J Periodont Res 2005; 40; 339–345

JOURNAL OF PERIODONTAL RESEARCH
doi:10.1111/j.1600-0765.2005.00808.x

Periodontal status and preterm low birth weight: a case control study

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Noack B, Klingenberg J, Weigelt J, Hoffmann T. Periodontal status and preterm low birth weight: a case control study. J Periodont Res 2005; 40: 339–345. © Blackwell Munksgaard 2005

Background: Previous studies have suggested that periodontal disease may be an important risk factor for preterm low birth weight. However, the link between periodontal health status of pregnant women and preterm low birth weight is contentious, as recent studies found no association between periodontitis and pregnancy outcome.

Objective: The aim of this study was to investigate this potential link in a German Caucasian population.

Methods: Fifty-nine pregnant women with a high risk for a preterm low birth weight infant (suffering from preterm contractions, cases, group 1) as well as 42 control women with no preterm contractions during pregnancy and having an infant appropriate for date and weight (≥ 37 weeks gestation, ≥2500 g, group 2) were examined. Clinical periodontal status was recorded on a full mouth basis. Subgingival plaque samples were taken and periodontal pathogens were identified by polymerase chain reaction. Additionally, interleukin-1β level in gingival crevicular fluid was analysed.

Results: The mean percentage of sites showing moderate to advanced attachment loss (≥ 3 mm) was low in all study groups (group 1: 9.9 ± 11.2%; group 2: 10.6 ± 14.1%, respectively). No significant differences between the groups in any aspects of the studied periodontitis parameters could be detected. Using a logistic regression model controlling for known preterm low birth weight risk factors, no periodontitis-associated factors increased risk for preterm contractions or preterm low birth weight. The odds ratio (OR) was 1.19 for preterm contractions, the 95% confidence interval (CI) 0.46; 3.11 and 0.73 for preterm low birth weight; 95% CI: 0.13; 4.19, respectively.

Conclusion: In this population, periodontitis was not a detectable risk factor for preterm low birth weight in pregnant women.

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Key words: low birth weight; periodontitis; preterm birth; risk factors

Accepted for publication December 29, 2004

The search for risk factors for preterm birth defined as gestational age less than 37 weeks (1) and low birth weight (< 2500 g) (2) is of special interest for public health because these factors are major causes of neonatal morbidity and mortality. The exact aetiology of preterm low birth weight is still under discussion. There are numerous risk factors known that can influence the pregnancy outcome. For example, women who smoke or women suffering from infections during pregnancy are at higher risk to give birth to a preterm low birth weight infant (3, 4). Some recent studies suggest a link between the periodontal health status of pregnant women and the outcome of pregnancy. Offenbacher *et al.* (5) were the first to report that periodontitis was a possible risk factor for preterm low birth weight. After adjusting for other known risk factors they showed that pregnant women suffering from periodontitis were at a higher risk (odds ratio 7.9) of delivering a preterm low birth weight infant as compared to

women with healthier periodontal conditions. These results were later confirmed (6–8) and potential pathogenetic mechanisms were reviewed (3, 9–11). However, animal studies to prove plausible biological hypotheses for a causal link between maternal periodontal infection and preterm low birth weight had no concordant results (12, 13). The first study could demonstrate that lipopolysaccharides from oral bacteria affect pregnant outcome negatively in animals. But, the used lipopolysaccharide doses were much higher than systemic levels that can be expected in periodontitis. In the second study, ligature-induced periodontal disease did not promote changes during pregnancy that resulted in low birth weight in newborn Wistar rats. On the other hand a number of recent studies (14–17) found no association between periodontitis and pregnancy outcome. Indeed, one study reported an inverse association between mothers mean pocket depth and preterm low birth weight (17). Such differences in findings could (i) reflect the differences in the studied populations, or may be (ii) caused by the fact that there is an association between periodontitis and preterm low birth weight only in the presence of other environmental or genetic risk factors. Thus, the aim of this study was to further investigate the potential link between preterm low birth weight and periodontal status in a Caucasian German population.

