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Race/ethnicity and untreated dental caries: the impact of material and behavioral factors

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Abstract – *Objective:* To use nationally representative data, group variables into categories of material and behavioral factors, and assess their relative contribution to racial/ethnic variation in untreated caries. *Methods:* Participants were from the Third National Health and Nutrition Examination Survey (NHANES III), aged 20–50 years. Material factors were income, education, employment status, dental insurance status, and urban residence. Behavioral factors were marital status, tobacco use, alcohol use, obesity, and social support. All models were additionally adjusted for age, gender, and quartile of missing teeth. The outcome was three or more carious teeth. *Results:* Non-Hispanic blacks and Mexican-Americans displayed excess risk of untreated caries compared with non-Hispanic whites when adjusted for age, sex, and missing teeth (adjusted odds ratios 1.73 and 1.69, respectively). The addition of behavioral factors to this model resulted in virtually no changes in the adjusted odds ratios for race/ethnicity and untreated caries. When material factors were added to the basic model the excess risk for untreated caries among non-Hispanic blacks was reduced by approximately 21% and that of Mexican-Americans was no longer statistically significant compared with non-Hispanic whites (adjusted odds ratios 1.36 and 0.83, respectively). *Conclusions:* Much of the excess risk for untreated dental caries among non-Hispanic blacks and Mexican-Americans compared with non-Hispanic whites was eliminated when material factors were controlled, while no risk reductions were observed when behavioral factors were controlled. Addressing material factors may provide greater reductions in untreated caries disparities than behavioral interventions, and these risk reductions may vary with racial/ethnic group.

Key words: dental caries; ethnicity; NHANES III; race

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There is substantial evidence of disparities in untreated dental caries between racial/ethnic groups in the USA (1–3). Such findings were given emphasis in the recent U.S. Surgeon General's report on oral health (4) and subsequent 'call to action'. The construct of race/ethnicity has found wide use in examining differences in health status and medical outcomes in the USA, with oral health and specifically untreated dental caries being no exception. Although it has limitations (5–7), the race/ethnicity construct has proved critical for identifying the unequal distribution of disease burden. However, in order to move beyond simply identifying disease burden and toward the development of interventions, pathways through which race/ethnicity may mediate its effects need to be explored.

Several conceptual approaches to explore health disparities have been applied in past reports. Income, education, and access to care have all been reported to be associated with untreated caries and race/ethnicity, and may help explain at least some of the disparities in disease burden (2, 8, 9). These and other potential explanatory factors for

disparities in untreated caries may arise from each other. For example, education may predict income which in turn may predict access to care and influence untreated caries prevalence. They are not, therefore, mutually exclusive but rather have both direct and indirect effects on untreated caries.

Attempts to capture the effect of social deprivation on health outcomes, including dental caries, have resulted in the development of several indices. For example, the Jarman score, a composite of eight socioeconomic variables, was used to reveal that community water fluoridation had its greatest benefits among the most socially deprived (10). Such approaches are not without limitations and caveats. More recently, it was demonstrated that different indices, including the Jarman score, may have differing levels of explanatory power among different sample populations, further pointing out the complexity of issues involved in addressing social deprivation (11).

Another conceptual approach to examining these complex inter-relationships involves classifying variables as behavioral factors (observable actions) and material factors (material life circumstances or assets). For example in studies of heart disease, a health condition which also displays racial/ethnic disparities, behavioral factors like smoking and alcohol consumption may be partly the result of and response to, material factors such as income, housing, and unemployment (12, 13). Further distinguishing these conceptual groups, behavioral factors tend to be addressed at the individual level, have an extensive literature, and follow a medical intervention model. Material factors tend to be addressed on a community or societal level, be structural in nature, relatively resistant to change, and often call for political interventions. A detailed description of a similar conceptual approach can be found in Schrijvers et al. (14), where behavioral and material factors were used to explore variation in all-cause mortality.

