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Is there an association between periodontal disease, prematurity and low birth weight? A population-based study

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Abstract

Background: The relationship between periodontal diseases in pregnancy and children born prematurely or with low birth weight has been increasingly investigated, showing inconclusive results.

Objectives: To test the link between periodontal disease in pregnant women and low birth weight or prematurity.

Methods: A population-based, cross-sectional study was carried out in Southern Brazil. The sample consisted of 449 parturients who were interviewed and examined up to 48 h post-partum. Three outcomes were investigated: low birth weight, prematurity and prematurity and/or birth weight. Periodontal disease, the exposure, was defined as (i) at least one site with a periodontal pocket; (ii) the presence of pockets at four or more sites. Socio-demographic information relating to health and maternal habits was collected through a questionnaire and by hospital medical records. Simple and multiple regression analysis was performed.

Findings: There was no statistically significant association between periodontal disease and low birth weight. Periodontal pocket was not associated with low birth weight and/or pre-term birth after being adjusted. A periodontal pocket in at least one site was associated with prematurity (odds ratio = 2.6; 95% confidence interval 1.0–6.9) even after adjusting for maternal schooling, parity, number of previous children of low birth weight, number of pre-natal consultations and body mass index. After the introduction of variables relating to maternal health during pregnancy, this association disappeared.

Conclusions: No association was found between periodontal disease in the mother and the low birth weight. An association between prematurity and periodontal pockets was found but it was confounded by maternal health variables.

Key words: adverse effects; low birth weight; periodontal disease; pregnancy; pre-term birth; risk factors

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Epidemiological studies in Perinatology are designed to examine hypotheses that enable the identification of risk factors for morbidity and mortality, as well as to identify possible long-term consequences and developmental problems in the different phases of life. The lower the weight at birth, the greater the risk of mortality within the first year of life (Puffer & Serrano 1987).

The weight and the health status of the new-born are determined by numerous, complex and inter-related factors, and stem from social, biological and environmental conditions, to which the mothers are exposed during pregnancy (Puffer & Serrano 1987).

Among the biological conditions, infections that can spread from their specific site of origin because of the dissemination of microorganisms via the blood or, through the presence of chemical mediators, can alter or trigger physiological processes, such as the duration of gestation (Offenbacher et al. 1993).

Chronic periodontal disease, particularly with the presence of periodontal pockets, leads to an infectious state, with a large number and variety of

microorganisms, in particular, Gram-negative bacteria, which find a suitable environment in these sites for their survival and proliferation (Lindhe 1999).

The relationship between periodontal disease, prematurity and new-borns of low birth weight is plausible in biological terms (Dixon et al. 1994), and possible mechanisms have been demonstrated experimentally in animals (Collins et al. 1994).

The systemic manifestations of localized infections, including periodontal disease, have recently become more widely studied and have provided varied results. Offenbacher et al. (1996), in a pioneering study, concluded that there was a statistically significant association between periodontal disease in pregnant women, prematurity and low birth weight of new-borns. Subsequent studies using different designs have shown varied findings, some of which have been conflicting. Mitchell-Lewis et al. (2001) investigated the relationship between periodontal infections and preterm low birth weight in a cohort of pregnant and post-partum women and the effect of periodontal interventions on pregnancy outcome, and did not find an association between women's periodontal clinical status and birth outcomes. Lopez et al. (2002a) carried out a randomized clinical trial to test whether periodontal therapy may reduce the risk of pre-term low birth weight in women with periodontal disease. They found a lower rate of pre-term low birth weight in women who received periodontal treatment before 28 weeks of gestation when compared with those who did not receive it. Moore et al. (2004) conducted a prospective study involving 3738 women recruited at 12 weeks of pregnancy in order to investigate the relationship between maternal periodontal disease and low birth weight, pre-term birth and late miscarriage. Their findings suggest that there is no association between periodontal disease and birth outcomes. However, some of these studies featured methodological limitations, either because of the use of a small sample size, the analysis of specific populations or because the statistical analysis was inadequately conducted, or did not include possible confounders. As periodontal disease and adverse pregnancy outcome share several common factors, it is mandatory to control confounder variables through both restriction criteria to eligibility and adequate statistical models. Moreover, a search performed in the Medline did not find any published observational epidemiological study related to this core issue conducted in developing countries, where adverse birth outcomes is a serious public health problem.

The presence of periodontal disease in the mother may be associated with the birth condition of the child. However, the main question is: does this association in fact exist and is it statistically significant and independent of other confounding variables? In a country with the social and economic characteristics of Brazil, what is the influence of other risk factors over the duration of gestation and the birth weight of babies?

