

Research Article

Periodontal Disease and Pregnancy: Exploring the Bidirectional Relationship between Maternal Periodontal Health and Pregnancy Outcome

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ABSTRACT

Background: Periodontal disease is a common chronic inflammatory condition that may be linked to pregnancy in both directions: the hormonal changes of pregnancy can worsen periodontal health, and periodontal inflammation may in turn affect pregnancy outcome. Evidence from Khyber Pakhtunkhwa is limited.

Aims and Objectives: To assess the association between maternal periodontal health and pregnancy outcomes, specifically preterm birth and low birth weight, among pregnant women in Peshawar.

Material and Methods: This Prospective observational study enrolled 186 pregnant women attending tertiary care hospitals in Peshawar. Periodontal status was assessed clinically using standardized indices, and pregnancy outcome data were taken from delivery records.

Results: Of the 186 participants, 121 (65%) had periodontitis. Preterm birth occurred in 81 women (43.5%) and low birth weight in 79 (42.5%). All of these cases were in women with periodontitis: 81 of 121 (66.9%) delivered preterm and 79 of 121 (65.3%) had a low birth weight infant, compared with none of the 65 women without periodontitis. Both outcomes became more frequent as severity increased, reaching 100% in women with severe periodontitis. Both associations were statistically significant ($p < 0.001$).

Conclusion: Maternal periodontal disease was strongly associated with preterm birth and low birth weight in this sample, and the frequency of both rose with disease severity. Adding periodontal screening to routine antenatal care could help identify higher-risk pregnancies and merits consideration in maternal health policy.

Keywords: Periodontal Disease, Pregnancy Outcome, Preterm Birth, Low Birth Weight, Gingivitis.

INTRODUCTION

Periodontal disease, commonly known as gum disease, is a chronic inflammatory infection of the supporting tissues of the teeth. Pregnancy induces many changes in the maternal immune and endocrine systems. Hormonal changes, especially in estrogen and progesterone, lead to increased gingival blood flow and vasodilation and a heightened inflammatory response, rendering gingivitis more likely. In susceptible patients, this can result in progression to periodontitis. Oral infection can also induce a systemic inflammatory response; it has been

suggested that maternal oral health and pregnancy outcome can be interrelated¹.

The relationship between maternal periodontal disease and adverse pregnancy outcomes was first suggested by Offenbacher et al., in 1996, who demonstrated that periodontal infection was a risk factor for preterm low birth weight². However, the relationship between these two outcomes is still controversial, and results have been conflicting. A systematic review of case-control studies reported odds ratios of roughly 2 to 4³. In contrast, a later review and meta-analysis of observational studies found only a

weak association, and another meta-analysis including cohort and case-control studies found no association after adjustment for confounding factors such as cigarette smoking, age, or systemic disease^{1,4,5}.

The two most commonly proposed mechanisms by which the conditions may be related are that periodontal pathogens and inflammatory mediators can enter the circulation and reach the fetoplacental unit, where they may disturb homeostasis and possibly promote labor, or that the endocrine changes associated with pregnancy alter the oral microbiota and the immune response, increasing susceptibility to periodontal disease^{1,6}. We analyzed both of these pathways within one study population¹. Interest in this field is increasing rapidly. A bibliometric analysis of publications between 2000 and 2023 described the volume of research as increasing rapidly from 2019 onward, and noted that oral microbiota and global health burden are current research priorities⁷. A separate bibliometric analysis also described periodontal disease in pregnancy as an increasingly multidisciplinary topic⁸. There are still few reports from Pakistan; in a multi-center study, pregnancy status was found to be significantly related to periodontal status when data for all the patients was analyzed together⁹. Recently, a cross-sectional study from Peshawar showed that severity of periodontal disease was significantly associated with preterm birth in postpartum women, but extent was not¹⁰. However, that study was single-center and based on a relatively small sample. Because of the conflicting published reports, the growing understanding that the relationship may work in two directions, and the lack of an index-based analysis from Peshawar, the association between maternal periodontal status and pregnancy outcomes continues to be an area of active research. Here, we studied a cohort of pregnant women attending three tertiary care hospitals in Peshawar, using standardized indices to assess periodontal disease and documented pregnancy outcomes, to evaluate the association between maternal periodontal health and birth outcome in this population.

