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Postpartum oral health parameters in women with preterm birth

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Abstract

Objective. It has been suggested that poor oral health and periodontal disease, in particular, associate with adverse birth outcomes. However, previous reports on the topic are conflicting. The objective of the present cross-sectional study was therefore to compare the oral health parameters of a racially and socio-economically homogeneous group of women who gave birth before 259 gestational days (37 weeks) with those of women who went full-term. ***Material and Methods.*** We studied various dental parameters, including prevalence of dental caries, gingival bleeding on probing, the probing periodontal pocket depths, and the carriage of periodontal pathogens in 328 all-Caucasian women with singleton births. Seventy-seven of the women had preterm births, while 251 had full-term. Dental data were recorded within 2 days postpartum and analyzed with data from medical history, prenatal care, and delivery records. ***Results.*** Preterm mothers had more dental caries (93.5%) than full-term mothers (85.3%) when assessed as carious teeth in the mouth ($p = 0.06$). In clinical and microbiological periodontal health parameters, however, no differences could be seen between the preterm and full-term mothers. Primiparity, low weight-gain, and antimicrobial drug use during pregnancy were the significant predictors for preterm birth. ***Conclusions.*** Although we cannot make any causal linkage, the oral health parameters were no different in women who experienced preterm births compared with those who had full-term births in this cohort. Only established systemic risk factors explained the preterm birth.

Key Words: *Oral health status, periodontal micro-organisms, pregnancy complications*

Introduction

The World Health Organization (WHO) defines preterm birth (PTB) as gestation period less than 37 weeks. In Europe, approximately 5–7% of all births are preterm [1,2] and this is an important social and health problem with a heavy economic burden. Most PTBs involve low birthweight (<2500 g) [3], which can also be caused by intrauterine growth retardation [4]. PTB infants are a strain on public health budgets through costs of neonatal intensive care and treatment of long-term disabilities. There are large national and ethnic differences in the frequency of PTB, ranging from 4% to 50% [5,6]. For example, in the United States, preterm low birthweight (PLBW) deliveries are more frequent in African-Americans than in whites [1,7]. In Finland, approximately 5.9% of all births are preterm [8].

Some of the known risk factors for PTB include very low or high maternal age, low socio-economic status, inadequate prenatal care, use of alcohol and tobacco, malnutrition, and multi-parity. The most important risk factor is previous spontaneous preterm delivery [1,9]. However, the predictive values of currently known risk factors for PTB are relatively low [10].

Infection associates with PTB [1,4,9], possibly contributing to up to 50% of PTB, especially those occurring before 30 weeks of gestation [11]. Both general and local maternal infections affect cytokine and hormone regulated gestation resulting in preterm labour [12,13]. Intrauterine infections can result in spontaneous preterm delivery by stimulating uterine

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contractions, or PTB may occur after membrane rupture [1].

Periodontal disease has been linked to PTB and may be a potential independent risk factor [14]. Studies have shown that pregnant women with periodontal disease have an increased risk of having PLBW infants [15,16]. Periodontal therapy significantly reduced PTB in one study [17], while in studies of multi-ethnic groups [18,19] and of Caucasian mothers [20], no association has been found between periodontal health and PTB.

Most of the earlier significant results associating poor oral health with poor pregnancy outcome were derived from socio-economically and racially heterogeneous populations. Offenbacher et al. [14] and Jeffcoat et al. [15] linked periodontal infection and PLBW, but both studies were conducted among multi-ethnic groups of women. Consequently, potential confounding by racial and socio-economic disparity was possible [21]. Therefore, in order to control this confounding, we set out to investigate whether there are differences in clinical or microbiological findings in a group of racially and socio-economically homogeneous people in Finland. Our study hypothesis was that there are differences in the oral health status of women with PTB compared to full-term mothers.

Material and methods

Patient selection

Each consecutive woman who delivered her child at the Department of Gynaecology and Obstetrics, Helsinki University Central Hospital (HUCH), Helsinki, Finland, between September 2002 and May 2004 was invited by a nurse to participate in this cross-sectional study. The mothers were informed about the study and they all signed consent before participation. Exclusion criteria were drug abuse, B- or C-hepatitis, and HIV infection. A total of 482 Caucasian mothers volunteered to take part in the study. Four dropped out for personal reasons and 25 mothers of twins were later excluded. We were unable to examine 125 women within 2 days postpartum, and these women, too, were excluded. The final study group thus comprised 328 women.