Dental caries treatment implies that an individual recognize a need for care and have access to, and the financial capacity for, dental treatment. Because material and behavioral factors likely influence and shape each step of this process, this particular conceptual approach may benefit the exploration of disparities in untreated dental caries, helping to identify general areas where the greatest impact on untreated caries may lie.

The purpose of our study was to use nationally-representative data, apply a simple conceptual model used in other disparity research which classifies available variables into material and behavioral factors, and then assess the relative contribution of each group to racial/ethnic variation in untreated caries.

Methods

Population

The study population was drawn from participants in NHANES III. The background and oral health portion of NHANES have previously been described (15). NHANES III was a nationally representative survey that was conducted by the National Center for Health Statistics between 1988 and 1994. The survey targeted the US civilian, non-institutionalized population aged 2 months and older and used a stratified-multistage-probability sampling design (16). NHANES III was approved by the Institutional Review Board of the National Center for Health Statistics.

For the current study, participants were included if they were aged 20–50 years at the time of their interview. This age group was selected, in part, because of the high numbers of teeth at risk of caries relative to older age groups and relative autonomy compared with younger age groups to manifest the behavioral variables of interest. The race/ethnicity category 'other' was excluded from all analyses because many cell sizes were too small for reliable estimates of effect. Persons with missing data were more likely than persons with no missing data to be Mexican-American, 45.8% versus 31.2%, and have three or more carious teeth, 20.7% versus 14.6%, respectively. This may have resulted in a more conservative estimated association between Mexican-Americans and untreated caries than if complete data were available.

Examination

NHANES III participants completed a household interview and a health examination that included an oral health component. Demographic data, medical and smoking histories, and blood pressure values were obtained at the household interview. The oral health examinations were conducted by trained and calibrated dental examiners. Replicate examinations were conducted throughout the period of data collection to assess intra-examiner reliability. Inter-examiner reliability was measured by comparing examination results with those of a reference examiner. The coronal caries examination was conducted with a mirror and explorer by

calibrated examiners. Two examiners conducted approximately 85% of the examinations. Intra-examiner reliability of decayed surfaces, filled surfaces, and decayed or filled surfaces for these examiners ranged between 0.98 and 1.00 (3).

Variable selection

Variables were first classified as material or behavioral factors as required for our *a priori* conceptual model. This process was guided by the available literature. To achieve some assurance that the factors selected to capture our latent material and behavioral variables had validity, a correlation matrix was developed. Each variable was then assessed for whether they met the ideal of having moderate correlations with other variables in their group and low correlation with variables of the other group. Variables with very low within-group correlations were to be eliminated assuming they had low convergent validity while variables with very high within-group correlations were to be eliminated because they would add little to the model beyond collinearity. However, no initially selected variables were later eliminated due to a high correlation. The range of pair-wise correlations of the final variable groupings had an absolute value of at least 0.1 but no higher than an absolute value of 0.4.

Subsequent to initial grouping and assessment of their correlations within and between groups, as described above, five variables were selected as material factors and five as behavioral factors. The material factors were income based upon percentage of the federal poverty level, education based upon completing high school, employment status, dental insurance status, and living in an urban area. Behavioral factors included whether or not a person was currently living with a spouse or living as married to another adult, tobacco use, alcohol use, obesity as measured by the body mass index (BMI), and social support as captured by average number of visits with relatives or friends in a week. Some of the variables eliminated by the selection process, all for correlations below an absolute value of 0.1, were the ability to perform activities of daily living, persons per household, medical insurance status, Medicare status, and a recent physician visit. A recent dental visit variable was associated with the outcome but not used because it was not possible in this conceptual model to interpret whether a visit represented access issues (material factor), or health-seeking (behavioral factor).

A basic model was constructed to assess the association of race/ethnicity with untreated caries adjusted for age, gender, and quartile of missing teeth. 'Three or more untreated carious teeth' was selected as the outcome variable in order to provide an unambiguous indicator for persons clearly not receiving appropriate and timely dental care.

