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ORIGINAL ARTICLE

RELATIONSHIP BETWEEN PERIODONTAL DISEASE WITH LOW BIRTH WEIGHT: A PROSPECTIVE COHORT STUDY *(A PATH ANALYSIS)*

Relación entre la enfermedad periodontal y el bajo peso al nacer: Un estudio de cohorte prospectivo *(Pathway analysis)*

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ABSTRACT

Objetive: The study aimed to assess the influence of periodontal diseases during pregnancy and identify potential risk factors associated with low birth weight.

Materials and Methods: This prospective cohort study was conducted on pregnant mothers in the second trimester of pregnancy. The final sample included 275 women. The severity of gingivitis, plaque, calculus, and attachment loss around 6 Ramfjord teeth were examined. After the estimated delivery time, we conducted a follow-up by phone to inquire about the delivery outcome and the baby's birth weight. Logistic regression and path analysis served to find the relationship between variables and low birth weight.

Results: About 190 cases in all 275 were in the range of 25-34. There was a significant relationship between low birth weight and calcium supplementation, gestational age of 37-42 weeks, gestational hypertension, asthma during the pregnancy, severe attachment loss, severe calculus in Ramfjord's teeth, and severe bleeding on probing (p<0.05). Multiple logistic regression analysis showed a significant relationship between low birth weight and the mother's weights of less than 60 kg (adjusted odds ratio=4.66), calcium supplementation (adjusted odds ratio=3.00), gestational hypertension (adjusted odds ratio=0.16), lining bleeding on probing (adjusted odds ratio=8.57), maximum bleeding on probing (adjusted odds ratio=29.56; p-value<0.05). Maternal education, gestational age, and maternal diabetes directly affect low birth weight. In contrast, maternal age, lack of folic acid and calcium supplementation, gestational hypertension, regular brushing, and attachment loss indirectly affected the conceptual model analysis (p-value<0.05).

Conclusion: The majority of edentulous patients both before and after prosthodon after prosthodontic rehabilitation.

Keywords: Periodontal diseases; Low birth weight; Analysis; Cohort studies; Pregnancy; Critical care outcomes.

RESUMEN

Objetivo: El estudio tuvo como objetivo evaluar la influencia de las enfermedades periodontales durante el embarazo e identificar los posibles factores de riesgo asociados con el bajo peso al nacer.

Materiales y métodos: Este estudio de cohorte prospectivo se realizó en madres embarazadas en el segundo trimestre del embarazo. La muestra final incluyó a 275 mujeres. Se examinó la severidad de gingivitis, placa, sarro y la pérdida de inserción alrededor de 6 dientes de Ramfjord. Después del tiempo estimado de parto, realizamos un seguimiento telefónico para preguntar sobre el resultado del parto y el peso del bebé al nacer. La regresión logística y el análisis de trayectoria sirvieron para encontrar la relación entre las variables y el bajo peso al nacer.

Resultado: Alrededor de 190 casos en total, 275 estaban en el rango de 25 a 34. Hubo una relación significativa entre el bajo peso al nacer y la suplementación de calcio, la edad gestacional de 37 a 42 semanas, la hipertensión gestacional, el asma durante el embarazo, la pérdida de inserción grave, el sarro grave en los dientes de Ramfjord y el sangrado grave al sondaje (p< 0,05). El análisis de regresión logística múltiple mostró una relación significativa entre el bajo peso al nacer y el peso de la madre menor de 60 kg (odds ratio ajustado = 4,66), la suplementación con calcio (odds ratio ajustado = 3,00), la hipertensión gestacional (odds ratio ajustado = 0,16), el sangrado al sondaje (odds ratio ajustado = 8,57), el sangrado máximo al sondaje (odds ratio ajustado = 29,56; valor p< 0,05). La educación materna, la edad gestacional y la diabetes materna afectan directamente el bajo peso al nacer. Por el contrario, la edad materna, la falta de ácido fólico y suplementación con calcio, la hipertensión gestacional, el cepillado regular y la pérdida de inserción afectaron indirectamente el análisis del modelo conceptual (valor p< 0,05).

Conclusión: Este estudio destacó la asociación significativa entre la enfermedad periodontal y el bajo peso al nacer.

Palabras Clave: Enfermedades periodontales; Recién nacido de bajo peso; Análisis; Estudios de cohortes; Embarazo; Resultados de cuidados críticos.