The objective of the present study was to test the hypothesis that parturients with indexes for the presence of periodontal pockets during gestation are at greater risk of giving birth to premature and/or low birth weight new-borns than parturients without periodontal pockets.

Methods

The study was carried out in Itajaí, a municipality located on the coast of Santa Catarina State, Southern Brazil, which, in the year 2000, had a population of 147,463 inhabitants, 96% of whom were resident in the urban area (IBGE 2000).

The study population consisted of pregnant women from Itajaí in the year 2003. The number of pregnant women was estimated using the figures for the number of births (2535) in 2002 (Secretaria de Estado da Saúde 2003), of which 99.7% took place in the only maternity hospital in the city (HMMKB).

A cross-sectional study was carried out to estimate the prevalence of gingival bleeding after probing, as well as shallow and deep periodontal pockets. In addition, the hypothesis of an association between parturients presenting periodontal pockets during gestation, and premature and/or low birth weight new-borns was tested.

This study involved the parturients who gave birth at the HMMKB during the period from July to November 2003, interviewed and examined up to 48 h after the birth of the baby. Thirty-five (7.7%) women were excluded for being younger than 15 or older than 40 years of age, for presenting diabetes, cardiac disease, glomerulonephritis, hyperthyroidism, multiple births, epilepsy, placental or uterine abnormalities, all of which were considered confounding factors (Kramer 1987, Romero & Mazor 1988, Offenbacher et al. 1998), or for having less than 18 natural teeth present.

The women selected for this study were those who were present and able to be examined and interviewed in their hospital beds, from Monday to Friday, between 11:00 and 14:00 hours, and who signed informed consent forms.

The data were collected by means of a structured interview, and other information was obtained from the medical records of the parturient performed by a trained nurse.

Sample size calculation

Two calculations were performed: (i) to estimate the prevalence of gingival bleeding and shallow and deep periodontal pockets; (ii) to test the hypothesis of an association between the presence of periodontal pockets in these parturients and premature and/or low birth weight new-borns. In order to complete these calculations, the prevalence of bleeding in pregnant women was estimated at 90%, with a confidence level of 95% and a sampling error of 5%, resulting in a total of 132 women. For shallow periodontal pockets, a prevalence of 50% was considered, with a confidence level of 95% and a sampling error of 5%, resulting in a total of 341. For deep periodontal pockets, a prevalence of 10% was considered, with a confidence level of 95%, and a sampling error of 5%, giving 132. The largest sample obtained in this way ($n = 341$) was accepted, with 10% added to cover for eventual losses and/or refusals. The final sample size was 376 women.

To test the association between the presence of periodontal disease in pregnant women, prematurity and low birth weight, the prevalence of prematurity and that of low birth weight in children of pregnant women with periodontal pockets (exposed) were estimated at 15%, and the same outcomes at 6% for pregnant women without periodontal pockets (unexposed), a test power of 80% ($\beta = 20\%$) and confidence level of 95% ($\alpha = 0.05$). Using these parameters, a minimum sample of 406 pregnant women was obtained, to which 10% was added to cover for eventual losses and/or refusals, giving a total of 447 women.

Clinical examinations

The periodontal examination was performed on all teeth using calibrated periodontal probes (Trinity®, Campo Mourão, Paraná, Brazil). The depths of all gingival sulci were measured and the presence or absence of bleeding at all sites probed was also observed, after the examination of each hemi arch (approximately 15 s). The observation of the presence of bleeding after the examination of the hemi arch was important, as movements of the tongue and cheek could remove traces of blood and lead to an underestimation in the results. All teeth were examined, with the exception of third molars, on mesiobuccal, buccal, distobuccal, distolingual, lingual and mesiolingual sites. The depth of probing was recorded as follows: shallower than 3.5 mm, equal to or deeper than 3.5 mm and shallower than 5.5 mm, equal to or deeper than 5.5 mm and shallower than 8.5 mm, equal to or deeper than 8.5 mm and shallower than 11.5 mm and deeper than 11.5 mm (Papapanou 1996, Lopez et al. 2002b). Gingival sulci with a depth greater than 3.5 mm and less than or equal to 5.5 mm were regarded as shallow pockets, while those that were deeper than 5.5 mm were regarded as deep pockets because of the small number of women with deep periodontal pockets (31% or 7%), these were added to those who had shallow periodontal pockets, forming a single category. Women who presented four or more sites with periodontal pockets accounted for 23.8% of severity of periodontal disease or they were placed in the third quartile of frequency distribution. Two calibrated blinded dentists examined all women (Peres et al. 2001).

Interview

Socio-demographic information and that relating to maternal health and habits were collected by means of a specific structured questionnaire after the clinical examinations, given by a trained nurse, and complemented by medical records. In the description of the variables, the data were obtained through the questionnaire, while the others were collected from the medical records of the parturients.

