ORIGINAL RESEARCH

The Association of Maternal Periodontal Diseases in the Postpartum Period with Preterm Low Birth Weight

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Abstract

Aim: Preterm birth is the most adverse effect of pregnancy, commonly leading to low birth weight. Our study aimed to assess the relationship between maternal periodontal status and adverse pregnancy outcomes by immediate postpartum periodontal examination and diagnosis.

Materials and methods: 125 mothers were divided into four groups based on gestational day (GD) and newborns' birth weight (BW); the mothers with GD $\geq$ 259 days and BW $\geq$ 2500 gm (Control), the mothers with GD <259 days and BW $\geq$ 2500 gm (PT group), the mothers with GD $\geq$ 259 days and BW <2500 gm (LBW group), and the mothers with GD <259 days and BW <2500 gm (PT-LBW group). The maternal periodontal assessment was carried out within 3 days after delivery.

Results: The bleeding on probing (BOP) of the PT-LBW group was significantly higher than the control ($P = 0.027$). The correlation test revealed a mild inverse relationship between BOP and BW ($R = -0.23$, $P = 0.044$). According to the new 2018 American Academy of Periodontology (AAP) periodontal classification, there was no significant difference between periodontal status within groups.

Conclusion: The present study suggests that BOP, an early sign of gingival inflammation, is involved in adverse pregnancy outcomes.

Clinical significance: This study is the first of its kind to use immediate postpartum periodontal examination and diagnosis by the new 2018 AAP periodontal classification. The findings demonstrate that signs of gingival inflammation may be associated with adverse pregnancy outcomes.

Keywords: Adverse pregnancy outcomes, Low birth weight, New 2018 AAP classification Periodontal diseases, Preterm birth.

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Introduction

Preterm birth is considered one of the most adverse effects of pregnancy, often resulting in low birth weight (BW). Previous studies have explored the potential connection between maternal periodontal diseases and preterm birth by collecting periodontal data during pregnancy. However, these studies often experienced losing large numbers of participants in a normal delivery.[1,2] To address these limitations, our study aimed to investigate the association between maternal periodontal status and adverse pregnancy outcomes in immediate postpartum mothers using a diagnosis based on the new 2018 American Academy of Periodontology (AAP) periodontal classification.[3]

Periodontal disease is a chronic inflammatory condition of the tissues surrounding the teeth, which is often associated with bacterial plaque-induced inflammation and occasionally related to smoking, systemic diseases, (e.g., diabetes), hormonal changes, (e.g., during pregnancy and puberty), certain medications or nutritional factors (e.g., vitamin deficiency). If the inflammation is confined to the gingival tissue, it is diagnosed as gingivitis, but if the inflammation progresses to the destruction of the alveolar bone, it is called periodontitis. In gingivitis, features such as redness, swelling, pain, or bleeding may be present without clinical attachment loss. Diagnosis is typically based on clinical examination and the presence of bleeding on probing.[4,5] In periodontitis, the symptoms include the destruction of periodontium, deepening of periodontal pockets, gingival recession, and loss of clinical attachment. Clinical and radiographic examination, especially clinical attachment level (CAL), are essential for diagnosing periodontitis.[6]

Several studies have found an association between periodontal disease and an increased risk of pregnancy adverse events. In the systematic review of Teshome and Yitayeh, which gathered 229 articles, the inclusion criteria were satisfied by 10 case-controlled studies. The review concluded that 9 out of 10 studies discovered a significant association between periodontal disease and low BW and/or preterm birth with odds ratios ranging from 2.04 to 4.19.[7] While the mechanism is not fully understood, there are several theories and findings proposed. These theories are typically related to the inflammatory response, caused by chronic inflammation in periodontal disease, that can also induce a systemic inflammatory response throughout the body, including the uterus. Furthermore, numerous inflammatory mediators in periodontal disease, such as interleukin-1β (IL-1β), tumor necrosis factor alpha (TNF-α), and prostaglandins E2 (PGE2),[8] are known to be involved in the onset

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of labor. They may reach the placenta and interfere with the normal progression of pregnancy or increase the risk of preterm birth. Another well-known hypothesis is related to the bacteria from infected periodontium, due to its ability to enter the bloodstream, which may cause an immune response leading to adverse effects of pregnancy.[9–11]