MATERIALS AND METHODS

Study Design and Setting

This Prospective observational study assessed the association between maternal periodontal health and pregnancy outcomes among pregnant women attending tertiary care

hospitals in Peshawar, Khyber Pakhtunkhwa, Pakistan.

Study Duration

The study ran for eight months, from November 2025 to June 2026.

Study Population

We included pregnant women aged 18 to 40 years who were between 20 and 40 weeks of gestation at examination, had at least six natural teeth, and gave written informed consent. We excluded women who were edentulous or had fewer than six teeth, who carried a pregnancy with a known congenital fetal anomaly, who had a multiple gestation, who had received periodontal treatment in the preceding three months, or who had used antibiotics in the preceding month.

Sampling Technique and Sample Size

We used non-probability consecutive sampling. All eligible pregnant women presenting to the participating outpatient and gynecology departments were invited to participate until the target sample size was reached. Sample size was calculated with Cochran's formula for a single proportion, using a 95% confidence level, a 5% margin of error, and an anticipated prevalence of generalized periodontitis among pregnant women of 87.5% based on local Peshawar data¹⁰. This gave a minimum of 169 participants. We added 10% for non-response or incomplete follow-up, for a final target of 186.

Data Collection Procedure

After enrollment, each participant completed a structured survey covering demographic, obstetric, behavioral, and medical history. A trained and calibrated examiner then performed a clinical periodontal examination. Pregnancy outcome data (mode of delivery, gestational age at delivery, birth weight, and neonatal outcome) were taken from hospital delivery records or collected by direct follow-up at the time of delivery.

Instruments Used

The intraoral examination used a stainless-steel mouth mirror and a No. 23 shepherd's hook explorer (both Hu-Friedy Mfg. Co., LLC, Chicago, IL, USA) to detect calculus and carious lesions by touch. Probing pocket depth and clinical attachment loss were measured with a UNC-15 color-coded periodontal probe (Hu-Friedy Mfg. Co., LLC, Chicago, IL, USA). A Williams periodontal probe (GDC Dental Products, Neoris Medicare Pvt. Ltd., Faridabad,

India) was used to verify sulcus depth. Lighting came from a portable LED dental headlight (Luxamed GmbH, Niederstetten, Germany). Reusable instruments were sterilized between examinations in a steam autoclave (Shinva Medical Instrument Co., Ltd., Zibo, China), and examiners wore disposable latex gloves and masks (Surgicare Industries, Karachi, Pakistan). Maternal height and weight were recorded with a portable stadiometer and a digital flat scale, and neonatal birth weight with a digital infant scale (all Seca GmbH & Co. KG, Hamburg, Germany).

Operational Definitions

Periodontal status was assessed using the Plaque Index of Silness and Löe, the Gingival Index of Löe and Silness, probing pocket depth, clinical attachment loss, and bleeding on probing, expressed as a percentage of sites examined. Disease extent was classified as localized when 30% or fewer of sites were affected and generalized when more than 30% were affected. Severity was classified as none, mild, moderate, or severe based on clinical attachment loss, following the Extent and

Severity Index of Carlos, Wolfe, and Kingman. Preterm birth was defined as delivery before 37 completed weeks of gestation, and low birth weight as a birth weight below 2,500 g.

Statistical Analysis

Data were entered in Excel and analyzed in R using RStudio (version 2026.05.1, Build 225, "Golden Wattle"). We computed descriptive statistics for all variables. Associations between categorical variables were tested with the Chi-square or Fisher's exact test, as appropriate. For continuous variables, we used the Mann-Whitney U test or the independent samples t-test, depending on normality as assessed by the Shapiro-Wilk test. Logistic regression was used to adjust for confounders. A p-value below 0.05 was considered statistically significant.

