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Parity & Untreated Dental Caries in US Women

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ABSTRACT

While parity (number of children) reportedly is related to tooth loss, the relationship between parity and dental caries has not been extensively investigated. We used path analysis to test a theoretical model that specified that parity influences dental caries levels through dental care, psychosocial factors, and dental health damaging behaviors in 2635 women selected from the NHANES III dataset. We found that while increased parity was not associated with a greater level of total caries (DFS), parity was related to untreated dental caries (DS). The mechanisms by which parity is related to caries, however, remain undefined. Further investigation is warranted to determine if disparities in dental caries among women are due to differences in parity and the likely changes that parallel these reproductive choices.

KEY WORDS: parity, dental caries, health disparities, path analysis.

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INTRODUCTION

There is a widely held belief among women that childbearing is related to oral disease (Habashneh *et al*., 2005; Payscale.com, 2007; Yahoo, 2010). Indeed, several studies over the last decade have shown that parity (number of children) is related to tooth loss (Rundgren and Osterberg, 1987; Halling and Bengtsson, 1989; Christensen *et al*., 1998; Russell *et al*., 2008), but the reason for this relationship is unclear. Few studies have examined whether parity is related to dental caries (Walker *et al*., 1983; Scheutz *et al*., 2002), a prerequisite to tooth loss. The purpose of this study was to determine whether parity is related to dental caries, and to examine whether this relationship can be explained by the effect of parity on socio-behavioral variables related to dental caries.

METHODS

Study Population and Sample Selection

We used data from the Third National Health and Nutrition Examination Survey (NHANES III, 1988-1994). Of 7073 Black and White non-Hispanic women aged 18-64 yrs, we included women who (1) had received a dental examination, (2) retained at least one tooth, (3) reported at least one pregnancy, and (4) were not missing parity or socio-economic status (SES—income, education, occupation) data. Of the 6501 White and Black women who received a dental examination, 95.2% (6186/6501) retained at least one tooth. Of these, 18.9% (1172/6501) reported no pregnancies, and 9.6% (593/6501) were missing data on SES or parity (number of live births). Since the aim of this analysis was to identify pathways by which parity affects dental caries, we excluded those with multiple missing explanatory variables (1786/4421), and our analysis therefore included 60.0% of the eligible women (2635/4421). The Institutional Review Boards of New York and Yale Universities approved this study.

Theoretical Model

Our theoretical model of the parity-caries relationship was adapted from that of Adler *et al.* (1993), who suggested that socio-economic status (SES) may affect health through three pathways: (1) health care, (2) psychosocial factors, and (3) health behaviors. We hypothesized that parity (which is closely related to SES) would influence dental caries through: (1) dental health care, (2) psychosocial factors, and (3) dental-health-damaging behaviors. (See online Appendix for theoretical model.)

Measurements

Tooth surfaces were scored as sound, decayed, missing, or filled according to the DMFS Index (USDHHS, 1998). Dental caries was expressed as the proportion of surfaces/total examined surfaces, and included: (1) cumulative caries experience (DFS), (2) the proportion of filled surfaces (FS), and (3) the proportion of decayed surfaces (DS).

All women were asked: "What is the total number of live births (live-born children) you have had?" SES included: (1) the poverty income ratio (PIR), (2) education (years of school), and (3) occupation [Duncan Socioeconomic Index (SEI), a measure of occupational prestige]. Dental care included dental insurance (covered by health insurance paying for dental care) and frequency of dental visits. We included two measures of psychosocial status: financial stress and social support. Women reporting one or more days during the previous month with no food/money for food were considered to have financial stress. Social support was measured with six questions exploring frequency of social contacts, attendance at church/meetings, and club memberships. Dental-health-damaging behaviors included smoking, which included (1) self-reported smoking, (2) number of cigarettes smoked/day, and (3) serum cotinine level, and cariogenic diet, which combined a monthly consumption of four groups of cariogenic foods [cakes/cookies, chocolate candy, sugared beverages (*e.g.*, Kool-Aid®), and sugared sodas]. Age, marital status (yes/no), time since last live birth (yrs), and race were included in all models.

