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Association between child caries and maternal health-related behaviours

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Objective: To examine the association between 2-6 year-olds' caries experience and selected maternal oral and general health-related behaviours in an American sample. ***Methods:*** Data pertaining to 917 child/mother pairs was from the Third National Health and Nutrition Examination Survey 1988-1994. Child caries experience was indicated by the presence of one or more decayed or filled tooth. Data on maternal smoking, frequency of dental visits, consumption of unhealthy food and oral hygiene was linked to children data using the natality file. An aggregate behavioural variable was created. Logistic Regression models were used to assess the association between child caries experience and maternal behaviours adjusting for child's age, gender, ethnicity, dental visits and mother's age, education and poverty-income ratio. ***Results:*** All four maternal behaviours were significantly associated with child caries in fully adjusted models with odds ratios 1.42 (95%CI:1.01,2.01) for current smokers versus non-smokers, 1.01 (95%CI:1.01,1.02) for frequent consumption of unhealthy food, 1.63 (95%CI:1.15,2.31) for infrequent dental visits, and 2.49 (95%CI:1.44,4.29) for poor oral hygiene. ***Conclusions:*** The results indicate that children's caries experience is related to a number of maternal behaviours including behaviours not directly related to caries such as smoking. Maternal oral and general health-related behaviours should be incorporated in children's caries risk assessment and in behaviour changing interventions provided in dental practice to improve children's oral health.

Key words: *child, dental caries, maternal, behavior, American*

Introduction

Most of the research on child caries has focused on biological and behavioural risk factors such as bacterial colonization (Li and Caufield, 1995), dietary patterns such as bottle-feeding and snacking and inadequate oral hygiene in children (Seow, 2012). Fewer studies have addressed the distal determinants of child caries (Leong *et al.,* 2013). Studies have postulated complex pathways explaining the determinants of child caries focusing on environmental, societal and socioeconomic factors (Fisher-Owens *et al.,* 2007; Seow, 2012) along with parental attributes (Hooley *et al.,* 2012; Kinirons and McCabe, 1995; Seow, 2012). Parents as the main caregivers have an enormous influence on children's behaviours and early life skills. Several studies have emphasized the mother's role in children's oral health status and habits (Dye *et al.,* 2011; Okada *et al.,* 2002; Shearer *et al.,* 2011).

Maternal education, socioeconomic status, age, ethnicity, attitudes and habits were identified as crucial determinants of child caries (Mattila *et al.,* 2000; Vargas *et al.*, 1998). There is also evidence that mothers who neglect their own oral health are prone to neglect that of their children (Seow, 2012). However, fewer studies have examined the relationship between maternal health-related behaviours and child caries (Mattila *et al.,* 2000; Moimaz *et al.,* 2014), or included behaviours not directly related to oral health such as smoking, and child caries. We postulate that mothers who adopt unhealthy behaviours are more likely to have children with dental caries than mothers who exhibit healthy behaviours.

The aim of this research is to assess the association between selected maternal health-related behaviours, namely dental visits, dietary habits, smoking and oral hygiene, individually and as an aggregate index of behaviours, with children's caries experience.

Methods

This research is a secondary analysis of data extracted from the Third National Health and Nutrition Examination Survey (NHANES III) (1998-1994), a nationally representative sample of civilian, non-institutionalized Americans. The survey included socio-demographic, behavioural, laboratory and comprehensive dental examination data (CDCP, 2014). Despite the fact that this information was collected two decades ago, the algorithm for linking mother and child data (using the natality file) was recently published (Dye *et al.,* 2011).

The sample was restricted to children aged 2-6 years who could be matched with their mothers' data (Dye *et al.,* 2011). The unique identification number of the household was the key to pair each mother with each child, and only the oldest child younger than 7 years was matched with the woman in the house to avoid duplication of maternal data. Only mother/child pairs with complete data for all the variables were included in the analysis. Trained NHANES dentists assessed caries through visual and tactile methods. Intra- and inter- examiner agreement was satisfactory for all components (CDCP, 2014).

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Caries assessment in 2-years and older children was performed in the ones with at least one primary tooth and recorded as the sum of decayed and filled surfaces or teeth (dfs/t). The primary outcome of interest was children's caries experience. Caries experience was categorized as having "caries" when at least one decayed or filled tooth was present, and "no caries" those without decayed or filled teeth.

Selected maternal variables were included as exposure measures of interest. Maternal smoking habit was recorded as ever smoked, former and current smoker. A person was defined as never smoked if she had smoked fewer than 100 cigarettes in her life. Maternal frequency of dental visits was indicated by visiting at least once in the last two years versus less often. Using the questions on consumption of sweets and sugary beverages and food, and fats containing food per month, a count variable for consumption of unhealthy food/beverage was created (CDCP, 2014). Fattening food included cakes, cookies, biscuits, cheese dishes, lasagna, ice cream, butter and margarine. While the unhealthy food variable includes a combination of cariogenic and non-cariogenic items, smoking habits are not directly related to dental caries and were used here as surrogate measure of maternal health compromising behaviours.

