (International Association of Diabetes and Pregnancy Study Groups Consensus Panel, et al., 2010), which proposes the following cut-off point for maternal hyperglycemia: ≥ 92 mg/dl (fasting level).

In addition, the behaviors related to oral hygiene were assessed, regarding the regular dental appointments (once per year, at least), daily occurrence of tooth brushing and daily dental floss use.

2.5 Anthropometric parameters

Pre-pregnancy weight and body mass index (BMI) were collected in order to analyze how the patients' nutritional status throughout life could affect systemic and oral health during pregnancy. Pre-pregnancy weight was obtained from medical files. Nevertheless, height was confirmed during the medical appointment by a calibrated stadiometer (Wood 2.20, WCS Ind., Curitiba/PR, Brazil). A normal pre-pregnancy BMI corresponded to BMI between 18.0–24.99 kg/m², while

underweight corresponded to BMI < 18.00 kg/m², overweight as BMI between 25.00 and 29.99 kg/m², and obesity as BMI ≥ 30.0 kg/m².

In the appointment during the third gestational trimester, patients' weight was also obtained using an automatic scale (MIC model 300PP, Micheletti Ind., São Paulo/SP, Brazil). Patients were classified according to their gestational weight gain based on Institute of Medicine protocol (Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines, Rasmussen & Yaktine, 2009). The recommended gestational weight gain according to the patients' anthropometric parameters before pregnancy is shown in Table 1. The following classifications were adopted: low, normal, or high gestational weight gain.

Table 1. Gestational weight gain recommendations.

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

(Institute of Medicine (US) and National Research Council (US) Committee to Reexamine IOM Pregnancy Weight Guidelines, Rasmussen & Yaktine, 2009)

2.6 Oral health-related quality of life

A short version of the Oral Health Impact Profile questionnaire (OHIP-14) was used to assess patient's quality of life and well-being. This questionnaire was applied with the aid of the examiner as an interview to avoid different interpretations among patients.

This version of OHIP-14 is composed of 14 questions, in which every two questions address one specific dimension of oral health-related quality of life (OHRQoL), totaling seven dimensions: functional limitation; physical pain; psychological discomfort; physical disability; psychological disability; social disability, and handicap (Oliveira & Nadanovsky, 2005). Patients reported how frequently one specific situation occurred by using one of the following response codes: 0 = never; 1 = rarely; 2 = occasionally; 3 = often; 4 = very often.

An average of each dimension was calculated and the overall score ranged from 0 to 28. The impact of OHRQoL was measured according to a previous study using the following classification: 0 - "no impact of oral condition on quality of life"; 1 - "low impact"; 2 - "moderate impact"; and 3 - "high impact of oral condition on quality of life" (Bastos, et al., 2012; Caracho, et al., 2020).

2.7 Statistical analysis

For statistical analysis, it was used IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA) and for sample size calculation, it was considered the protocol for regression logistic analysis proposed by Hosmer and Lemeshow (Caracho, et al., 2020; Hosmer & Lemeshow, 2000), which requires at least 15 cases for each independent variable inserted in the initial logistic model. Thus, it was performed the dichotomization of the outcomes: periodontitis (0- no periodontitis; 1- with periodontitis) and quality of life (0- no/low impact on quality of life; 1- moderate/high impact on quality of life), and then at maximum 8 variables were inserted in the logistic regression, requiring a total of 120 patients in the sample. Therefore, 128 patients composed this study.

In the bivariate analysis, initially, the normality of the sample for each quantitative variable was tested by

Kolmogorov-Smirnov test. T test was used to evaluate the normally distributed quantitative variables (maternal age), the Mann-Whitney U-test was used to examine non-normally distributed quantitative variables (gestational BMI; pre-pregnancy BMI; gestational weight gain; daily frequency of tooth brushing and dental floss use; OHIP-14) and ordinal variables (maternal nutritional status, education level and household monthly income). The binomial variables were analyzed by chi-square test (hypertension, diabetes mellitus and regular dental appointments). After, binary logistic regressions were adopted to analyze independent variables related to the outcomes (periodontitis during pregnancy and patients' quality of life). Variables that presented $P < 0.20$ in the bivariate analysis were included in the logistic regression. The Hosmer-Lemeshow, collinearity and residual analyses were used to increase the understanding of the logistic regression results. Significance level of 5% was considered.

