Journal of Dental Research

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>> Version of Record - Aug 16, 2012

OnlineFirst Version of Record - Jul 20, 2012

What is This?

S. Nelson[1]*, W. Lee[1], J.M. Albert[2], and L.T. Singer[3]

[1]Department of Community Dentistry, School of Dental Medicine, Case Western Reserve University, 10900 Euclid Avenue, Cleveland, OH 44106, USA; [2]Department of Epidemiology and Biostatistics, School of Medicine, Case Western Reserve University, Cleveland, OH, USA; and [3]Department of General Medical Sciences and Pediatrics, School of Medicine, Case Western Reserve University, Cleveland, OH, USA; *corresponding author, sxn15@case.edu

Early Maternal Psychosocial Factors Are Predictors for Adolescent Caries

ABSTRACT

Few studies have investigated the role of early maternal enabling and psychosocial factors on subsequent adolescent caries experience. In this retrospective cohort study of 224 adolescents, we hypothesized that the causal pathway between early maternal enabling factors (education, cognitive abilities, psychological distress) and adolescent caries experience (DMFT) at age 14 yrs is mediated by maternal psychosocial factors (stress, coping, social support) and adolescent dental behavior/access. Maternal data on socio-demographic, medical, and psychosocial variables were measured when the child was 3, 8, and 14 yrs old. A structural equations model (SEM) evaluated the causal pathway, with latent variables for maternal enabling factors (MEF), stress, coping, and social support. Poor MEF was associated with increased stress and poorer coping when the child was 3 yrs old, which in turn affected adolescent dental visits and behavior. Greater social support at child's age 3 was directly associated with lower mean DMFT in adolescence. Maternal psychosocial factors measured when children are young are important mediators for adolescent mean DMFT, but these factors measured when children are adolescents are not. Better early and concurrent MEF, however, was associated directly/indirectly (through dental visits and insurance) with adolescent DMFT. Early maternal factors are important predictors for adolescent caries.

KEY WORDS: dental caries, children, longitudinal, psychosocial, dental behavior, epidemiology.

INTRODUCTION

A systematic review (Harris *et al.*, 2004) found certain socio-demographic (family income and parental education) and child-related (toothbrushing, high frequency of daily sugary foods intake) factors to be significantly associated with caries prevalence in young children. But most studies use standard regression techniques with social/behavioral factors as isolated risk predictors, without a theoretical framework. Thus, it is difficult to understand the complex pathways through which psychosocial and behavioral factors act as mediators for oral health (Newton and Bower, 2005). Conceptually, social ecological models suggest a multi-level causal approach to investigating dental caries in childhood (Patrick *et al.*, 2006; Fisher-Owens *et al.*, 2007).

Structural equations modeling (SEM) is particularly suitable for delineating complex pathways between social factors and oral health (Newton and Bower, 2005). A few studies have utilized SEM to evaluate causal pathways by which caregivers' self-efficacy for dental behaviors and socio-economic status (SES) influence mediating factors such as cariogenic diet and oral hygiene behaviors for dental caries (Litt *et al.*, 1995; Polk *et al.*, 2010). Other studies, applying the life-course approach, have found that early childhood biological and socio-economic factors were associated with subsequent tooth decay in adolescence (Kuh and Ben-Shlomo, 1997; Nicolau *et al.*, 2003; Peres *et al.*, 2007). A few cross-sectional studies have reported parenting stress to be linked to caries in children (LaValle *et al.*, 2000; Tang *et al.*, 2005; Finlayson *et al.*, 2007), while another did not find such an association (Quinonez *et al.*, 2001). However, none of these studies evaluated, within a theoretical framework, the effect of maternal psychosocial variables measured when the child was young to assess their effect on later caries experience.

Psychosocial stress arises when an individual cognitively appraises a perceived challenge in his/her environment and discerns it as requiring more resources than he or she has available to protect against endangerment. Coping is the process by which an individual manages the troubled person-environmental relationship through cognitive and behavioral efforts and social support (Lazarus and Folkman, 1984). Stress that exceeds coping resources may be linked to unhealthy behaviors. In turn, these behaviors can result in poor health outcomes (Sanders *et al.*, 2007).

