Dental Service Utilization and Neighborhood Characteristics in Young Adults in the United States: A Multilevel Approach

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Abstract

Objective: To investigate the association between neighborhood level factors and dental visits in young adults in the United States after adjusting for individual level factors.

Methods: The National Longitudinal Study of Adolescent Health Wave 1 (1994–1995) to Wave III (2001–2002) was analyzed. The primary outcome of having had at least one dental visit in the previous 12 months was analyzed via a multilevel random-effects logistic model accounting for geographic clustering in Wave III and survey design clustering from Wave I. Neighborhood level covariates were defined at the census tract level.

Results: Overall dental visits was 57%, highest amongst 18–20 year olds (65%) and lowest in 23–26 year olds (52%). Increased proportion of African-Americans (5% to 20%) and Hispanics (5% to 20%) in a neighborhood corresponded with a decrease in dental visits (60% vs. 52%) and (58% vs. 51%) respectively. Neighborhoods with a high proportion of college-educated residents reported increased dental visits. Similar differences were found when comparing the lowest and highest tertiles defined by poverty level and unemployment with dental visits. Neighborhood education was significantly associated with dental service utilization after adjustment for individual level factors and dental utilization in adolescence (Waves I and II) in the random effects model.

Conclusion: This study demonstrates that the education level of residents within a neighborhood was associated with dental service utilization in young adults in the United States.

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Keywords

Adolescence; Dental visit; adulthood; life-course

INTRODUCTION

The association of person level factors such as race/ethnicity, age, gender, income, insurance, and education on health services utilization based on the Andersen's behavioral model of health services[1–4] has dominated the dental literature for a number of years. It is important to recognize that health care utilization and access has shifted from a strictly person-level focus to a focus on a combined mix of persons, the health care system, neighborhood and the effects of these factors on one another.[5–7] In addition, there is a growing body of research in social sciences and medicine that documents how neighborhood conditions affect self-perception of general health by influencing health behaviors, promoting diffusion of health related information and increasing the adoption of healthy normative behaviors.[5–7]

Neighborhood related factors are important determinants of health services utilization and public policy. Neighborhood conditions are products of government policy, corporate investment decisions and political power imbalances which tend to favor some neighborhoods and harm others. In addition, neighborhoods tend to be defined by socioeconomic status and race/ethnicity, which can give rise to neighborhood health differences along similar constructs.[8] One study indicated that neighborhood socioeconomic conditions have been associated with self-rated oral and general health, and account for some racial/ethnic differences identified in adults.[9] Sheiham and Watt reported that individual behaviors are largely determined by the conditions in which people live.[10]

Studies have also shown that habits formed in the earlier years of a person's lifespan tend to affect their healthcare choices in later years.[11] Our study examined the relationship between neighborhood level factors and dental visits in young adults in the United States, using a multi-level approach. We expect that a better understanding of neighborhood effects in dental service utilization by young adults will be helpful for policy development and early intervention.

METHODS

Data Source, Sampling and Design

We used data from the National Longitudinal Study of Adolescent Health (Add Health), which is the largest and most comprehensive nationally representative sample of adolescents in the United States. The database contains information on adolescents and their transition to adulthood based on three in-home interviews. Add Health used a school-based design with schools as the primary sampling units. They derived the primary sampling frame from the Quality Education Database. From this frame, a stratified sample of 80 high schools (defined as schools with an 11th grade and more than 30 students) with probability proportional to size were selected. Schools were stratified by region, urbanicity, school type (public, private,

parochial), ethnic mix, and size. For each high school selected, they identified and recruited one of its feeder schools (typically a middle school) with probability proportional to its student contribution to the high school, yielding one school pair in each of the 80 different communities.[12] More than 70 percent of the originally selected schools agreed to participate in the study. Replacement schools were selected within each stratum until an eligible school or school-pair was found. Overall, 79 percent of the schools that were contacted agreed to participate in the study. Since some schools spanned grades 7 to 12, a total of 132 schools were in the sample, and each associated with one of 80 communities. School size varied from fewer than 100 students to more than 3,000 students, and the communities were located in urban, suburban and rural areas of the country."[12] Add Health subjects completed in-school questionnaires and a 90-minute in-home interview. Core and special supplemental samples were used. The core in-home sample is essentially self-weighting, and provides a nationally representative sample of 12,105 American adolescents in grades 7 to 12.[12]

