The Association between Maternal Oral Health Experiences and Risk of Preterm Birth in 10 States, Pregnancy Risk Assessment Monitoring System, 2004–2006

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Abstract

The aim of this study is to investigate the association between oral health experiences of women in the peripartum period and the risk of preterm delivery (<37 weeks). We analyzed 2004–2006 data from the CDC Pregnancy Risk Assessment Monitoring System (PRAMS), a population-based surveillance system that collects data on pregnancy and postpartum experiences of mothers who have recently delivered a live infant. Ten states included in the analysis had a 70% weighted response rate and three standard questions pertaining to oral health. White non-Hispanic (WNH), Black non-Hispanic (BNH), and Hispanic women were selected for analysis. Chi-squared analysis was performed for our bivariate analysis and multivariate logistic regression models were created to calculate adjusted odds ratios, controlling for socio-demographic characteristics and peripartum morbidities. Weighted percentages and standard errors were used for all analyses. Among the 35,267 women studied, in the multivariate analysis, mothers who did not receive dental care during pregnancy and did not have a teeth cleaning during pregnancy were at higher risk for delivering a preterm infant (OR 1.15, CI 1.02–1.30; OR 1.23, CI 1.08–1.41). In this population-based study, women who did not receive dental care or have a teeth cleaning during pregnancy were at slightly higher risk for preterm delivery after adjustment for pertinent confounders.

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Keywords

Maternal oral health; Preterm birth; Dental care during pregnancy

Introduction

Improving the oral health of the US population has become a major public health issue. Recent studies have demonstrated that overall health cannot be achieved without oral health. For instance, periodontal disease has been implicated in the increased risk for coronary artery disease and stroke [1–3]. For pregnant women, achieving and maintaining periodontal health also has additional implications for pregnancy outcome. Periodontal disease has been shown in some studies to contribute to a higher risk of preterm birth. The Oral Conditions and Pregnancy (OCAP) Study, a prospective observational study, has shown that maternal periodontal disease and disease progression during pregnancy conferred a significant increased risk for preterm delivery [4, 5]. The proposed mechanism involves the up-regulation of inflammatory markers in the mother as well as the fetus secondary to oral infection [6]. Infection and inflammation have been shown to be important risk factors in causing preterm birth [7]. However, significant controversy still exists; the most recent clinical trials which treated pregnant women with periodontal disease during their second trimester has shown no difference in rates of preterm birth when compared to untreated mothers [8–10]. In these clinical trials, treatment took place in the second trimester, perhaps too late to reverse the lifelong exposure of poor oral health experienced by some pregnant women, thus offering some explanation for the discrepancy in results from longitudinal cohort studies and randomized clinical trials. Instead of treating active oral infection during pregnancy to prevent preterm birth, the maintenance of oral health to prevent disease before and during pregnancy may yield more significant results. This argument receives support from a recently published population-based study by Albert et al. [11] in which, women who received preventive dental care during the study's period of observation, which included the time period prior to delivery, were less likely to deliver preterm or low birth weight infants. This study, however, included only privately insured women of mid to high socioeconomic status. Given that privately insured individuals are more likely to receive preventive dental services [12], the positive effect of dental care during pregnancy in potentially improving birth outcomes may have been biased toward the null given that these women may already have had optimal dental health.

In this report, we assess the association of maternal oral health experiences and the risk of preterm delivery in a population-based multi-state cohort of mothers of varying insurance and socioeconomic status.

Materials and Methods

Sample and Data

As outlined in our prior study [13], we analyzed data from the 2004–2006 (Phase 5) PRAMS, a population-based surveillance system that collects data on pregnancy and postpartum experiences of mothers who have recently delivered a live infant. Participating

states sample between 1,300 and 3,400 women per year from their birth certificate files. Selected women are first contacted by mail and if there is no response to repeated mailings, women are contacted and interviewed by telephone. Additional details regarding the data collection process have been described elsewhere [14.]