This survey did not include data on oral hygiene behaviour; but it included clinical assessment of the amount of calculus, a marker of ineffective removal of plaque (Maizels and Sheiham, 1987). Calculus has been used as a surrogate measure of oral hygiene behaviour (Sabbah *et al.,* 2009). The presence of calculus was registered during periodontal examination of half mouths chosen randomly. A variable reflecting the proportion of tooth surfaces covered with calculus was created to indicate extent of calculus.

To assess whether accumulation of maternal unhealthy behaviours is associated with child caries, an aggregate variable indicating the count of unhealthy behaviours was created by classifying as unhealthy (coded as 1 vs 0): being a current smoker, making dental visits less often than once in two years, consumption of 41 or more unhealthy foods per month (the median value), and, having 10% or more tooth surfaces with calculus, Finally, since most of the mothers included in the analysis had some calculus (93.9%), this variable was dichotomized into two groups: 10% or less versus more than 10% of examined tooth surfaces covered with calculus. Summing the four codes created the aggregate variable.

Other variables included in the analysis were child's age, gender and ethnicity (White American, Black American, Mexican American and other ethnicities), child dental visits (at least once a year), maternal age, education (less than 12 years, 12 years or more than 12 years) and family poverty-income ratio (family income : poverty threshold) (CDCP, 2014).

Only 917 mother/child pairs with complete data were included throughout the analyses. Given that this subsample is not representative of the population, sampling weights were not used. Statistical analyses were performed using STATA 11.0. Descriptive analysis of all variables included in the study was performed within groups of children with/without caries.

To assess the associations between caries experience (dft =1 vs dft=0) and each of the maternal health-related behaviours, two sets of logistic regression models were constructed, each adjusting for one behaviour at a time. Maternal behaviours used in the regression models were dental visit (once in last 2 years versus less often), extent of calculus (continuous variable), consumption of unhealthy food (count variable) and smoking (never smoked, former smoker and current smoker). The first model adjusted for child's gender, age, ethnicity, dental visits, and maternal age. The second model also adjusted for maternal education and poverty-income ratio. Finally, a model adjusting for the aggregate maternal behaviours and child's age, gender, ethnicity, dental visits, and maternal age, education and poverty-income ratio was constructed.

Results

Of the 1,260 matched mother-child pairs, 917 mother-child pairs having full data sets were included in the analyses. Table 1 exhibits the distribution of variables. Children's caries was higher among those whose mothers had unhealthy behaviours and lower education (Table 1).

Table 2 shows the results from logistic regression analysis and reports odds ratios for child caries experience by maternal health-related behaviours. Smoking (current smoker), infrequent dental visits, frequent consumption of unhealthy food and poor oral hygiene indicated by calculus extent were all significantly associated with child caries in the partially and fully adjusted regression models. The strongest association with having any dental caries was for maternal extent of calculus (OR 2.49), while the smallest observed association was with consumption of unhealthy food (OR 1.01 per additional consumption of unhealthy food per month by the mother).

The fully adjusted model included the aggregate maternal behaviour variable. The odds ratio for children whose mothers had three or four unhealthy behaviour were 2.20 (95%CI: 1.01, 4.83) and 2.65 (95%CI: 1.10, 6.35), respectively, compared to those with no unhealthy behaviours. Higher child age, lower maternal education, and ethnicity (Mexican Americans) were also significantly associated with children's caries in this ajusted model (Table 3)

Discussion

This study showed evidence of a relationship between maternal health-related behaviours and caries in their children. Maternal smoking status, dietary habits, dental visits and oral hygiene were all significantly associated with child caries experience. Lower family income, lower maternal education and ethnicity (Hispanic and African Americans) were associated with child caries, confirming findings from earlier studies (Fisher-Owens *et al.,* 2007; Hooley *et al.,* 2012). Interestingly the association between all maternal behaviours and child caries persisted even after adjusting for socioeconomic factors and children's dental visits. Behaviours such as dental visits and oral hygiene, but also behaviours not directly related to caries such as smoking were associated with child caries. Furthermore, the study showed that co-occurrence of maternal health compromising behaviours was related to their children's caries experience. Mother's caries was reported to be associated with their children's caries in this subsample of NHANES in an earlier study (Dye *et al.,* 2011).