The definition of PTB (study outcome) was birth before 259 gestation days (37 weeks) as stated by the WHO and the International Federation of Gynaecology and Obstetrics (FIGO) [22]. Gestational age was determined based on the date of the previous menstrual period and confirmed by ultrasound examination at between 11 and 14 weeks of gestation. Among the 328 singleton births, 77 were PTB, while 251 were full-term. The Department of Gynaecology and Obstetrics is a tertiary referral center and the rate of adverse pregnancy outcome is higher than the Finnish average.

Ethical consideration

The Ethics Committee of HUCH approved the study, which was conducted in accordance with the Helsinki Declaration. The study is registered in the clinical investigation register of the HUCH at www.hus.fi (64.01.12.2006).

Clinical examination

Mothers were examined by two experienced dentists within 2 days postpartum in a specially equipped dental office at the hospital. If the mother was too tired to come to the examination room, a bedside examination was carried out using an otological light source. Pregnancy complication was blinded to the examiners. The examiners were not calibrated, but they were both employees of the City of Helsinki Health Department, where regular diagnostic meetings served as calibration sessions according to the principles of oral diagnosis. Periodontal probing depth (PD) was measured using a calibrated probe at six sites per tooth on all teeth. Gingival bleeding on probing (BOP) and teeth with visible dental plaque were recorded at four sites per tooth on all teeth (plaque index). Assessment of the severity of periodontal infection was based on the number of periodontal pockets with probing depth ≥ 4 mm and on the number of gingival bleeding surfaces. Dental caries was recorded and the World Health Organization decayed, missing, filled (DMF) and tooth surface indexes (DMFS) were calculated. The presence of any initial (enamel) or dentin caries was defined as diseased teeth. Third molars were recorded separately for all dental parameters.

Subgingival plaque sampling and analyses

Subgingival dental plaque was collected with sterile curettes from the periodontal pockets of 1st molars of the 1st and 3rd jaw quadrants. If the 1st molar was extracted, the sample was taken from the 2nd premolar or molar from the same jaw quadrant. Before sampling, supragingival plaque was removed with cotton swabs and the tooth surface was dried with cotton rolls. The samples were analyzed with polymerase chain reaction (PCR) for the presence of periodontal pathogens, including *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Prevotella intermedia*, *Prevotella nigrescens*, *Treponema denticola* and *Tannerella forsythia*. The analyses were in accordance with the methods of Wahlfors et al. [23] and Meurman et al. [24]. The PCR method has been validated and is commonly used in our

laboratory to detect anerobic oral bacteria. The PCR results are given as the number and percentage of women with positive findings.

Maternal characteristics

The mothers completed a questionnaire about their dental care, oral symptoms as well as smoking habits and alcohol use. Smoking was recorded as yes/no, and, if yes, the number of cigarettes per day was recorded. Smoking cessation time was also recorded when relevant. Alcohol consumption was recorded as alcohol used daily, less than once a day/week/month, or not at all. Data on demographic factors, prenatal care, medical history, previous and current pregnancies, obstetrical data and data on pregnancy outcomes were obtained from the medical records. Maternal chronic diseases and constant medications before pregnancy were recorded from questionnaire and validated against medical records (validity 97.4%) [25]. Weight gain (weight in the third trimester minus weight in the first trimester) and body mass index (BMI) were calculated. The number of previous pregnancies, spontaneous miscarriages, PLBW births and stillbirths was also recorded. Furthermore, *in vitro* fertilization, pregnancy complications such as infections, pre-eclampsia, and hospitalization caused by preterm contractions were also recorded. Gestational diabetes was categorized using the simplified White's classification as follows: White A – gestational diabetes that requires treatment with special diet only; White A/B – gestational diabetes that requires special diet and insulin; White B – adult onset diabetes developed at age ≥ 20 and disease duration <10 years; White C – diabetes developed between ages 10 and 19 or the patient having had the disease for 10–19 years; and White D – diabetes developed before age 10, the patient has had the disease for more than 20 years or has vascular complications [26].