Outcome variables

The outcomes studied were: (i) prematurity, (ii) birth weight. These variables were dichotomized in births at term ($\geqslant 37$ weeks) and premature (<37 weeks); in low birth weight (<2500 g) and adequate weight ($\geqslant 2500$ g) (WHO 1977); and (iii) prematurity and/or low birth weight.

Exploratory variables

The following were considered as markers of periodontal disease during gestation: those parturients who presented at least one site with a gingival sulcus equal to or greater than 3.5 mm in depth (periodontal pocket) and pregnant women with four or more sites that had a gingival sulcus greater than 3.5 mm in depth (Lopez et al. 2002b).

As there are numerous situations associated with the outcomes studied, it was necessary to collect control variables.

The following variables were collected through a questionnaire: ethnicity (White or Black and other); presence of the father or partner during the pregnancy (Yes/No); family income over the last month calculated by summing all of the incomes of members of the household (>2 Brazilian minimum salaries (MS), 1–2 Brazilian MS, <1 Brazilian MS; maternal schooling in whole years (>8 or $\leqslant 8$ years); obstetric history/number of previous births (primiparous or multiparous); previous births of low weight babies (Yes/No); complications during this pregnancy: bleeding during the pregnancy (Yes/No); genitourinary tract infections (Yes/No); other infections (Yes/No); substances abuse: use of tobacco during pregnancy (Yes/No); use of illegal drugs during pregnancy (Yes/No); pre-natal care: number of pre-natal consultations (>6 or $\leqslant 6$); dental treatment during pregnancy (Yes/No); and oral health guidance during pregnancy (Yes/No).

The following variables were collected through interview or from medical records: Socio-demographic: age of the mother in whole years ($\leqslant 19$ or >19 years); sex of the new-born (male or female); and anthropometric: body mass index (BMI) (malnourished $\leqslant 18.5$ or presented >18.5).

Questionnaire

The questionnaire was pre-tested with 10 women at the HMMKB, in the month of June 2003.

Diagnostic reliability

The diagnostic reliability was high ($\kappa \geqslant 0.98$), both for depth of probing, and for bleeding ($\kappa = 0.92$). Ten percent of the sample was examined twice during the field work, with a minimum interval of 12 h, to verify the diagnostic reliability ($\kappa \geqslant 0.89$).

Pilot study

The pilot study was carried out with the participation of 50 women, at the same venue (HMMKB), and the necessary adjustments were later made to the standardization of the procedures for examinations and interviews.

The classification of the women according to per capita income was based on the tertiles distribution, and the number of people who lived with the pregnant woman was dichotomized (one and two people; and three or more). The use of illegal drugs was disregarded as this had been confirmed by only four women.

Data entry and statistical analysis

The data were entered by the author of the project (A. L.), processed and analysed using the Statistical Package for Social Science (SPSS for Windows, version 10.0, SPSS Inc., Chicago, IL, USA).

The statistical analysis included: (a) descriptive statistics (measures of central tendency and of dispersion) of the variables of the cross-sectional study; (b) univariate analysis of the outcomes (prematurity, low birth weight and prematurity and/or low birth weight) and the independent variables; and (c) unconditional multiple logistic regression analysis for examination of the factors independently associated with the outcomes. In the unconditional logistic regression analysis, the variables that presented $p<0.20$ in the univariate analysis were used. For the multiple analysis, the stepwise forward procedure was used for variable's entry (Hosmer & Lemeshow 1989).

Ethical issues

The appropriate guidelines for research in humans were followed, according to resolution no. 196 of the National Health Council (Brazil), using the term informed consent. This research project was approved by the Committee for

Ethics in Research of the Federal University of Santa Catarina and by the Ethics Committee of the HMMKB.

Results

Four hundred and ninety-six parturients were invited to participate in this study; there were 12 refusals (2.7%) and 35 women were excluded for presenting probable confounding factors for prematurity or low birth weight or for having less than 18 natural teeth present at the time of the examination. Therefore, 449 parturients were involved in this study and were interviewed and examined after signing informed consent forms.

Of the children born to these women, 7.1% (32) were considered premature and 5.8% (26) of low birth weight; of the 26 children of low birth weight, 16 (61.5%) were born prematurely. Children born prematurely or with low birth weight were 39 (8.7%).

The prevalence of gingival bleeding found in at least one site was 95.8% (95% confidence interval (CI) 93.9–97.6), the prevalence of shallow pockets was 56.3% (95% CI 51.7–60.9) and that of deep pockets was 5.1% (95% CI 3.1–7.1). The average number of teeth present was 25.5 (95% CI 21.2–29.8).