Material and methods

Subjects/study groups

A total of 59 pregnant women who had suffered from preterm contractions and were therefore at high risk for preterm low birth weight constituted the case group (group 1). They were compared with 42 women available at the time of the study who had given birth to a healthy infant weighing > 2500 g and who had no preterm contractions during pregnancy (control group, group 2). These two groups volunteered to participate in this case-control study. Considering that in a majority of the cases of the high risk group, preterm labour could be averted by some kind of intervention, the 59 subjects of the high risk group (selected prior to giving birth) were further classified according their pregnancy outcome into two subgroups for the data analysis. For this reason, women were contacted after childbirth to get information about the duration of pregnancy and the child's weight at birth. Women in group 1a ($n = 16$) gave birth before 37 gestation weeks to an infant weighing less than 2500 g (preterm low birth weight). Group 1b ($n = 43$) included women suffering from preterm contractions but giving birth to an infant weighing 2500 g or more, probably mainly due to the intensive antenatal care. The control mothers were selected randomly from those present on the ward in the same hospital at the time that cases were recruited. They came from the same German city area population as the women of the case group. We selected these controls after they gave birth to a full-term normal weight child. The clinical examinations were performed within 3 days after delivery.

All women were inpatients of the Clinic of Gynecology and Obstetrics, Medical Faculty, University of Technology Dresden. Each received an appropriate description of the study protocol and signed a consent form, approved by the ethics committee of the Dresden University of Technology (reference # EK 151102000).

Criteria for inclusion in the study were: women having at least 20 teeth, aged 18–40 years, with body height > 150 cm, and body weight > 40 kg. It was conceivable that women with more severe disease who may have lost teeth due to periodontal disease and had less than 20 teeth were excluded from the study. However, at interview, no women reported advanced tooth loss because of increased tooth mobility due to periodontitis. No person had to be excluded because of less than 20 teeth.

Subjects with the following medical history were excluded: severe infections of genital or urinary system (including bacterial vaginosis), diabetes mellitus, indication of prophylactic antibiotics for invasive procedures, as well as obstetric abnormalities including, for example, placenta previa, hydramnion, gestosis, or deformities of the uterus. Also women who had a multiple birth (i.e. twins or triplets) were not included in the study.

All women in the study were German Caucasians. Demographic information, a thorough history of systemic diseases and smoking, drug and drinking history were obtained by interviews. Previous preterm low birth weight deliveries or miscarriage, and systemic infections during pregnancy were scored as either present or absent. Smoking was recorded as none, as the number of cigarettes consumed per day or as quit smoking at the beginning of the pregnancy. Use of alcohol was evaluated as one or more than one drink per week. Questions about stress during pregnancy were selected and modified from standardized questionnaires (18). To avoid overcontrol for premature contractions induced stress, questions for other significant stressful events during pregnancy as well as the attitude toward the expected infant were included. Based on the questionnaire the stress level was stratified into five ordered categories: no (1), little (2), moderate (3), high (4), or very high (5) stress. The socio-economic status was evaluated by a questionnaire including information about marital status and occupation. Based on these data, a social stratification index (19) was calculated.

In Germany, where medical insurance is required by law, all pregnant women have ready access to medical care. Thus, the actual status of health care was evaluated by verifying whether these women had taken advantage of the existing system by getting antenatal as well as dental care during pregnancy or not.

Measurement of clinical periodontal status

Periodontal examination was performed by two examiners on all 101 volunteers during their stay in the clinic. The two examiners were trained and calibrated with each other until they reached a correlation coefficient in all parameters equal or better than 0.9.

The periodontal status was recorded at the bed-side. To optimize these

conditions a headlamp was used. Sites were air-dried prior to measurement. However, the conditions to detect the cemento-enamel junction to calculate the attachment level were not as good as in a dental clinic. Clinical measures of periodontal parameters recorded on a full mouth basis included plaque index (20), bleeding on probing, probing pocket depth, and attachment loss, all determined at six sites per tooth. The percentage of sites with attachment loss ≥ 3 mm was calculated and used to describe the severity of periodontal disease (21).

Women with preterm labour were usually medicated with antibiotics, especially in cases of elevated C-reactive protein levels of unknown origin. Thus, subjects of case groups 1a and 1b were examined within 12 h after hospitalization to minimize effects of a potential prophylactic antibiotic medication on periodontal microbiological findings. Control subjects were examined within 3 days postpartum.