Study Design

Our analysis was mainly based on data from Wave III (2001–2002) of the National Longitudinal Study of Adolescent Health (Add Health). Add Health Wave III was a follow-up interview with original Wave I respondents as they entered the transition to adulthood.[12] Wave III data collection was conducted nationwide (including Hawaii and Alaska) between August 2001 and April 2002.[12] Respondents were aged 18–26 and in the midst of the transition to adulthood. Add Health completed interviews with 15,170 respondents at Wave III, resulting in a 76% response rate. Wave III in-home interviews allowed researchers to map early trajectories out of adolescence in health and economic status and to document how adolescent experiences and behaviors are related to health outcomes in the transition to adulthood. A detailed description of the study design is available in an earlier articles published.[12,13]

Measures:

Individual level variables: The primary outcome was having had at least one dental visit in the previous 12 months as reported at Wave III. While this study focuses on the effect of neighborhood-level factors on dental utilization, to minimize residual confounding we attempted to include a wide range of individual level predictors into the model. These covariates were selected based on findings in a previous study by Okunseri et al 2013[14]. Okunseri et al showed that in addition to demographics, dental utilization by young adults is associated by both current and adolescent socio-economic circumstances.[14] Covariates collected at the Wave III interview included age, gender, race/ethnicity, current household income, health insurance, and highest level of education. Additional covariates relevant to experiences during adolescent years were collected at Wave I; we included household income during adolescence, parental education levels, and dental utilization at waves I and II during adolescence. Race and ethnicity were self-designated under the following categories: White, African-American, Asian or Pacific Islander, American Indian or Native American, and Other for race and having Hispanic or Latino origin versus not for ethnicity. Multiracial respondents were asked to identify a category that best described their racial background. We combined race and ethnicity into one variable, and collapsed categories with low numbers to increase the stability of estimates. In addition, we placed all subjects

who indicated their ethnicity as Hispanic into the Hispanic group, and participants of unknown race were included in the 'Other' group. Our final groups were Whites, African Americans, Hispanics, Asians, and Other.

Household income was defined as pre-tax income during the previous year from all sources in the household in which the participant resided. Exact answer options offered varied between waves, so we grouped the answers into four categories that were well defined in every wave with cutoffs of $30,000, $50,000, and $75,000 per year used. Current educational attainment information was collected for respondents at Wave III, while maternal and paternal education was collected at Wave I only. As for household income, the answers were grouped to provide consistent definitions for all the educational variables. Subjects without a high school diploma or GED were assigned to the "less than high school" category, those with such diplomas but without a college degree (but potentially with some college-level education) were assigned to the "high school" category, those with a college degree but no post-graduate or professional degree were assigned to the "college" category, and parents/participants with a post-graduate or professional degree made up the "beyond college" category. Since parental education was collected only for parents living with the adolescent, a "No resident parent" category was added to the parental education variables to capture such instances. Health insurance information was obtained at Wave III and was categorized as 'No insurance', 'Medicaid', 'Private insurance', 'Other insurance', or 'Unknown'. Information on dental insurance was not collected by Add Health and therefore not included in our analysis. History of utilization of dental services was collected at Waves I and II, and recoded as having had a dental visit within the previous 12 months to mirror the primary outcome.