Analyses

The complex sampling design of NHANES III and the non-response and post-stratification adjustments resulted in unequal probabilities of selection for each participant. Final sample weights were used to produce unbiased population estimates based on the 1990 census estimate of the US population. Adjusted odds ratios were considered statistically significant when *P*-values derived from a Wald statistic were ≤0.05. Survey logistic regression models were used to produce weighted population estimates. The McFadden's R^2 is a statistic used with survey logistic regression and reported here to express the amount of variability explained by a given statistical model. Hosmer-Lemeshow goodness-of-fit was calculated using the un-weighted sample collapsed on quintiles of probability and 10 groups with *P*-values derived from a chi-square distribution with 8 degrees of freedom. The software package STATA (Version 7.0 College Station, TX, USA) was used for all calculations and analyses.

Results

Bivariate analyses indicate that non-Hispanic blacks, males, and persons in the highest quartile of missing teeth were more likely than their counterparts to have untreated caries (Table 1). Among the behavioral factors, persons who smoked cigarettes, consumed high levels of alcohol, or had a high BMI were more likely to present with untreated caries. Persons who visited with friends or relatives once or more per week or were married and living with their spouse or living as married were slightly less likely to present with untreated caries. Among the material factors, persons with a high school education, living in an urban area, with dental insurance, with employment, and having an income at least twice the federal poverty level were less likely to have untreated caries than their respective comparison groups.

Table 1. Untreated dental caries status by selected demographic characteristics

	Three or more carious teeth	Less than three carious teeth
Mean age (years)	$n = 1408$	$n = 7400$
	33.2	33.5
Race/ethnicity	$n = 1408$	$n = 7400$
Non-Hispanic black	46.6	31.7
Mexican-American	34.0	34.6
Non-Hispanic white	19.4	33.7
Sex	$n = 1408$	$n = 7400$
Female	49.8	54.8
Quartile of missing teeth	$n = 1408$	$n = 7400$
Highest 5–28	35.2	16.6
2–4	32.2	25.4
1	13.4	14.3
Lowest 0	19.2	43.7
Smoked 100 or more cigarettes	$n = 1408$	$n = 7400$
	56.2	45.9
Five or more alcohol drinks/day	$n = 1304$	$n = 7031$
	16.6	11.7
Body mass index ≥30 (obese)	$n = 1406$	$n = 7393$
	27.0	24.6
Sees friends/relatives more than once per week	$n = 1408$	$n = 7396$
	72.7	73.6
Currently living as married	$n = 1407$	$n = 7389$
	57.8	62.4
Lives in urban area	$n = 1408$	$n = 7400$
	49.3	54.5
High school education	$n = 1399$	$n = 7356$
	52.6	71.5
Employed	$n = 1240$	$n = 6790$
	70.7	80.8
Dental insurance	$n = 1362$	$n = 7216$
	28.4	46.4
Above 200% of federal poverty level	$n = 1272$	$n = 6820$
	26.9	51.6

Numbers expressed as column percentages except mean age.

Using multivariate analyses in a basic model (Table 2, model 1), non-Hispanic blacks and Mexican-Americans displayed excess risk of untreated caries compared with non-Hispanic whites after adjusting for age, sex, and quartile of missing teeth. The addition of the five behavioral factors obesity, tobacco use, alcohol use, marital status, and social support to the basic model resulted in virtually no changes in the adjusted odds ratios for race/ethnicity and untreated caries (Table 2, model 2).

Table 2. Adjusted survey odds ratios (OR) with 95% confidence intervals (95% CI) for the association between untreated dental caries and race/ethnicity

	Model 1 ($n = 8808$)	Model 2 ($n = 7190$)	Model 3 ($n = 8316$)	Model 4 ($n = 6812$)
Race/ethnicity				
Non-Hispanic black [OR (95% CI)]	1.73 (1.43–2.10)*	1.78 (1.42–2.21)*	1.36 (1.05–1.77)*	1.41 (1.04–1.90)*
Mexican-American [OR (95% CI)]	1.69 (1.35–2.11)*	1.71 (1.36–2.15)*	0.83, 0.62–1.12	0.83, 0.60–1.15
Non-Hispanic white (OR)	1.00	1.00	1.00	1.00
Variables included	Age, sex, quartile of missing teeth	Model 1 + Behavioral factors: BMI, alcohol use, tobacco use, marital status, social support	Model 1 + Material factors: Dental insurance, education, employment, poverty level, urban residence	Model 1 + Behavioral factors + Material factors

*$P \leq 0.05$.