Based on the Lazarus and Folkman (1984) model of the stress process in caregiving, our proposed conceptual model included four stages in the following hypothesized causal order: (1) maternal enabling factors (antecedent); (2) maternal psychosocial factors (mediator); (3) adolescent dental behavior and access (mediator); and (4) caries experience (outcome). Hence, the objective

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was to investigate whether early (child age 3, 8 yrs) and concurrent (age 14 yrs) maternal enabling and psychosocial factors are associated with adolescent caries experience.

MATERIALS & METHODS

Study Sample

The sample was recruited from a cohort of children participating in a longitudinal study evaluating the effects of very low birthweight on neurodevelopment (Singer *et al.*, 1997). The original cohort consisted of 321 participants consecutively recruited from three hospitals in a four-county region, providing a convenient regional sample. The cohort was followed from birth until 14 yrs of age, with an 84% participation rate at 14 yrs. Among this cohort, 246 participated in the dental study, but further exclusions for incomplete records, severe medical problems, or fixed orthodontic appliances resulted in a final sample of 224 (Nelson *et al.*, 2010). The Institutional Review Board of the participating hospital gave approval, and consent of the parent/caregiver and assent of the adolescent were obtained.

Study Design

A retrospective cohort design was used. Existing prior demographic, medical, and psychosocial assessments (3, 8 yrs) along with concurrent assessments (14 yrs) were utilized to study the dental outcomes at 14 yrs of age.

Measures

Demographics and Medical Assessments

Socio-demographic and medical data were collected from hospital charts at birth and included the child's gender, mother's race (African-American *vs.* Caucasian/other), and socio-economic status (SES) according to Hollingshead's (1957) classification of social class based on parent's education and income. Birth group was categorized as: (1) high-risk very low birth-weight [HR-VLBW, had diagnosis of broncho-pulmonary dysplasia, ≤ 36 wks' gestational age, < 1500 g birthweight]; (2) low-risk VLBW [LR-VLBW, did not have diagnosis of broncho-pulmonary dysplasia, ≤ 36 wks' gestational age, < 1500 g birthweight]; and (3) full-term [Term > 36 wks' gestation and ≥ 2500 g birthweight] (Singer *et al.*, 1997).

Maternal Enabling Factors (MEF)

We define the latent variable MEF as antecedent mother's intrinsic ability to deal with environmental stressors. MEF was measured by 4 indicators at child's ages 3, 8, and 14 yrs: Peabody Picture-Vocabulary Test Revised (PPVT-R/PPVT-III) score for verbal ability (Dunn and Dunn, 1981); Wechsler Adult Intelligence Scale Revised (WAIS-R/WAIS-III) score for cognitive ability (Wechsler, 1981); Brief Symptom Inventory (BSI) measured psychiatric symptom patterns and a global measure derived from the BSI, General Severity Index (GSI) summarized psychological distress (Derogatis, 1992); and years of education (low ≤ 12 yrs, high > 12 yrs). A higher MEF score indicates greater cognitive and verbal ability, and better emotional well-being.

Maternal Psychosocial Factors

Three latent variables that represented extrinsic maternal responses to child, family/others, and situational characteristics were: stress, coping, and social support at child's age of 3, 8, and 14 yrs. Stress was measured by subscale scores from the Family Inventory of Life Events and Changes (FILE) and the Parenting Stress Index (PSI) at ages 3 and 8 yrs; and FILE and the Stress Index for Parents of Adolescents (SIPA) at age 14 yrs. FILE assessed family experience of stressful life changes in the previous year (McCubbin *et al.*, 1985). PSI and SIPA assessed perceptions of the degree of parenting stress by using domain scores for parent, child, and adolescent (Abidin, 1986; Sheras *et al.*, 1998). A higher score indicated greater maternal stress. The COPE Questionnaire with 15 subscales (Appendix Table 2) assesses four distinct theoretically derived dimensions of coping (Carver *et al.*, 1989). A higher score indicates better coping skills. Social support was measured by marital status and the Multidimensional Scale of Perceived Social Support (MSPSS). MSPSS assesses perceived social support from family, friends, and significant others (Zimet *et al.*, 1990). A higher score indicates more resources to manage stress.