However, periodontal disease and adverse pregnancy outcomes share several contributing factors, such as smoking, systemic diseases, malnutrition, certain medications, and socioeconomic factors, which may contribute to the interactive results of both conditions. Although several studies have found an association between periodontal disease and adverse pregnancy outcomes, they do not imply the mechanisms involved. Hence, further studies are required to determine a definitive cause-and-effect relationship and high-quality randomized controlled trials to clarify the true relationship between these incidents.[12]

From the year 2016–2021, the neonatal mortality under 28 days of age per 1,000 live births in Thailand steadily increased from 4.27 to 4.81. While the Ministry of Public has set the criteria to be less than 3.60. When analyzing the causes of death of newborns in 2019 (excluding Bangkok), it is found that the leading causes are preterm birth combined with low BW at 50.97%, followed by congenital malformation and chromosome abnormality (9.6) and birth asphyxia (7.49).[13] From these data, it is evident that premature birth along with low BW is a major nationwide issue that has the greatest impact on newborn deaths.

The Nang Rong Hospital is a general hospital with 350 beds, located in Buriram provinces. In 2022, Buriram province recorded a preterm birth rate of 9.41. In 2018, Nang Rong Hospital had 5,535 new pregnancies with a premature birth as high as 30%,[14] compared WITH Thailand situation of 12.47% in 2021, reported by The Ministry of Public Health (target to not exceeding 10).[13,15]

In 2019–2020, Nang Rong District reported a low BW percentage at 1.22 and 1.43.[16] In 2022, Thailand (excluding Bangkok) and Buriram province had the rates at 5.03 and 6.46%, respectively, while The Ministry of Public Health has set a target of not exceeding 7.[15,17] Although the data for Nang Rong District is considered to be somewhat lower than the regional situation, low BW can still affect a baby's overall health especially when combined with premature birth. This study therefore emphasizes the importance of both issues and hopes that the data will assist in planning maternal and child care from the prenatal period onwards.

Materials and Methods

This study is a case-control study among postpartum mothers attending antenatal care and giving birth from March 2020 to August 2020 (N = 125) at Nang Rong Hospital, Buriram. The inclusion criteria were postnatal mothers attending antenatal care and giving birth at Nang Rong Hospital, who were willing to participate in this research within 3 days after the delivery. The exclusion criteria were mothers having twin pregnancies, congenital disease, mental disorder, antibiotics/anti-inflammatory drug usage, or undergoing periodontal treatment in the past 6 months. The sample size was calculated using p reference values from a case-control study in the similar context ($p1 = 0.94$ and $p2 = 0.71$).[18] The confidence level and the power were established at 90 and 70%, respectively. Consequently, the sample size and control should each be a minimum of 21 and 41 (Fleiss; OpenEpi Ver. 3).[19] This research protocol was approved by the Human Research Ethics Committee of Buriram Provincial Public Health Office (BRO 2020-09 and BRO 2020-003). General and clinical data of mothers and infants were collected from the hospital medical files, (e.g., age, weight, height, periodontology history, and pregnancy history). Oral and periodontal status were measured by the same single dentist within 3 days post-labor. Clinical parameters were recorded by the periodontal probe (PCPUNC15; Hu-Friedy, Chicago, U.S.A). Probing depth (PD) and CAL were measured on six surfaces (mesiobuccal, buccal, distobuccal, distolingual, lingual, and mesiolingual), and the results were reported in millimeters (mm).[18] PD was defined as the distance from the gingival margin to the bottom of the periodontal sulcus, while CAL was the distance from the cementoenamel junction (CEJ) to the bottom of the sulcus. Bleeding on probing (BOP) was recorded approximately 10 s after probe application (Ainamo and Bay 1975).[20] Two recording sites per tooth were recorded (buccal and lingual) and reported as percentages. All participants provided informed consent and oral hygiene instruction (modified bass brushing technique and flossing). If the participant was diagnosed with periodontitis, according to the new 2018 AAP classification, an extraoral panoramic film would be performed.