When the material factors dental insurance, education, employment, poverty level, and urban residence were added to the basic model, the excess risk for untreated caries among non-Hispanic blacks was reduced by approximately 21% and that of Mexican-Americans was no longer statistically significant compared with non-Hispanic whites (Table 2, model 3). The basic model adjusted by both the material and behavioral factors (Table 2, model 4) resulted in odds ratios little changed from those of a basic model and material factors alone (Table 2, model 3). The McFadden's R^2scores were 0.11, 0.17, 0.13, and 0.18 for models 1, 2, 3, and 4, respectively, while the Hosmer-Lemeshow goodness-of-fit had *P*-values of 0.25, 0.18, 0.05, and 0.16 for models 1, 2, 3, and 4, respectively (Table 2).

Discussion

We found that the risk for untreated dental caries among US adults 20–50 years of age was significantly higher among non-Hispanic blacks and Mexican-Americans than it was among non-Hispanic whites, controlling for age, sex, and missing teeth. These findings support earlier reports that untreated dental caries is distributed disproportionately according to race/ethnicity among adults (3).

When the basic model containing race/ethnicity, age, sex, and missing teeth (Table 2, model 1) was further adjusted by behavioral factors, the odds ratios for having untreated dental caries remained essentially unchanged for Mexican-Americans and non-Hispanic blacks. In contrast to the addition of behavioral factors, when material factors were added to the basic model the odds ratios for having untreated dental caries declined substantially for these two race/ethnicity groups.

Specifically, the difference in the prevalence of three or more untreated carious teeth between Mexican-American adults and non-Hispanic white adults became non-significant, and the difference in prevalence of untreated dental caries between non-Hispanic blacks and non-Hispanic whites became less pronounced (21% reduction in odds ratios). When behavioral factors and materials factors were added to the basic model together (Table 2, model 4), the odds ratios for having untreated dental caries across race/ethnicity groups were essentially unchanged from that of the model containing only material factors (Table 2, model 3).

Based on these findings, material factors helped to explain some of the disparities in untreated dental caries experienced by non-Hispanic blacks and all of the disparities in untreated dental caries experienced by Mexican-Americans. In contrast, behavioral factors had no direct or indirect effects nor did they mediate any indirect effects from material factors on disparities in untreated dental caries.

Our findings of a lack of impact on racial/ethnic disparities by controlling for behavioral factors were unexpected, as previous investigations have shown a significant association between heavy tobacco use, heavy alcohol use, and dental caries (17–19).

Behavioral factors such as tobacco use, alcohol use, and marital status may arise from material factors and function as proxies for socioeconomic status (SES), as persons who use tobacco (17, 20) and live in a single-person household (21) tend to have lower SES than their counterparts. In fact, little association was found between smoking and dental caries in a population of low-SES homeless adults, probably because the entire study population was poor effectively controlling for SES (22). Yet in a similar study, in a population of low-SES homeless veterans and substance abusers, the authors concluded that behavioral factors were more important than living conditions in determining oral health (18). In any event, we found no evidence in our study for behavioral factors explaining any variation in untreated caries disparities whether directly, indirectly through material factors, or as proxies for SES.

We included missing teeth in models to address being at risk for dental caries, but this decision was not without potential problems in interpreting the role played by this variable and the overall results. Missing teeth are frequently the result of past dental caries, and past dental caries experience has been shown to predict future disease (23). Consequently, missing teeth are both a result of the carious process and determine the teeth at risk for current caries.

Missing teeth may also be a proxy for material factors, as poor adults have a significantly higher number of missing teeth than do wealthier adults (24). As such, the basic model, with its inclusion of missing teeth, might have already controlled for a portion of the role played by material factors resulting in a conservative estimate

of the reduction in excess risk by controlling material factors.