Statistical Analysis

We created summated standardized scales for SES, smoking, and age/time since last live birth, to maximize use of the available data and avoid collinearity for modeling. To create scales, we examined correlations between items, standardized the items, and examined Cronbach-α reliabilities. We then stratified by parity, and by SES, and conducted univariate and bivariate analyses using ANOVA or the Kruskal-Wallis test. Since we found that many respondents had missing values on multiple explanatory variables in the model (dental insurance, etc.), we used multiple imputation with PRELIS 2 (SSI, Chicago, IL, USA). We began with candidate regression models to predict non-missing endogenous variables with assorted other explanatory/auxiliary variables and used Monte Carlo analysis with multiple chains to simulate five datasets with which to impute missing values along with the covariance structure among them. For all other analyses, we used Stata/SE (Stata Corporation, College Station, TX, USA). We used Dunn-Sidak corrections for multiple comparison adjustment.

We used path analysis to explore complex relationships among variables. Because of skewed and non-normal distributions of multiple variables, and influential outliers and notable heteroskedasticity in the data, we performed robust path analyses using two algorithms: the first symptotically attenuated heteroskedasticity with a White sandwich variance estimator (White, 1980), and the second down-weighted the influence of the outliers. Path analysis for each robust regression algorithm included: (1) performing general-to-specific regressions for variables loading significantly on the outcome variable (Hendry and Richard, 1982), (2) trimming the full models of non-significant paths, and (3) creating path diagrams based on the final models. To compute total effects, we calculated zero-order relationships between the exogenous variables that loaded on each endogenous variable in the path diagram. We performed intermediate regressions for each of these variables, identified all indirect paths, and calculated the sums of each of these indirect effects as the products of direct paths. Finally, we computed the unexplained effects for each independent variable as the difference of zero order and total effects, and calculated an error term for each endogenous variable.

Since our participants represented only a small subpopulation compared with that anticipated by the sample design, we chose not to perform a weighted analysis. When comparing our sample with the US population of women giving birth over the years 1988-1992 in the National Vital Health Statistics birth records for the same years as the NHANES III (1988-1992), we indeed found the demographics of our sample to be dissimilar to that of the general US population of childbearing age (*i.e.*, giving birth). Consequently, because our analysis was unweighted, our results cannot be generalized to the US population.

RESULTS

Scale Construction

Education, PIR, and SEI were correlated at levels of 0.42 (education, PIR), 0.36 (PIR, SEI), and 0.49 (education, SEI). Smoking, number of cigarettes, and serum cotinine were correlated at levels of 0.67 (smoking, number of cigarettes), 0.70 (numbers of cigarettes, cotinine), and 0.64 (smoking, cotinine). Age and time since last live birth were correlated at 0.84. Cronbach-α reliabilities for the summary variables SES, smoking, and age/time were 0.69, 0.87, and 0.89, respectively.

Women with missing data were older (47 *vs.* 39 yrs, Mann-Whitney test, $p \leq 0.001$), had higher parity (2.9 *vs.* 2.3 births, Mann-Whitney test, $p \leq 0.001$), were less educated (11.9 *vs.* 13.1 yrs, $p \leq 0.001$), had lower incomes (PIR 2.1 *vs*. 3.0, Mann-Whitney test, $p \leq 0.001$), and were more likely to be Black (56.0% *vs*. 49.1%, $\chi^2 = 26.14$, df = 1, $p \leq 0.001$) than those in our selected subsample.

Descriptive Analyses

Parity was inversely related to SES (Table 1). Women with the highest parity levels (4-6, 7+ births) exhibited similar total amounts of filled + decayed surfaces (median of 17.9% and 18.5%), but had more untreated decay (21.7% *vs*. 6.1% of all affected surfaces) than women with lower parity (Fig. 1).

Robust Regression Modeling

Race, SES, dental insurance, dental care frequency, and age/time since last live birth were significant predictors of (a) the proportion of filled surfaces, and (b) the proportion of decayed surfaces (Table 2). Parity was an important predictor of decayed, but not filled, surfaces, and marital status was an important predictor of filled, but not decayed, surfaces.