Dental Behavioral and Access Variables

The variables measured by parent questionnaire administered when the child was at age 14 yrs included (Nelson *et al.*, 2010): Behavioral (fluoride treatment: yes = adolescent had ever received fluoride treatment such as varnish, supplements, or mouthrinse, no = otherwise; consumption of sugary drinks: yes = adolescent most often drinks soft drinks or juice, no = otherwise); Access (dental insurance: none, Medicaid, private only; and frequency of dentist visits: 0 = never/rarely, 1 = as needed, 2 = every 2 yrs, 3 = every yr). Clinical examinations assessed plaque accumulation according to the Simplified Oral Hygiene Index (OHI-S) for debris (Green and Vermillion, 1964) and the number of sealants on permanent molars.

Dental Outcomes

Caries experience was determined by the number of decayed, missing, or filled (DMFT) permanent teeth (Radike, 1968), evaluated by a single trained examiner. All participants' teeth were photographed. For inter-examiner reliability, random photographs were examined by a second experienced examiner. For intra-examiner reliability, photographs were compared with clinical examination findings (presence/absence of decay) by the study examiner. Kappa values indicated moderate to excellent (0.51 -0.83) inter- and intra-examiner reliability.

Statistical Analysis

Descriptive and non-parametric bivariate statistics were used to describe the sample, and to compare the mean DMFT scores across socio-demographic, dental behavior, and access categories.

To test the effects of the hypothesized multidimensional factors on adolescent DMFT, we used a four-stage model as follows: (1) MEF (antecedent); (2) maternal psychosocial factors (mediator); (3) adolescent dental behavioral and access variables (mediator); and (4) DMFT (outcome). A corresponding model was fit to the data by structural equation modeling (SEM) methods

Table. Caries Extent by Socio-demographic Status, Dental Behavior Categories, and Dental Care Access Categories

Categories	Variables		Dental Caries at 14 yrs (mean DFMT[a])		
			N (%[b])	Mean (SD[c])	p-value[d]
Socio-demographic status	Race (Mother)	African American	106 (47%)	2.19 (2.49)	0.01*
		Caucasian and others	118 (53%)	1.74 (3.11)	
	Gender (Adolescent)	Female	119 (53%)	2.29 (3.21)	0.15
		Male	105 (47%)	1.56 (2.30)	
	SES	Low	136 (61%)	2.46 (3.08)	0.00*
		High	88 (39%)	1.16 (2.20)	
	Birth Group	Term	85 (38%)	2.39 (2.94)	0.10
		LR-VLBW	59 (26%)	1.56 (2.07)	
		HR-VLBW	80 (36%)	1.78 (3.17)	
	Education (Mother)	Low	120 (54%)	2.48 (3.21)	0.00*
		High	104 (46%)	1.35 (2.20)	
Adolescent dental behaviors	Sealant	No	162 (72%)	2.20 (3.10)	0.10
		Yes	62 (28%)	1.31 (1.89)	
	Oral Hygiene Index	0 (good hygiene)	16 (7%)	0.06 (0.25)	0.00*
		1	112 (50%)	1.96 (3.04)	
		2	66 (29%)	2.00 (2.17)	
		3 (poor hygiene)	30 (13%)	2.80 (3.64)	
	Fluoride Treatment[e]	No	77 (35%)	1.88 (2.64)	0.95
		Yes	145 (65%)	1.96 (2.92)	
	Sugary Drinks	No	157 (70%)	1.83 (2.89)	0.09
		Yes	67 (30%)	2.22 (2.71)	
Adolescent dental care access	Dental Visit[e]	Never or rarely	5 (2%)	1.40 (2.61)	0.05*
		As needed (irregularly)	20 (9%)	3.15 (3.25)	
		Every 2 years	14 (6%)	2.07 (2.02)	
		Every year	181 (82%)	1.80 (2.82)	
	Insurance[e]	None	28 (13%)	1.04 (2.22)	0.07
		Medicaid	74 (33%)	2.01 (2.37)	
		Private only	119 (54%)	2.11 (3.17)	

[a]Mean DMFT, mean number of decayed, missing, filled teeth.
[b]Percentages may not total 100 due to rounding.
[c]SD, standard deviation.
[d]The asterisk (*) denotes significant difference (p < 0.05) by the Wilcoxon test for binary variables or the Kruskal-Wallis test for variables with more than 2 values.
[e]Due to missing data for Fluoride Treatment, Dental Visit, and Insurance, the sample sizes for these variables are 222, 220, and 221, respectively.