Missing teeth also might be a proxy for health-seeking behaviors, as adults who chose to have carious teeth extracted may have less appreciation for preventive treatments or understanding of the importance of retained teeth. As such, the basic model also might have controlled for a portion of the role played by health behaviors by including missing teeth. This could have the effect of masking a weak association and offer an alternate explanation for the lack of impact observed by the addition of behavioral factors as in model 2 (Table 2). Although missing teeth represented a problematic variable, it did not seem reasonable to interpret the relation between race/ethnicity and untreated dental caries without accounting for teeth at risk of dental caries.

To assess the missing teeth situation we ran all the models in Table 2 without the variable missing teeth (data not shown). The result was that virtually no change occurred in risk estimates. There was also virtually no change in Mcfadden's R^2 values for models that included material factors. However, models without material factors (models 1 and 2 in Table 2) displayed Mcfadden's R^2 values which were approximately half of that seen in models that included missing teeth. This would appear to indicate that material factors explain some of the same variability in untreated decay as missing teeth. Conversely, it indicates that behavioral factors alone explain very little variability in untreated decay.

To remain true to our initial study purposes, we did not disaggregate the component variables of each group for analysis. It was tempting to disaggregate the variables as material factors had greater risk reductions among Mexican-Americans than non-Hispanic blacks. Disaggregating component variables might identify specific variables more important among one racial/ethnic group than another. However, disaggregating the component variables would additionally raise the serious issues of multiple comparisons and lack of prior hypotheses for the individual components. Rather, with this study we hoped to identify fruitful areas for future research when applying these findings to data from other sources, and to identify the general areas where the greatest impact might be expected from future interventions. This goal is more modest than reporting and explaining risk estimates of disaggregated component variables, but is more in keeping with the limitations of the data, methodology, and conceptual model.

This investigation had a number of limitations. The first was the cross-sectional study design, which precluded analysis of temporal relationships and cohort effects. The second related to the lack of radiographs and the use of a conservative examination, which likely underestimated the true prevalence of dental caries among survey respondents. The resulting misclassification would most likely be non-differential with regard to racial/ethnic group biasing effect estimates to the null. The third limitation related to the limited number of explanatory variables contained within the NHANES III survey. No explanatory variables were available for investigating the contribution of factors such as attitudes toward healthcare, access to oral-healthcare services, and bacterial counts.

The investigation also exhibited important strengths. For example, the multivariate analysis controlled for a number of potential confounding factors, providing a more valid picture of material and behavioral factors in the relations between race/ethnicity and untreated caries. The relatively large sample size resulted in precise bivariate and multivariate effect estimates. In addition, the complex sampling design of NHANES III allows generalization of the findings to the US population.

Given the complex interrelationships between material circumstances and a variety of individual- and population-level factors, improvements in oral health would need to include successful public health interventions at the individual, community, and societal levels.

At the individual level, most interventions are impractical, as improving a person's material circumstances goes far beyond the capacity of any public health program. However, to the extent that attitudes and knowledge of health and illness are associated with material circumstances (25–29) changing attitudes and knowledge of oral health issues may represent a more feasible individual-level intervention. The literature also shows that attitudes and level of knowledge regarding health and illness are related to the cultural norms that exist within and among population groups (30). Public health interventions would also need to include culturally competent messages, accounting for the unique expression of material circumstances across racial/ethnic groups.

Community level factors are also associated with health and illness (31, 32) and at the community level, several interventions could be used to affect

untreated dental caries. For example, persons in poor material circumstances may find it difficult to take time away from work or childcare during the day to visit a dental clinic or health department. Communities could provide treatment locations with hours that are responsive to the needs of those who find 'regular' hours less convenient. In addition, dental screening and treatment might be located at sites that are more accessible to the community, or provide adjunct services such as childcare.