Gingival crevice fluid samples

A link between oral inflammation and intra-amniotic cytokine levels had shown (10) that the gingival crevice fluid levels of prostaglandin E_2 and interleukin-1β were highly correlated with the intra-amniotic levels (22). Based on these data, gingival crevice fluid samples were taken from the mesio-vesibular sites of each first or second molar before probing using paper strips (Periopaper®, PRO FLOW™ Inc., Amityville, NY, USA) to measure interleukin-1β gingival crevice fluid level. After determination of gingival crevice fluid volume by a Periotron® 8000 (Ora*flow*® Inc., Plainview, NY, USA) the paper strips were pooled, placed in pyrogen/endotoxin-free tubes containing 200 µl Standard Diluent Buffer (BIOSOURCE International, Inc., Camarillo, CA, USA) and stored at −20°C until further examination. The interleukin-1β gingival crevice fluid level of each woman was quantified by enzyme-linked immunosorbent assay using a commercial ultra sensitive kit for human interleukin-1β (BIOSOURCE International, Inc.,). The test was performed according to the instructions of the manufacturer. A reference standard curve was run with each assay to calculate the final interleukin-1β concentrations.

Subgingival plaque samples

At the end of the clinical examination, pooled subgingival plaque samples were taken from the sites with the deepest probing depth of each quadrant. After supragingival plaque removal and isolation of sample sites using cotton rolls, sterile paper points were inserted to the depth of the sulcus for 20 s. The samples were analysed using a commercial available polymerase chain reaction (PCR, CellTechnologie GmbH, Leipzig, Germany) kit for the presence of the following periodontal pathogens: *Actinobacillus actinomycetemcomitans*, *Tannerella forsythensis*, *Fusobacterium nucleatum*, *Porphyromonas gingivalis*, as well as *Prevotella intermedia*. The results were expressed as a bacterial load score (number of bacteria in a pooled plaque sample) according to the recommendation of the manufacturer: 0: < 100, 1: 100, 2: 100–800, 3: > 800 to $\leq 10^3$, 4: > 10^3 to $\leq 10^4$, 5: > 10^4 to $\leq 3 \times 10^4$, 6: > 3×10^4 to $\leq 8 \times 10^4$, 7: > 8×10^4. The threshold of detection of this PCR is declared to be 100 bacteria (score 0).

Statistical analysis

Analyses included descriptive statistics as well as univariate and multivariate logistic regression. Group comparisons for continuous variables were performed by analysis of variances (ANOVA) in cases of normal distribution. The Kruskal–Wallis test was used in cases of extreme non-normal distributed or ordinal data. Frequency data were compared by the chi-squared test.

To examine the association between periodontal disease and risk for preterm low birth weight, logistic regression models were developed using a dichotomized pregnancy outcome variable as having had a preterm low birth weight infant (group 1a, $n = 16$) or having had a healthy normal term infant (control group, $n = 42$). In a second model we used the pregnancy variable as having had preterm contractions (high risk for preterm low birth weight) (case groups 1a and 1b, $n = 59$) or having had a healthy normal term infant with no preterm contractions during pregnancy (control group, $n = 42$). Univariate and multivariate logistic regression analyses were performed starting with all measured potential risk variables included in the univariate analyses. In a second step, analyses were controlled for the effects of variables whose association with preterm low birth weight in univariate analyses had a p-value ≤ 0.1. Unadjusted and adjusted odds ratios (OR) with a 95% confidence interval (CI) of risk for preterm low birth weight or preterm contractions were calculated. p-values < 0.05 for all analyses were selected to be statistically significant.