The experimental groups (N = 125) were divided according to gestational day (GD) and newborn BW, in which GD <259 days was defined as a preterm birth, while BW <2500 gm was defined as a low BW. The experimental groups consist of 4 groups: the control group ($N = 50$), the preterm birth group (PT; $N = 22$), the low BW group (LBW; N = 25), and the preterm with low BW group (PT-LBW group; $N = 28$). Since the number of subjects in each group was uneven, a non-parametric test was chosen (IBM SPSS 26.0). Data were expressed as mean ± SD. Statistical differences between groups were analyzed by the Kruskal–Wallis test. However, if data were categorized as a nominal scale (periodontal status, periodontal treatment, types of labor, and smoking and alcohol assumption), it would be reported as a number with percentage and Fisher's exact test would be applied. The level of statistical significance was set at p-value < 0.05. Additionally, a significant difference between Control vs PT-LBW group was found in the %BOP parameter, so the Pearson correlation test was performed.

Results

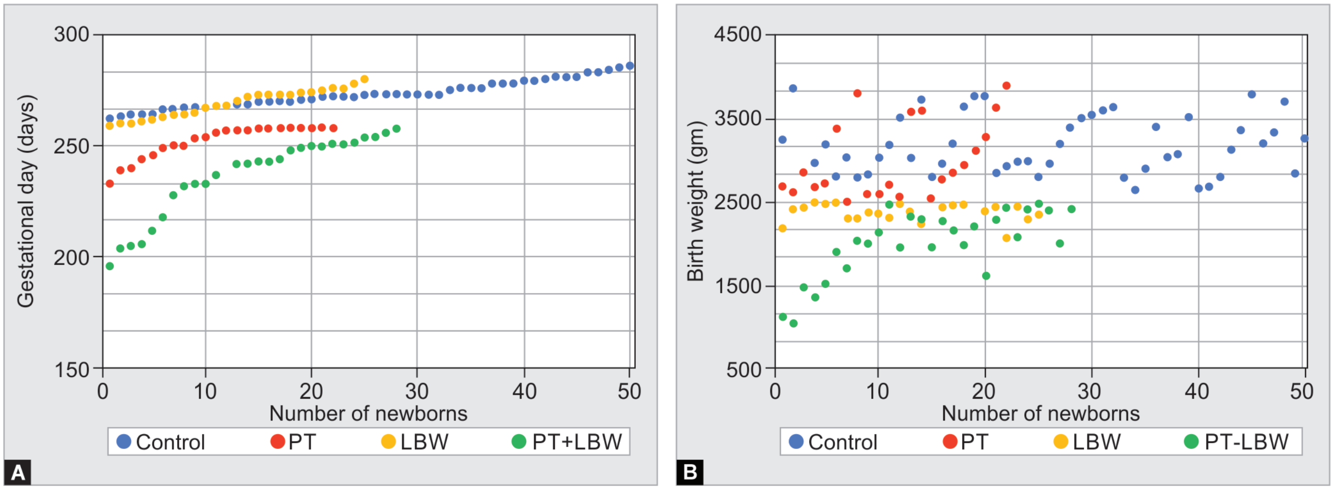
Obstetric characteristics (Table 1) were utilized to divide the experimental groups. (<2500 gm = LBW; <259 GD = PT). This results in significant differences between the groups. When considering the GD (Fig. 1A), statistically significant differences were found between Control vs PT, Control vs PT-LBW, PT vs LBW, and LBW vs PT-LBW. Corresponding to the BW (Fig. 1B), statistically significant differences were found between Control vs LBW, Control vs PT-LBW, PT vs LBW, and PT vs PT + LWB. Upon analyzing trends in BW, it was found that in the PT-LBW group (2000.36 ± 405.79 gm), the BW was likely to be less than that of the LBW group (2350 ± 135.34 gm).

The general characteristics of postpartum mothers are shown in Table 2. The mean maternal age was around 25–28 years, which was highest in control (27.76 ± 6.04 y) and lowest in the PT-LBW group (25.39 ± 7.00 y), without statistical significance between groups. The mean weight of the mothers who gave birth to the low BW infants (61.04 ± 9.90 kg in LBW and 61.90 ± 15.84 kg in PT-LBW) was significantly lower than the Control (68.78 ± 11.48 kg). Correspondingly, a statistically significant difference was found in the maternal BMI parameter (Fig. 2), between Control (27.37 ± 4.24) and PT-LBW (24.67 ± 6.98).