Table 1 shows that low per capita income, smoking during pregnancy, having had low birth weight babies, having had fewer than six pre-natal consultations and giving birth prematurely were variables associated with low birth weight ($p < 0.05$). The presence of periodontal pockets was not associated with low birth weight, although since it presented a value of $p < 0.20$ (χ^2 test), it was included in the multiple logistic regression analyses (data not shown). When multiple logistic regression analyses were performed, it could be observed that there was no association between periodontal disease (at least one site and four or more sites) and low birth weight even after the inclusion of potential confounding variables.

The following were associated with prematurity: the presence of periodontal pockets, low per capita income, BMI below or equal to 18.5, multiparity, previous children of low birth weight, having had six or fewer pre-natal consultations, having presented increased arterial pressure during the pregnancy and low birth weight (Table 2).

The presence of a periodontal pocket in at least one site was associated with prematurity (odds ratio (OR) = 2.6, 95% CI 1.0–6.9) even after adjusting for potential confounding factors such as maternal schooling, parity, number of previous children with low birth weight, BMI and number of pre-natal consultations. After the inclusion of infections and other pathologies during pregnancy

Table 1. Association between LBW and periodontal condition, biological, socio-economic and behavioural variables in pregnant women (Itajai, Santa Catarina, Brazil, 2003)

Variable/categories	LBW, *n* (%)	Adequate weight, *n* (%)	χ^2	*p*
Ethnicity				
White	24 (5.8)	392 (94.2)	0.00	
Black	2 (6.1)	31 (93.9)	0.94	
Income per capita (MW)				
>2	3 (2.0)	148 (98.0)		
1–2	10 (6.9)	134 (93.1)		
<1	13 (8.4)	141 (91.6)	6.34	0.04
Schooling (years)				
>8	8 (4.7)	162 (95.3)		
⩽8	18 (6.5)	261 (93.5)	0.59	0.44
Body mass index				
>18.5	23 (5.7)	379 (94.3)		
⩽18.5	3 (7.7)	36 (92.3)	—	0.49
Parity				
Multiparous	19 (6.9)	258 (93.1)		
Primiparous	7 (4.1)	165 (95.9)	1.51	0.22
Previous children with LBW				
No	9 (2.2)	406 (97.8)		
Yes	17 (50.0)	17 (50.0)	131.79	<0.001
Smoked during pregnancy				
No	19 (4.8)	379 (95.2)		
Yes	7 (13.7)	44 (86.3)	6.64	0.01
Pre-natal consultations				
>6	9 (2.9)	301 (97.1)		
⩽6	17 (12.2)	122 (87.8)	15.30	<0.01
Vaginal bleeding				
No	7 (8.0)	81 (92.0)		
Yes	19 (5.3)	342 (94.7)	0.93	0.33
Urinary tract infection				
No	12 (4.8)	239 (95.2)		
Yes	14 (7.1)	184 (92.9)	1.06	0.30
Other infections				
No	1 (10.0)	9 (90.0)		
Yes	25 (5.7)	414 (94.3)	—	0.45
Increased arterial pressure				
No	21 (5.4)	368 (94.6)		
Yes	5 (8.3)	55 (91.7)	—	0.37
Prematurity				
No	10 (2.4)	407 (97.6)		
Yes	16 (50.0)	16 (50.00)	123.44	<0.01
Dental treatment during pregnancy				
No	1 (1.7)	59 (98.3)		
Yes	25 (6.4)	363 (93.6)	—	0.23
Oral health guidance during pregnancy				
No	6 (3.2)	183 (96.8)		
Yes	20 (7.7)	240 (92.3)	4.09	0.04
Child's sex				
Female	11 (5.2)	200 (94.8)		
Male	15 (6.3)	223 (93.7)	0.24	0.62
Periodontal pocket				
No	8 (4.1)	187 (95.9)		
Yes	18 (7.1)	236 (92.9)	1.80	0.18
Periodontal pocket				
No	8 (4.1)	187 (95.9)		
⩾4 sites	9 (8.4)	98 (91.6)	2.41	0.12
Maternal age (years)				
>19	20 (5.8)	326 (94.2)		
⩽19	6 (5.8)	97 (94.2)	0.00	0.99

MW, minimum wages; LBW, low birth weight.