Results

Table 1 displays characteristics and potential risk parameters for preterm low birth weight in the subjects. The majority of mothers were at a middle or high socio-economic status and all except one control subject had antenatal care mostly in the first 12 weeks of pregnancy. The percentage of women undergoing dental care during pregnancy was high. No significant differences were found among the groups regarding these parameters. The mean age of the women in the three groups was also similar (between 27.8 and 30.3 years). Most of the women were non-smokers. There were only a few light smokers (smoking no more than 10 cigarettes per day) or former smokers in all study groups. Differences in stress levels were found between the groups. The subjects of the two case groups 1a and 1b had a higher stress level during pregnancy compared to the control group (overall $p = 0.038$). In *post hoc* testing, the difference between case group 1a and controls was significant ($p = 0.024$). There was a tendency for the percentage of systemic infections during pregnancy as well as the percentage of women with previous miscarriage or preterm low birth weight delivery to be higher both in case subgroup 1a compared to

Table 1. Characteristics of study groups and possible risk factors for preterm low birth weight

Risk factor	PLBW group $n = 16$	Group with high risk for PLBW $n = 43$	Control group with normal birth $n = 42$	p-value	Odds ratio (95% CI) (a) PLBW (b) High risk for PLBW	p-value
Socio-economic status (%)						
Low	3 (8.18)	5 (11.6)	9 (21.4)	0.529[a]	(a) 0.94 (0.47; 1.90)	0.872
Middle	3 (8.18)	9 (20.9)	4 (9.5)		(b) 1.09 (0.65; 1.82)	0.750
High	10 (62 4)	29 (67.4)	29 (69.0)			
Antenatal care[c] (%)						
No	–	2 (4.7)	3 (7.1)	0.53[a]	(a) 0.001 (0.00; 3.3*10E26)	0.834
Yes	16 (100)	41 (95.3)	39 (92 9)		(b) 0.46 (0.07; 0.86)	0.402
Dental care[d] (%)						
No	1 (6.2)	11 (25.6)	4 (9.5)	0.066[a]	(a) 0.63 (0.07; 0.14)	0.693
Yes	15 (93.8)	32 (74.4)	38 (90.5)		(b) 2,43 (0.72; 0.13)	0.151
Age in years (mean ± SD)	27.8 ± 5.3	28.6 ± 5.9	30.2 ± 4.9	0.203[b]	(a) 0.90 (0.80; 1.02) (b) 0.94 (0.87; 1.01)	0.099 0.090
Smokers (%)						
No	14 (87.5)	38 (88.4)	39 (92.9)	0.163[a]	(a) 0.921 (0.26; 3.25)	0.898
Former	2 (12.5)	4 (9.3)			(b) 0.96 (0.40; 2.34)	0.936
Yes		1 (2.3)	3 (7.1)			
Stress (%)						
No, little or moderate	7 (43.7)	28 (65.1)	33 (78.6)	0.038[a]	(a) 4.71 (1.38; 16.2)	0.014
High or very high	9 (56.3)	15 (34.9)	9 (21.4)		(b) 2.51 (1.021; 6.195)	0.045
Systemic infections (%)						
No	11 (68.8)	34 (79.1)	39 (92.1)	0.058[a]	(a) 5.91 (1.22; 28.69)	0.028
Yes	5 (31.2)	9 (20.9)	3 (7.1)		(b) 1.76 (1.05; 2.95)	0.033
Previous PLBW or miscarriage (%)						
No	11 (68.8)	33 (76.7)	37 (88.1)	0.193[a]	(a) 3.36 (0.82; 13.78)	0.092
Yes	5 (31.2)	10 (23.3)	5 (11.9)		(b) 2.52 (0.84; 7.60)	0.100

p-value for differences between the groups from [a]chi-squared test and [b]ANOVA.
[c]Antenatal care before 13th week of gestation.
[d]Dental care during pregnancy.
PLBW, preterm low birth weight; CI, confidence interval.

subgroup 1b as well as to controls, although these differences were not significant. In the univariate analysis for preterm low birth weight, as well as for high risk for preterm low birth weight, a significant association was found with stress and infections during pregnancy. Maternal high stress levels increased significantly the risk for preterm low birth weight with a crude OR 4.71 (95% CI: 1.38; 16.2). This was true for systemic infections during pregnancy (crude OR 5.91, 95% CI: 1.22; 28.69). There was also a tendency for previous preterm low birth weight delivery or miscarriage and young age to be associated with an increased risk for preterm low birth weight. No significant influence on preterm low birth weight risk was found regarding the other variables tested.