3. Results

Table 2 demonstrates the bivariate analysis comparing the pregnant women's general characteristics according to the presence and absence of periodontitis. The mean age of the women with and without periodontitis was 29.12 ± 6.07 and 29.73 ± 5.41 , respectively.

Of the 64 patients in GP, 3 (4.69%), 52 (81.25%), and nine (14.06%) were classified as stage I (PPD 2.29 ± 0.10 and CAL 2.28 ± 0.15), stage II (PPD 2.32 ± 0.30 and CAL 2.31 ± 0.18), and stage III (PPD 2.78 ± 0.50 and CAL 3.19 ± 0.65) periodontitis, respectively. None of them was classified as stage IV.

More than 73% of GP presented lower than complete higher education, whilst 55% of GWP presented, at least, complete higher education. Similarly, household monthly income was lower in GP than in GWP. More than 62% of patients in GP presented household monthly income equal to or lower than R\$2,811.00 (approximately USD 724.00), whereas more than 71% of patients in GWP presented household monthly income higher than R\$2,811.00 (approximately USD 724.00).

According to the nutritional status before pregnancy, 4.7% ($n = 3$) of patients in GP were underweight, 25% ($n = 16$) had normal BMI, 39% ($n = 25$) were overweight, and 31.3% ($n = 20$) were obese. In contrast, no patients in GWP were underweight, 68.8% ($n = 44$) had normal BMI, 23.4% ($n = 15$) were overweight, and 7.8% ($n = 5$) were obese (Table 2).

Regarding weight gain during pregnancy, none presented low weight gain. Sixteen patients in GP (25%) showed high gestational weight gain according to proposed recommendation. In contrast, only five (7.81%) patients in GWP presented high weight gain ($P = 0.008$) (Table 2).

Concerning oral hygiene behaviors, GP had a low frequency of dental floss use per day and low regular dental appointments (Table 2).

Table 2. Contextual variables, behaviors related to oral hygiene and general conditions between groups.

Variables		GP (n = 64)	GWP (n = 64)	P
		Mean ± SD	Mean ± SD	
		Median [1 st –3 rd quartiles]	Median [1 st –3 rd quartiles]	
Age (years)		29.12 ± 6.07	29.73 ± 5.41	0.550 [†]
Education level		4 [3.5–6.0]	6 [4–6]	<0.001 [‡]
Household monthly income		3 [2–5]	5 [3–6]	<0.001 [‡]
Maternal height (m)		1.62 [1.56–1.65]	1.62 [1.58–1.64]	0.854 [‡]
BMI before pregnancy (kg/m ²)		27.11 [24.40–30.91]	24.09 [21.96–26.53]	<0.001 [‡]
BMI - 3 rd trimester (kg/m ²)		30.59 [27.43–34.15]	27.29 [24.83–29.43]	<0.001 [‡]
Maternal nutritional status - n (%)				
	Underweight	3 (4.7%)	0 (0%)	<0.001 [‡]
	Normal	16 (25%)	44 (68.8%)	
	Overweight	25 (39%)	15 (23.4%)	
	Obesity	20 (31.3%)	5 (7.8%)	
Daily tooth brushing		3 [3–3]	3 [3–3]	0.654 [‡]
Daily use of dental floss		0 [0–1]	1 [0–1]	0.021 [‡]
PPD (mm)		2.31 [2.13–2.57]	1.93 [1.83–2.02]	<0.001 [‡]
CAL (mm)		2.36 [2.19–2.49]	1.95 [1.86–2.03]	<0.001 [‡]
Weight gain during pregnancy				
	Normal	48 (75%)	59 (92.2%)	0.008 [§]
	High	16 (25%)	5 (7.8%)	
Gestational diabetes mellitus				
	No	56	61	0.116 [§]
	Yes	8	3	
Hypertension - during pregnancy				
	No	51	57	0.145 [§]
	Yes	13	7	
Regular dental appointments				
	No	43	32	0.049 [§]
	Yes	21	32	