Table 1. Demographic Characteristics of the Study Participants, NHANES III, by Socioeconomic Status (n = 2635)

Characteristic		Socio-economic Status (tertile) Low (n = 878)	Middle (n = 878)	High (n = 879)
Age (yrs)	Mean (SD)	36.8 (13.0)	38.7 (12.7)	41.2 (11.3)
Race	Black	61.3%	38.8%	26.5%
Income (PIR)	Mean (SD)	1.5 (0.8)	3.0 (1.0)	4.6 (1.8)
Education (yrs)	≤ 11	36.3%	6.5%	0.9%
	= 12	53.8%	51.0%	19.1%
	13+	9.9%	42.4%	80.0%
Occupational prestige (SEI)	Mean (SD)	23.6 (6.4)	31.4 (9.1)	58.0 (21.1)
Parity	0	14.7%	24.6%	27.9 %
	1	17.1%	19.3%	18.8%
	2	27.1%	27.9%	30.8%
	3	19.8%	15.8%	12.5%
	4-6	18.5%	11.3%	9.7%
	7+	2.9%	0.9%	0.3%
	Mean (SD)	2.4 (1.9)	1.8 (1.6)	1.6 (1.4)
Time since last birth	Mean yrs (SD)	11.7 (10.6)	13.6 (10.9)	14.1 (10.3)
Dental insurance		53.4%	67.2%	68.5%
Dental visit frequency	Reporting ≥ once/yr	37.6%	60.8%	77.6%
Marital status	Married	49.1%	61.9%	73.6%
Social support	Median contacts/wk	50.7	52.0	46.3
Financial stress	Reporting ≥ 1 days with no food/money for food	7.3%	1.8%	0.5%
Cariogenic food frequency	Mean (SD) servings/mo.	64.4 (55.7)	50.1 (46.75)	41.8 (33.3)

*All demographic factors differed between the socio-economic tertiles, p ≤ 0.001, except for social support (p = 0.60).

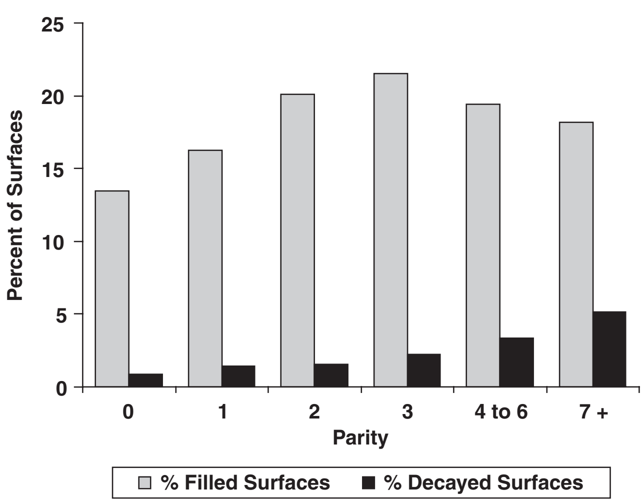

Figure 1. Dental caries (filled, decayed surfaces) by parity level, Black and White US women ages 18-64 yrs, NHANES III, n = 2365.

Robust Path Analysis

Robust path models show variables that significantly (*via* both algorithms) relate to (a) the % filled surfaces (model a) and (b) the % of decayed surfaces (model b) (Fig. 2). Standardized robust regression coefficients (betas) are on the paths, and error terms are in grey. With the exception of SES and social support, higher measurements of all variables indicate *less* favorable characteristics.

Direct paths leading to both filled surfaces and decayed surfaces include those from SES to dental insurance and dental frequency. The directionality of these relationships was reversed between the two path models: Higher SES, having dental insurance, and visiting the dentist at least once a year were all related to more filled and fewer decayed surfaces. The relationship between dental visit frequency and decayed surfaces was especially strong (robust beta = 0.27, $p \leq 0.001$).

Common paths for both models included those from SES to dental insurance and to dental frequency, and the path between these two variables. Women of higher SES were more likely to report going to the dentist at least once a year and were more likely to have dental insurance. The relationship between SES and dental visit frequency, however, was almost twice as strong as the relationship between SES and dental insurance (robust beta of -0.25 *vs*. -0.14, both $p \leq 0.001$).

Additional consistent paths included those between SES and parity, SES and marital status, and marital status and parity. Higher-SES women were more likely to be married, and married women had higher parity. The SES-parity relationship was twice as strong as the SES-marital status relationship (robust beta of -0.25 *vs*. -0.13, both $p \leq 0.001$). Cariogenic diet was unrelated to caries. A small indirect effect of SES through smoking and dental frequency was found for both filled and decayed surfaces (-0.002).