Table 2. Association between prematurity and periodontal condition, biological, socio-economic and behavioural variables in pregnant women (Itajai, Santa Catarina, Brazil, 2003)

Variable	Premature, *n* (%)	Term, *n* (%)	χ^2	*p*
Ethnicity				
White	30 (7.2)	386 (92.8)	—	1.00
Black	2 (6.1)	31 (93.9)		
Income per capita (*MW*)				
>2	3 (2.0)	148 (98.0)		
1–2	15 (10.4)	129 (89.6)	9.28	0.01
<1	14 (9.1)	140 (90.9)		
Schooling (*years*)				
>8	16 (9.4)	154 (90.6)	2.16	0.14
⩽8	16 (5.7)	263 (94.3)		
Body mass index				
>18.5	25 (6.2)	377 (93.8)	7.27	<0.01
⩽18.5	7 (17.9)	32 (82.1)		
Parity				
Multiparous	25 (9.0)	252 (91.0)	3.94	0.05
Primiparous	7 (4.1)	165 (95.9)		
Previous children with LBW				
No	18 (4.3)	397 (95.7)	64.43	<0.01
Yes	14 (41.2)	20 (58.8)		
Smoked during pregnancy				
No	27 (6.8)	371 (93.2)	0.62	0.43
Yes	5 (9.8)	46 (90.2)		
Pre-natal consultations				
>6	9 (2.9)	301 (97.1)	27.00	<0.01
⩽6	23 (16.5)	116 (83.5)		
Vaginal bleeding				
No	8 (9.1)	80 (90.9)	0.64	0.43
Yes	24 (6.6)	337 (93.4)		
Urinary tract infection				
No	14 (5.6)	237 (94.4)	2.06	0.15
Yes	18 (9.1)	180 (90.9)		
Other infections				
No	1 (10.0)	9 (90.0)	—	0.53
Yes	31 (7.1)	408 (92.9)		
Increased arterial pressure				
No	22 (5.7)	367 (94.3)	9.52	<0.01
Yes	10 (16.7)	50 (83.3)		
Birth weight				
Adequate	16 (3.8)	407 (96.2)	123.44	<0.01
Low	16 (61.5)	10 (38.5)		
Dental treatment during pregnancy				
No	1 (1.7)	59 (98.3)	—	0.01
Yes	31 (8.0)	357 (92.0)		
Oral health guidance during pregnancy				
No	5 (2.6)	184 (97.4)	—	0.01
Yes	27 (10.4)	233 (89.6)		
Child's sex				
Female	14 (6.6)	197 (93.4)	0.15	0.70
Male	18 (7.6)	220 (92.4)		
Periodontal pocket				
No	8 (4.1)	187 (95.9)	4.76	0.03
Yes	24 (9.4)	230 (90.6)		
Periodontal pocket				
No	8 (4.1)	187 (95.9)	5.65	0.02
⩾4 sites	12 (11.2)	95 (88.8)		
Maternal age (*years*)				
>19	25 (7.2)	321 (92.8)	0.02	0.88
⩽19	7 (6.8)	96 (93.2)		

MW, minimum wages; LBW, low birth weight.

(Table 3), the statistical significance of this association was lost. A similar pattern could be seen when periodontal disease was defined as the presence of four or more sites with pockets (Table 4).

Table 5 shows that low per capita income, low BMI, multiparity, previously having had low birth weight babies, smoking during pregnancy, having had fewer than six pre-natal consultations, previous urinary tract infection, previous other infections, having had an increased arterial pressure, access to dental treatment during pregnancy, having had oral guidance during pregnancy, and the presence of periodontal pockets were variables selected to enter into the logistic model since that they were associated with low birth weight and/or pre-term birth ($p<0.20$). The presence of a periodontal pocket in at least one site was associated with prematurity and/or low birth weight (OR = 2.4, 95% CI 1.1–5.0). However, after the introduction of confouding variables in the model, OR decreased from 2.4 (crude) to 2.0 (after all variables were included), and the *p*-value of 0.022 to 0.116, respectively (Table 6). A similar pattern is observed when the main exploratory exposure is periodontal pocket in four or more sites. In this case, a high risk was observed in the unadjusted model (OR = 2.8), decreasing to 2.2 ($p = 0.094$) when the model was adjusted by previous babies with low birth weight, pre-natal visits and oral guidance during pregnancy (Table 7).

Discussion

The prevalence of low weight newborns found (5.8%) was lower than those for Itajaí (8.3%) and Brazil as a whole (10%). This difference could be explained by the exclusion criteria used for women who presented situations of risk for low birth weight and prematurity, such as multiple pregnancies, or that they were younger than 15 and older than 40 years, for example. The prevalence of prematurity (7.1%) was slightly higher than those for Itajaí (6.0%) and the State of Santa Catarina (6.1%) (Secretaria de Estado da Saúde 2003).

The prevalence of gingival bleeding (95.8%) was in agreement with data found in the literature (Desanayake 1998, Offenbacher et al. 2001, Lopez et al. 2002b), where almost all of the pregnant women presented bleeding after probing.