RESULTS

Participants

We enrolled 186 pregnant women, and data were complete for all variables. Periodontitis was present in 121 women (65%) and absent in 65 (35%). Baseline characteristics are shown in Table 1.

Table 1. Baseline characteristics by periodontitis status

Characteristic	No periodontitis (n=65)	Periodontitis (n=121)	p-value
Age (years), median	21.0	31.0	<0.001
Low socioeconomic status	10 (15%)	40 (33%)	<0.001
Illiterate	0 (0%)	31 (26%)	<0.001
3rd trimester	34 (52%)	121 (100%)	<0.001
Tobacco use	0 (0%)	39 (32%)	<0.001
Diabetes	1 (1.5%)	18 (15%)	0.003
Clinical attachment loss (mm), median	0.0	4.5	<0.001

Periodontal status and baseline characteristics

Compared with women without periodontitis, those with periodontitis were older, had lower socioeconomic status and less education, and were more often in the third trimester (all $p<0.001$, Table 1). Tobacco use, prior preterm birth, and prior low birth weight were reported only by women with periodontitis.

Preterm birth and low birth weight

Preterm birth occurred in 81 of 186 women (43.5%) and low birth weight in 79 (42.5%). All

of these cases were in women with periodontitis (preterm: 81/121, 66.9%; LBW: 79/121, 65.3%). None of the 65 women without periodontitis had either outcome (Fisher's exact test, $p<0.001$). Both outcomes became more frequent with increasing severity: 0% in the healthy and gingivitis groups, about 50% in moderate periodontitis, and 100% in severe periodontitis (chi-square trend, $p<0.001$; Table 2, Figure 1).

Table 2. Pregnancy outcomes by periodontal diagnosis

Outcome	Healthy (n=34)	Gingivitis (n=31)	Moderate (n=82)	Severe (n=39)	p-value
Preterm birth	0 (0%)	0 (0%)	42 (51%)	39 (100%)	<0.001
Low birth weight	0 (0%)	0 (0%)	40 (49%)	39 (100%)	<0.001

Birth weight (g), median	3,100	2,900	3,800	1,950	<0.001
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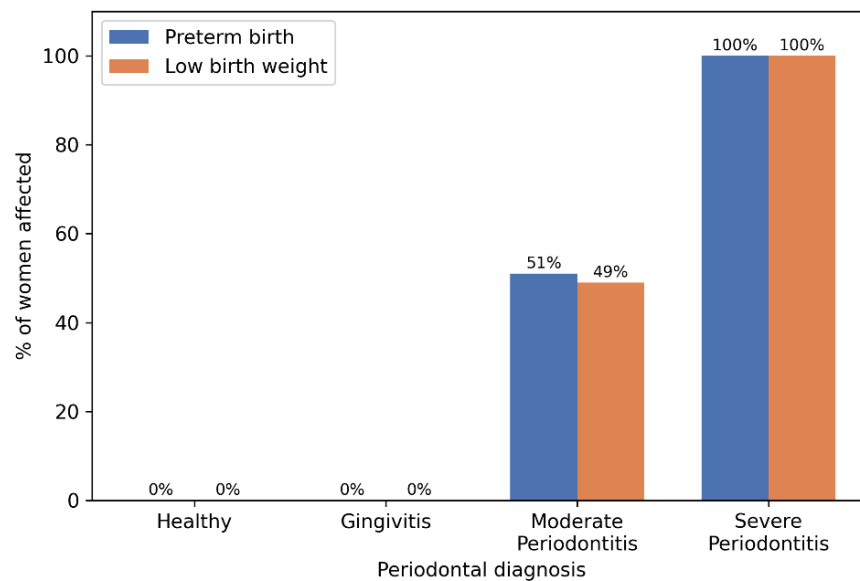


Figure 1 Preterm birth and low birth weight percentages across the four periodontal diagnosis groups

Regression Analysis

Because some cells had zero events, we used Firth logistic regression. Periodontitis was associated with higher odds of both outcomes, and the odds were higher in severe than in

moderate disease. The associations remained significant after adjustment for age, UTI/genital infection, and diabetes, although the confidence intervals were wide (Table 3).