Table 1: Obstetric characteristics

Obstetric characteristics	*Control (N = 50)*	*PT (N = 22)*	*LBW (N = 25)*	*PT-LBW (N = 28)*	*p-value*
Gestational day (GD) (days; mean ± SD)	273.14 ± 6.15	252.23 ± 7.48	269.12 ± 6.27	236.79 ± 17.90	<0.001*
Birth weight (BW) (gm; mean ± SD)	3176.6 ± 348.41	2997.73 ± 455.83	2350 ± 135.34	2000.36 ± 405.79	<0.001*

*Statistically significant differences between groups [Kruskal–Wallis test (p-value < 0.05)]



Figs 1A and B: (A) Newborns' gestational day; (B) Newborns' birth weight. Data were sorted by gestational day

Table 2: The general characteristics of postpartum mothers

Maternal characteristics	*Control (N = 50)*	*PT (N = 22)*	*LBW (N = 25)*	*PT-LBW (N = 28)*	*p-value*
Age (years)	27.76 ± 6.04	26.05 ± 7.62	28.32 ± 7.33	25.39 ± 7.00	0.297
Maternal BMI (kg/m^2)	27.37 ± 4.24	26.24 ± 4.13	25.47 ± 4.31	24.67 ± 6.98	0.013*
Maternal weight (kg)	68.78 ± 11.48	67.18 ± 10.70	61.04 ± 9.90	61.90 ± 15.84	0.004*
Maternal height (cm)	158.44 ± 4.79	158.95 ± 4.74	154.96 ± 5.18	157.68 ± 7.74	0.054
Order of pregnancy = *N* (%)					0.300
1st pregnancy	20 (40)	13 (59)	14 (56)	16 (57)	
2nd pregnancy	20 (40)	5 (23)	8 (32)	9 (32)	
3rd pregnancy	6 (12)	4 (18)	1 (4)	3 (11)	
4th pregnancy	4 (8)	0 (0)	2 (8)	0 (0)	
Maternal periodontal treatment = *N* (%)					>0.05
Never	12 (24)	6 (27)	10 (40)	14 (50)	
Scaling <1 year	9 (18)	4 (18)	5 (20)	4 (14)	
Scaling >1 year	29 (58)	12 (55)	10 (40)	10 (36)	
Types of labor and delivery = *N* (%)					>0.05
Normal labor	21 (42)	7 (32)	12 (48)	19 (68)	
Cesarean section	29 (58)	14 (64)	13 (52)	9 (32)	
Birth before arrival	0 (0)	1 (5)	0 (0)	0 (0)	
Smoking and alcohol assumption = *N* (%)					0.117
No	50 (100)	22 (100)	25 (100)	26 (93)	
Smoking and alcohol assumption	0 (0)	0 (0)	0 (0)	2 (7)	

*Statistically significant differences between groups [Kruskal–Wallis test ($p < 0.05$); mean ± SD]