At the societal level, interventions are also difficult in the absence of sufficient political will. Many states do not provide an adult dental benefit via their healthcare provisions for the poor. As such, no safety net exists by which low-income adults might access definitive oral health care services. Funding priorities remain one of the primary reasons why these safety net services do not exist. In order for this situation to change, society must address the question of whether access to healthcare is a right for everyone, including the poor. Attempts to restructure the US health care financing system have progressed during the last few decades, but often to the exclusion of low-income adults.

This investigation intended to shed light on one small piece of a complex puzzle. Specifically, that material circumstances explain more variation in untreated dental caries for adults in the US than do some behavioral factors, and that material circumstances help to explain variations across race/ethnicity. Focusing future studies in the area of material pathways leading to dental caries may greatly inform the creation and implementation of appropriate public health policy to address disparities in untreated dental caries.

Conclusions

We found that the risk for untreated caries among US adults 20–50 years of age was higher among non-Hispanic blacks and Mexican-Americans compared with non-Hispanic whites after adjusting for age, sex, and missing teeth. We also found that among the variables available for analysis, much of the excess risk among non-Hispanic blacks and Mexican-Americans compared with non-Hispanic whites could be eliminated when material factors were controlled, while no risk reductions were observed when behavioral factors were controlled.

The implications of our findings, if replicated, are twofold (i) that racial/ethnic disparity in untreated caries has more to do with differences in material circumstances across groups than with differences in behavioral factors, and (ii) addressing material differences may have differing impacts on reducing excess risk across racial/ethnic groups.

References

1. Kaste LM, Selwitz RH, Oldakowski RJ, Brunelle JA, Winn DM, Brown LJ. Coronal caries in the primary and permanent dentition of children and adolescents 1–17 years of age: United States, 1988–1991. J Dent Res 1996;75:631–41.
2. Vargas CM, Crall JJ, Schneider DA. Sociodemographic distribution of pediatric dental caries: NHANES III, 1988–1994. J Am Dent Assoc 1998;129:1229–38.
3. Winn DM, Brunelle JA, Selwitz RH, Kaste LM, Oldakowski RJ, Kingman A et al. Coronal and root caries in the dentition of adults in the United States,1988–1991. J Dent Res 1996;75:642–51.
4. National Institute of Dental and Craniofacial Research, National Institutes of Health. Oral health in America: a report of the Surgeon General. Bethesda, MD: Department of Health and Human Services; 2000.
5. Andersen RM, Mullner RM, Cornelius LJ. Black-white differences in health status: methods or substance? Milbank Q 1987;65(Suppl 1):72–99.
6. Berkman LF, Macintyre S. The measurement of social class in health studies: old measures and new formulations. IARC Sci Publ 1997;138:51–64.
7. Bhopal R, Donaldson L. White, European, Western, Caucasian, or what? Inappropriate labeling in research on race, ethnicity, and health. Am J Public Health 1998; 88:1303–7.
8. Reisine ST, Psoter W. Socioeconomic status and selected behavioral determinants as risk factors for dental caries. J Dent Educ 2001;65:1009–16.
9. Drury TF, Garcia I, Adesanya M. Socioeconomic disparities in adult oral health in the United States. Ann N Y Acad Sci 1999;896:322–4.
10. Jones CM, Taylor GO, Whittle JG, Evans D, Trotter DP. Water fluoridation, tooth decay in 5 year olds, and social deprivation measured by the Jarman score: analysis of data from British dental surveys. BMJ 1997;315:514.
11. Morgan MZ, Treasure ET. Comparison of four composite deprivation indices and two census variables in predicting dental caries in 12-year-old children in Wales. Community Dent Health 2001;18:87–93.
12. Stronks K, van de Mheen HD, Looman CW, Mackenbach JP. Cultural, material, and psychosocial correlates of the socioeconomic gradient in smoking behavior among adults. Prev Med 1997;26:754–66.
13. Van Lenthe FJ, Gevers E, Joung IM, Bosma H, Mackenbach JP. Material and behavioral factors in the explanation of educational differences in incidence of