Statistical analyses

To compare the distribution of individual risk factors in preterm and full-term groups, we used the Statistical Package for Social Sciences for Unix (SPSS). Continuous variables were tested with *t*-tests after evaluating normality and categorical data were tested with chi-squared tests.

The multivariate analysis was conducted using logistic regression methods utilizing the Statistical Analysis System (SAS) version 9.1. The predictor variable was the number of sites with PD ≥ 4 mm in four categories and the dependent variable was the PTB. We controlled for established independent risk factors, namely age as continuous variable, smoking in three categories, *in vitro* fertilization (yes/no), maternal asthma (yes/no), antimicrobial medication use (yes/no), weight gain during pregnancy (below or above the median), and primiparity (yes/no). All significance levels were set at $p = 0.05$ (two tails) and confidence intervals at 95%. Alcohol consumption and education were not included in the final model because they were not significant as univariates and did not change the parameter estimate by more than 10%. Ethnicity could not be assessed because we have 100% Caucasian women. We had only one woman in each group who had previous PTB. Thus, it was not necessary to adjust prior PTB.

Results

Table I gives the demographic data of the study population. The mothers were between 18 and 44 years of age (mean (SD) age 31.1(5.0)) with no difference in the mean age between preterm and full-term mothers; 69.5% were highly educated with a university or higher vocational school degree, 22.3%

Table I. Demographic data.

	All ($n=328$)	Preterm ($n=77$)	Full-term ($n=251$)	*p*-value
Age, mean (SD)	31.1 (5.0)	30.9 (5.4)	31.2 (4.9)	0.62
Categorical variables (*n*, %)				
Education				
High education (university or higher vocational school)	228 (69.5)	53 (68.8)	175 (69.7)	0.89
Moderate education (vocational school, student)	73 (22.3)	14 (18.2)	59 (23.5)	0.35
No professional education	21 (6.4)	7 (9.1)	14 (5.6)	0.29
Smoking				
During pregnancy	36 (11.0)	11 (14.3)	25 (10.0)	0.30
Before pregnancy	49 (14.9)	7 (9.1)	42 (16.7)	0.14
Not at all	243 (74.1)	59 (76.6)	184 (73.3)	0.66
Alcohol consumption during pregnancy				
Not at all	240 (73.2)	61 (79.2)	179 (71.3)	0.19
Less than once a month	64 (19.5)	9 (11.7)	55 (21.9)	0.05
Less than once a week	24 (7.3)	7 (9.1)	17 (6.8)	0.46

Due to missing values, not all categories have $n=328$.

had moderate education with vocational school degree, were educated at work, were still studying, or were housewives. Only 6.4% had no professional education. There was no difference in the level of education between the preterm and full-term groups.

Data on smoking and alcohol use are also given in Table I. Most mothers did not smoke, but a slightly higher percentage of the preterm (14.3%) than full-term mothers (10.0%) were current smokers (ns). Among smokers, the mean number of cigarettes smoked daily was 5, and the 75 percentile was 10 cigarettes per day. The proportion of women who smoked more than 10 cigarettes was not different between groups.

A slightly higher percentage of preterm mothers abstained from alcohol than did full-term mothers (79.2% vs 71.3%, ns). However, mothers of the preterm group reported alcohol use less frequently less than once a month than those of the full-term group (11.7% vs 21.9%; $p=0.05$). Only 9.1% of preterm and 6.8% of full-term mothers consumed alcohol less than once a week (ns). No one reported drinking alcohol daily or more frequently than once a week.

Medical and obstetrical data

The medical and obstetrical data of the women are given in Table II. BMI between the groups was not statistically different, but full-term mothers gained significantly more weight than preterm mothers (mean (SD) weight gain 13.9 (5.1) vs 11.7 (4.8) kg; $p<0.01$). There were more primiparous women in the preterm than in the full-term group (64.9 vs 45.4%; $p<0.01$).

Table II. Medical and obstetrical data.