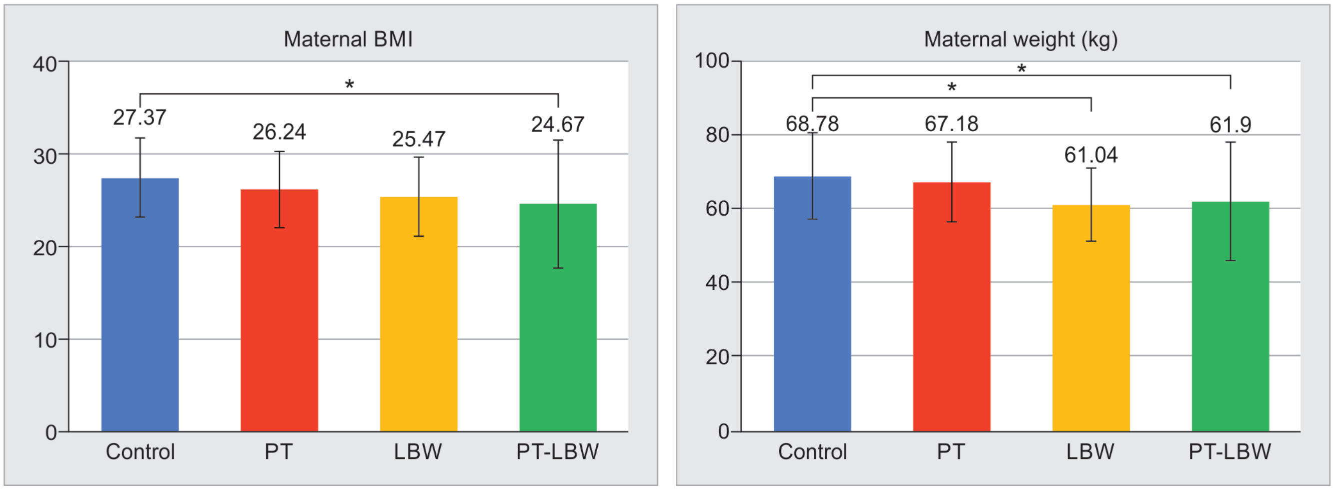


Fig. 2: Maternal BMI and weight
*Statistically significant differences between groups [*Kruskal–Wallis test ($p < 0.05$); mean ± SD]

Table 3: The clinical parameters of postpartum mothers

Clinical parameter	*Control (N = 50)*	*PT (N = 22)*	*LBW (N = 25)*	*PT-LBW (N = 28)*	*p-value*
Number of teeth	27.84 ± 1.91	27.91 ± 1.97	28.04 ± 2.09	28.32 ± 1.34	0.677
Site	167.04 ± 11.46	167.45 ± 11.84	168.24 ± 12.55	169.71 ± 8.46	0.689
Mean PD (mm)	1.80 ± 0.41	1.80 ± 0.41	1.87 ± 0.37	1.76 ± 0.23	0.732
Mean CAL (mm)	0.32 ± 0.53	0.54 ± 0.74	0.28 ± 0.51	0.37 ± 0.76	0.535
BOP (%)	41.90 ± 25.74	56.36 ± 23.51	45.01 ± 22.91	58.29 ± 24.16	0.014*

*Statistically significant differences between groups [Kruskal–Wallis test ($p < 0.05$); mean ± SD]

Clinical parameters are given in Table 3. Mean number of teeth ranged from 27 to 28, with no significance between groups. The mean PD and mean CAL were also not significant. However, statistically significant differences were found between Control and PT-LBW in the %BOP (Fig. 3). Hence, the Pearson correlation test between %BOP and BW was performed, which revealed a mild inverse relationship (Fig. 4; $R = -0.23$, $p = 0.044$).

Maternal periodontal status was given according to the new 2018 AAP classification (Table 4 and Fig. 5A). The majority of mothers were diagnosed as gingivitis without significant correlation to obstetric characteristics (Fig. 5B; p-value > 0.05).

Discussion

The mean weight of mothers who gave birth to the low BW infants in both the LBW group (61.04 ± 9.90 kg) and the PT-LBW group (61.90 ± 15.84 kg) were significantly lower than Control (68.78 ± 11.48 kg). Correspondingly, a statistically significant difference in the maternal BMI parameter was observed between Control and PT-LBW. The mean BMI of mothers in Control (27.37 ± 4.24) were highest among groups and fell into the overweight range (25.0–29.9) along with the PT group (26.24 ± 4.13) and the LBW group (25.47 ± 4.31), while the PT-LBW group (24.67 ± 6.98) was in the normal weight range (18.5–24.9). This suggested that maternal weight may have an impact on infants' weight. This is consistent with the study of He et al. in Africa, which reported that underweight mothers were more prone to giving birth to low BW infants. The study also found a significant relationship between low maternal BMI and low BW in Senegal.[21] Another study conducted in Senegal by Cisse et al., addressed that young age (<18 years), BMI, and periodontitis have an association with low BW.[22] Therefore, maternal weight is one factor that should be taken into account during pregnancy.