Neighborhood level variables: Neighborhood level covariates were defined using the 2000 census data at the census tract level. For each individual the census tract was identified based on current residence during the Wave III interview. In parallel with the individual level covariates, we included indicators of neighborhood racial composition, education, and socio-economic status. Racial composition was measured using two variables indicating the proportion of African American residents and proportion of residents of Hispanic origin. Neighborhood education level was quantified as the proportion of residents age 25+ without a high school diploma. Socio-economic status was measured by the unemployment rate and a composite poverty index. Factor analysis was used to combine six poverty indicators: proportion of tract population, families, and households under the poverty level, proportion of households receiving public assistance, proportion of female-headed households with children, and proportion of occupied households without telephone. There was strong support for one underlying factor (Cronbach α=0.88) with approximately equal loadings. Thus the poverty index was defined as the average of the six measures.

Analytical approach

We performed descriptive statistics and counts were reported as both the actual frequencies among the survey respondents and as weighted frequencies representing the estimated counts in the entire population from which the respondents were sampled. These are reported with standard errors. We analyzed the data via a multilevel random-effects logistic

model accounting for geographic clustering in Wave III (census tracts nested within counties nested within states) and survey design clustering from Wave I. As pointed out by a reviewer, adolescent dental utilization can be considered as intermediate outcome, mediating the effect of some of the individual and neighborhood level covariates on the primary outcome. Thus we present analyses both including and excluding these two predictors. All analyses were adjusted for the survey design using weights that accounted for loss to follow-up from Wave I to Wave III. The analyses were performed in SAS 9.3, using the Surveyfreq procedure for descriptive statistics, and the Surveylogistic procedure for logistic regression (SAS Institute, Cary, NC.) The effect of neighborhood-level covariates was expressed as change from the 5th to the 95th percentile in the study population to allow comparisons between effect sizes of different predictors. All model estimates are reported with 95% confidence intervals. The Institutional Review Boards of Marquette University and the Medical College of Wisconsin approved this study.

RESULTS

Descriptive statistics

Table 1 represents the study population characteristics including reported dental examinations at Waves III by frequency, weighted frequencies, percent and standard errors. A total of 5,341 participants representing 9,376,736 adolescents to young adults aged 18–26 years old in 2001–2002 participated in Wave III. In Wave III, approximately 57.4% of the study population reported having had a dental examination in the previous 12 months. The largest group of subjects (33%) was those aged 21–22 years and the lowest (28%) was those 23–26 years. Slightly more females (51%) than males (49%) participated in the study and a higher proportion had a high school diploma (74%). Dental examination was highest amongst 18–20 year olds (65%) and lowest in 23–26 year olds (52%). More females (59%) reported having dental examination than males. Majority of the study population were Whites (69%) followed by African Americans (15%) and Hispanics (12%) respectively. The groups with the highest percent of dental examination were Asians at 62% followed by non-Hispanic Whites (61%).

As the proportion of African Americans and Hispanics increased in a neighborhood, there was a corresponding decrease in the proportion of residents with a reported dental examination. (60% and 58% to 52% and 51%) for <5% and >20% respectively. As the proportion of subjects without a high school diploma in a neighborhood increased, the proportion with reported dental examination decreased. Similar patterns were seen when comparing the lowest and highest tertiles defined by poverty level and unemployment.

Multivariable logistic regression

Table 2 shows the results for the hierarchical logistic regression models for dental examination in Wave III based on the fixed and random effects. We considered three models with successive additions of neighborhood-level predictors: first adding only indicators racial composition, then socio-economic status, and finally education. An additional model including all neighborhood-level predictors but not adjusting for dental service utilization during adolescence was fitted to eliminate the potential mediating effect of