	All ($n=328$)	Preterm ($n=77$)	Full-term ($n=251$)	p-value
BMI, mean (SD) ($n=326$)	23.4 (4.2)	23.5 (4.6)	23.4 (4.1)	0.82
Weight gain, mean (SD) ($n=295$)	13.4 (5.1)	11.7 (4.8)	13.9 (5.1)	<0.01
Categorical variables (n, %)				
Primiparous	164 (50.0)	50 (64.9)	114 (45.4)	<0.01
Previous miscarriage	74 (22.6)	22 (28.6)	52 (20.7)	0.15
Previous stillbirth	6 (1.8)	0 (0)	6 (2.4)	0.34
Maternal diseases	60 (18.8)	17 (23.6)	43 (17.4)	0.24
Hypertension	3 (0.9)	1 (1.4)	2 (0.8)	0.54
Asthma	17 (5.3)	7 (9.6)	10 (4.0)	0.08
Diabetes mellitus	11 (3.4)	4 (5.2)	7 (2.8)	0.29
Gestational diabetes	40 (12.2)	11 (14.3)	29 (11.6)	0.55
Hypothyroidism	4 (1.2)	1 (1.4)	3 (1.2)	1.00
Diabetes during pregnancy	51 (15.5)	15 (19.5)	36 (14.3)	0.28
White's classification				
White A	31 (9.5)	8 (10.4)	23 (9.2)	0.82
White A/B	4 (1.2)	1 (1.3)	3 (1.2)	1.00
White B	4 (1.2)	1 (1.3)	3 (1.2)	1.00
White C	4 (1.2)	2 (2.6)	2 (0.8)	0.24
White D	2 (0.6)	1 (1.3)	1 (0.4)	0.42
Unclassifiable†				
Infection	35 (10.7)	11 (14.3)	24 (9.6)	0.29
Urinary tract infection	5 (1.5)	1 (1.3)	4 (1.6)	1.00
Gynecological infection	20 (6.1)	6 (7.8)	14 (5.6)	0.59
Respiratory infection	3 (0.9)	1 (1.3)	2 (0.8)	0.55
Amnionitis	5 (1.5)	2 (2.6)	3 (1.2)	0.34
Other infection	3 (0.9)	1 (1.3)	2 (0.8)	0.55
Hospitalization caused by preterm contractions	13 (4.0)	8 (10.4)	5 (2.0)	<0.01
Pre-eclampsia	30 (9.1)	8 (10.4)	22 (8.8)	0.66
Intrahepatic choleostasis	13 (4.0)	4 (5.2)	9 (3.6)	0.51
Placental ablation	2 (0.6)	1 (1.3)	1 (0.4)	0.42
Medication (all)	101 (30.8)	38 (49.4)	63 (25.1)	<0.001
Antimicrobial drugs	38 (12.3)	18 (24.3)	20 (8.5)	<0.01
Painkillers	4 (1.2)	1 (1.3)	3 (1.2)	1.00
Oral corticosteroids	9 (2.8)	5 (6.8)	4 (1.6)	<0.05
Respiratory drugs	16 (4.9)	7 (9.1)	9 (3.6)	0.07
Vaginal delivery (n, %)	288 (87.8)	56 (72.7)	232 (92.4)	<0.001
Cesarean section (n, %)	23 (7.0)	10 (13.0)	13 (5.2)	<0.05
Emergency caesarean section (n, %)	17 (5.2)	11 (14.3)	6 (2.4)	<0.001

Due to missing values, not all categories have $n=328$. †Unable to classify 6 subjects; 1 in diabetes and 5 in gestational diabetes. BMI: body mass index.

The frequency of previous pregnancy complications between the groups was not statistically different. Of the women, 22.6% had experienced a previous spontaneous miscarriage, which was the most common pregnancy complication recorded in their obstetrical history. However, only one woman in each group had previous preterm delivery. All mothers had received uniformly excellent prenatal care according to the Finnish National Plan and almost all (99.7%) had had over 6 appointments of antenatal care. Altogether 51 mothers (15.5%) had diabetes during pregnancy; gestational diabetes in 40 cases and Type I diabetes mellitus in 11 cases.