[†] t-test; [‡] Mann-Whitney; [§] Chi-square; GP, group with periodontitis; GWP, group without periodontitis; SD, standard deviation; P, significance level; BMI, body mass index; PPD, probing pocket depth; CAL, clinical attachment level; Gestational diabetes mellitus (maternal hyperglycemia: ≥ 92 mg/dl - fasting level); Hypertension ≥ 140x90 mmHg; Regular dental appointments: once per year.

For overall score of OHIP-14, GP showed a mean ± SD and a median [1st–3rd quartiles] of 9.16 ± 7.40 and 9 [2.25–15.25], respectively (Table 3). In contrast, GWP showed 4.86 ± 4.70 and 3.75 [1–7.75], respectively (P < 0.01). GP presented negative influence of oral health on quality of life for all evaluated dimensions of OHIP-14.

Table 3. OHRQoL during pregnancy in patients with and without periodontitis.

Variables	GP (n = 64)	GWP (n = 64)	P
	Median [1 st –3 rd quartiles]	Median [1 st –3 rd quartiles]	
Functional limitation	0 [0–1.5]	0 [0–1]	0.049[†]
Physical pain	2 [0–3.75]	1 [0–2]	0.015[†]
Psychological discomfort	2 [0–3.75]	1 [0–2]	0.003[†]
Physical disability	0 [0–3]	0 [0–0.25]	0.007[†]
Psychological disability	0.5 [0–2]	0 [0–1]	0.018[†]
Social disability	1.25 [0–2]	0 [0–1.5]	0.027[†]
Handicap	0 [0–1.5]	0 [0–0]	0.001[†]
Overall OHIP-14 classification			
No impact	5 (7.8%)	11 (17.2%)	<0.001[†]
Low impact	29 (45.3%)	42 (65.7%)	
Moderate impact	20 (31.3%)	10 (15.6%)	
High impact	10 (15.6%)	1 (1.5%)	

[†] Mann-Whitney; GP, group with periodontitis; GWP, group without periodontitis; P, significance level. Source: Authors.

The variables included in the logistic regression (backward method based on the likelihood ratio) related to periodontitis (0 = no periodontitis; 1 = periodontitis) during the third trimester of pregnancy were: household monthly income, gestational hypertension, gestational diabetes mellitus, regular dental appointments, daily dental floss use, maternal BMI and gestational weight gain (Table 4). All independent variables presented values of tolerance greater than 0.10 and variance inflation factor values less than 2 (Multicollinearity analysis). Maternal BMI, household monthly income and gestational weight gain were the variables that remained in the final model ($X^2[3] = 28.58$; $P < 0.0001$; R^2 of Nagelkerke = 0.267). The overall accuracy of the final model was 70%. Hosmer-Lemeshow analysis indicated a chi-square for the final model of 9.96 for 8 degrees of freedom ($P = 0.268$). Maternal BMI (adjusted odds ratio [OR] = 1.14; 95% confidence interval [CI] = 1.03–1.22; $P = 0.008$) and household monthly income (adjusted OR = 0.69; 95% CI = 0.55–0.86; $P = 0.001$) were significantly associated with periodontitis in third gestational trimester. Monthly income presented a negative coefficient, therefore, when the household monthly income is lower, the frequency of periodontitis is greater.

Table 4. Logistic regression showing the variables related to periodontitis during pregnancy.