Major differences between the two path diagrams included: (1) a path between marital status and filled surfaces, indicating that married women were more likely to have more filled surfaces; and (2) a path between parity and decayed surfaces,

Table 2. Results of Robust Regression for Dependent Variables: Filled Surfaces (%FS) and Decayed Surfaces (%DS), Women Ages 18-64 yrs, NHANES III (n = 2635)

	Regression Algorithm Results (management of heteroskedasticity) (regress, robust beta)		
	Robust Beta	Robust SE for Beta	p
Filled Surfaces			
Socio-economic status	0.121	0.441	≤ 0.001
Race	–0.191	0.576	≤ 0.001
Dental insurance	–0.030	0.591	= 0.045
Dental care frequency	–0.181	0.622	≤ 0.000
Marital status	–0.043	0.559	= 0.007
Age/time	0.370	0.323	≤ 0.001
	R^2 = 0.32, F (6, 2628) = 192.36, p ≤ 0.001		
Decayed Surfaces			
Socio-economic status	–0.132	0.006	≤ 0.001
Race	0.233	0.012	≤ 0.001
Births	0.081	0.004	= 0.001
Dental insurance	0.060	0.011	= 0.002
Dental care frequency	0.273	0.012	≤ 0.000
Age/time	–0.016	0.005	= 0.003
	R^2 = 0.25, F (6, 2488) = 98.21, p ≤ 0.001		

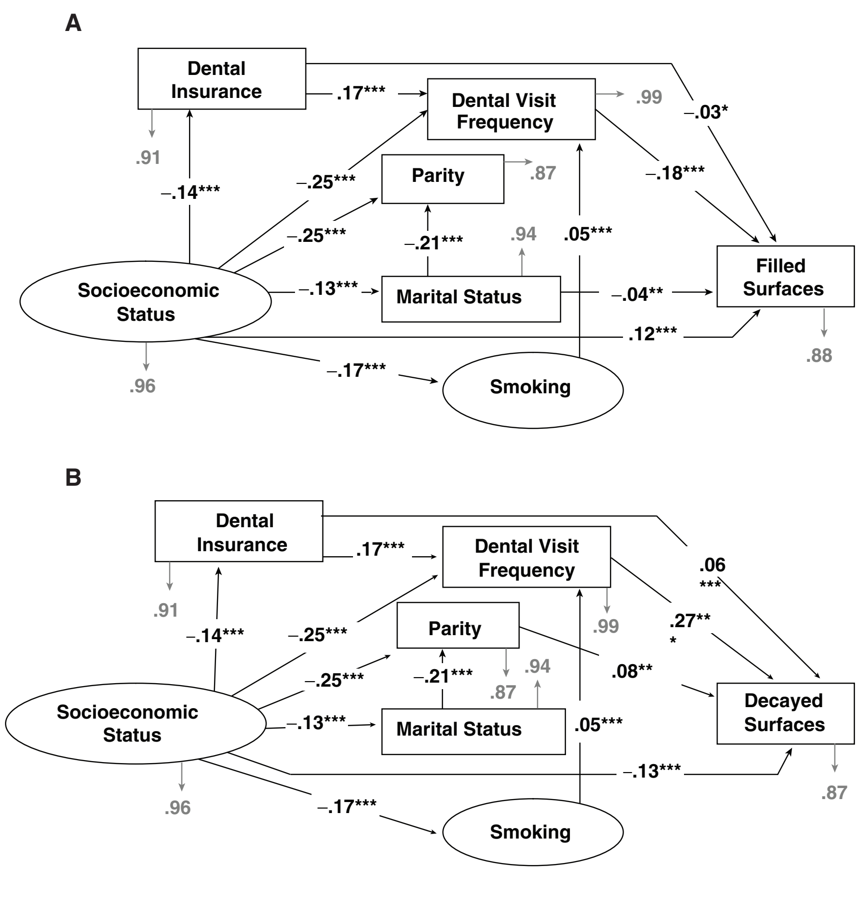

Figure 2. Path diagrams, parity, and dental caries, Black and White US women ages 18-64 yrs, NHANES III. **(A)** Path model for filled surfaces. Model controlled for: race, age, and time since last live birth; *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001. **(B)** Path model for decayed surfaces. Model controlled for: race, age, and time since last live birth; **p ≤ 0.01, ***p ≤ 0.001.

demonstrating that higher-parity women were more likely to have more decayed surfaces.