Prevalence of recorded infections was 10.7% during pregnancy and these were mostly gynecological infections (6.1%). However, no differences were observed between the groups in this regard. The overall incidence of hospitalization caused by preterm contractions was 4.0%, and this was more common in the preterm mothers, as expected (10.4% vs 2.0%; $p<0.01$). Pre-eclampsia was observed in 9.1% of the mothers and the difference between the groups was not significant. Medical records revealed a significant difference in the intake of medications showing a higher proportion of antimicrobial medication during pregnancy among the preterm mothers ($p<0.01$). Significant differences in the mode of delivery were also seen between the preterm and full-term groups: 72.7% of preterm and 92.4% of full-term mothers had vaginal delivery ($p<0.001$), 13.0% vs 5.2% had cesarean section ($p<0.05$), and 14.3% vs 2.4% had an emergency section ($p<0.001$). However, these differences are the results of problem pregnancy in general and cannot be considered as risk factors of PTB.

Dental health data

Most dental health parameters were not statistically different between the groups (Table III). The women in both groups had complete dentitions, on average (mean (SD)) 28.9 (2.7) teeth in the preterm group vs 28.7 (1.7) in the full-term group. Of the preterm women, 93.5% had dental caries compared to 85.3% of the full-term women ($p=0.06$).

Only 5 women had periodontal pocket depth $\geq$6 mm (regarded a marker of severe periodontal disease) and 75% had less than one site of periodontal pockets $\geq$4 mm. Thus, periodontal disease was not a major problem. However, gingival bleeding at the examination was prevalent, with a median number of 22 bleeding sites (interquartile range 10–33). More bleeding sites than median were seen in the preterm group, but the difference between groups was not significant. No significant differences were detected in the prevalence of women with periodontal pathogens. The microbiological PCR results are also given in Table III.

The three-way cross-tabulation of periodontal pocket depth $\geq$4 mm at more than 3 sites and current smoking and heavy smoking (defined as $>$10 cigarettes/day) among the 6 women who had all three risk factors showed that 5 women had full-term and only one had PTB. Thus, smoking and/or periodontal disease did not appear to be major risk factors in this study population, while primiparity, low weight gain, and antimicrobial drug treatment were significant predictors in the regression model. The results are given in Table IV. Respective analyses with the frequency of dental caries as the predictor were also non-contributory as regards PTB.

Table III. Oral health parameters and microbiological results.

Parameter	Preterm ($n=77$)	Full-term ($n=251$)	p-value
No. of teeth, mean (SD)	28.9 (2.7)	28.7 (1.7)	0.75
DMFS, mean (SD)	19.2 (17.7)	19.2 (14.4)	0.97
Prevalence of caries (n, %)	72 (93.5)	214 (85.3)	0.06
No. of partly erupted 3rd molars, mean (SD)	0.3 (0.7)	0.3 (0.6)	0.67
No. of plaque covered surfaces, mean (SD)	20.4 (20.0)	18.2 (18.1)	0.35
No. of bleeding sites, mean (SD)	23.4 (15.2)	23.4 (18.3)	0.99
No. of gingival bleeding surfaces			
quartile 1 (up to 10 surfaces)	11 (14.7)	62 (25.5)	0.05
quartile 2 (10 <bleeding surface $\leq$22)	27 (36.0)	64 (26.3)	0.11
quartile 3 (22 <bleeding surface $\leq$33	18 (24.0)	50 (20.6)	0.53
quartile 4 (33)	19 (25.3)	67 (27.6)	0.70
No. of >4 mm periodontal pockets, mean (SD)	1.8 (5.9)	1.8 (5.1)	0.98
Positive for (n,%)			
Aggregatibacter actinomycetemcomitans	9 (11.7)	16 (6.4)	0.12
Porphyromonas gingivalis	1 (1.3)	4 (1.6)	0.85
Prevotella intermedia	6 (7.8)	12 (4.8)	0.31
Prevotella nigrescens	26 (33.8)	84 (33.5)	0.96
Treponema denticola	8 (10.4)	26 (10.4)	0.99
Tannerella forsythia	6 (7.8)	34 (13.6)	0.17

DMFS: decayed, missing, filled surface.

Table IV. Multivariate regression model for the prediction of preterm birth.