The mean maternal age was highest in Control (27.76 ± 6.04 y) followed by the LBW groups (28.32 ± 7.33 y), The PT group (26.05 ± 7.62 y), and lowest in the PT-LBW group (25.39 ± 7.00 y), without significant difference. This aligns with many studies including the Thailand Reproductive Health report, which identified a greater prevalence of low BW as the age of mothers decreases, particularly among mothers under 20 years old.[22–24] This indicated that the mother's physical condition may play a role in determining the baby's characteristics.

Upon analyzing the trends in BW, it was observed that the BW in the PT-LBW group was seemingly lower than that in the LBW group. This observation might suggest a potential negative effect of preterm birth on weight. Though no statistically significant difference was found, preterm birth is frequently known to be associated with low BW due to the shortened gestational period, which leads to insufficient time for the fetus to fully develop.[25]

The bleeding on probing of the PT-LBW group showed a significant increase compared with the control. Moreover, when analyzing data from the control and the PT-LBW group with the correlation test, a mild inverse relationship between BOP and BW was revealed ($R = -0.23$, $p = 0.044$). This can be interpreted that as BOP increases, the BW tends to decrease in a relatively mild manner. This is in line with a study by Radnai et al., which found a significant association between initial localized periodontitis (defined as BOP ≥50% and PD ≥4 mm in ≥1 site) and preterm birth. The significant differences between the PT group (N = 77) and