this intermediate outcome. After adjusting for individual level factors including sex, race/ethnicity, age, current and adolescent household income, health insurance status, self and parental education, and dental utilization in adolescence (Waves I and II) in the random effects model, neighborhood race/ethnicity composition, unemployment, and poverty were not significantly associated with dental visits in young adulthood. The educational level of the neighborhood was significantly associated with reported dental examination, with an estimated OR=0.69 (95% CI: 0.51 – 0.93) for comparing two hypothetical neighborhoods at the 5th and 95th percentile of residents age 25+ without high school diploma. The addition of the neighborhood-level predictors did not appreciably change the size of the individual effects as demonstrated by the essentially identical coefficients across Models 1– 3. Even adding the statistically significant neighborhood education level in Model 3 only slightly attenuated the effect of individual education level. Omitting the potential intermediate outcomes of dental examinations during adolescence in Model 4 lead to a slightly stronger effect of neighborhood education, and more pronounced effects of wave I demographic characteristics, however the results are qualitatively unchanged.

For completeness, Table 2 also lists estimates of the standard deviation attributable to each level of clustering in the data: primary sampling unit and tract, county, and state of residence during young adulthood. While inclusion of these effects is important for proper estimation of the impact of neighborhood-level predictors, the Add Health study design, these estimates are not readily interpretable. First, there is relatively little clustering of subjects at the census tract and county levels - almost 70% of the tracts are represented by only one person. Second, the primary sampling unit is also geographically based, and many of the subjects who live in the same census tract or county in wave III are also in the same primary sampling unit. Thus the low variability estimates at tract and county level should not be interpreted as lack of effects.

DISCUSSION

Numerous studies on the association of neighborhood characteristics on general health in medicine, sociology, and psychology have continued to be refined based on recent theoretical approaches.[5–7, 15–19]. One report stated that where and with whom individuals live may directly affect their health status, health-related behavior, health needs, and health services use because of the potential impact of these variables on financial stability and stress.[20] This increased awareness that neighborhoods influence several health outcomes independent of person level factors has received little attention relative to dental service use. This study expands the literature on the relationship between dental service utilization and neighborhood characteristics of young adults in the United States.

First, we examined the prevalence of dental examinations in young adults as well as the distribution by different demographic factors. We found that over fifty percent of young adults reported having had a dental examination. While this finding potentially relates to individual level factors, it is important to note that individual oral health is not influenced by individual characteristics alone, but also by contextual characteristics. Leyland and colleague indicated that neighborhood influences act either directly or indirectly by influencing individual behavior or coping strategies.[21]

Secondly, we examined the distribution of dental examinations in young adults by different demographic factors. We found that the percentage of individuals with a dental examination was highest amongst 18–20 year olds and lowest among 23–26 year olds. This finding is somewhat consistent with that reported by the Medical Expenditure Panel survey which indicated that over fifty percent of adolescents up aged 20 years had at least one dental visit in the year 2004, and that this remained virtually unchanged from the 51 percent reported in 1996.[22, 23] In our analysis, the percentage of females with dental examination was higher than that of males. This finding is consistent with what has been reported in the literature for many years,[24, 25], and reflects what is often reported and seen in clinical settings.

Third, we recognize that individual characteristics only explain some of the individual differences identified by demographic factors and that neighborhoods could influence the health care system and health.[26] Neighborhood characteristics, such as poverty, racial/ethnic composition and educational attainment, which can be obtained from US Census estimates, have hitherto received limited attention from dentistry. We investigated the association of neighborhood characteristics (e.g., education level, unemployment rate, proportion of African Americans or Hispanics, and poverty rate) on dental visits in young adults in the United States after adjusting for individual level factors. In our study, we found that after taking into account individual characteristics in the random effect model, only the educational level of a neighborhood was significantly associated with reporting a dental examination. This finding reflects the fact that neighborhood environments may be associated with the use of dental services through a variety of mechanisms. One simple mechanism could be differences in the educational levels of residents in a particular neighborhood. Neighborhoods provide a place for social interaction, exchange of cultural values, and development of positive oral health habits. It is important to note that dental public health and health promotion activities occur in individuals within their neighborhood. Our findings suggest a need for continuous health education and promotion activities to help sustain or improve upon the dental service utilization of young adults in their neighborhood.