The low proportion of parturients who presented deep periodontal pockets (5.1%) was very close to figures obtained in studies carried out (Loe

Table 3. Association between periodontal disease in pregnant women (periodontal pocket at one or more sites) and prematurity

Model	OR (95% CI)	*p*
1	2.4 (1.1–5.6)	0.03
2	2.5 (1.1–4.9)	0.04
3	2.3 (1.0–5.2)	0.05
4	2.4 (1.0–6.0)	0.05
5	2.6 (1.0–6.5)	0.04
6	2.6 (1.0–6.9)	0.05
7	2.5 (0.9–6.7)	0.07
8	2.2 (0.8–6.1)	0.12
9	2.2 (0.8–6.3)	0.12
10	2.2 (0.8–6.3)	0.13

Logistic regression analysis. Unadjusted and adjusted models.
1, crude: PD; 2, PD adj for schooling; 3, PD adj for sch+parity; 4, PD adj for sch+parity+LBW children; 5, PD adj for sch+parity+LBW children+BMI; 6, PD adj for sch+parity+LBW children+BMI+pre-n cons; 7, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec; 8, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+ Incr. AP; 9, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+Incr. AP+dental treatment; 10, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+Incr. AP+dental treatment+oral health guidance.
OR, odd's ratio; CI, confidence interval; PD, periodontal disease; adj; adujusted; sch, schooling; LBW, low birth weight; BMI, body mass index; pre-n cons, pre-natal consultations; GUT infec, genitourinary tract infection; Incr. AP, increased arterial pressure.

Table 4. Association between periodontal disease in pregnant women (periodontal pocket at four or more sites) and prematurity

Model	OR (95% CI)	*p*
1	3.0 (1.2–7.5)	0.02
2	3.1 (1.2–7.9)	0.02
3	2.9 (1.1–7.6)	0.03
4	2.8 (1.0–7.7)	0.05
5	2.8 (1.0–7.8)	0.05
6	3.3 (1.1–10.1)	0.04
7	2.9 (0.9–9.3)	0.06
8	2.3 (0.7–7.7)	0.18
9	2.7 (0.7–9.8)	0.13
10	2.7 (0.7–9.7)	0.13

Logistic regression analysis. Unadjusted and adjusted models.
1, crude: PD; 2, PD adj for schooling; 3, PD adj for sch+parity; 4, PD adj for sch+parity+LBW children; 5, PD adj for sch+parity+LBW children+BMI; 6, PD adj for sch+parity+LBW children+BMI+pre-n cons; 7, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec; 8, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+ Incr. AP; 9, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+Incr. AP+dental treatment; 10, PD adj for sch+parity+LBW children+BMI+pre-n cons+GUT infec+Incr. AP+dental treatment+oral health guidance.
OR, odd's ratio; CI, confidence interval; PD, periodontal disease; adj; adujusted; sch, schooling; LBW, low birth weight; BMI, body mass index; pre-n cons, pre-natal consultations; GUT infec, genitourinary tract infection; Incr. AP, increased arterial pressure.

et al. 1986, Mitchell-Lewis 2001, Offenbacher et al. 2001, Lopez et al. 2002b) with adults and pregnant women.

Our study is the only population-based investigation performed in an underdeveloped country that tested the hypothesis of an association between parturients with indexes for the presence of periodontal pockets during gestation, compared with parturients without periodontal pockets, and premature and/or low birth weight new-borns. The sample size and the quality control in the data collection conferred internal validity to the study. Furthermore, our results can be extrapolated to the pregnant women of Itajaí, since the HMMKB is the only maternity hospital in the municipality, and the proportion of hospital births exceeds 99% (Secretaria de Estado da Saúde 2003). The response rate was high (97.3%) and the number of refusals from women staying in individual rooms (nine), indicative of higher income, was greater than that in public wards (three), indicative of lower income. In fact, the proportion of refusals was very low (2.6%) and did not compromise the results. It is very unlikely that there were lapses of memory. The parturients demonstrated clear recollection of the episodes occurring during their pregnancies, including their anthropometric characteristics, probably because of the high level of pre-natal monitoring. In addition, the medical information of interest was collected from the medical records of the parturients.

The methods used in this study and in others that attempted to test the same hypotheses were different, from the form of diagnosis of periodontal disease to the categorization of the outcome (low birth weight, prematurity or premature and low birth weight). For example, Offenbacher et al. (1996) categorized the levels of periodontal disease into extent and severity, with the extent being related to the depth of probing and the severity to the loss of insertion. Offenbacher et al. (2001) defined severe periodontal disease for women with four or more sites 5 mm or more in probing depth, and 2 mm of loss of attachment in four or more sites, while Desanayake (1998) used the CPITN and performed unadjusted statistical analyses for cases and controls. The option of using CPITN did not appear appropriate as it is recommended for the estimation of treatment needs and can underestimate the prevalence of bleeding and periodontal pockets, by promoting the recording of the worst situation found in each sextant.