		B	P	Adjusted OR	95% CI
Initial Model	Household monthly income	-0.35	0.009	0.71	0.55–0.91
	Gestational hypertension	0.31	0.630	1.37	0.39–4.86
	Gestational diabetes mellitus	-0.98	0.220	0.38	0.78–1.80
	Daily dental floss use	-0.94	0.681	0.91	0.58–1.42
	Regular dental appointments	0.91	0.848	1.10	0.43–2.79
	Maternal BMI	0.12	0.009	1.13	1.03–1.24
	Weigh gain during pregnancy	-1.03	0.083	0.36	0.11–1.14
	Constant	-0.29	0.872	0.75	
Final Model	Household monthly income	-0.40	0.001	0.69	0.53–0.83
	Maternal BMI	0.12	0.008	1.14	1.03–1.22
	Weigh gain during pregnancy	-0.95	0.104	0.39	0.12–1.21
	Constant	-0.72	0.588	0.48	

B, coefficient; p, significance level; OR, odds ratio; CI, confidence interval; BMI, body mass index. Multicollinearity analysis: all independent variables presented values of tolerance greater than 0.10 and variance inflation factor values less than 2. R^2 of Nagelkerke = 0.267. Overall percentage accuracy of the final model: 70%. Hosmer-Lemeshow analysis: chi-square for the final model of 9.96 for 8 degrees of freedom ($P = 0.268$). Source: Authors.

The variables included in the regression (backward method based on the likelihood ratio) related to patients' quality of life (0 = no impact/low impact of oral health on quality of life; 1 = moderate/high impact of oral health on quality of life) were: presence of periodontitis; household monthly income, gestational hypertension, gestational diabetes mellitus, regular dental appointments, daily dental floss use, maternal BMI and gestational weight gain (Table 5). All independent variables had values of tolerance higher than 0.10 and variance inflation factor values less than 2 (Multicollinearity analysis). "Periodontitis" and "household monthly income" remained in the final logistic model ($X^2[2] = 34.75$; $P < 0.0001$; R^2 of Nagelkerke = 0.332). The overall accuracy of the final model was 77.4%. Presence of periodontitis (adjusted odds ratio [OR] = 2.59; 95% confidence interval [CI] = 1.06–6.38; $P = 0.038$) and household monthly income (adjusted OR = 0.55; 95% CI = 0.42–0.72; $P < 0.0001$) were significantly associated with moderate/high impact of oral health on quality of life. Household monthly income showed a negative coefficient, therefore, when the household monthly income is lower, the frequency of periodontitis is greater.

Table 5. Logistic regression models showing the variables related to the negative influence on quality of life during pregnancy.

		B	P	Adjusted OR	95% CI
Initial Model	Periodontitis	0.97	0.040	2.83	1.15–6.74
	Household monthly income	-0.62	<0.0001	0.57	0.41–0.77
	Gestational hypertension	-0.59	0.377	0.55	0.15–2.07
	Gestational diabetes mellitus	0.08	0.925	1.09	0.21–5.78
	Daily dental floss use	-0.58	0.052	0.56	0.31–1.01
	Regular dental appointments	-0.37	0.517	0.69	0.23–2.12
	Maternal BMI	-0.01	0.764	0.99	0.91–1.07
	Weight gain during pregnancy	-0.34	0.559	0.72	0.23–2.22
Final Model	Periodontitis	0.96	0.038	2.59	1.06–6.38
	Household monthly income	-0.60	<0.0001	0.55	0.42–0.72
	Constant	0.88	0.163		

B, coefficient; P, significance level; OR, odds ratio; CI, confidence interval. Multicollinearity analysis showed that all independent variables presented values of tolerance greater than 0.10 and variance inflation factor values less than 2. The overall percentage accuracy of the final model was 77.4%. Source: Authors.

4. Discussion

This study evaluated the factors associated with periodontitis and quality of life during pregnancy. High maternal BMI, excessive gestational weight gain, low socioeconomic level and poor oral hygiene behaviors are associated with periodontitis during pregnancy. Moreover, our main findings suggest that social inequality is a significant determinant associated with periodontitis and low quality of life in pregnant women during the third gestational trimester. Therefore, the results of this study draw the attention of readers and promote a discussion about special care in dentistry during pregnancy, taking into account social inequities.