Another interesting finding in our descriptive statistics was that as the proportion of subjects without a high school diploma in a neighborhood increased, there was a corresponding decrease in the proportion of subjects with reported dental examinations. Similar patterns were identified when comparing the lowest and highest tertiles defined by poverty level and unemployment. Tellez et al. examined the relationship between neighborhoods and the severity of dental caries among low-income African-Americans and concluded that neighborhoods contribute something unique to caregivers' oral health, beyond socioeconomic position and individual risk factors.[27] Turrell et al. examined the association between neighborhood disadvantage and individual-level socioeconomic position on self-reported oral health in adults age 43–57 in Australia, and concluded that the socioeconomic characteristics of neighborhoods are important for oral health over and above the socioeconomic characteristics of the people living in those places.[28]

Neighborhood characteristics including socioeconomic conditions have been associated with self-rated oral and general health, and account for some of the racial/ethnic differences identified in adults.[28,] Neighborhoods tend to follow a pattern along lines of socioeconomic

status and race/ethnicity,[9] and this pattern gives rise to neighborhood health differences and service utilization along similar lines. In our study, we did not find a significant association between having a dental examination and neighborhood levels of unemployment, poverty status and race/ethnicity after adjusting for individual predictors. This finding is not consistent with literature evidence.[29,30] However, we believe that the differences between these studies could be related to differences in the research question, analytic approach, study design such as the actual questions for data collection, as well as the unique ability of this study to adjust for predictors from adolescence.

Certain potential limitations of our study should be noted. First, the study used self-reported dental examination information and the responses from the survey could not be validated. Second, a school-based design was used with schools as the primary sampling units. This could limit the opportunity to gather information from other young adults who were not adolescents in the schools at the time of data collection, and could possibly limit the generalizability of our findings to all young adults. Additionally, participants who lived in the same neighborhood during young adulthood often belong to the same school-based primary sampling unit, thus direct estimates of variability are confounded. There was also a lack of information about whether respondents had dental insurance. Finally, omitted variable bias is another possible limitation in our study. In conclusion, our study demonstrates that the education level of residents within a neighborhood was associated with dental service utilization among young adults in the United States. Understanding oral health behaviors of young adults and their relationships to neighborhoods is important for early intervention as well as for program and policy development.

ACKNOWLEDGEMENTS

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Table 1:

Descriptive Statistics for Study Population Characteristics: 2001–2002

Predictor	Frequency	Weighted Frequency	Weighted Population percent (SE)	Weighted Dental exam percent (SE)
Overall				57.4 (1.2)
Age group				
18–20 years	1,585	3,502,938	33.1 (3.4)	64.8 (1.7)
21–22 years	2,104	3,484,027	38.7 (1.5)	55.1 (1.6)
23–26 years	1,652	2,389,771	28.2 (2.1)	51.9 (1.6)
Sex				
Female	3,007	4,944,819	51.3 (0.7)	59.0 (1.2)
Male	2,334	4,431,916	48.7 (0.7)	55.7 (1.5)
Race/Ethnicity				
Asian	375	336,058	3.3 (0.7)	62.4 (2.7)
Hispanic	739	929,245	11.5 (1.7)	49.5 (2.2)
African Americans	934	1,109,397	14.7 (2.0)	46.3 (1.9)
Other	82	126,080	1.5 (0.3)	50.5 (5.5)
Non-Hispanic White	3,211	6,875,955	69.0 (2.8)	61.0 (1.3)
Education				
Beyond college	85	123,870	1.2 (0.2)	60.9 (6.6)
College	805	1,186,385	10.3 (1.0)	70.4 (2.0)
High school	4,018	7,152,071	73.6 (0.9)	59.5 (1.2)
Less than high school	432	908,385	14.9 (0.9)	37.4 (1.7)
Father's Education				
Beyond college	570	932,038	7.7 (0.9)	76.9 (2.1)
College	929	1,698,445	15.5 (1.0)	70.0 (1.8)
High school	1,880	3,489,536	37.9 (1.4)	58.8 (1.2)
No resident parent	1,261	2,085,783	27.6 (1.3)	48.5 (1.5)
Less than high school	482	818,183	11.3 (0.9)	46.2 (2.3)
Mother's Education				
Beyond college	517	785,422	6.9 (0.7)	72.6 (2.5)
College	1,206	2,022,468	18.6 (1.1)	69.4 (1.6)
High school	2,589	4,809,423	54.5 (1.4)	56.4 (1.2)
No resident parent	214	376,257	4.7 (0.4)	51.8 (3.4)
Less than high school	639	1,076,126	15.3 (1.1)	45.1 (1.8)
Household Income				
Less than $29,999	2,541	4,583,678	58.9 (1.2)	53.4 (1.5)
$30,000 to $49,999	795	1,311,121	16.6 (0.7)	54.2 (1.8)
$50,000 to $74,999	615	1,091,986	11.7 (0.6)	64.0 (2.3)
$75,000 or more	756	1,311,628	12.8 (0.8)	70.0 (1.9)
Insurance				
Medicaid	245	418,613	6.1 (0.5)	42.0 (2.6)