Maternal Oral Health Experiences

The introduction of oral health questions in the PRAMS survey occurred in 1996 at the suggestion of the CDC's Division of Oral Health because of the lack of information on dental care utilization during pregnancy, concern for the increased risk for oral diseases during pregnancy, the transmission of pathogenic oral flora from mother to infant, and the association of maternal periodontitis and preterm birth.

States that included the three questions pertaining to oral health (Table 1) and had a 70% or more weighted response rate were included in the analysis (Alaska, Arkansas, Maine, Michigan, Mississippi, Nebraska, New York, Ohio, South Carolina, and Utah).

Preterm Birth

Our outcome of interest was preterm birth which was defined as delivery at less than 37 0/7 weeks gestation based upon birth certificate data that was linked to the maternal response to the PRAMS questionnaire. Since the reasons for delivery, i.e. indicated versus spontaneous preterm delivery, were not available, all preterm births were included in the analysis.

Maternal Characteristics

Several variables assessing maternal demographic characteristics were included in our analysis. We selected these variables based upon previously studied socio-demographic factors that predicted dental care utilization [15, 16] that have also been shown to be associated with preterm delivery [7, 17.] Age at delivery was divided into three groups of interest (<20, 20–34, and 35) based upon risk of preterm birth, with women less than 20 and greater than 35 years of age bearing the greatest risk for premature delivery. Our cohort consisted of white non-Hispanic (WNH), black non-Hispanic (BNH), and Hispanic women. Women from other racial and ethnic groups were excluded due to insufficient sample size. Maternal education was categorized based on completed years of school (0–8, 9–11, 12, 13–15, 16+ years). Annual household income was classified into five categories (<$10,000, $10–19,999, $20–34,999, $35–49,999, and >$50,000). Health insurance status before pregnancy was coded as private, Medicaid, or uninsured. For women who chose both Medicaid and another source of payment, they were assigned to the Medicaid insurance group. The timing of the first prenatal visit along with the total number of prenatal visits obtained from birth certificate records were used to calculate the Adequacy of Prenatal Care Utilization Index [18.]

A recent analysis investigating the effect of tobacco smoke on the oral health of US women of childbearing age concluded that smoking was a significant independent risk factor for untreated dental caries and periodontal disease [19]. Women who smoke during pregnancy have also been shown to bear increased risk for preterm birth [7, 17], so we included maternal smoking status in the analysis. As outlined by earlier work, maternal tobacco use

during pregnancy was included in our analysis as follows: if women responded "yes" on the birth certificate to being a smoker or "yes" to smoking any number of cigarettes during the last 3 months of pregnancy on the PRAMS questionnaire, they were considered to be smokers [20]. Women who answered "no" to both of the above questions, or answered "no" to one question but provided no answer for another, were considered to be non-smokers.

The following peri-partum morbidities which have been implicated in the increased risk for preterm delivery were also included in our analysis: (a) diabetes that started before and/or during this most recent pregnancy, (b) hypertension including pregnancy induced hypertension, (c) placental problems such as placental abruption or previa, and (d) kidney/bladder infections. We also controlled for multiple gestation given the increased risk for preterm birth.

Statistical Analysis

In order to accommodate the complex survey design of PRAMS, we used SAS version 9.1 with proc survey procedures to calculate weighted percentages and standard errors to correct for oversampling. Our outcome of interest was preterm birth defined as birth at less than 37 weeks gestation. Chi-square analysis was performed to assess for bivariate associations of each maternal oral health experience and preterm delivery. Multivariate logistic regression was performed to obtain adjusted odds ratios for the association of each maternal oral health experience and preterm birth, controlling for all maternal and infant socio-demographic variables mentioned earlier, which have been shown to be associated with oral health and preterm birth. The relative contributions of each variable included in the two models that assessed the association of preterm birth and a dental visit during pregnancy and dental cleaning during pregnancy were calculated as follows: (a) the difference between the likelihood ratio (LR) of the full model and the model without the variable of interest was calculated; (b) this difference was then divided by the sum of the differences between the LR of the full model and the models excluding each variable; (c) this value was then multiplied by 100 to yield a percentage. We excluded responses coded as "missing", "blank", or "don't know" from the analyses. Approval from the Center for Disease Control and Prevention as well as exemption from the Institutional Review Board of Beth Israel Deaconess Medical Center was obtained for this data analysis.