Table 3. Firth logistic regression: odds ratios (95% CI) for preterm birth

Variable	OR (95% CI)
Periodontitis (vs none), crude	263.6 (36.3–33,556)
Age (per year), adjusted	0.87 (0.79–0.94)
UTI/genital infection, adjusted	131.0 (16.6–16,963)
Diabetes, adjusted	80.4 (9.9–10,323)

Birth Weight and Gestational Age

Gestational age at delivery and birth weight both fell as periodontal severity increased.

Median gestational age dropped from 39 to 34 weeks, and median birth weight was 1,950 g in severe periodontitis (Figure 2).

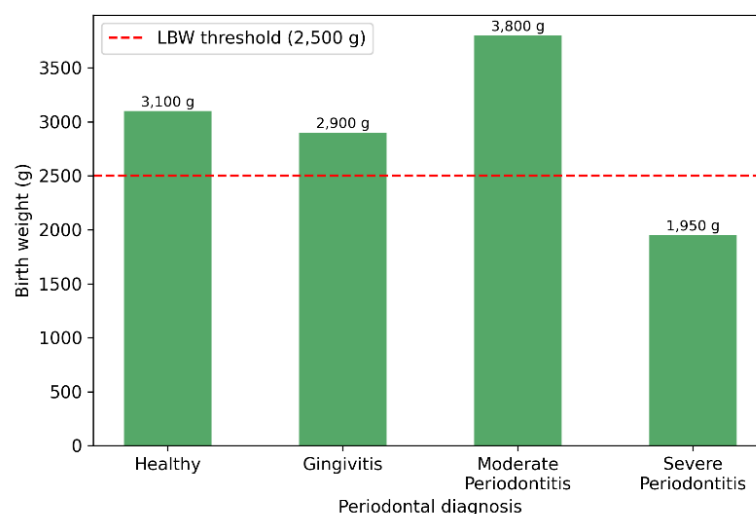


Figure 2 Median birth weight by diagnosis group, with the 2,500 g LBW threshold marked

Clinical Indices

Women with preterm birth or low birth weight had higher Gingival Index, probing pocket depth, clinical attachment loss, and bleeding on probing (Mann-Whitney U test, $p < 0.001$ for all). Clinical attachment loss and Gingival Index were strongly and negatively correlated with gestational age at delivery ($\rho = -0.98$ and -1.00 , $p < 0.001$).

DISCUSSION

In this study conducted among 186 pregnant women in Peshawar, 65% had periodontitis, which was associated with both preterm delivery and low birth weight. Both outcomes increased from the healthy/gingivitis group through the moderate and severe periodontitis groups, in which 100% of 39 women delivered preterm and had low birth weight infants. Gingival Index, probing pocket depth, clinical attachment loss, and bleeding on probing were higher in women with adverse pregnancy outcomes, and clinical attachment loss and Gingival Index correlated with delivery age.

The question was well-defined: in 186 pregnant women in Peshawar, how does maternal periodontal status associate with two objective outcomes. There was a lack of Peshawar data available from different locations to compare to in previous studies. The cross-sectional design allows for a snapshot of exposure (periodontal indices) and outcome (delivery data) at the same time, without the loss of the longitudinal cohort study. Standardized clinical indices (Plaque Index, Gingival Index, probing pocket depth, clinical attachment loss, bleeding on probing) were used in lieu of self-reported oral health, which limits misclassification. Delivery data was obtained, but the study also included data collected from a structured interview and a clinical exam. Most confounders relevant to this question (tobacco/naswar use, diabetes, socioeconomic status, education, and prior adverse obstetric history) were collected at time of enrollment rather than after the fact. Firth penalized logistic regression was used due to sparse data; conventional maximum likelihood estimates are not possible when complete separation occurs, and Firth's penalized model is the standard recommendation in this case^{11,12}.