Table 2 shows the periodontal status of the study groups. There were no significant differences in the mean periodontitis parameters between any of the groups. The mean plaque index, the mean percentage of sites exhibiting bleeding on probing as well as the mean probing pocket depth and attachment loss in the case groups were not statistically different from the controls. The majority of all clinical measurements corresponded to gingivitis or to healthy periodontal conditions. Only a low percentage of sites (7.7%, 10.8% and 10.6% in case groups 1a, 1b, and control group, respectively) had an attachment loss ≥3 mm. The differences between the study groups in these periodontitis severity parameters were not statistically significant. There was a tendency for the mean gingival crevice fluid interleukin-1β level to be higher in the case groups (case group 1a: 720 ± 535 pg/ml, case group 1b: 780 ± 696 pg/ml) when compared to controls (581 ± 465 pg/ml) but the differences were not significant ($p = 0.299$, ANOVA).

The microbiological findings are summarized in Table 3. A scoring system of 0–7 was used to quantify the PCR results according to the recommendation of the manufacturer. The levels of the detected pathogens were low in all groups. The medians of *A. actinomycetemcomitans*, *T. forsythensis*, *F. nucleatum*, *P. gingivalis* and *P. intermedia* were mostly between scores 0 and 2, indicating no detectable bacteria or low numbers (100–800). Using the Kruskal–Wallis test, no significant differences could be observed between the groups. In the univariate logistic regression model for group 1a (preterm low birth weight), different periodontal measurements as exposure variables were included. No

Table 2. Levels of periodontal disease in the study populations

Periodontal measures	Groups			
	PLBW ($n = 16$)	High risk for PLBW ($n = 43$)	Normal birth (control, $n = 42$)	p-value
Mean PlI ± SD	0.29 ± 0.20	0.31 ± 0.30	0.34 ± 0.28	0.799[a]
Mean % sites BOP ± SD	27.1 ± 20.1	30.2 ± 22.6	26.3 ± 20.3	0.699[a]
Mean PPD ± SD (mm)	2.38 ± 0.34	2.49 ± 0.42	2.47 ± 0.51	0.690[a]
Mean AL ± SD (mm)	2.40 ± 0.35	2.51 ± 0.24	2.50 ± 0,49	0.688[a]
Mean % sites AL ≥ 3 mm ± SD	7.7 ± 10.3	10.8 ± 11.5	10.6 ± 14.1	0.529[b]
Mean GCF IL-1β ± SD (pg/ml)	720 ± 535	780 ± 690	581 ± 465	0.299[a]

[a]ANOVA, [b]Kruskal–Wallis test.
PLBW, preterm low birth weight; PlI, plaque index; BOP, bleeding on probing; PPD, probing pocket depth; AL, attachment loss; GCF, gingival crevice fluid; interleukin-1β, interleukin-1β.

Table 3. Levels of specific periodontal pathogens in the study populations[a]

Groups	Periodontal pathogens				
	Actinobacillus actinomycetemcomitans	*Tannerella forsythensis*	*Fusobacterium nucleatum*	*Porphyromonas gingivalis*	*Prevotella intermedia*
PLBW ($n = 16$)					
Median	0.00	0.50	2.00	0.00	0.00
Range	0.00–5.00	0.00–6.00	0.00–7.00	0.00–7.00	0.00–4.00
High risk for PLBW ($n = 43$)					
Median	0.00	2.00	4.00	0.00	1.00
Range	0.00–4.00	0.00–7.00	0.00–7.00	0.00–6.00	0.00–6.00
Normal birth (control, $n = 42$)					
Median	0.00	1.00	4.00	0.00	0.00
Range	0.00–7.00	0.00–7.00	0.00–7.00	0.00–7.00	0.00–7.00

[a]Polymerase chain reaction scores (number of bacteria in the pooled plaque sample): 0: < 100; 1: 100; 2: 100–800; 3: > 800 to $\leq 10^3$; 4: 10^3 to $\geq 10^4$; 5: $> 10^4$ to $\leq 3 \times 10^4$; 6: $> 3 \times 10^4$ to $\leq 8 \times 10^4$; 7: $> 8 \times 10^4$.
No significant differences between study groups (Kruskal–Wallis test).
PLBW, preterm low birth weight.