Predictor	Frequency	Weighted Frequency	Weighted Population percent (SE)	Weighted Dental exam percent (SE)
None	782	1,468,035	24.7 (0.9)	36.4 (1.4)
Private	4,259	7,381,735	67.9 (1.2)	66.5 (1.1)
Unknown	55	108,351	1.3 (0.2)	52.9 (6.8)
Wave III: Tract African Americans				
0% − 5%	2,811	5,228,650	55.0 (2.6)	59.7 (1.3)
5% − 20%	1,283	2,136,096	24.0 (1.6)	56.1 (1.7)
20% − 100%	1,118	1,748,133	21.0 (2.2)	52.2 (2.3)
Wave III: Tract Hispanic				
0% − 5%	2,971	5,916,005	64.5 (2.8)	57.6 (1.5)
5% − 20%	1,240	2,062,669	21.7 (1.9)	59.8 (1.6)
20% − 100%	1,001	1,134,205	13.9 (2.0)	51.3 (1.9)
Wave III: Tract Low Education				
0% − 13%	1,985	3,734,039	35.6 (2.1)	65.8 (1.4)
13% − 23%	1,594	2,966,932	33.2 (1.9)	56.3 (1.4)
23% − 81%	1,633	2,411,908	31.3 (2.3)	48.5 (1.5)
Wave III: Tract Poverty Index				
0 – 0.07	1,855	3,358,772	32.5 (2.0)	64.9 (1.3)
0.07 – 0.14	1,981	3,369,823	37.9 (1.6)	55.9 (1.5)
0.14 – 0.55	1,375	2,382,666	29.6 (2.1)	50.5 (1.6)
Wave III: Tract Unemployment				
0% − 3.5%	1,318	2,550,437	24.7 (1.8)	64.8 (1.6)
3.5% − 6.5%	2,014	3,610,227	38.7 (1.7)	58.6 (1.4)
6.5% − 87%	1,880	2,952,214	36.6 (2.3)	50.7 (1.4)

Table 2:

Hierarchical Logistic Regression Models for dental examination in Wave III: Fixed and Random Effects

