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ORIGINAL ARTICLE

Maternal periodontal status and preterm low birth weight delivery: a case–control study

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Abstract
Objectives To assess the association between severity and extent of maternal periodontal disease and preterm birth/low birth weight (PLBW) among women in the north of Jordan.
Methods A total of 148 woman who gave preterm birth/low birth weight birth and 438 women with uncomplicated full term vaginal delivery were included in this study. Socio-demographic characteristics, antenatal history, medical history, and family medical history were collected through personal interview or abstracted from maternal records. The oral hygiene status, and periodontal and dental parameters were assessed for all women.
Results The average of probing pocket depth (PPD) and average of clinical attachment level (CAL) were significantly higher among women who gave PLBW babies. The mean gingival recession was not significantly different between the two groups. The percentages of sites with PPD $\geq$ 3 mm and CAL $\geq$ 3 mm were significantly higher among women who gave PLBW babies. Number of decayed teeth, number filled teeth, and number of missing teeth showed no significant association with PLBW delivery.
Conclusion The extent and severity of periodontal diseases appeared to be associated with increased odds of PLBW delivery. Nevertheless, more and larger intervention trials are needed before it can be fully accepted that periodontal infection is a true risk factor for PLBW.

Keywords Periodontitis · Pregnancy complications · Preterm delivery

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Introduction

Preterm birth and low birth weight are important health problems in both developing and industrialized countries. Worldwide, more than 20 million infants are born with low birth weight with more than 95% of them being born in developing countries [1]. It was estimated that 11% of pregnancies end in preterm birth [2].

Risk factors for preterm birth/low birth weight (PLBW) are multiple. Considering the impact of PLBW deliveries on prenatal morbidity and mortality and the failure of recognized risk factors to explain them, a search for other risk factors has been active. Elevated levels of inflammatory mediators had been observed in PLBW deliveries, even in the absence of clinical or subclinical genitourinary tract infection. It was postulated that the majority of PLBW deliveries are caused by infections of unknown origins [3]. Several reports have explored the association between periodontal diseases and PLBW delivery [4–9]. Most of these studies were conducted in developed countries despite the fact that the vast majority of low birth weight babies are born in developing countries.

To our knowledge, this association was not explored among Jordanian women. The majority of women in Jordan is of similar ethnic background, nonsmokers, nonalcohol drinkers, and has only one sexual partner all through their life. Such characteristics were found to be associated with PLBW. Therefore, this study was conducted to assess the association between the severity and extent of maternal periodontal disease and PLBW delivery among women in the north of Jordan.

Materials and methods

This case–control study was conducted among women who gave birth at Princes Badea Teaching Hospital in the north of Jordan over a period of 5 months. The study was approved by the Human Research Committee of the Jordan University of Science and Technology. Informed consents for the interview and examination were obtained from all study participants.

The hospital's register was scrutinized each day to identify all PLBW deliveries. A case was defined as a woman who gave birth of an infant with birth weight under 2,500 g and one or more of the following: gestational age < 37 weeks, preterm labor, or premature rupture of membrane during the last 24 h. The control subjects were defined as women with uncomplicated full term vaginal delivery who gave birth of an infant with a birth weight of more than 2,500 g in the same day of that for the case. For each case identified, three controls were randomly selected from a pool of women who gave birth on the same day as the cases. Women were excluded from the study if they had medical conditions requiring antibiotic prophylaxis before periodontal examination. Women with multiple delivery and stillbirth were excluded. Six controls were excluded because of missing information in their medical records, leaving a total of 148 cases and 438 controls. All included women were Jordanian, insured, nonsmokers, and nonalcohol drinkers.

Data were obtained through personal interview and from maternal records. All information was filled in a pilot-tested structured questionnaire. The questionnaire included information on age at delivery, education level, occupation, family income, prepregnancy weight (kg), height (cm), body mass index (defined as the ratio of weight in kilograms to the square of height in meters), blood group, consanguinity with partner, passive smoking status, coffee and tea consumption, antenatal history, and the newborn status. Additional information was collected on the number of previous pregnancies, number of previous deliveries, number of previous abortions, time interval between the last two deliveries, history of preterm birth, history of low birth weight, history of pre-eclampsia, and history of caesarian delivery. Information related to the last pregnancy included antenatal visits, maternal history of diabetes mellitus, self-reported emotional status during pregnancy, and history of urinary tract infections or candidal vaginosis during pregnancy. Information regarding family history of cardiovascular diseases, hypertension, cerebrovascular accidents, diabetes mellitus, preterm birth, low birth weight, and pre-eclampsia was documented using yes or no response.