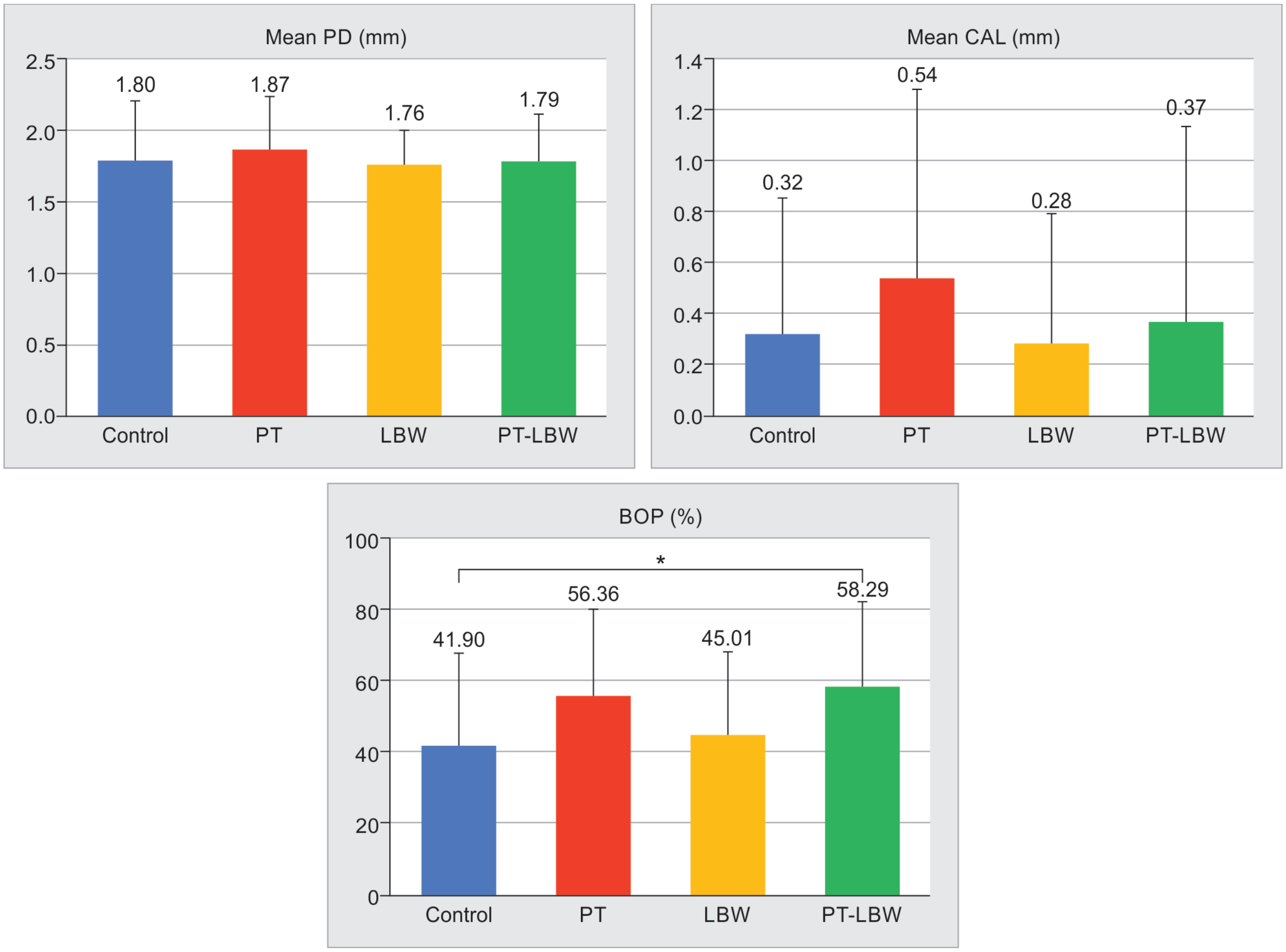


Fig. 3: Mean PD, mean CAL and %BOP
*Statistically significant differences between groups [*Kruskal–Wallis test ($p < 0.05$); mean ± SD]

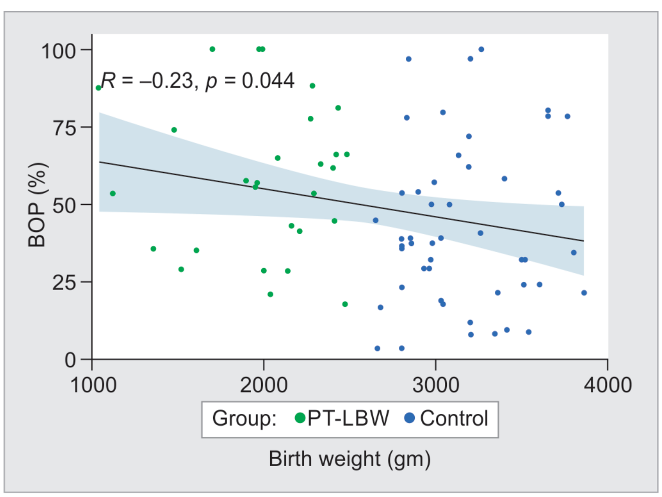


Fig. 4: A mild inverse relationship between %BOP and birth weight [Pearson correlation test ($R = -0.23$, $P = 0.044$)]

Control ($N = 88$) were found when comparing these factors; (1) PD ≥4 mm in ≥1 site, (2) BOP ≥50%, and (3) both conditions combined. However, it failed to find any difference in mean PD, mean BOP, and plaque index. The study also interestingly found a significant decrease in newborn weight among periodontitis mothers (2834.5 gm vs 3180.3 gm).[26] Another consistent study was the retrospective case-control study of Nabet et al., which identified that PT-LBW mothers ($N = 150$) have significantly higher BOP than Control ($N = 223$); however, no difference in extent and severity of periodontal disease was observed (defined as BOP ≥30% and PD ≥4 mm in ≥4 sites). The study also analyzed a logistic regression which expressed that the risks for PT-LBW were low maternal age ≤19 years (ORa = 2.09), hypertension during pregnancy [adjusted odds ratio (ORa) = 2.44], and being unmarried (ORa = 1.59).[24] In 1998, Offenbacher et al. attempted to access the pathogenic nature of inflammation in maternal periodontal tissue, which revealed that PGE2 in the gingival crevicular fluid (GCF) of PT-LBW ($N = 25$) was significantly higher than Control ($N = 15$) and an inverse relationship between PGE2 and BW was found ($p = 0.029$). Similarly, the IL-1β level was also twice as much compared with Control but not significant. Additionally, the levels of the red complex and *Actinobacillus actinomycetemcomitans (A.a)* were analyzed, in which all microbial scores of PT-LBW were significantly higher than Control. The study suggested that GCF-PGE2 could be used as a marker of active periodontal disease and decreased BW.[27]

Table 4: Maternal periodontal status according to the new 2018 AAP classification