Group	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)	Model 4 Odds Ratio (95% CI)
		Fixed Effects		
Age Group				
16–18 years	1.47 (1.26 – 1.73) ***	1.48 (1.26 – 1.73) ***	1.48 (1.26 – 1.73) ***	1.55 (1.32 – 1.81) ***
19–22 years	1.14 (1.00 – 1.30)	1.14 (1.00 – 1.30)	1.13 (0.99 – 1.29)	1.19 (1.05 – 1.36) **
23–26 years	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Sex				
Female	1.18 (1.06 – 1.33) **	1.18 (1.06 – 1.33) **	1.19 (1.06 – 1.33) **	1.23 (1.10 – 1.38) ***
Male	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Race/Ethnicity				
Asian	1.17 (0.86 – 1.58)	1.16 (0.86 – 1.57)	1.16 (0.86 – 1.57)	1.10 (0.81 – 1.49)
Hispanic	1.00 (0.81 – 1.23)	1.00 (0.81 – 1.23)	0.98 (0.79 – 1.20)	0.93 (0.75 – 1.14)
African Americans	0.78 (0.64 – 0.96) *	0.78 (0.64 – 0.96) *	0.77 (0.63 – 0.95) *	0.69 (0.56 – 0.84) ***
Other	0.92 (0.60 – 1.43)	0.93 (0.60 – 1.44)	0.93 (0.60 – 1.43)	0.92 (0.60 – 1.42)
Non-Hispanic White	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Wave I: Dental Examination				
Yes	1.63 (1.42 – 1.87) ***	1.63 (1.42 – 1.87) ***	1.62 (1.41 – 1.85) ***	-
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	
Wave II: Dental Examination				
Yes	1.56 (1.36 – 1.79) ***	1.56 (1.36 – 1.80) ***	1.56 (1.36 – 1.79) ***	-
No	1.0 (reference)	1.0 (reference)	1.0 (reference)	
Wave III: Education				
Beyond college	1.69 (1.04 – 2.74) *	1.69 (1.04 – 2.76) *	1.63 (1.00 – 2.66) *	1.74 (1.08 – 2.83) *
College	1.85 (1.44 – 2.38) ***	1.85 (1.44 – 2.38) ***	1.80 (1.40 – 2.32) ***	1.95 (1.53 – 2.50) ***
High school	1.41 (1.18 – 1.70) ***	1.41 (1.18 – 1.70) ***	1.40 (1.17 – 1.68) ***	1.46 (1.22 – 1.75) ***
Less than high school	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Father's Education				