(Bollen, 1989). Three separate models were considered, each including MEF and psychosocial variables measured when the children were ages 3, 8, and 14 yrs. In each model, all causally preceding variables were linked to (*i.e.*, hypothesized to predict) each outcome variable. The exception was that the link from "MEF" to "social support" was removed, because it lacked a theoretical basis and to prevent non-convergence in some cases.

The SEM model assumed: normality/linear models for continuous outcome variables (MEF, stress, coping, social support, sealant, and OHI-S); Bernoulli/logistic regression models for binary outcomes (fluoride treatment, sugary drinks); multinomial/proportional odds models for ordinal outcomes (frequency of dental visits and insurance type); and a negative binomial distribution/loglinear model for DMFT counts. The models were fit by maximum likelihood with Monte Carlo simulation for numerical integration in MPlus Version 6. The latent variables were constrained to have variance equal to 1. Non-standardized regression coefficient estimates were obtained along with model-based standard errors and chi-square test

two-sided p values. Model goodness of fit was assessed by the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), which allow for comparisons of alternative models (Bollen, 1989), and by the root mean square error of approximation (RMSEA). To account for multiple testing, we reduced the number of tests *a priori* by including conceptually distinct variables (Cook and Farewell, 1996); thus, statistical significance was determined at the 0.05 alpha level.

RESULTS

Descriptive and Bivariate Analyses

The sample consisted of 224 children, with 47% men, 47% African-American, and 61% low SES (Table). A higher mean DMFT was found in adolescents who were of low SES, African-American, mothers with < high school education, and poor oral hygiene. A lower mean DMFT was found in adolescents who had yearly dental visits (Table).
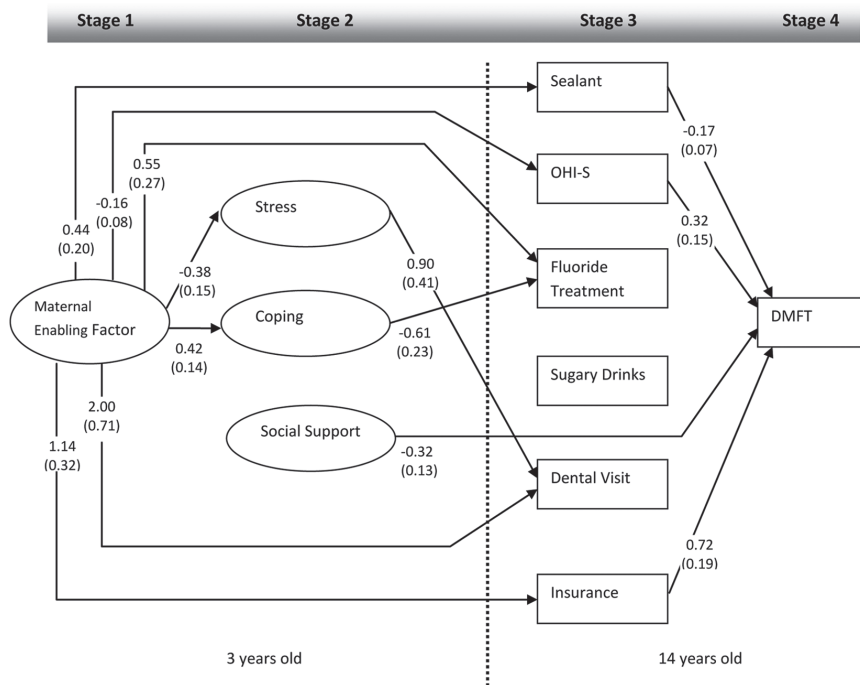
SEM Analyses

Figs. 1-3 show the hypothesized structural models for adolescent DMFT. All paths except stage 1 (MEF adjusted for SES only) were adjusted for gender, race, SES, and birth group. Technical details of SEM are described in the Appendix. The models assuming negative binomial distribution for DMFT counts provided better model fit (lower scores on AIC and BIC) compared with models assuming normal distribution of DMFT (Appendix Table 1). The RMSEA at the three ages was 0.081, 0.080, and 0.086, respectively, indicating reasonable goodness of fit (Kline, 1998). Factor loadings of latent with indicator variables are given in Appendix Table 2.