Results

Maternal Characteristics

The initial PRAMS sample of women totaled 41,321. Inclusion of only WNH, BNH, and Hispanic women who had answered the first two parts of the oral health questions yielded 35,267 women for analysis (Fig. 1). Table 2 lists the descriptive characteristics of the cohort. The majority of the sampled women were WNH, 20–34 years old, with 12 or more years of education, private health insurance, and adequate to adequate plus prenatal care. The majority of women reported that they did not smoke during pregnancy. Less than 2% of women reported having diabetes before pregnancy and 9% during pregnancy. Nearly 14% of women reported having hypertension before and/or during pregnancy, 21% had kidney or bladder infections, and 5% of women had placental problems.

Infant Characteristics

Table 3 lists the descriptive characteristics of the infants. Only 9% of infants were born preterm (less than 37 weeks) and 7% weighed less than 2,500 g.

Maternal Oral Health Experiences

Table 4 lists the oral health experiences of the study cohort. Of note, only 41% of all women received dental counseling during pregnancy. In addition, while the majority of women had a teeth cleaning before pregnancy, only 33–40% of mothers had a cleaning during or after pregnancy.

Bivariate Analyses

In the bivariate analyses (Table 5), when compared to women who delivered term infants, women who delivered prematurely were less likely to receive dental care during pregnancy as well less likely to receive a teeth cleaning before and during pregnancy. There was no difference between the two groups of mothers in terms of having a tooth problem during pregnancy, receiving dental counseling, or ever having a teeth cleaning.

Multivariate Analyses

In the multivariate analyses (Table 6), after adjusting for the maternal characteristics listed in Table 2, women who did not receive dental care during pregnancy were at slightly higher risk for delivering a premature infant when compared to women who did receive dental care, OR 1.15, 95% CI 1.02–1.30. In other words, women who did not receive dental care were 15% more likely to experience preterm delivery. In addition, when compared to women who received a teeth cleaning during pregnancy, women who did not receive a cleaning, were at higher risk for premature birth. There was no difference in the risk of preterm birth among women who had a tooth problem during pregnancy compared to those who did not have a problem. Moreover, women who did not receive dental counseling, did not ever have a teeth cleaning, and did not have a cleaning before pregnancy did not have an increased risk for preterm delivery when compared to their counterparts.

We also compared the risk for preterm delivery for women with dental problems who did or did not seek care during pregnancy and found that those who did not seek dental care were at slightly higher risk for preterm birth (OR 1.28; 95% CI 1.02–1.59).

Relative Contributions

The relative contributions of each variable in our analyses are shown in Tables 7 and 8. For both models, the largest contributors to the risk of preterm birth were multiple gestation and inadequate, intermediate, and adequate plus prenatal care. Of note, in our model assessing the association of preterm birth and teeth cleaning during pregnancy, teeth cleaning contributed 8.3% of the risk to preterm birth which was greater than placental problems or high blood pressure.

Discussion

In this population-based study, we found that women who did not receive dental care or have a teeth cleaning during pregnancy were at slightly higher risk for preterm birth after controlling for pertinent confounders. Given that routine dental care is important in the prevention and treatment of dental caries, gingivitis, and periodontal disease, and periodontal disease has been associated with preterm birth, achieving and maintaining oral health during pregnancy may play an important role in ensuring positive birth outcomes. Dental health may require even greater attention during pregnancy as the potential for gingival inflammation is at its peak due to hormonal changes and subsequent changes in oral flora [21]. Untreated dental disease can lead to infection and inflammation, which have been implicated as significant contributors to preterm birth. Indeed the OCAP investigators have demonstrated that the fetus does mount an inflammatory response to maternal oral infection [6].