This study adds index-based clinical data from Peshawar. Pakistani studies on this subject are largely published from the cities of Karachi¹³. It addresses periodontal status in relation to both preterm and low birth weight deliveries individually, as opposed to grouping the

deliveries together and comparing the periodontal index of this group to a control group; it matters because the maternal periodontal indices are different between preterm and low birth weight deliveries, as is reported in large South Asian studies¹⁴. For example, Plaque Index was higher in women who delivered preterm, the opposite of the Gingival Index pattern. If only one outcome is reported, that relationship would be missed. The risk of preterm and low birth weight deliveries were much higher than the odds ratios of 2 to 3 in large South Asian cross-sectional studies^{14,15}. This is not evidence of an unexpectedly high risk, as 0% of those in one group and 100% of those in the other group experienced both adverse pregnancy outcomes; this reflects small numbers within each diagnostic group rather than an accurate estimate. The statistical problem of separation in logistic regression is well documented in the biostatistical literature^{11,12}.

If larger, multi-site studies with these data confirm these results, it would support a policy that has already been put forth in other resource-limited settings: incorporating periodontal screening into prenatal visits rather than waiting for the patient to have a nonurgent dental visit¹⁶. In fact, network meta-analytic evidence supports such prenatal screening, as periodontal therapy can decrease the risk of preterm and low birth weight deliveries, although it depends on the type of intervention and the timing¹⁷. Diabetes, tobacco use, and low education were highly associated with periodontitis in our data. Therefore, a periodontal screening program for pregnant women should be combined with the prenatal counseling about other risk factors. In addition, periodontitis and gestational diabetes are often found together, and this may be due to shared risk factors^{13,18,19}.

This finding is in disagreement with some other studies from the subcontinent, which found no association between maternal periodontal status and preterm/low birth weight deliveries, or found an association with one outcome but not the other²⁰. Recent reviews have cautioned that periodontal status and pregnancy outcomes are difficult to link due to differences in how periodontal disease is defined, the time at which it was assessed, and the confounding factors that were controlled for¹⁸. The very high odds ratios, and the resulting complete separation in the fitted logistic regression models, should be interpreted with care. When separation occurs, confidence intervals are very

wide and the estimated effect should really be interpreted as one with a specific direction but not a specific value^{11,12,21}. The odds ratios in the hundreds or thousands should not be interpreted literally. This result should be replicated by other studies.

Further research is needed, and large multi-center studies should be conducted at the tertiary care hospitals in Peshawar. These studies should have adequate power to analyze the effect of periodontal status within each severity category. Longitudinal studies with periodontal status assessed prior to and during pregnancy would allow for more evidence regarding the bidirectional relationship described in the title of this paper. Since diabetes and tobacco use were highly associated with periodontitis, and maternal periodontal status and diabetes are themselves linked^{13,18,19}, future studies should be adequately powered to control for these two major risk factors individually. In fact, since periodontal therapy does not have a clear effect on maternal outcome depending on the type of therapy and the time at which it is performed¹⁷, the next logical step would be an interventional trial within the Peshawar setting, where periodontal therapy is initiated early in pregnancy and maternal and infant outcomes are evaluated in the resulting birth cohort.

CONCLUSION

In this study of pregnant women in Peshawar, periodontal disease was significantly associated with preterm birth and low birth weight, and the prevalence of both increased with the severity of periodontal disease. The risk of preterm birth and low birth weight was greatest in women with periodontitis, followed by women with gingivitis, and lowest in women with healthy periodontium. These data suggest that periodontal health may be a modifiable risk factor for preterm birth and low birth weight in this patient population. Periodontal screening as part of routine antenatal care may facilitate early identification of women at risk for adverse pregnancy outcomes. Larger prospective studies at multiple sites are required before these data can be used to support the development of maternal health policy.

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