At age 3 yrs (Fig. 1), mothers with each 1-standard deviation unit increase in MEF had a 0.38 decrease and 0.42 increase in mean stress and coping, respectively. Greater psychosocial stress was associated with 2.5 times greater odds ($e^{0.90}=2.46$) of dental visits, while greater coping skills were associated with 46% decreased odds ($e^{-0.61}=0.54$) of fluoride treatment. Mothers reporting greater social support were 28% less likely ($e^{-0.32}=0.72$) to have a child with a higher mean DMFT. MEF also had indirect effects on DMFT mediated by behavioral and access variables. Children whose mother had higher MEF had significantly more dental sealants, better oral hygiene, increased odds of fluoride treatment, frequent dental visits, and having dental insurance. Dental sealants, in turn, were significantly associated with lower mean DMFT, while worse oral hygiene and having dental insurance were associated with higher mean DMFT.

For children at age 8 yrs (Fig. 2), mothers with higher MEF had significantly greater coping skills, which in turn was associated with higher mean DMFT. At age 14 yrs (Appendix Fig.), higher MEF was associated with greater coping skills, but no further relationship between mothers' psychosocial factors and dental behaviors/dental access was found. Other relationships at ages 8 and 14 yrs were found to be consistently similar to those found at age 3 yrs.

DISCUSSION

The sequential hypothesis that early/concurrent mothers' enabling factors are

Figure 1. Structural equation model of the effects of maternal psychosocial factors at age 3 yrs on caries extent (mean DMFT) at age 14 yrs. Only SES was adjusted for stage 1. Gender, race, SES, and birth group were adjusted for stages 2-4. Arrows denote the presence of a statistically significant (p < 0.05) relationship. Estimated β-coefficients with the standard errors for the estimates (in parentheses) are displayed. The latent variables (MEF, Stress, Coping, and Social support) were derived by confirmatory factor analysis.
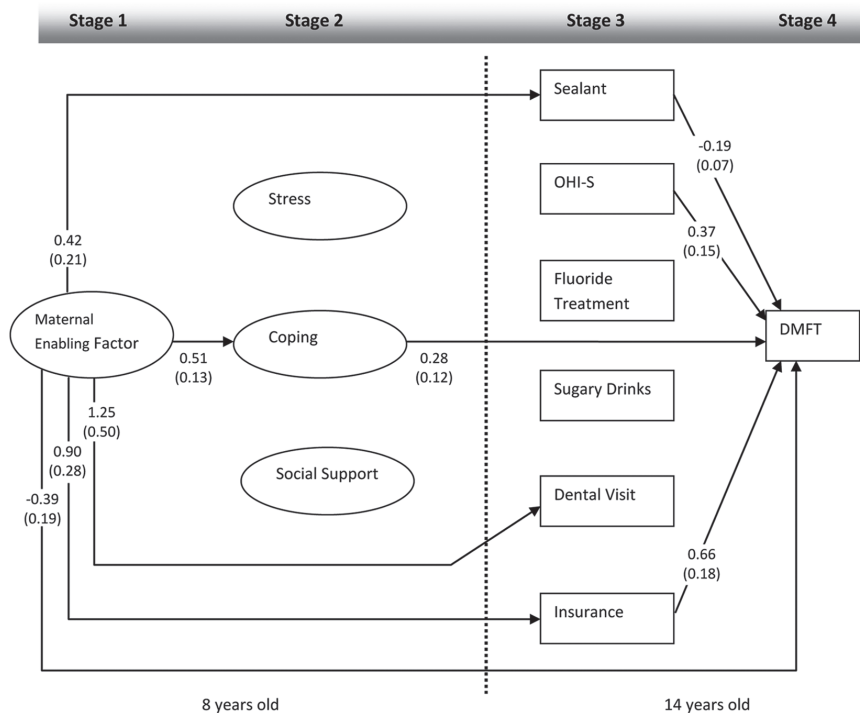