All participants underwent a clinical periodontal examination that was carried out by one dental clinician who was blinded to the case–control status. The examination took place in the maternity ward with the subject supine on the hospital bed to facilitate a reproducible examination position. The oral hygiene of six selected teeth and the periodontal status of all teeth, excluding third molars, were assessed using plaque index (PlI) of Silness and Loe [10], gingival index (GI) of Loe and Silness [11], probing pocket depth (PPD), clinical attachment level (CAL), and gingival recession (GR). Sterile dental mirrors and explorers were used to assess plaque accumulation and gingival status, while standardized Michigan 0 periodontal probes with Williams's markings (Diatech, Switzerland) were used to measure PPD, CAL, and GR. Probing pocket depth was measured from the gingival margin to the bottom of the crevice to the nearest millimeter. Clinical attachment level was measured to the nearest millimeter in cases of exposure of cement–enamel junction (CEJ) by reading off the distance from the CEJ or the margin of fixed restoration to the base of the pocket, and in other cases indirectly by subtracting the distance from the gingival margin to the CEJ from the pocket depth. Gingival recession was measured to the nearest millimeter by reading off the distance from the CEJ to the gingival margin. The tip of the probe was used to feel for and determine the CEJ level. Six representative teeth and four surfaces (mesio-facial, mid-facial, disto-facial, and mid-lingual) of each studied tooth were assessed and scored for plaque index. GI, PPD, CAL, and GR were measured at six sites (mesio-facial, mid-facial, disto-facial, mesio-lingual, mid-lingual, and disto-lingual) per tooth for all teeth, excluding third molars. The number of decayed teeth, number of filled teeth, and number of missing teeth for each participant were recorded. The means PlI, GI, PPD, CAL, and GR over all examined surfaces or sites as well as percentages of sites with CAL $\geq$3 mm and PPD $\geq$3 mm were calculated for each woman.

Statistical analysis

The Statistical Package for Social Sciences software (SPSS Inc., version 11.5, Chicago) and Microsoft Office Excel 2003 were used for data processing and data analysis. Characteristics of subjects' variables were described using frequency distribution for categorical variables and mean and

standard deviation for continuous variables. Chi-square test and independent sample *t* test were used wherever appropriate. Crude and adjusted odds ratios and their 95% confidence intervals were calculated. The effect of periodontal parameters on PLBW delivery was adjusted for possible predictors using binary logistic regression. At the first step of analysis, factors that were significantly associated with PLBW in the univariate analysis were entered in the regression equation. A variable was entered into the model if the probability of its score statistic was less than the entry value of 0.05, and was removed if the probability was greater than the removal value of 0.1. At this step, all variables that remained significant in the multivariate analysis constituted the reference model. At the second step, each periodontal/dental parameter was assessed by what it adds to the equation of the reference model at its point of entry. The second step was repeated for each individual parameter. A *P* value of less than 0.05 was considered statistically significant.

Results

This study included a total of 148 women with PLBW deliveries and 438 women with full term and normal birth weight deliveries. Their socio-demographic characteristics are presented in Table 1. More than one-third of women (39%) were over 30 years old and 35% were younger than 25 years. Only 27% of women had an education level higher than high school, and about 59% of women had a total family income of 200 JD (1 JD = $1.41) or more. There was no significant difference between cases and controls in the level of education, occupation, and total family income.

After adjusting for all important variables in the multivariate analysis, the only variables that were significantly associated with PLBW delivery were maternal age, parity, habitual abortions, history of preterm birth, and history of cesarean section. Compared to women aged between 17 and 25 years, women older than 30 years were more likely to give PLBW delivery (OR = 2.0, $P = 0.030$). Primiparous women (OR = 2.6, $P < 0.005$), women with history of habitual abortions (OR = 2.8, $P < 0.005$), women with history of preterm delivery (OR = 8.6, $P < 0.0001$), and women with history of cesarean section (OR 2.3, $P = 0.020$) were more likely to give PLBW delivery.

Table 2 shows the multivariate analysis of periodontal/dental parameters in relation to PLBW after adjusting for significant variables. The severity of periodontal disease as measured by the average of probing pocket depth and average of clinical attachment level was significantly higher among women who delivered PLBW infant. The odds ratios associated with 1 mm increase in the average probing pocket depth and clinical attachment level were 2.04 (95% confidence interval: 1.59, 2.61) and 2.21 (95% confidence interval: 1.66, 3.00), respectively. The mean gingival recession was not significantly different between the two groups. The extent of periodontal disease as measured by the percentages of sites with probing pocket depth ≥3 mm and clinical attachment level ≥3 mm were significantly higher among women with PLBW delivery. Number of decayed teeth, filled teeth, and missing teeth showed no significant association with PLBW delivery.