Cross-sectional studies such as this do not present the best design when one wishes to test aetiological hypotheses. From a clearly methodological point of view, it would be most appropriate to carry out a randomized interventional study, although the current one is a design that may present ethical problems for testing aetiological hypothesis.

This investigation used methods similar to the ones in the study by López et al. (2002b) mainly in relation to the diagnosis of periodontal disease; however, the aim of these authors was to perform a prospective intervention study. Papapanou (1996) and Armitage (2001) warned of these difficulties and demanded standardized methodologies in studies in periodontology to enable comparative analyses.

In our study, the results of the unconditioned multiple logistic regression analysis for prematurity demonstrated a statistically significant association with parturients with indexes of periodontal pockets during gestation and parturients with indexes of four or more sites with periodontal pockets. These associations, before adjusting for other risk factors for prematurity, presented OR values similar to those found by Offenbacher et al. (1996) and Desanayake (1998).

There was no association between parturients with indexes of periodontal pockets during gestation, independent of the number of sites affected, and newborns of low birth weight. These results differed from the findings of Offenbacher et al. (1996), Desanayake (1998), Offenbacher et al. (1998, 2001) and López et al. (2002b) and match those of Mitchell-Lewis et al. (2001) and Davenport (2002). The control of confounding factors was cited by these authors, although it was not presented in a clear form in their studies. This may have been the most significant difference in terms of the discrepancies found, besides the population differ-

Table 5. Association between LBW and/or prematurity and periodontal condition, biological, socio-economic and behavioural variables in pregnant women (Itajai, Santa Catarina, Brazil, 2003)

Variable/categories	LBW and/or prematurity, *n* (%)	Adequate weight and term, *n* (%)	χ^2	*p*
Ethnicity				
White	36 (8.7)	380 (91.3)	0.000	0.932
Black	319 (9.1)	30 (90.9)		
Income per capita (*MW*)				
>2	5 (3.3)	146 (96.7)	8.318	0.016
1–2	14 (11.1)	128 (88.9)		
<1	18 (11.7)	136 (88.3)		
Mother schooling (*years*)				
>8	16 (9.4)	154 (90.6)	0.182	0.670
⩽8	23 (8.2)	256 (91.8)		
Body mass index				
>18.5	32 (8.0)	370 (92.0)	4.400	0.036
⩽18.5	7 (17.9)	32 (82.1)		
Parity				
Multiparous	29 (10.5)	248 (89.5)	2.899	0.089
Primiparous	10 (5.8)	162 (94.2)		
Previous children with LBW				
No	21 (5.1)	394 (94.9)	90.834	<0.001
Yes	18 (52.9)	16 (47.1)		
Smoked during pregnancy				
No	32 (8.0)	366 (92.0)	1.842	0.175
Yes	7 (13.7)	44 (86.3)		
Pre-natal consultations				
>6	12 (3.9)	298 (96.1)	29.270	<0.001
⩽6	27 (19.4)	112 (80.6)		
Vaginal bleeding				
No	10 (11.4)	78 (88.6)	0.989	0.320
Yes	29 (8.0)	332 (92.0)		
Urinary tract infection				
No	18 (7.2)	233 (92.9)	1.646	0.199
Yes	21 (10.6)	177 (89.4)		
Other infections				
No	2 (20.0)	8 (80.0)	1.651	0.199
Yes	37 (8.4)	402 (91.6)		
Increased arterial pressure				
No	29 (7.5)	360 (92.5)	5.561	0.018
Yes	10 (16.7)	50 (83.3)		
Dental treatment in pregnancy				
No	2 (3.3)	58 (96.7)	2.516	0.113
Yes	37 (9.5)	351 (90.5)		
Oral health guidance during pregnancy				
Yes	9 (4.8)	180 (95.2)	6.337	0.012
No	30 (11.5)	230 (88.5)		
Child's sex				
Female	17 (8.1)	194 (91.9)	0.199	0.656
Male	22 (9.2)	216 (90.8)		
Periodontal pocket				
No	10 (5.1)	185 (94.9)	5.501	0.019
Yes	20 (11.4)	225 (88.6)		
Periodontal pocket				
No	10 (5.1)	185 (94.9)	5.978	0.014
⩾4 sites	14 (13.1)	83 (86.9)		
Maternal age (*years*)				
>19	30 (8.7)	316 (91.3)	0.000	0.983
⩽19	9 (8.7)	94 (91.3)		

MW, minimum wages; LBW, low birth weight.

ences and those in diagnostic methods. The lack of statistical significance between parturients with indexes of periodontal pockets during pregnancy and new-borns of low birth weight and the decrease in the statistical significance after the inclusion of possible confounding variables strongly support the influence of other risk factors for low birth weight.