Given the association between dental care during pregnancy and preterm birth, it has been disappointing that the clinical trials of treating women with periodontal disease during pregnancy have not shown improvement in preterm birth rates. Although clinical trials have not shown benefit, we would argue that providing dental care to women of childbearing age should remain a priority for a number of reasons. First, the causes of preterm birth are not clearly understood and it is widely accepted that the etiology is multi-factorial, encompassing biologic, socio-demographic, behavioral and genetic factors [17]. Prior studies which addressed only one possible cause of preterm birth have not demonstrated reductions in incidence. For instance, the clinical trials where pregnant women with periodontal disease were treated during the second trimester can be likened to the treatment of bacterial vaginosis during pregnancy. Bacterial vaginosis has also been associated with an increased risk of preterm birth in cohort studies but clinical trials where affected women were treated showed no improvement in preterm birth rates [22, 23]. In addition, expecting reductions in preterm birth rates through providing dental care to all pregnant women without addressing the other risk factors for preterm birth would be native given the lack of improvement in national preterm birth rates with the large scale effort to provide comprehensive prenatal care to the majority of pregnant women. It, therefore, is obvious that a multifaceted approach, targeting a number of risk factors of which oral health is one, is needed to effectively address the problem of preterm birth. Our calculation of the relative contribution of teeth cleaning during pregnancy with respect to other risk factors for preterm birth suggests that it may be necessary to include preventive dental care as part of routine prenatal care.

A second reason to include dental care in multi-disciplinary efforts to reduce preterm birth rates is the modifiability of women's oral health practices. While addressing the socio-demographic risk factors for preterm birth such as race/ethnicity, income, and education and their resultant health inequities may take a much longer time, increasing awareness of the importance of oral health during pregnancy and ensuring access to dental services for all pregnant women is achievable with a reasonable amount of resources and time. In Oregon, a community-based intervention was successful in providing a dental home for pregnant women insured by Medicaid. Prior to the initiation of the program, only 8.8% of pregnant

women covered by Medicaid received dental care. However, between 2004 and 2006, the years of the initiative, almost 56% of eligible women received dental care [24]. New York State and more recently California convened experts from dentistry and obstetrics to develop a comprehensive set of guidelines for ensuring the oral health of women during pregnancy [25, 26]. In addition, from 2000 to 2005, the Medicaid programs from these states offered full dental coverage unlike the majority of states which offered limited, emergency, or no dental services [27].

Finally, ensuring access to dental services not just during pregnancy but also prior to conception offers an additional opportunity to engage women of childbearing age in health promoting behaviors. As outlined by the Centers for Disease Control and Prevention in their report entitled *Recommendations to Improve Preconception Health and Health Care*, achieving health prior to conception can improve outcomes for both the mother and the infant [28]. Preconception risk assessment along with health education by primary care providers is recommended for a number of areas including oral health. Initiating dental care during pregnancy may not be early enough to achieve the degree of oral health needed to reap the clinical benefits for the mother and infant.

Our study has several limitations related to the retrospective cross-sectional study design. Given that mothers are surveyed 2–4 months post-partum, recall bias could lead to reporting of inaccurate information. Moreover, since maternal information is collected via mail and telephone, clinical data from medical records or examinations are not available. Thus the clinical oral health status of women in the peripartum period can only be inferred from their report of a problem. For instance, periodontal disease cannot be distinguished from other types of dental problems. Also, for women who reported that they went to the dentist during pregnancy, it is unclear what type of dental care they actually received. Furthermore, given that many dental problems such as caries and periodontal disease in their early stages are often asymptomatic, there may be an underestimation and under-reporting of dental problems in both comparison groups, resulting in bias to the null. However, recent studies have shown that self-reported oral health measures demonstrate sufficient concordance with clinical assessments and therefore are useful tools in oral health surveillance [29, 30]. An additional limitation is the lack of detail regarding the reason for premature delivery; the PRAMS dataset does not distinguish indicated from spontaneous preterm births.