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INTRODUCTION

Periodontal disease is recognized as a significant public health concern, impacting approximately 20-50% of the global population.[1] Notably, chronic oral infections have been associated with systemic diseases, including endocarditis and coronary heart disease .[2]

Hormonal changes during pregnancy have been associated with an increased risk of periodontal diseases. Nearly two-thirds of pregnant mothers experience gingivitis.[3] This association is attributed to elevated progesterone levels during pregnancy, which lead to increased vascular permeability and the release of subgingival microorganisms.[4] The spread of the infection to deeper tissues leads to chronic destructive periodontitis.[5] This condition has been associated with systemic diseases and can also extend to the fetus, potentially causing metastatic infection. However, the precise impact of this infection on pregnancy outcomes remains unclear.[6] Some studies suggest that periodontal disease may be a risk factor for Low Birth Weight (LBW).[3]

Among individuals aged 30 to 45 years, moderate periodontal disease is prevalent in most cases, while approximately 10% experience severe periodontal disease. During pregnancy, the prevalence of periodontal diseases varies significantly, ranging from 11% to 100%.[7]
Notably, some studies have highlighted LBW as a significant contributor to neonatal mortality, with rates reaching as high as 70%.[1] As a result of this wide range, we have chosen to observe this phenomenon in our society.
Annually, approximately 18 million LBW neonates are born[8] These LBW infants face a significantly higher risk of mortality compared to normal-weight neonates up to 40 times more likely to die. This increased risk is attributed to various disorders they may experience, including both short-term and long-term nutritional and digestive issues.[9]

The birth of preterm infants imposes an undue burden on the healthcare system and creates economic and psychological stress for families.[10] Newborn weight serves as an essential indicator of life expectancy and health, psychological and social development.[11] In developing countries, some studies have indicated that periodontal disease may increase the risk of preterm birth by 1.8 times and the risk of LBW by 2.9 times.[2] However, some research results suggest that maternal periodontal disease might not be considered a significant risk factor for adverse pregnancy outcomes.[12,13] As a result of the importance of neonatal health, the present study was designed to determine the factors affecting LBW, emphasizing periodontal diseases in mothers.

MATERIALS AND METHODS

This prospective cohort study was conducted on pregnant women during the second trimester. The participants were mothers who were referred to the prenatal clinic. The study adhered to the Helsinki Declaration and received approval from the ethics committee. Informed consent was obtained from all individual participants, following the Ethics Code 25839-69-03-93 of Tehran University of Medical Sciences.

We recorded demographic information from the mother's file, conducted a periodontal examination at the clinic, and documented the mother's phone number for follow-up purposes. Trained researcher examined six Ramfjord's teeth[3,9,12,19,25,28] during the periodontal examination.[14] Gingival inflammation around the teeth was scored (G0 indicating the absence of inflammation to G3 indicating severe gingivitis).
If the free gingival margin was located on the cementum, its distance from the cemento-

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enamel junction (CEJ) was recorded as a negative number. Subsequently, the distance from the CEJ to the base of the sulcus was calculated by subtracting the two measurements. Ramfjord's method served as the indirect approach for determining the amount of periodontal attachment loss.[14]

The Periodontal Disease Index (PDI) score was derived from the gingival probing depth measured from the CEJ. When there was no extension beyond the CEJ, gingival scores were assigned. However, if an extension to the apical region of the CEJ was 3 mm or less, the PDI score was considered 4. A PDI score of 5 indicated probing depths ranging from 3 to 6 mm, while extensions greater than 6 mm were assigned a score of 6. PDI was calculated by averaging all numeric scores across the examined teeth, excluding any teeth that did not replace missing ones. In addition, a zero score was assigned for the absence of plaque. When the plaque was presented on the proximal surface of the gingival margin or covered at least one-third of the facial or lingual gingival area, it received a score of 1. If the plaque covered was more than one-third but less than two-thirds of the area, a score of 2 was assigned. For cases where plaque covered more than two-thirds of the area, a score of 3 was given.

Regarding calculus examination, the absence of calculus received a score of zero. If supra-gingival calculus was found under the gingival margin and measured less than 1 mm, it received a grade of 1. When moderate sub and supra-gingival calculus were observed, a grade of 2 was assigned. Finally, if there was an abundance of calculus, it scored 3.

Subsequently, the participants were asked to report their labor experiences. In the study, the ratio of mothers with periodontal disease to those without the disease was 1 to 3 (15). Out of the 299 pregnant women, 224 women were without periodontal disease, while 75 had periodontal disease. All eligible pregnant participants were included in the study, and follow-up was conducted via phone. The researcher contacted each participant a few days after their expected date of delivery to ask about the weight of the neonate.