periodontitis-associated increased risk of preterm low birth weight could be found (mean probing pocket depth: OR = 0.63; 95% CI: 0.16; 2.51, mean percentage of sites with attachment loss ≥ 3 mm: OR = 0.98; 95% CI: 0.93; 1.03). Controlling for variables whose association with preterm low birth weight in univariate analyses was significant (maternal high stress level, systemic infections during pregnancy) or had a p-value ≤ 0.1 (age and previous preterm low birth weight deliveries or miscarriage) resulted in no significant changes of these results. All crude and adjusted odds ratios with 95% CI are shown in Table 4. The important known risk factors of preterm low birth weight, smoking and use of alcohol, were not included in the models because no women reported a significant use of alcohol (more than one glass wine per week) and only a few women smoked (less than 10 cigarettes per day) with no significant differences in frequency between the groups and no significant influence on the preterm low birth weight risk in the univariate analyses.

The results of these logistic regression models were confirmed by including pooled case groups 1a and 1b (high risk for preterm low birth weight due to preterm contractions) and control group in further analyses. No periodontitis-associated increased risk of preterm contractions could be found (mean probing pocket depth: adjusted OR 1.19; 95% CI: 0.46; 3.11, mean percentage of sites with attachment loss ≥ 3 mm: adjusted OR 1.00; 95% CI 0.97; 1.04) (Table 4).

Discussion

This study addressed the question, did pregnant women with preterm

Table 4. Association between risk for preterm low birth weight and periodontal parameter

	Crude OR for PLBW(95% CI) [p-value]	Adjusted[a] OR for PLBW(95% CI) [p-value]	Crude OR for preterm contractions (95% CI) [p-value]	Adjusted[a] OR for preterm contractions (95% CI) [p-value]
Mean PPD	0.63 (0.16; 2.51) [0.51]	0.73 (0.13; 4.19) [0.728]	0.96 (0.40; 2.34) [0.93]	1.19 (0.46; 3.11) [0.72]
Mean AL	0.57 (0.13; 2.46) [0.45]	0.58 (0.09; 3.69) [0.56]	0.89 (0.36; 2.20) [0.80]	1.09 (0.41; 2.88) [0.87]
Mean % sites AL ≥ 3 mm	0.98 (0.93; 1.03) [0.45]	0.98 (0.91; 1.05) [0.546]	1.00 (0.96; 1.03) [0.79]	1.00 (0.97; 1.04) [0.867]

[a]Adjusted for maternal age, previous PLBW or miscarriage, infections during pregnancy, and stress level during pregnancy.
OR, odds ratio; CI, confidence interval; PLBW, preterm low birth weight; PPD, probing pocket depth; AL, attachment level.

contractions (high risk for preterm low birth weight) or mothers with preterm low birth weight delivery have a periodontal status worse than women of the same age with a risk-free pregnancy and giving birth to a normal weight healthy infant? Preterm and low birth weight births represent an important health problem world wide, as these factors are major causes of neonatal morbidity and mortality. Low birth weight can result from preterm birth or intrauterine growth restriction, or both. It is difficult to separate the preterm component of low birth weight. However, low birth weight is very closely related to preterm birth, as it is estimated that approximately 50% of preterm infants weigh less than 2500 g, whereas only 2% of full-term infants weigh below that threshold (23). For this reason, both outcomes were combined in the case definition.

The results of this investigation are in contrast to the association between periodontitis and a higher risk for preterm low birth weight reported in other studies (5–9). To examine the association between periodontal disease and risk for preterm low birth weight, regression models were used in general. Adjustment for potential confounding variables (maternal age, race, smoking, drug use, bacterial vaginosis, socio-economic status) in these models is of high importance to avoid study bias (24). Thus, the association between periodontitis and preterm low birth weight supported in some studies may be due to inadequate adjustment. For example, most studies did not control for indicators of socio-economic status (5–7), or bacterial vaginosis (6, 7).

Additionally, the difference in findings might be due to large differences in the characteristics of the studied groups. In the investigation by Offenbacher *et al*. (5) the prevalence of generalized periodontitis (≥ 60% of sites with attachment loss ≥ 3 mm) both in the preterm low birth weight case group and the control group was very high (94% and 71%, respectively). Furthermore, the mean periodontal attachment loss in their case group exceeded 3 mm. Both parameters are unusually high, taking into account the young age of the study population (mean age in preterm low birth weight cases 25 ± 6.3 years, in controls 22 ± 3.4 years, respectively). They were not typical of the US population (25), as well as populations of other countries (26, 27). In contrast, in our study a much lower percentage of patients had generalized periodontitis as defined by the criteria of Offenbacher *et al*. (5). The prevalence was 12.5%, 20.9%, and 18.8% in case subgroups 1a, 1b, and control group, respectively). These levels are still quite high for females less than 30 years old. The periodontal status of the examined women is comparable with data from a cross-sectional study of an urban East German population (27).