A major strength of this study is that the women surveyed by PRAMS are a population-based sample. PRAMS states maintain high response rates, greater than 70%. Moreover, due to the extensive information collected by PRAMS, we were able to control for a number of important confounders. This is the first study that assesses the effect of maternal oral health experiences on birth outcomes of women in varying socioeconomic status on a multi-state population level.

In conclusion, our study found that women who did not receive dental care during pregnancy or did not have a teeth cleaning during pregnancy were at slightly higher risk for preterm delivery. Given that the cause of preterm birth is multi-factorial and that no single intervention has been proven effective in reducing the rates of preterm delivery, a multi-faceted approach addressing a number of significant risk factors will need to be undertaken.

The findings from this study as well as other cross-sectional and cohort studies demonstrate the contribution of poor oral health practices to adverse birth outcomes and thus, preventive and therapeutic dental care should be an essential component of preconception and prenatal care. This life-course approach should be the basis for providing adequate dental screening and treatment of all women.

Acknowledgments

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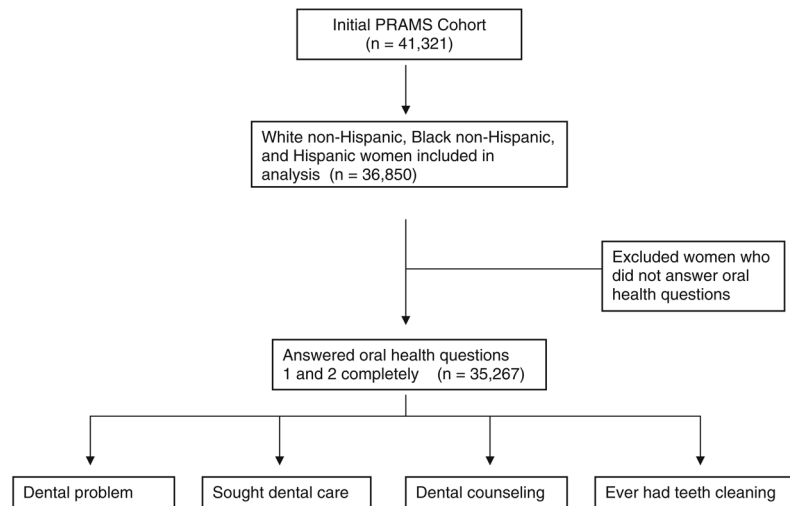
Fig. 1.
Participant inclusion flow diagram

Table 1

PRAMS oral health questions

1	This question is about the care of your teeth during your most recent pregnancy. For each item, circle Y (Yes) if it is true or circle N (No) if it is not true.
	a. I needed to see a dentist for a problem.
	b. I went to a dentist or dental clinic.
	c. A dental or other health care worker talked with me about how to care for my teeth and gums.
2	Have you ever had your teeth cleaned by a dentist or dental hygienist?
3	When did you have your teeth cleaned by a dentist or dental hygienist? For each of the three time periods, circle Y (Yes) if you had your teeth cleaned then or circle N (No) if you did not have your teeth cleaned then.
	a. Before my most recent pregnancy.
	b. During my most recent pregnancy.
	c. After my most recent pregnancy.