The programs SPSS 16 and AMOS were employed to analyze the data. The analysis of multiple logistic regression and "path analysis" was used to explore the association between risk factors and LBW. In addition, Path analysis allowed us to assess the direct and indirect effects of variables on LBW. Our model quantified the outcome variables, and we estimated coefficients using the generalized least square model. We applied the Monte Carlo method to provide confidence intervals, which yielded a 90% confidence limit for the estimates. The statistical significance level was less than 0.05.

RESULTS

The initial sample consisted of 304 women invited and accepted to participate in the investigation; however, during the examination period, 29 of them withdrew from participation. Among these, 10 mothers were excluded from the study due to abortion and intrauterine-fetal death, and 19 mothers due to fetal macrosomia. This constituted a loss rate of 9%. The final sample included 275 women.

A descriptive analysis of factors related to LBW revealed that out of the participants,190 were between 25 and 34 years old, and 93 had a diploma (Table 1).

Using univariate logistic regression analysis showed the factors related to LBW. There was a significant relationship between LBW and using calcium supplementation (odds ratio (OR) =0.38, 95% CI=0.19-0.78), gestational age of 37-42 weeks (OR=240.80, CI=32.1-1806.1), gestational hypertension (OR=8.22, CI=3.17-21.34), asthma

Table 1. Descriptive analysis of factors related to low birth weight.

		Total (%)	Weight (g) 2500-4000*(%)	Weight (g) <=2500* (%)	*p*-value*
Gestational age (weeks)	37-42	197(71.64)	196 (99.49)	1 (0.51)	0.001
	<= 37	78(28.36)	35 (44.87)		
Gestational Hypertension	Yes	20(7.27)	9 (45)	11 (55)	0.001
	No	255(92.73)	222 (87.06)	33 (12.94)	
Asthma during pregnancy	Yes	10(3.64)	4(40)	6(60)	0.001
	No	265(96.36)	227 (85.66)	38 (14.34)	
(Periodontal index >=4)	Yes	166(60.36)	152 (91.57)	14(8.43)	0.001
Attachment loss	No	109(39.64)	79(72.48)	30(27.52)	
Bleeding on probing	No	44(16)	43(97.73)	1(2.27)	
	Pointed	46(16.73)	41(89.13)	5(10.87)	0.14
	Lining	93(33.82)	83(89.25)	10(10.75)	0.12
	Maximun	92(33.45)	64(69.57)	28(30.43)	0.001

Table 2. Univariate logistic regression analysis of factors related to low birth weight.

	Odds Ratio	95% confidence interval of Odds Ratio	*p*-value*
Using calcium supplementation	0.38	0.19 - 0.78	0.01
37-42 weeks gestational age	240.80	32.1-1806.1	0.001
Gestational hypertension	8.22	3.17- 21.34	0.001
Asthma during pregnancy	8.96	2.42- 33.24	0.001
(Periodontal index >=4) Attachment loss	4.12	2.07 - 8.22	0.001
Maximum calculus in Ramfjord's teeth (more than +2/3)	10.12	1.3 - 78.68	0.03
Maximum bleeding on probing	18.81	2.47- 143.49	0.001

Table 3. Univariate logistic regression analysis of factors related to low birth weight.

	Adjusted odds ratio	95% confidence interval	*p*-value*
Mother's weightLess than 60 kg	4.66	1.5 - 14.53	0.008
Using calcium supplementation	3.00	1.32 - 6.8	0.009
Gestational hypertension	0.16	0.05 - 0.5	0.001
Lining bleeding on probing	8.57	0.97 - 75.5	0.05
Maximum bleeding on probing	29.56	3.53 - 247.86	0.002

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Table 4. Total effects of the relationship between the risk factors and low birth weight by path analysis.

Total effectsl	Unstandardized 90% confidence interval				Standardized 90% confidence interval			
	Effect	Lower	Upper	*p*-value*	Effect	Lower	Upper	*p*-value*
Mother's age	22.43	0.09	0.30	0.002	0.20	0.09	0.30	0.002
Lack of folic acid supplementation	296.86	0.05	0.18	0.003	0.11	0.05	0.18	0.003
Lack of tooth brushing	-46.16	-0.05	-0.01	0.002	-0.02	-0.05	-0.01	0.002
Lack of calcium supplementation	82.81	0.01	0.14	0.03	0.07	0.01	0.14	0.03
Attachment loss	-155.47	-0.20	-0.07	0.001	-0.13	-0.20	-0.07	0.001
Pregnancy hypertension	-453.83	-0.32	-0.13	<0.001	-0.22	-0.32	-0.13	<0.001
Gestational age	37.40	0.6	0.72	0.003	0.67	0.6	0.72	0.003

Table 5. Direct effects of the relationship between the risk factors and low birth weight by path analysis.