Periodontal status [N (%)]	*Control (N = 50)*	*PT (N = 22)*	*LBW (N = 25)*	*PT-LBW (N = 28)*	*p-value*
Healthy	6 (12)	0 (0)	1 (4)	0 (0)	>0.05
Gingivitis	29 (58)	13 (59)	17 (68)	21 (75)	
Periodontitis	15 (30)	9 (40)	7 (28)	7 (25)	

No significant difference between the groups [Fisher's exact test ($p > 0.05$)]

Figs 5A and B: (A) Maternal periodontal status; (B) Maternal periodontal diagnosis. (GG, generalized gingivitis; LG, localized gingivitis; P, periodontitis stages and grade)

Regarding the 2018 AAP periodontal classification, there was no significant difference between periodontal status, mean CAL, and mean PD of any groups. Take into consideration that in the Southeast Asian region, people often get pregnant at young ages, and it is uncommon to find periodontal disease at this age. The findings align with many studies that find an association between some indicators, but not all, among periodontitis and preterm birth or low BW. For example, in 2001, Dasanayake et al. examined the IgG level in mid-trimester maternal serum and reported approximately four times higher *Porphyromonas gingivalis (P.g.)* IgG level in LBW mothers ($P = 0.004$). However, they did not find any difference in periodontal status between the case ($N = 17$) and the control ($N = 63$), using periodontal screening and recording (PSR) as criteria. The study also tested 17 other bacterial plaque species but failed to find any significance.[28] In a randomized controlled trial involving mothers with gingivitis, conducted by Ló et al., it was revealed that mothers who did not receive periodontal treatment ($N = 580$) experienced a significantly higher rate of preterm births when compared with those who underwent the treatment before 28 weeks of gestation ($N = 290$). The incidence of low BW was also elevated but no difference was found. However, the incidence of preterm combined with low BW was more than three times higher in Control than in the treatment group (6.71% vs 2.14%, $p = 0.002$).[29] In the large case-control study of Nabet et al. (1,108 preterm births and 1,094 term births case), a significant association was found between periodontitis (defined by CAL $\geq$ 3 mm and PD $\geq$4 mm in $\geq$ 2 teeth) and induced preterm birth for preeclampsia (ORa = 2.46). However, no relationship was found between periodontitis and preterm birth or any other preterm factors. The study also observed that the preterm group had a significantly higher incidence of smoking, living alone, unemployment, obesity, high calculus level, and low education.[30]

These inconclusive findings have led to controversy surrounding the hypothesis that periodontitis has an impact on pregnancy complications. Nonetheless, evidence has demonstrated that periodontal treatment has a positive influence on health-promoting behaviors, contributing to improved overall well-being and better management of risk factors associated with periodontal disease.[12] Therefore, maintaining proper oral healthcare remains essential, as it not only serves to motivate the patients but also aids in identifying risks of periodontal disease that could occur during pregnancy.

This study has limitation because the research was conducted in a rural hospital, resulting in a relatively small and less diverse population group. Furthermore, Thailand currently has the Universal Coverage Scheme (UCS), which allows people to access dental care and prenatal care more easily. This improved accessibility could contribute to a lower prevalence of periodontal disease and pregnancy complications in the study population.

Conclusion

The present study observed that the percentage of bleeding on probing among postpartum mothers who experienced preterm birth along with low BW infants was significantly higher compared with those with normal pregnancies. Additionally, we noted a mild inverse correlation between bleeding on probing and BW. Moreover, the mothers of low BW infants had significantly lower body weights compared with mothers with normal pregnancies. Interestingly, we did not identify any significant association between the periodontal status and adverse pregnancy outcomes. It is worth highlighting that periodontitis and pregnancy complications share various contributing factors, potentially suggesting a link between the two occurrences.

In conclusion, this study suggested that early signs of gingival inflammation, which is bleeding on probing, were likely to be associated with preterm birth and low BW. Consequently, it is recommended to prioritize regular dental check-ups and maintain good oral hygiene practices during and before pregnancy.

Clinical Significance

This study is the first of its kind to use immediate postpartum periodontal examination and diagnosis by the new 2018 AAP periodontal classification. The findings demonstrate that signs of gingival inflammation may be associated with adverse pregnancy outcomes.

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