Figure 2. Structural equation model of the effects of maternal psychosocial factors at age 8 yrs on caries extent (mean DMFT) at age 14 yrs. Only SES was adjusted for stage 1. Gender, race, SES, and birth group were adjusted for stages 2-4. Arrows denote the presence of a statistically significant (p < 0.05) relationship. Estimated β-coefficients with the standard errors for the estimates (in parentheses) are displayed. The latent variables (MEF, Stress, Coping, and Social support) were derived by confirmatory factor analysis.

a significant predictor for adolescent caries through mediation was not supported by the data. However, there were key findings indicating the temporal pathway by which maternal factors influence later adolescent dental outcomes: (1) Longitudinally, early MEF (education, cognitive ability, psychological distress) predicts adolescent-level caries experience through a potential pathway in which psychosocial stress and coping are important factors influencing dental preventive behavior and access. Thus, poor maternal factors have a cumulative impact on future caries experience. (2) Cross-sectionally, caries experience is predicted by adolescent-level prevention behaviors, as well as through MEF factors influencing dental insurance. However, the mediating influence of stress and coping disappears with concurrent analysis. (3) Social support at an early age is independently related to adolescent caries experience. These results are consistent with the existing social ecological approach (Patrick *et al*., 2006; Fisher-Owens *et al*., 2007). Because of the use of latent variables for MEF and psychosocial factors, we are unable to make comparisons with previous studies.

Effect of MEF on Dental Outcomes

Our findings indicate that mothers with higher MEF when the child was 3 yrs of age were associated with higher number of sealants, better oral hygiene, and greater odds of dental visits, having dental insurance, and fluoride treatments at adolescence. We speculate that mothers with better intrinsic ability are more attentive to the oral hygiene and dental access needs of their children, which may prevent caries development from a young age. Interestingly, in all models, MEF was consistently related both directly and indirectly (through dental insurance) to adolescent mean DMFT. Other studies have shown that parental educational levels used independently are associated with child's dental access and tooth decay in later years (Harris *et al*., 2004). Also, kindergarten children whose mothers had depression were twice as likely to lack routine dental visits and to have a lower brushing frequency (Kavanaugh *et al.*, 2006). In all models, dental visits did not predict DMFT, but having insurance predicted a higher mean DMFT. It is likely that having dental insurance stimulated more dental visits through which the adolescent had a higher likelihood of receiving treatment for caries.

Effect of MEF on Psychosocial Factors and Dental Outcomes

Mothers with lower MEF had higher stress and poorer coping skills, and these were important mediators for dental outcomes during younger ages. However, higher stress at age 3 yrs resulted in increased odds of adolescent dental visits. It is likely that highly stressed mothers may be more vigilant to a young child's health care needs (Litt *et al.*, 1995), resulting in increased dental visits. In our study, stress was not further associated with adolescent caries at any age, which is similar to the findings of a prior study (Quinonez *et al.*, 2001). Better mother/caregiver coping when the child was 3 yrs resulted in decreased odds of the child's having fluoride treatments. The unexpected result with fluoride treatment was probably due to poor parental recall or subject to social desirability bias, since this factor was not measured from dental records. Among the psychosocial factors, better coping and social support resulted in higher and lower mean DMFT, respectively. To our knowledge, literature is lacking regarding the role of maternal coping in prediction of childhood caries. Latino mothers with social support from family or friends had three times greater likelihood of utilizing dental services for their children (Nahouraii *et al*., 2008). We speculate that mothers with better coping skills and social support are better adapted to parenting stress, thus affecting adolescent caries.

An important strength of this study is that the temporal order between MEF and adolescent caries can be established for the ages 3- and 8-year models. The limitations of the study are that: questionnaire responses may not have captured behaviors such as cariogenic drink consumption; some of the associations found could be affected by unmeasured confounders; other possible models could fit our data better; and causal inferences rely on the assumption of sequential ignorability, *i.e*., no unmeasured confounder was not completely met. However, we included most known and suspected confounders.

This study identifies early intrinsic ability of the mother as an important predictor of subsequent caries experience, but the psychosocial factors had a limited role in this pathway. More longitudinal research is necessary to assess if these maternal enabling factors have an effect on caries from an early age. Also, research is needed into the best ways to support parents with poor enabling factors to address oral health issues for their child.

ACKNOWLEDGMENTS

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