Table 1. Descriptive statistics of the sample's 917 mother-child pairs from NHANES III (1988-1994)

		Caries experience in children			
		No	*Yes*		*Overall*
Child's age, mean (95%CI)		3.9 (3.8, 4.0)	4.7 (4.6, 4.8)	<0.001	4.2 (4.1, 4.3)
Child's gender	Male	51.0%	49.0%	NS	50.3%
	Female	49.0 %	51.0%		49.7%
Ethnicity	White	27.6%	17.1%	<0.001	23.8%
	African American	37.8%	33.9%		36.4%
	Mexican American	30.7%	46.9%		36.5%
	Others	3.9%	2.1%		3.3%
Child dental visits	At least annual	34.4%	40.5%	NS	36.6%
	Less often/ never	65.6%	59.5%		63.4%
Mothers' age in years (95%CI)		30.1 (29.7, 30.6)	30.1 (29.5, 30.8)	NS	30.1 (29.7, 30.5)
Family poverty-income ratio* mean (CI)		1.9 (1.7, 2.0)	1.4 (1.3, 1.5)	<0.001	1.7 (1.6, 1.8)
Mothers' education	<12 years	27.9%	43.6%	<0.001	33.7%
	12 years	38.0%	37.0%		37.6%
	>12 years	34.1%	19.3%		28.7%
Maternal smoking	Never smoked	65.9%	57.4%	<0.05	62.8%
	Former smoker	9.9%	12.3%		10.8%
	Current smoker	24.2	30.3		26.4
Maternal dental visits	At least once per 2 years	48.5%	35.4%	<.001	43.7%
	Less often/never	51.5%	64.6%		56.3
Monthly consumption of unhealthy foods, mean (95%CI)		44.9 (42.6, 47.2)	52.4 (48.2, 56.5)	<0.01	47.6 (45.5, 49.7)
Oral hygiene (mean extent of calculus) (95%CI)		0.35 (0.33, 0.37)	0.44 (0.41, 0.47)	<.001	0.38 (0.36, 0.40)
Aggregate maternal behaviours	None	7.4%	3.3%%	<0.05	5.9%
	One behaviour	22.4%	17.4%		20.6%
	Two behaviours	37.0%	29.1%		34.1%
	Three behaviours	25.3%	36.9%		29.6%
	Four behaviours	7.9%	13.2%		9.8%

* Higher family poverty-income ratios indicate higher incomes

Table 2. Logistic regression analysis for the association between child caries experience and maternal health-related behaviours for 917 NHANES III 1988-1994 mother/child pairs

Maternal behaviours		*Odds ratios (95%CI)*			
		Model 1		*Model 2*	
Smoking	Never	Reference			
	Former	1.43	(0.89, 2.30) ^{NS}	1.41	(0.87, 2.28) ^{NS}
	Current	1.61	(1.15, 2.26) **	1.42	(1.01, 2.01) *
Consumption of unhealthy food and beverages		1.01	(1.01, 1.02) **	1.01	(1.01, 1.02) **
Dental visits	At least once/ 2 years	Reference			
	Less often/ never	1.42	(1.37, 2.69) *	1.63	(1.15, 2.31) **
Poor oral hygiene (extent of calculus)		3.35	(2.00, 5.61) ***	2.49	(1.44, 4.29) **

*p value < 0.05, **p value <0.01, *** p value <0.001, ^{NS} Insignificant Model 1: adjusted for child gender, age, ethnicity and dental visit, and mother age. Model 2: additionally adjusted for mother's education and family poverty-income ratio

Table 3. Fully adjusted logistic regression analysis for the association between child caries experience showing association with an aggregate of four maternal unhealthy behaviours for 917 NHANES III 1988-1994 mother/ child pairs

		Odds ratio	(95%CI)	
Child age (reference: 2 years)	3 years	2.28	(1.19, 4.38)	*
	4 years	4.17	(2.25, 7.70)	***
	5 years	5.91	(3.21,10.88)	***
	6 years	7.22	(3.86,13.49)	***
Child gender (reference male)		1.14	(0.85, 1.53)	NS
Child ethnicity (reference: White American)	African American	1.17	(0.76, 1.79)	NS
	Mexican American	2.18	(1.41, 3.38)	NS
	Others	0.79	(0.29, 2.14)	NS
Child dental visit (reference: at least once/year)		1.37	(0.98, 1.91)	NS
Mother's age		0.99	(0.96, 1.02)	NS
Family poverty-income ratio		0.86	(0.74, 1.00)	NS
Maternal education (reference > 12 years)	12 years	0.82	(0.57, 1.16)	NS
	<12 years	0.60	(0.38, 0.95)	*
Aggregate variable of maternal behaviours (reference: none)	One behaviour	1.23	(0.55, 2.73)	NS
	Two behaviours	1.28	(0.59, 2.79)	NS
	Three behaviours	2.20	(1.01, 4.83)	*
	Four behaviours	2.65	(1.10, 6.35)	*

*p value < 0.05, **p value <0.01, *** p value <0.001, NS Insignificant
Model adjusted for child gender, age, ethnicity and dental visit, and mother age, education, family poverty-income ratio and an aggregate variable of maternal unhealthy behaviour

This study complements findings from earlier research that indicated that mothers with more untreated caries and poor oral health were more likely to have children with caries experience (Okada *et al.,* 2002). The findings are also in line with studies that examined parental oral and general health related behaviours and child caries (Wigen and Wang, 2011). The current study has the advantage of examining a wide array of maternal behaviours and an aggregate behavioural variable in relation to their children's dental caries.