DISCUSSION

This is the first evidence in a large, heterogeneous sample of US women that parity is related to untreated dental caries, regardless of SES, race, and age. Despite the public perception that childbearing causes oral health deterioration, only two studies have specifically examined the relationship between parity and caries (Walker *et al*., 1983; Scheutz *et al*., 2002). While neither of these previous investigations identified a relationship between parity and caries, it is possible that, because these existing studies were performed in Africa, the results are not completely relevant to women with access to dental care.

The old wives' tale "a tooth for every child" is generally attributed to the idea that pregnancy depletes maternal teeth of calcium, making them more caries-susceptible. In truth, the developing fetus actually draws needed calcium from the skeleton (Casamassimo, 2001), but other biologic mechanisms for an increase in susceptibility to caries during pregnancy have been proposed. Many of these physiologic mechanisms—including variations in saliva (Laine, 2002), oral flora alterations (Laine, 2002), and the immunosuppressed state of pregnancy (Luppi, 2003)—are those that possibly contribute to a documented mild, but persistent, sex/gender disparity in caries rates in the US (Brown *et al*., 2002; Dye *et al*., 2007; Lukacs, 2008).

Our finding that increased parity is associated with *untreated* decay, along with other evidence that relates parity to tooth loss (Rundgren and Osterberg, 1987; Halling and Bengtsson, 1989; Christensen *et al*., 1998; Russell *et al.*, 2008), suggests that greater caries susceptibility associated with higher parity may not be solely biological, but also socio-behavioral.

It is possible that higher-parity women are more likely to have carious teeth extracted, while lower-parity women are likely to have teeth restored. Pregnancy and maternity alter patterns of dental treatment, and traditionally dentists have been advised that routine dental care for pregnant women should occur only during a limited window, the second trimester (Gaffield *et al*., 2001; Pistorius *et al*., 2003; AAP, 2004; ADA, 2006). Also, because of a lack of knowledge regarding the safety of treatment during pregnancy, fear of malpractice, or fear that a woman may go into labor, dentists may refuse outright to treat pregnant women (Strafford *et al*., 2008), may revise treatment plans when they discover a woman's pregnancy, or may postpone care until after the woman has given birth (Livingston *et al*., 1998; Pistorius *et al*., 2003). Additionally, some pregnant women feel that going to the dentist is unsafe during pregnancy (Strafford *et al*., 2008) and may postpone treatment until after the birth, but at that point access to dental care may be restricted due to childcare and time or financial constraints (Redford, 1993).

Pregnant women in the US have high levels of dental disease (Silberman *et al*., 1980) and treatment needs (Gaffield *et al*., 2001; Lydon-Rochelle *et al*., 2004), but the proportion of pregnant women who report having a dental visit is low (22.4-43.2%) (Mangskau and Arrindell, 1996; Gaffield *et al*., 2001). In fact, even pregnant women with a dental problem are unlikely to see a dentist (Gaffield *et al*., 2001). Our finding that being married was related to filled surfaces supports the findings from a previous study that most pregnant women who reported a dental visit were non-minority, married, and educated beyond high school (Timothe *et al*., 2005). Unfortunately, since rates of dental access and utilization among pregnant women vary significantly by SES (Timothe *et al*., 2005), those pregnant women most at risk for dental disease are least likely to receive dental care when pregnant.

There are several limitations to this study. Because we did not use the sampling weights supplied by NHANES III, our results are not generalizable to the US population. Second, because of the complexity of our analysis, we chose to limit the study to only Black and White women. Mexican-American women are likely different from non-Hispanic women regarding issues related to parity, including culture and psychological factors related to parity, such as social support. In the future, studies should examine the parity-oral health relationship among different ethnic/cultural groups. Third, we were limited to those variables measured as a part of NHANES III. Finally, these data are cross-sectional, and although the directionality of the associations in the path models were created based on judgment of how relationships would work in reality, we should emphasize that one cannot assume directionality in the case of this study (*i.e.*, models in Fig. 2 would be equivalent if the arrows were reversed).

Receiving dental care during pregnancy is safe (Michaelowicz, 2009), and guidelines have been published that advocate for dental care for pregnant women (Kumar and Samelson, 2006; Russell and Mayberry, 2008). Interventions aimed at pregnant women, and women with small children, could have a bearing on the dental health status of this significant proportion of the US population, not only because most women do have children, but also since maternal oral health is related to a child's oral health. Efforts to correct disparities in parity-related dental caries may serve to correct this imbalance by addressing specific needs of women with children regarding issues including care of dental disease during pregnancy, access to dental care, and dental programs aimed at families.

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