In a recent prospective study of Oral Conditions and Pregnancy (OCAP) by Offenbacher and colleagues (28), their earlier results were confirmed by using a three-level definition of periodontal disease. A moderate to severe periodontal case was defined as ≥4 sites with at least 5 mm probing pocket depth and 2 mm attachment loss. The prevalence of these moderate to severe diseased cases among preterm mothers was significantly higher as compared to full-term mothers (9.6% vs. 4.3%). However, when this three-level definition of periodontal cases was applied to our data set, we failed to confirm these results. No significant differences between the groups in the distribution of moderate to severe periodontitis patients could be found (6.3%, 7.0%, and 7.3% in case group 1a, case group 1b, and control group, respectively). Most of the clinical and microbiological findings corresponded to gingivitis or a healthy periodontium as expected in this studied age group.

A second important difference between our population and the other study populations may be the very high percentages of Afro-Americans, which made up between 58–82% in the previous studies (5, 7, 29). In addition, the subjects in these studies were of low socio-economic status (5, 8, 29). There are marked racial differences in the prevalence of both preterm low birth weight (30, 31) and in the prevalence of severe forms of periodontitis (25, 32, 33). In the present study, all recruited women were German Caucasians mostly of middle or high socio-economic status (83%).

The only parameter that showed a tendency to be higher in the case groups when compared to controls was the mean gingival crevice fluid interleukin-1β level. But, the differences did not reach the significance level. The low prevalence of moderate to severe periodontitis and generalized periodontitis subjects, as well as the high standard deviations enable no clear interpretation of this finding. Additionally, there was a tendency of mean gingival crevice fluid interleukin-1β level of moderate to severe periodontitis patients to be higher compared to periodontal healthy subjects (1067.5 ± 863.9 pg/ml and 666.2 ± 555.2 pg/ml, respectively). The difference between these two groups, however, was not statistically significant (*t*-test: $p = 0.269$) because of the low prevalence of periodontitis in the entire study cohort.

Taking into account that the number of preterm low birth weight cases (group 1a) was very low ($n = 16$), one might argue that the results were less compelling because of the small sample size. The women with preterm contractions were all at a higher risk for preterm low birth weight. However, in a majority of the 59 cases originally recruited, preterm labour was averted by medical intervention. Thus, only 16 pregnant women with premature contractions gave birth before 37 gestation weeks to an infant weighing less than 2500 g (preterm low birth weight). When comparing the 59 original cases to the 42 control women, no significant differences for any of the parameters could be found between these groups (data not shown). These results were confirmed by the logistic regression models including pooled case group 1 and control group in the models. No periodontitis-associated increased risk of preterm contractions, and thus, for preterm low birth weight could be detected. Our findings are consistent with a number of recent studies (14–17, 34). They failed to find an association between periodontal disease and preterm low birth weight. Indeed, the British case-control study showed a general tendency for decreasing odds

of preterm low birth weight with increasing mean probing pocket depth (16). Curtis (in 35) summarized the explanations for the differences between the results of the British study and previous reports thus: '…first, there may in fact be no association; second, the differences may reflect differences in the study populations; and finally, periodontal disease may be associated with preterm low birth weight but only in the presence of other specific environmental or genetic risk factors…'. His comments are relevant to our findings.

Our findings suggest that in the studied German Caucasian population, with a periodontitis prevalence and severity comparable to that in other European countries (36), no link between periodontal status and preterm low birth weight was demonstrated.

Acknowledgements

The authors would like to thank Ms. A. Lauterbach for her technical assistance in analysing gingival crevice fluid interleukin-1β level, Professor I. Wachter from the Clinic of Gynecology and Obstetrics of the University of Technology Dresden for the cooperation in recruiting women for the study.

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