Maternal oral health-related behaviours showed the strongest association with child caries in this analysis. This implies that mothers who visit a dentist more often, and maintain good oral hygiene may be more likely to inculcate similar behaviour in their children. It should be noted though that a maternal behaviour not related to dental caries (smoking, included as an indicator of risky behaviour) was also associated with child caries. Furthermore, the accumulation of maternal unhealthy behaviours was also associated with child caries. This finding suggests that maternal behaviours in general, not just oral health-related behaviours are important determinants of child caries and highlights the importance of integrating oral and general health promotion interventions. Earlier studies implied that certain maternal attributes were associated with poorer child rearing habits (Carson and Schauer, 1992) and subsequently to child oral health (Wigen and Wang, 2011). The finding of the current study is in line with these observations, and implies that mothers who adopt unhealthy behaviours are less likely to take good care of their children's oral health. However, health-risk behaviours tend to cluster among the least educated, most deprived and marginalized (Singh *et al.,* 2013). It is plausible that the association between maternal health-related behaviours and child caries observed in this analysis is attributed to socioeconomic position, particularly that maternal education and social status were shown to be a robust predictors of child caries (Hooley *et al.,* 2012; Kinirons and McCabe, 1995; Mattila *et al.,* 2000). Unsurprisingly, the current analysis revealed that maternal education was significantly and inversely associated with children's caries experience. Furthermore, psychological problems, particularly depression and stresses, are linked to adopting unhealthy behaviours (Sabbah *et al.,* 2008) and poorer child-rearing behaviours (Albon, 2005; Carson and Schauer, 1992) on the one hand and lower socioeconomic position on the other. Although we did not examine a psychosocial pathway between maternal behaviour and child oral health in this study, it is possible that such a pathway could explain part of the complex relationship assessed in this study.

Acknowledging key maternal behaviours as potential risk factors for children's oral health and describing some of the underlying causes of this relationship is a step forward to expand our understanding of the distal risk factors for child caries in top of proximal behavioural and biological causes of caries that have been extensively studied (Selwitz *et al.*, 2007). It is also plausible that a behaviour not directly related to dental caries such as maternal smoking could impact on children's general health, subsequently the child may receive long-term or repeated treatments with sugary and/or steroid medications that may increase the child's risk for caries.

Furthermore, identifying some maternal attributes as possible risk factors for dental caries highlights the importance of adopting a broader approach to promoting children oral health which should consider maternal health compromising behaviours, life events and socioeconomic circumstances, as well as focusing on the proximal causes of child caries.

To the best of our knowledge, this is the first study that examined this range of maternal behaviours in relation to child caries. Furthermore, the study uniquely used a variable indicating co-occurrence of maternal health-related behaviours and assessed its association with child caries. Nevertheless, the study has limitations. Only a subsample of NHANES III was examined in this study, so it cannot be considered representative of the USA population. Second, the cross-sectional nature of the survey does not support conclusions about causality. Third aside from child dental visits, we could not include other child-related behaviours due to data limitations. Fourth, dental visit variables indicated frequency of visit but did not reflect the type of services provided. Finally, NHANES III is relatively old; yet the algorithm for linking mothers and children through the natality file was only recently published (Dye *et al.,* 2011). The unique possibility to link mother and child caries presented an excellent opportunity to assess this neglected determinant of child caries in a large study sample. Furthermore, there is a plausible mechanism linking some of the maternal behaviours used in this study such as dental visits and oral hygiene with child caries that is unlikely to change over time. On the other hand, smoking (used here as a surrogate marker of risk taking behaviour) has decreased over the past few years, it is possible the other markers of known or emerging risky behaviours play a greater role in child caries.

This study demonstrated that maternal health compromising behaviours is related to dental caries status in children. The findings highlight maternal attributes that should be considered when assessing children at high risk of dental caries. The findings of this study on maternal behaviours and child caries, along with evidence from other studies indicating an association between maternal behaviours and child rearing behaviours highlight the importance of adopting a holistic approach to promote the general wellbeing of mothers and children.

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