Table 1 Socio-demographic characteristics of women with preterm/low birth weight delivery and women with normal delivery

Variables	Number *n* (%)		*P* value*
	Normal delivery (control) (*n* = 438)	Preterm/low birth weight delivery (*n* = 148)	
Mother's age at birth (year)			0.045
17–25	145 (33.1)	60 (40.5)	
26–30	127 (29.0)	28 (18.9)	
>30	166 (37.9)	60 (40.5)	
Mean ± SD	28.65 ± 5.34	28.74 ± 6.26	
Mother's education			0.516
<High school	178 (40.6)	68 (45.9)	
High school	140 (32.0)	42 (28.4)	
>High school	120 (27.4)	38 (25.7)	
Mother's occupation			0.607
Not employed	397 (90.6)	132 (89.2)	
Employed	41 (9.4)	16 (10.8)	
Income (per month)			0.298
<200 JD	174 (39.7)	66 (44.6)	
≥200 JD	264 (60.3)	82 (55.4)	

* Using chi-square test

Discussion

This case–control study showed that the extent and severity of periodontal diseases were significantly associated with increased odds of PLBW delivery. This association remained significant after adjusting for maternal age, parity, habitual abortions, history of cesarean section, and history of preterm birth. The findings of this study support the findings of recent epidemiological and microbiological immunological studies that have suggested that periodontal disease may be an independent risk factor for PLBW [12, 13]. Of the twenty-five studies (13 case–control, nine cohort, and three controlled trials) included in a meta-analysis by Xiong et al. [14], only 18 studies suggested an association between periodontal disease and increased risk of adverse pregnancy outcome and seven

Table 2 The multivariate analysis of the association between periodontal/dental parameters and preterm/low birth weight delivery (PLBW)

	Mean ± SD		*P* value*
	Full term and normal birth weight delivery (control) (*n* = 438)	Preterm/low birth weight delivery (cases) (*n* = 148)	
Plaque index	1.60 ± 0.63	1.92 ± 0.62	<0.0001
Gingival index	1.55 ± 0.63	1.86 ± 0.60	<0.0001
Probing pocket depth (mm)	2.89 ± 0.88	3.50 ± 0.97	<0.0001
Clinical attachment level (mm)	3.00 ± 0.80	3.36 ± 0.80	<0.0001
Gingival recession (mm)	0.03 ± 0.28	0.02 ± 0.11	0.487
Percentages (%) of sites with			
Plaque index score ≥ 2	50.1 ± 27.2	73.4 ± 41.3	<0.0001
Gingival index score ≥ 2	48.2 ± 28.3	73.3 ± 42.1	<0.0001
Probing pocket depth ≥ 3 mm	18.2 ± 16.1	36.1 ± 43.1	<0.0001
Clinical attachment level ≥ 3 mm	16.3 ± 14.4	34.5 ± 43.2	<0.0001
Recession	1.3 ± 1.01	1.4 ± 1.0	0.849
Number of:			
Decayed teeth	1.00 ± 1.64	1.30 ± 2.30	0.105
Filled teeth	2.31 ± 3.16	2.32 ± 3.20	0.784
Missing teeth	1.20 ± 2.20	1.34 ± 2.41	0.272

* Each parameter was adjusted for maternal age, parity, habitual abortions, history of cesarean section, and history of preterm birth

studies found no evidence of such association. Vergnes and Sixou [15], in another meta-analysis of 17 studies, reported a pooled odds ratio of 2.83 as a measure of the strength of this association. However, Vergnes and Sixou [15] recommended that this pooled estimate need to be interpreted cautiously because of a clear trend for the better quality studies to be of lower association strength. Furthermore, both studies recommended that large, well-designed, multicenter trials and more methodologically rigorous studies are needed for confirmation of such association.

Although the exact mechanism underlying this association is still unclear, microbiological similarities between the oral cavity and the female genital tract may support this association [16–18]. Evidence is accumulating that oral bacteria, and especially *Pseudomonas gingivalis*, can invade the placental tissues and trigger inflammatory responses, which will result in release of effector molecules involved in preterm delivery. This evidence is supported by studies on fetal cord blood from spontaneous preterm birth babies that indicated a strong in utero IgM antibody response specific to several oral periodontal pathogens, which induces an inflammatory response at the fetal-placental unit, leading to prematurity [19–21].

In conclusion, the extent and severity of periodontal diseases appeared to be associated with increased odds of PLBW delivery. Nevertheless, more and larger intervention trials are needed before it can be fully accepted that periodontal infection is a true risk factor for PLBW.

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