The inflammatory and immune responses in a woman's body during pregnancy play a major role in periodontal disease. Periodontal disorders are initiated and persist because of both increased hormonal levels and factors related to the subgingival microflora. In brief, the impact of gestation on the periodontal tissue is a result of hormonal alteration, which increases the vulnerability to inflammatory response in the presence of plaque (Silva de Araujo Figueiredo, et al., 2017).

Previous studies pointed out the association among periodontitis and low socioeconomic level (Piscosya, et al., 2012). The findings of this study corroborate with those in the literature, since pregnant women with periodontitis showed lower schooling level ($P = 0.0008$) and monthly income ($P = 0.0001$). No intergroup difference was observed in daily brushing frequency ($P = 0.654$), however, pregnant women with periodontitis presented low using of dental floss ($P = 0.021$) and low access to dental services ($P = 0.049$) (Table 2). The lower socioeconomic level results in low knowledge about oral care and less access to dental services, which explains the inadequate oral hygiene behaviors and, consequently, the higher prevalence of periodontitis (Piscosya, et al., 2012). Nevertheless, in this study there was a high prevalence of patients from both groups who had low access to dental services and it is important to emphasize that the variable “regular dental appointment” had borderline significance, so this result should be carefully analyzed. Although lower socioeconomic status may be associated

with less access to dental services, in this study, lower socioeconomic status may have been mainly associated with poor oral care knowledge, such as the importance of flossing, which resulted in worse periodontal condition.

In our study, women with periodontitis during pregnancy also presented elevated maternal BMI ($P < 0.001$) and excessive gestational weight gain ($P = 0.008$) (Table 2). There are some hypotheses which may explain the association between high BMI and periodontitis, for instance, tumor necrosis factor alpha (TNF- α), IL-6, C-reactive protein are example of inflammatory mediators secreted by adipose tissue in overweight patients secretes, which in turn, increase the host's vulnerability to inflammation (Zimmermann, et al., 2013). Consequently, patients with excessive weight may present higher destruction of the periodontal tissues as the result of the greater accumulation of dental biofilm. Furthermore, there are other evidences that gram-negative bacteria's lipopolysaccharides release specific proteins, such as IL-6 and TNF- α , promoting dyslipidemia and reduced insulin sensitivity, which result in an increased risk of obesity and DM (Nishimura, et al., 2003).

Jesuino et al. (2020) sought to analyze the systemic and periodontal condition in women with excessive gestational weight gain (GWG) during pregnancy and after delivery. Their findings corroborate with the results of this study since they found that pregnant women with excessive GWG show high prevalence of hypertension and periodontitis during pregnancy. The aforementioned study highlighted the important role of high BMI in gestational weight gain due to the inadequate dietary pattern, characterized by consumption of low-cost foods that are more caloric and less nutritious.

Pregnant women with excessive weight before pregnancy present a greater amount of fat mass throughout pregnancy; however, the weight gain is lower than that in pregnant women with normal weight (Gunderson, et al., 2015). Nevertheless, in this study, the group of patients with periodontitis that presented higher anthropometric parameters also presented excessive weight gain during pregnancy (Table 2). The hypothesis for this finding is that patients with a lower socioeconomic status have inadequate dietary patterns, therefore, they intake cheaper foods, which in turn have a low nutritional value and high caloric content (Garcia, et al., 2019). The authors believe that these patients had no change in eating habits during gestation, which explains the high BMI values and the excessive weight gain among patients with periodontitis. However, future studies should aim to evaluate patients' dietary patterns to gain a better understanding of the association among periodontal condition, anthropometric parameters, and feeding behaviors.

The positive association between periodontitis and excessive weight in pregnant women was found in previous studies (Caracho, et al., 2020; Chapper, et al., 2005; Foratori-Junior, et al., 2020a; Foratori-Junior, et al., 2020b; Fusco, et al., 2019; Lee, et al., 2014; Piscoya, et al., 2012; Vogt, et al., 2012). Although they had differences in methodology, mainly in the classification of patients' nutritional status and periodontitis, they are important for a better understanding regarding the triangular association between these factors: overweight, pregnancy and periodontitis. Besides that, one of these studies, with longitudinal design, pointed out that low socioeconomic level was an important predictor of periodontitis during pregnancy and after delivery (Foratori-Junior, et al., 2020a). Our study affirms this statement once maternal BMI and low household monthly income were the variables of the final model of regression related to periodontitis (Table 4).