Table 2

Characteristics of study cohort

	Weighted %	SE
Race		
WNH	79.12	0.36
BNH	13.60	0.30
Hispanic	7.28	0.25
Age (years)		
< 20	8.59	0.27
20–34	78.01	0.40
35	13.40	0.33
Education (years)		
0–8	2.46	0.16
9–11	12.12	0.32
12	29.58	0.43
13–15	27.33	0.41
16	28.51	0.41
Annual Income		
< $10,000	18.69	0.37
$10–19,999	15.92	0.35
$20–34,999	18.25	0.36
$35–49,999	12.15	0.30
> $50,000	34.99	0.44
Insurance before pregnancy		
Private	61.58	0.45
Medicaid	13.99	0.34
Uninsured	24.43	0.40
Adequacy of prenatal care index		
Inadequate	8.83	0.27
Intermediate	11.51	0.31
Adequate	46.69	0.47
Adequate plus	32.97	0.44
Smoking during pregnancy	18.30	0.38
Diabetes before pregnancy	1.81	0.12
Diabetes during pregnancy	8.99	0.27
Hypertension (before/during pregnancy)	13.64	0.31
Kidney/bladder infection	20.70	0.38
Placental problems	4.97	0.20

Table 3

Infant characteristics

	Weighted %	SE
Gestational age: < 37 weeks	9.07	0.21
Birthweight: < 2,500 grams	6.86	0.06
Plurality: twins or more	1.68	0.08
NICU admission	10.38	0.25

Table 4

Oral health experiences of study cohort

	Weighted %	SE
Tooth problem during pregnancy	26.35	0.41
Sought dental care during pregnancy	44.21	0.47
Received dental counseling during pregnancy	41.16	0.46
Ever had teeth cleaning	94.25	0.21
Teeth cleaning before pregnancy	80.94	0.38
Teeth cleaning during pregnancy	39.96	0.48
Teeth cleaning after pregnancy	33.31	0.47

Table 5

Bivariate analysis: preterm birth and maternal oral health practices

	37 Weeks weighted %	< 37 Weeks weighted %	P-value
Teeth problem	26.17	28.24	0.073
Went for care	44.70	39.34	**<0.0001**
Dental counseling	41.36	39.23	0.099
Teeth clean-ever	94.28	93.93	0.530
Teeth clean-bef	81.13	79.11	**0.048**
Teeth clean-dur	40.65	32.98	**<0.0001**

Significance for *P*-values was 0.05

Table 6

Adjusted odds ratio and 95% confidence interval

	Preterm birth
Teeth problem	1.00 (0.87–1.14)
Did not seek care	**1.15 (1.02–1.30)**
Did not receive dental counseling	1.06 (0.94–1.20)
No teeth clean—ever	0.96 (0.77–1.20)
No teeth clean—before	1.09 (0.94–1.27)
No teeth clean—during	**1.23 (1.08–1.41)**

Significance for *P*-values was 0.05

*
Adjusted for age, income, education, insurance status before pregnancy, adequacy of prenatal care, smoking, multiple gestation, maternal morbidities: diabetes, hypertension, placental problems, kidney/bladder infections

Table 7

Relative contributions for model assessing the association of dental care during pregnancy and preterm birth

Variable	Relative contribution (%)
Dental care during pregnancy	< 1
Age	< 1
Race	2.7
Income	< 1
Maternal education	< 1
Insurance	< 1
Smoking	< 1
Multiples	26.9
Diabetes before or during pregnancy	< 1
Kidney/bladder infection	< 1
Placental problems	8.2
Blood pressure	5.1
Inadequate, intermediate, adequate plus PNC	54.7

Table 8

Relative contributions for model assessing the association of teeth cleaning during pregnancy and preterm birth

Variable	Relative contribution (%)
Teeth cleaning during pregnancy	8.3
Age	< 1
Race	3.0
Income	< 1
Maternal education	< 1
Insurance	< 1
Smoking	< 1
Multiples	24.9
Diabetes before or during pregnancy	< 1
Kidney/bladder infection	< 1
Placental problems	7.9
Blood pressure	4.5
Inadequate, intermediate, adequate plus PNC	49.1