acute myocardial infarction. The globe study. Ann Epidemiol 2002;12:535–42.
14. Schrijvers CT, Stronks K, van de Mheen HD, Mackenbach JP. Explaining educational differences in mortality: the role of behavioral and material factors. Am J Public Health 1999;89:535–40.
15. Drury TF, Winn DM, Snowden CB, Kingman A, Kleinman DV, Lewis B. An overview of the oral health component of the 1988–1991 National Health and Nutrition Examination Survey (NHANES III-Phase 1). J Dent Res 1996;75:620–30.
16. Ezzati TM, Massey JT, Waksberg J, Chu A, Maurer KR. Sample design: Third National Health and Nutrition Examination Survey. Vital Health Stat 2 1992;113:1–35.
17. Centers for Disease Control and Prevention. Cigarette smoking among adults – United States, 2000. Morbidity Mortality Weekly Rep 2002;51:642–5.
18. Gibson G, Rosenheck R, Tullner JB, Grimes RM, Seibyl CL, Rivera-Torres A et al. A national survey of the oral health status of homeless veterans. J Public Health Dent 2003;63:30–37.
19. Winn DM. Tobacco use and oral disease. J Dent Educ 2001;65:306–12.
20. Centers for Disease Control and Prevention. Office on Smoking and Health. Prevalence of current cigarette smoking among adults and changes in prevalence of current and some day smoking – United States, 1996–2001. Morbidity Mortality Weekly Rep 2003;52:303–7.
21. U.S. Bureau of the Census. People and families in poverty by selected characteristics: 2000 and 2001. http://www.census.gov/hhes/poverty01/table1.pdf, accessed on 10–12–2003.
22. Gelberg L, Linn LS, Rosenberg DJ. Dental health of homeless adults. Spec Care Dentist 1988;8:167–72.
23. Beck JD, Weintraub JA, Disney JA, Graves RC, Stamm JW, Kaste LM et al. University of North Carolina Caries Risk Assessment Study: comparisons of high risk prediction, any risk prediction, and any risk etiologic models. Community Dent Oral Epidemiol 1992;20:313–21.
24. Bloom BGHJS. Dental services and oral health: United States, 1989. DHHS Publ No. (PHS) 92–1511. Hyattsville, MD: National Center for Health Statistics; 1992. Vital Health Stat 10.
25. Harnack L, Block G, Subar A, Lane S, Brand R. Association of cancer prevention-related nutrition knowledge, beliefs, and attitudes to cancer prevention dietary behavior. J Am Diet Assoc 1997;97: 957–65.
26. Sung JF, Blumenthal DS, Coates RJ, Alema-Mensah E. Knowledge, beliefs, attitudes, and cancer screening among inner-city African-American women. J Natl Med Assoc 1997;89:405–11.
27. Lannon C, Brack V, Stuart J, Caplow M, McNeill A, Bordley WC et al. What mothers say about why poor children fall behind on immunizations. A summary of focus groups in North Carolina. Arch Pediatr Adolesc Med 1995;149:1070–5.
28. Johnson JL, Primas PJ, Coe MK. Factors that prevent women of low socioeconomic status from seeking prenatal care. J Am Acad Nurse Pract 1994;6:105–11.
29. Kiefe CI, McKay SV, Halevy A, Brody BA. Is cost a barrier to screening mammography for low-income women receiving Medicare benefits? A randomized trial. Arch Intern Med 1994;154:1217–24.
30. Sharps PW, El Mohandes AA, Nabil El-Khorazaty M, Kiely M, Walker T. Health beliefs and parenting attitudes influence breastfeeding patterns among low-income African-American women. J Perinatol 2003;23:414–9.
31. Lannin DR, Mathews HF, Mitchell J, Swanson MS. Impacting cultural attitudes in African-American women to decrease breast cancer mortality. Am J Surg 2002;184:418–23.
32. Fournier AM, Carmichael C. Socioeconomic influences on the transmission of human immunodeficiency virus infection: the hidden risk. Arch Fam Med 1998;7:214–7.