Group	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)	Model 4 Odds Ratio (95% CI)
Beyond college	1.04 (0.77 – 1.40)	1.03 (0.76 – 1.40)	1.01 (0.74 – 1.36)	1.13 (0.84 – 1.52)
College	1.00 (0.78 – 1.28)	1.00 (0.78 – 1.28)	0.98 (0.77 – 1.26)	1.08 (0.85 – 1.38)
High school	0.97 (0.79 – 1.19)	0.97 (0.79 – 1.19)	0.97 (0.79 – 1.19)	1.03 (0.84 – 1.26)
No resident parent	1.05 (0.85 – 1.29)	1.05 (0.85 – 1.29)	1.03 (0.84 – 1.27)	1.09 (0.89 – 1.34)
Less than high school	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Mother's Education				
Beyond college	1.29 (0.97 – 1.72)	1.30 (0.98 – 1.72)	1.26 (0.95 – 1.68)	1.38 (1.04 – 1.82) *
College	1.31 (1.06 – 1.64) *	1.32 (1.06 – 1.64) *	1.29 (1.03 – 1.60) *	1.37 (1.11 – 1.70) **
High school	1.04 (0.87 – 1.25)	1.04 (0.87 – 1.25)	1.03 (0.87 – 1.24)	1.10 (0.92 – 1.31)
No resident parent	1.17 (0.85 – 1.62)	1.17 (0.85 – 1.61)	1.15 (0.84 – 1.59)	1.14 (0.83 – 1.57)
Less than high school	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Wave I: Household Income				
$75,000 or more	1.32 (1.06 – 1.63) *	1.31 (1.06 – 1.63) *	1.29 (1.04 – 1.60) *	1.49 (1.21 – 1.85) ***
$50,000 to $74,999	1.32 (1.11 – 1.57) **	1.32 (1.11 – 1.57) **	1.30 (1.10 – 1.55) **	1.47 (1.24 – 1.74) ***
$30,000 to $49,999	1.05 (0.90 – 1.22)	1.05 (0.90 – 1.22)	1.04 (0.89 – 1.21)	1.12 (0.97 – 1.30)
Less than $29,999	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Wave III: Household Income				
$75,000 or more	1.46 (1.22 – 1.75) ***	1.46 (1.21 – 1.76) ***	1.49 (1.24 – 1.79) ***	1.50 (1.25 – 1.81) ***
$50,000 to $74,999	1.33 (1.11 – 1.59) **	1.33 (1.11 – 1.59) **	1.35 (1.13 – 1.62) **	1.33 (1.11 – 1.59) **
$30,000 to $49,999	1.02 (0.88 – 1.18)	1.02 (0.87 – 1.18)	1.03 (0.88 – 1.19)	1.03 (0.89 – 1.20)
Less than $29,999	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Wave III: Insurance				
Private	2.33 (2.03 – 2.68) ***	2.34 (2.03 – 2.68) ***	2.32 (2.01 – 2.66) ***	2.31 (2.01 – 2.65) ***
Medicaid	1.38 (1.06 – 1.79) *	1.37 (1.06 – 1.79) *	1.38 (1.06 – 1.79) *	1.35 (1.04 – 1.75) *
Other/Unknown	2.12 (1.22 – 3.69) **	2.13 (1.22 – 3.70) **	2.11 (1.21 – 3.67) **	1.98 (1.15 – 3.40) *
None	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
Region				
West	0.74 (0.57 – 0.97) *	0.75 (0.57 – 0.98) *	0.72 (0.55 – 0.94) *	0.69 (0.52 – 0.91) **
Midwest	0.75 (0.59 – 0.95) *	0.75 (0.59 – 0.95) *	0.74 (0.58 – 0.94) *	0.73 (0.56 – 0.94) *

Group	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)	Model 4 Odds Ratio (95% CI)
South	0.76 (0.60 – 0.96) [*]	0.76 (0.60 – 0.97) [*]	0.77 (0.61 – 0.98) [*]	0.73 (0.57 – 0.93) [*]
Northeast	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)
		Random Effects [1]		
Wave III: Tract African Americans	0.95 (0.75 – 1.20)	0.95 (0.73 – 1.25)	0.98 (0.75 – 1.29)	1.00 (0.77 – 1.31)
Wave III: Tract Hispanic	0.89 (0.74 – 1.08)	0.90 (0.73 – 1.10)	1.08 (0.84 – 1.39)	1.10 (0.86 – 1.42)
Wave III: Tract Poverty	-	1.10 (0.85 – 1.42)	1.27 (0.96 – 1.68)	1.28 (0.97 – 1.70)
Wave III: Tract Unemployment	-	0.89 (0.74 – 1.06)	0.89 (0.74 – 1.06)	0.88 (0.74 – 1.05)
Wave III: Tract Low Education	-	-	0.69 (0.51 – 0.93) [*]	0.63 (0.47 – 0.86) [**]
		Standard Deviation		
Wave I: School ID	0.08	0.08	0.08	0.11
Wave III: Tract	0.00	0.00	0.00	0.00
Wave III: County	0.04	0.04	0.06	0.00
Wave III: State	0.15	0.15	0.14	0.17

Statistical significance: '***', <0.001; '**' <0.01; '*' <0.05

[1] Random effects are quantified as the odds ratio corresponding to moving between the 5th and 95th percentiles of the predictor

Four models shown differ by which context variables are included

Model 1 – demographics (proportion of African Americans, proportion of Hispanic)

Model 2 – demographics + SES (Poverty index, unemployment rate)

Model 3 – demographics + SES + Education (proportion Age 25+ without HS)

Model 4 – demographics + SES + Education, no adjustment for adolescent dental examination.