Predictor	Odds ratio (95% CI)	P-value
No. of PD sites with ≥4 mm		
• 0 ($n=226$)	1.00	
• 0 <PD ≤1 ($n=35$)	1.37 (0.55–3.40)	0.49
• 1 <PD ≤4 ($n=46$)	1.70 (0.77–4.54)	0.24
• PD >4 ($n=21$)	0.44 (0.09–2.18)	0.31
Smoking		
Never smoker ($n=243$)	1.00	
Past smoker ($n=49$)	0.44 (0.17–1.16)	0.14
Current smoker ($n=36$)	0.98 (0.39–2.48)	0.84
Age (years)	0.99 (0.93–1.06)	0.81
Weight gain less than 13 kg (median)	2.26 (1.18–4.30)	0.01
Asthma (yes/no)	2.31 (0.74–7.21)	0.15
Antimicrobial treatment (yes/no)	4.32 (1.95–9.57)	0.0003
In vitro fertilization (yes/no)	3.09 (0.84–11.33)	0.10
Primiparity (first child)	2.91 (1.55–5.46)	0.002

PD: probing depth of periodontal pockets.

Discussion

We studied the relationship between oral health and pregnancy outcome in this group of women with high socio-economic status and homogeneous ethnic background. No significant differences were seen between PTB and full-term mothers in the oral health variables that could statistically link with the outcome of pregnancy. However, the prevalence of caries was higher among the preterm women. This finding may partly support our study hypothesis even though no association was found between the previously addressed periodontal disease–PTB link in this cohort. Low weight gain, antimicrobial drug use, which is a probable proxy of infections, and primiparity were the significant explanatory factors for PTB. All these are well-known risk factors for PTB.

The women in both groups had complete dentitions. DMFS index score, which measures previous and current dental health status, was similar in both groups. Present dental health, however, when assessed by the detection of one or more initial or dentine caries lesions showed an almost significant difference between the pre- and full-term women. It has to be emphasized that dental patients with fillings are considered as healthy, while patients with caries are considered as diseased. However, dental caries is not expected to trigger systemic inflammatory reactions unless rampant with necrotic pulps, which was not the case in the present material.

Many women had gingival bleeding probably due to pregnancy gingivitis, but only 5 women had periodontal pocket depth ≥6 mm and 75% had less than one site of pockets ≥4 mm. Thus, the periodontal disease challenge was low in this material, giving no support to the periodontitis–poor pregnancy outcome hypothesis. However, no causal relationship can be deduced from a cross-sectional study such as ours. Furthermore, a deep periodontal pocket does not necessarily reflect an ongoing active infection, but could be a sign of past periodontal disease experience [27]. Thus, more precise biological oral infection markers are needed.

Higher levels of periodontal pathogens have been detected in PLBW mothers compared to full-term and normal birthweight mothers [6,7,12]. Periodontal bacterial endotoxins may trigger pro-inflammatory cytokines that pose a threat to the feto-placental unit [7,14]. Significantly higher levels of *Tannerella forsythia* [6] and *Campylobacter rectus* [12] were reported in PTB mothers compared to full-term mothers. However, in our study, the presence of periodontal pathogens was not statistically different between the groups. This, together with the low prevalence of deep periodontal pockets and high number of remaining teeth, shows that the mothers in our study had uniformly excellent oral health. The apparently low inflammatory burden of the mouth of the women inevitably weakens the power of our study but, on the other hand, emphasizes successful controlling of confounders in our results.

The observation of good oral health among women giving birth in HUCH is in agreement with results of retrospective data from the same hospital [28]. As stated, many earlier studies have investigated mothers of low socio-economic status [12,16,29] and patients with racial differences [12,14,15,29]. Mitchell-Lewis et al. [12] studied the relationship between periodontal disease and PLBW among low socio-economic status women, as did Lopez et al. [16]. The study from Mitchell-Lewis et al. [12] reported significantly increased levels of periodontal pathogens among women with PLBW and reduced incidence of PLBW in women who received periodontal treatment during pregnancy. Lopez et al. [16] reported a higher incidence of PLBW among women with periodontal disease and defined the presence of 4 or more teeth with one or more sites with probing depth ≥4 mm and with clinical attachment loss ≥3 mm at the same site. A study by Jarjoura et al. [29] reporting increased loss of periodontal tissue support in women with PTB was conducted among multi-ethnic women, mainly Hispanic (60%), of whom only 30.8% of controls and 36.1% of cases had private medical insurance measuring socio-economic status. Many other previous studies have also had multi-ethnic study populations or high percentages of African-American women. In the study by Jeffcoat and colleagues [15], the majority of the study population were African-American (82.68%), as was also the case in the study by Mitchell-Lewis et al. [12]. Davenport and colleagues conducted their study among a multi-ethnic group of women, majority Bengali (52.5%), as did Offenbacher et al. [14]. Confounding by low socio-economic status and racial differences could