The possibility of premature births occurring influenced by the presence of infections of the membrane and of the amniotic fluid was described and discussed by Romero & Mazor (1998), not only in terms of the possible presence of microorganisms but also immune protection factors.

In the multivariate analysis for prematurity, the association lost its statistical significance when controlled for infections of the genitourinary tract and an increase in the arterial pressure of the parturients, and this was independent of the number of sites with periodontal pockets. Such a finding reconfirms the importance of rigorous control in the recording of infectious diseases and other insults in pregnant women, for the appropriate adjustment of these confounding factors.

Our study presents some limitations. We did not collect women's smoking status before the pregnancy, which could explain why smoking, a well-known risk factor for prematurity and low birth weight, was not associated with the outcomes studied. In addition, we did not investigate whether the delivery was spontaneous or induced. In addition, we combined shallow and deep periodontal pockets to perform statistical analysis, while the best option to test our hypothesis could include only deep pocket as a marker of more aggressive periodontal disease.

Although there have been unquestionable technological advances in diagnosis and treatment in the pre-natal period, and studies to identify the risk factors for prematurity and low birth weight are numerous, the incidence of these adverse events has not decreased in decades (Armitage 2001).

With regard to the hypothesis examined and the data presented, it can be concluded that parturients who had indexes for the presentation of periodontal pockets during pregnancy, independent of their severity, were not associated with low birth weight children. The same hypothesis, when related to premature new-borns, presented a statistically significant association until known risk factors related to maternal health were included. After this inclusion, no association was identified between periodontal disease in these women and prematurity, reinforcing the influence of the confounding factors highlighted in this study.

The hypothesis regarding the existence of a possible association between

Table 6. Association between periodontal disease in pregnant women (at least one site with periodontal pocket) and LBW and/or prematurity

Model	OR (95% CI)	*p*
1	2.4 (1.1–5.0)	0.022
2	2.2 (0.9–5.1)	0.053
3	2.2 (1.0–5.1)	0.053
4	2.2 (1.0–5.0)	0.062
5	2.1 (0.9–4.8)	0.078
6	2.0 (0.9–4.7)	0.096
7	2.1 (0.9–5.0)	0.078
8	2.2 (0.9–5.1)	0.074
9	2.2 (0.9–5.1)	0.073
10	2.2 (0.9–5.1)	0.074
11	2.1 (0.9–5.0).	0.082
12	2.0 (0.8–4.8)	0.116

Logistic regression analysis. Unadjusted and adjusted models.
1, crude: PD; 2, PD adjusted for previous LBW children; 3, PD adjusted LBW+pre-natal consultation; 4, PD adjusted for LBW+pre-natal consultation+oral guidance in the pregnancy; 5, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita; 6, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure; 7, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index; 8, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity; 9, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy; 10, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy; 11, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy+urinary tract infection; 12, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy+urinary tract infection+other infection.
OR, odd's ratio; CI, confidence interval; PD, periodontal disease; LBW, low birth weight.

Table 7. Association between periodontal disease in pregnant women (periodontal pocket at four or more sites) and LBW and/or prematurity

Model	OR (95% CI)	*p*
1	2.8 (1.2–6.5)	0.018
2	2.3 (0.9–5.7)	0.072
3	2.3 (0.9–5.7)	0.072
4	2.2 (0.9–5.4)	0.084
5	1.9 (0.8–4.9)	0.169
6	1.7 (0.6–4.4)	0.296
7	1.7 (0.6–4.6)	0.282
8	1.7 (0.6–4.7)	0.277
9	1.9 (0.7–5.2)	0.218
10	1.9 (0.7–5.2)	0.218
11	1.7 (0.6–4.9)	0.291
12	1.5 (0.5–4.4)	0.430

Logistic regression analysis. Unadjusted and adjusted models.
1, crude: PD; 2, PD adjusted for previous LBW children; 3, PD adjusted LBW+pre-natal consultation; 4, PD adjusted for LBW+pre-natal consultation+oral guidance in the pregnancy; 5, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita; 6, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure; 7, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index; 8, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity; 9, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy; 10, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy; 11, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy+urinary tract infection; 12, PD adjusted for LBW+pre-natal consultations+oral guidance in the pregnancy+income per capita+increased arterial pressure+body mass index+parity+dental treatment in the pregnancy+smoking in the pregnancy+urinary tract infection+other infection.
OR, odd's ratio; CI, confidence interval; PD, periodontal disease; LBW, low birth weight.

the presence of periodontal disease in pregnant women and the birth of premature babies, as well as those of low birth weight, was rejected by this study.

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