Direct effects	Unstandardized 90% confidence interval				Standardized 90% confidence interval			
	Effect	Lower	Upper	*p*-value*	Effect	Lower	Upper	*p*-value*
Educational degree	84.28	30.32	136.95	0.01	0.12	0.04	0.19	0.008
Diabetes	209.86	47.41	373.68	0.04	0.09	0.02	0.17	0.03
Gestational age	37.40	33.04	41.56	0.001	0.67	0.6	0.72	0.003

Table 5. Direct effects of the relationship between the risk factors and low birth weight by path analysis.

Indirect effects	Unstandardized 90% confidence interval				Standardized 90% confidence interval			
	Effect	Lower	Upper	*p*-value*	Effect	Lower	Upper	*p*-value*
Mother's age	13.59	5.309	23.08	0.004	0.12	0.04	0.20	0.005
Lack of folic Acid supplementation	296.86	130.92	471.37	0.006	0.11	0.05	0.18	0.003
Lack of tooth brushing	-46.17	-92.77	-15.84	0.003	-0.02	-0.05	-0.01	0.002
Lack of calcium supplementation	82.81	12.67	154.55	0.04	0.07	0.01	0.14	0.03
Attachment loss	-155.48	-228.69	-77.70	0.001	-0.13	-0.20	-0.07	0.001
Pregnancy Hypertension	-328.96	-456.63	-193.86	0.001	-0.16	-0.22	-0.10	0.001

during the pregnancy (OR=8.96, CI=2.42-33.24), severe attachment loss (PDI>=4, OR=4.12, CI= 2.07-8.22), calculus more than +2/3 in Ramfjord's teeth (OR=10.12, CI= 1.3-78.68), severe bleeding on probing (BOP) (OR=18.81, CI= 2.47-143.49) (p<0.05) (Table 2).

After adjusting for confounders, multiple logistic regression analysis presented a significant relationship between LBW and the mother's weights of less than 60 kg (adjusted odds ratio (AOR)=4.66,95% confidence interval (CI)=1.5-14.53), using calcium supplemen-tation (AOR =

Table 6. Indirect effects of the relationship between the risk factors and low birth weight by path analysis.

Indirect effects	Unstandardized				Standardized			
	90% confidence interval				90% confidence interval			
	Effect	Lower	Upper	*p*-value*	Effect	Lower	Upper	*p*-value*
Mother's age	13.59	5.309	23.08	0.004	0.12	0.04	0.20	0.005
Lack of folic Acid supplementation	296.86	130.92	471.37	0.006	0.11	0.05	0.18	0.003
Lack of tooth brushing	-46.17	-92.77	-15.84	0.003	-0.02	-0.05	-0.01	0.002
Lack of calcium supplementation	82.81	12.67	154.55	0.04	0.07	0.01	0.14	0.03
Attachment loss	-155.48	-228.69	-77.70	0.001	-0.13	-0.20	-0.07	0.001
Pregnancy Hypertension	-328.96	-456.63	-193.86	0.001	-0.16	-0.22	-0.10	0.001

3.00, CI=1.32-6.8), Gestational Hypertension (AOR =0.16, CI=0.05-0.5), lining bleeding on probing (AOR=8.57, CI=0.97-75.5), maximum bleeding on probing (AOR=29.56, CI= 3.53-247.86) (*p*-value <0.05) (Table 3).

In the conceptual model analysis, after removing the Collinear variables and adding the relationship between the variables, total effects showed a significant relationship between LBW and maternal age (*p*=0.002), lack of folic acid supplementation (*p*=0.003), lack of regular tooth brushing (*p*=0.002), lack of calcium supplementation (*p*=0.039), attachment loss (*p*= 0.001), gestational age (*p*=0.003), and gestatio-nal hypertension (*p*<0.001) (Table 4).

In addition, in conceptual model analysis assessing the direct relationship, after removing Collinear variables and adding relationships between variables and LBW, maternal educational status (*p*=0.008), gestational age (*p*=0.003), and diabetes (*p*=0.039) had a significant relationship (Table 5).