not therefore be ruled out in these investigations, unlike in our material of highly (69.5%) or moderately (22.3%) educated 100% Caucasian women. Likewise, the study of Noack and colleagues [20] on middle or high socio-economic status women did not find any association between periodontal health and PTB. On the other hand, Marin et al. [30] found an association between periodontal disease and reduction in the infant birthweight in Caucasian pregnant women, but only 21.7% of their subjects had secondary or higher education. Pitiphat et al. [31] reported that periodontal disease was a non-significant risk factor for adverse pregnancy outcome among middle-class women, but the periodontitis was self-reported by questionnaire and only 72.7% were Caucasian. Thus potential confounding was still possible.

A further strength of our study is the exact definition of PTB (birth before 259 days). Balchin et al. [32] reported that up to 10.1% of preterm babies were found to be misclassified when using the WHO/FIGO criteria. If gestational days are rounded up to gestational weeks, 7 days in the late gestational age will be misclassified. These 7 days may make a substantial difference in intrauterine development.

Because the patients were examined postpartum, no causal relationship between oral health and PTB can be concluded, and this can be considered a weakness of our study. However, in several previous studies the dental examination has been done postpartum [14,18,20,29,34,35]; thus, our study design is not uncommon.

Extremely young or old maternal age has been reported as a risk factor for PTB [1]. In our study, the mean age was 31.1 years, which is similar to the average age of primiparous women in the greater Helsinki area (29.2 years; 22.6% of those who give birth are 35 years or older). In the Mitchell-Lewis et al. study [12], very young women (mean age 16.7 years) were investigated. On the other hand, Marin et al. [30] had a study cohort with a mean age of 23.3 years and Noack et al. [20] had groups with mean ages between 27.8 and 30.2 years. Because no one in our cohort was younger than 18 or older than 44, the effects of extreme maternal age on PTB were eliminated. Hujoel et al. [21] stated that periodontal care and low birthweight are related to common risk factors such as cigarette smoking. However, as we reported, smoking did not appear to be a major risk factor in our material.

Alcohol consumption is the second modifiable risk factor for PTB [13]. In our study, the only significant difference in alcohol consumption was that the proportion of women who consumed alcohol less than once a month was higher in the full-term group.

Infection during pregnancy is indeed known to be a significant risk factor of PTB [1,13,22]. Our results were consistent with these reports showing a higher prevalence of antimicrobial drug use, as a proxy for infections, in the preterm group. We observed that antibiotic drug use was reported more often than recorded infectious episodes. This might be explained by the prophylactic antibiotic usage to prevent problems if the delivery is progressing in preterm. Antibiotics are also given if the test for *Streptococcus* B is positive. These situations are not classified as infections in the hospital records.

Use of corticosteroids has also been reported to be a significant risk factor [33], but in our study only 9 individuals (5 preterm and 4 full-term mothers) had taken oral corticosteroids and thus no conclusions can be drawn from these numbers.

Primiparity [13] and low maternal weight gain [12] were also significant determinants for PTB. Our results are in agreement with observations showing a higher proportion of primiparous women and significantly lower weight gain in the preterm group.

In conclusion, in this study population of homogeneous ethnic and socio-economic status, no association was found between periodontal health parameters and PTB. Contrary to our expectations, periodontal health status was uniformly good and the frequency of harbouring periodontal pathogens was low among the women in both groups. The prevalence of caries, however, was higher among the preterm mothers. Nevertheless, antimicrobial drug treatment during pregnancy, low weight gain, and primiparity were the strongest explanatory factors for PTB.

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