Maternal overweight may result in adverse systemic consequences during pregnancy (Foratori-Junior, et al., 2020a). Previous evidence showed that maternal overweight and obesity result in hypertension, preeclampsia and gestational diabetes mellitus, which may negatively influence the individuals' quality of life (Gao, et al., 2017). Although in this study the patients with periodontitis have presented higher anthropometric values, no intergroup difference was observed in the prevalence of gestational hypertension and diabetes mellitus. This finding may possibly be a reflection of the multidisciplinary work of several professionals from private and public health sectors, since they follow the principles of the Brazilian Unified Health System, mainly related to Women's Health Care Program. In contrast, it is important to highlight the need to include dental professionals in Women's Health Care Programs in both the public and private sectors.

Previous evidences have shown that the worst periodontal condition during pregnancy reduced the quality of life of

the pregnant women evaluated (Acharya & Bhat, 2009; Acharya, Bhat & Acharya, 2009; Geevarghese, Baskaradoss & Sarma, 2017). In this study, patients with periodontitis presented an impact on quality of life in all evaluated dimensions of OHIP-14 (Table 3). However, it is important to emphasize that, although OHIP-14 is a questionnaire, which assesses the impact of oral condition on quality of life, several factors can influence quality of life, since this is a subjective variable. In this sense, the entire context of patients should be analyzed for a correct understanding of quality of life.

Caracho and collaborators (2020) showed that pregnant women with overweight have higher prevalence of periodontitis and also worst parameters regarding OHIP-14. The main quality of life dimensions affected in pregnant women with overweight were physical pain; psychological discomfort; physical disability; and psychological disability (Caracho, et al., 2020). Similarly, Foratori-Junior et al. (2021) demonstrated that obese pregnant women had their quality of life affected mainly in terms of functional limitation, physical disability and handicap (Foratori-Junior, et al., 2021). In this study 70.3% (n = 45) of patients with periodontitis were classified as overweight/obesity. In addition, approximately 47% (n = 30) of patients with periodontitis also had moderate or high impact of quality of life. Considering the whole sample of this study, 15.62% (n = 20) had overweight/obesity, periodontitis and also negative impact on quality of life and well-being.

Lu and coauthors (2015) highlighted that higher impact on quality of life during pregnancy was associated with less access to dental services (Lu, et al., 2015). This statement supports our findings (Table 5), since low household monthly income together with the presence of periodontitis were the variables of the final model of logistic regression related to patients' quality of life. Therefore, social inequality is an important determinant for the quality of life, and professionals should consider the context in which patients are inserted in order to understand the influence of several factors on health and quality of life and thus, provide the best care to individuals.

This study presents some limitations. Ideally, for better understanding of the cause-and-effect relationship, a longitudinal study should be developed. In addition, pre-pregnancy weight and BMI, as well as maternal systemic conditions during pregnancy were obtained from medical follow-up records. Obtaining the numerical values regarding maternal glycemia and hypertension would make this analysis more precise. The oral behaviors were self-reported by the patients and the self-reference of these information is subjective.

5. Final Considerations

Despite these limitations, this study has an important contribution to the scientific literature, because it sought to analyze several health determinants related to periodontitis and quality of life during pregnancy. For this reason, this study suggests an integral and multidisciplinary approach to assess patients with periodontitis during pregnancy. In conclusion, pregnant women with periodontitis showed low socioeconomic level, low oral hygiene behaviors, high BMI, excessive gestational weight gain and worst quality of life. The results of this study suggested that social inequality is an important determinant of periodontitis during pregnancy and is associated with the negative impact of quality of life. Future prospective cohort population-based studies must be conducted in order to understand the influence of these outcomes during pregnancy on health of the neonates.

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