After removing collinear variables, the indirect relationship between variables and LBW was appraised using the conceptual model analysis. Maternal age (*p*=0.005), lack of folic acid supplementation (*p*=0.003), lack of toothbrush use (*p*=0.002), lack of calcium supplementation (*p*=0.039), Attachment loss (*p*=0.001), and gestational hypertension (*p*=0.001) had a signifi-cant relationship (Table 6).

DISCUSSION

It is essential to identify factors affecting LBW due to the annual birth of 15 million preterm infants worldwide.[2] Two mechanisms explain how oral health is associated with adverse pregnancy outcomes. The first involves oral pathogens that can translocate from an unhealthy oral cavity and cross the placenta, ultimately reaching the intra-amniotic fluid and fetal circulation.[16] The second mechanism hypothesizes that the systemic dissemination of endotoxins or inflammatory mediators originates from periodontal disease.[17] The present data clearly illustrated that attachment loss (PDI>=4), more than two-thirds of the calculus in Ramfjord's teeth, and maximum bleeding on probing are signs of periodontitis and gingivitis related to LBW. In line with these findings, there is evidence linking periodontal diseases to adverse pregnancy outcomes, including preterm labor and preeclampsia.[18,19] Moreover, a dose-dependent relationship was observed between increased prostaglandin E2

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levels in gingival crevicular fluid (GCF), an indicator of new periodontal disease, and LBW.[20] In addition, mothers with preterm or LBW neonates were more likely to have periodontal problems.[5] Other studies illustrated that periodontal disease increased the risk of LBW by up to 1.15 times.[21] In the case-control study, among individuals with moderate to severe periodontal disease, a significant relationship was observed between age and the amount of GCF (p=0.001), dental plaque (p=0.004), and maternal gingival index (p=0.011) with respect to LBW. There was no association between newborn weights and mild periodontal disease. However, moderate to severe periodontal disease emerged as a risk factor for LBW.[1] Vanka's research demonstrated that out of 232 mothers with at least four teeth exhibiting periodontal pockets, 134 gave birth to LBW neonates. 44.8% of LBW neonates were born to mothers with 6-8 mm periodontal pockets. Moreover, the multi-variable logistic regression analysis results showed a correlation between attachment loss and LBW (p<0.001),[11] which is consistent with our results. In addition, periodontal disease has been associated with a 4.12-fold increased risk of preeclampsia and a 2.41-fold increased risk of LBW.[22]

Other factors related to LBW include the mother's weight of less than 60 kg, asthma during pregnancy, lack of oral health, attachment loss and calculus, and severe BOP. In line with the present study, Wahabi *et al.,*[23] demonstrated that underweight women had increased odds of delivering an LBW infant. Lack of calcium supplementation and gestational hypertension are among the factors affecting LBW.[24] Schowitz identified several factors that affect LBW, including households with inferior financial status, parents' low education, history of preterm labor, smoking during the third trimester of pregnancy, inadequate care, maternal anemia, recent preterm labor, maternal weight gain of less than seven kilograms during pregnancy, maternal urinary tract infection, and female neonate. The probability of LBW increases by 1.93-fold with more than three pregnancies, 4.01-fold with a history of preterm labor, 2.61-fold for female neonates, and 2.57-fold with inadequate prenatal care,[25] which aligns with the findings of the present study. Moreover, gestational hypertension/preeclampsia appears to be a relatively more detrimental exposure window for LBW.[26]

According to previous research, scaling and root planning in patients with periodontitis effectively reduced preterm birth and LBW.[27] The most crucial action the dental community can take to support mothers in this era is to provide health education and level 1 treatment.
This reduction maybe due to decreasing bacterial load, endotoxins, or inflammatory mediators from periodontal disease

CONCLUSION

The importance of LBW and the impact of periodontal disease on its diagnosis and treatment should be recommended as part of routine care during pregnancy to reduce complications.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

ETHICS APPROVAL

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Approval was obtained from the Ethics Committee of Tehran University of Medical Sciences (Ethics Code: 25839-69-03-93). All patients were provided with and signed an informed consent form acknowledging that participation in the research is mandatory.

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AUTHORS' CONTRIBUTIONS

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Ahmad Reza Shamshiri, Mohammad Mahdi Farshad, and Masoomeh Kheirkhah. The first draft of the manuscript was written by Fatemeh Farshad, and all authors commented on the previous version of the manuscript. All authors read and approved the final manuscript.

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