Dental Care Visits among Dentate Adults with Diabetes, United States, 2003

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Abstract

Objectives: *Regular dental assessments are beneficial to adults with diabetes. This analysis evaluates nationally representative data to test the relation between diabetes status and dental care visits, and to compare diabetes care, foot care, eye care, and dental care visits among dentate adults with diabetes.* ***Methods:*** *Data from the 2003 National Health Interview Survey were used to test whether diabetes status was associated with dental care visits among dentate adults aged ≥25 years, controlling for available covariates.* ***Results:*** *There was a significant interaction between diabetes status and sex for the odds of having a dental care visit. Among dentate men, there was no significant association between diabetes status and dental care visits. Dentate women with diabetes were significantly less likely to have had a dental care visit than were dentate women without diabetes. Of the four types of health care visits compared, dentate adults with diabetes were least likely to have had a dental care visit in the preceding year. Disparities in health care visit rates across race/ethnicity, poverty status, and education categories were most pronounced for dental care.* ***Conclusions:*** *Having diabetes is associated with a variety of adverse health outcomes, including periodontitis. Adults with diabetes would benefit from regular health care visits to address these concerns, but this report shows that women with diabetes are underutilizing dental care services. The underutilization may be a result of the barriers to dental care that disproportionately affect women. Additional research should test the plausibility of these explanations and the influence of sex.*

Key Words: adults, dental care, diabetes mellitus, health services accessibility, primary health care, health services utilization

Introduction

Approximately 20.6 million (9.6 percent) American adults have diabetes, including 14.5 million diagnosed cases and an estimated 6.1 million undiagnosed cases (1). Diabetes is associated with a variety of health complications, including neuropathies relating to the foot (2), diabetic retinopathy (3,4), and periodontitis (5,6). In addition, unresolved periodontal infections may be a risk factor for poor glycemic control (7,8) and other diabetic complications (9-11).

Despite the link between diabetes and periodontitis, evidence suggests that dentate adults with diabetes may not be seeking dental care services at a rate that is consistent with their periodontitis risk. For example, an analysis of Behavioral Risk Factor Surveillance System (BRFSS) data showed that adults with diabetes were 18 percent less likely than adults without diabetes to have visited a dentist within the preceding year, controlling for age, race/ethnicity, education level, household income, and dental insurance status (12). That study also showed that adults with diabetes were less likely to visit a dentist than they were to visit a physician for diabetes care, eye care, or foot care.

Eke and colleagues (13) used BRFSS data to describe dental care visits among adults with diabetes. They reported that the median percentage of dentate adults ≥18 years of age who visited a dentist in the previous year was 67.3 percent in 2004; up from 65.9 percent in 1999. Eke and colleagues did not compare their findings with dental care visit rates among adults without diabetes, nor did they stratify by or adjust for any other covariates in their analysis.

The state-specific BRFSS data referenced earlier may have provided a nationwide perspective on the relation between diabetes and dental care visits, but they were not strictly representative of the US population. Although researchers have used combined BRFSS data to provide national estimates in the past, these combined data may have been less accurate than nationally representative data for measures of health status and descriptions of some population groups (14). In addition, some have cautioned against combining BRFSS data to estimate national prevalence, particularly when different sampling and nonsampling errors have existed across states (15).

The purpose of this study is to build on BRFSS findings by providing nationally representative estimates of the relation between diabetes and dental care visits. This report includes an additional covariate (private health insurance) and investigates the potential interactions between diabetes status and several

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covariates. This report also builds upon Tomar and Lester's work (12) by placing dental care visit findings in the context of other health care visits, with stratification by private health insurance status.

Methods

Data Source and Sampling Method. Data for this analysis came from the 2003 National Health Interview Survey (NHIS) (16). The NHIS is a cross-sectional survey of health and disability status in the United States. It is administered by the National Center for Health Statistics via a face-to-face interview in respondents' homes. The NHIS has been administered since 1957 and has contained questions periodically on diabetes status and oral health.

Sample households for the 2003 NHIS were selected according to a multistage, probability sampling method (17). The first stage included an area sampling frame for all US housing units in place during the 1990 census. The second stage included the stratification of states, followed by the selection of numerous primary sampling units (PSU), usually at the county level. Sample households were selected from within each of these PSUs. Finally, within each household, one sample adult and child were selected. Overall, African-American and Hispanic populations were oversampled to maximize the precision of estimates for these groups.

The multistage, probability sampling plan ensured that estimates at the household and person levels would be representative of the civilian, noninstitutionalized population of US children and adults (16). For the 2003 NHIS, a total of 35,921 households were selected, yielding 36,573 families and 92,148 individuals (16). The total household response rate was 89.2 percent (16). The conditional response rate for sample adults (considering the selection of one sample adult from each sample household) was 74.2 percent (16).

Study Variables. Having a visit for diabetes care, foot care, eye care, or dental care in the preceding year comprised the four outcome variables. Data for the dental care visit variable came from a question that asked, "About how long has it been since you last saw a dentist? Include all types of dentists, such as orthodontists, oral surgeons, and all other dental specialists, as well as dental hygienists." Those coded as having had a dental care visit in the preceding year included those who reported a dental visit at "6 months or less" and "more than 6 months, but not more than 1 year ago." Data for the diabetes care visit variable came from two questions that asked, "Is there one medical doctor that you usually see for your diabetes? Do not include other health professionals such as nurses or dieticians" and "How many times have you seen this medical doctor in the past 12 months?" Those coded as having had a diabetes care visit included those who answered "yes" to the first question and who had one or more visits in the preceding 12 months. Data for the foot care visit variable came from a question that asked, "During the past 12 months, how many times has a health professional checked your feet for any sores or irritations?" Those coded as having had a foot care visit in the preceding year included those who reported one or more visits in the last 12 months. The eye care visit question asked, "When was the last time you had an eye exam in which the pupils were dilated? This would have made you temporarily sensitive to bright light." Those coded as having had an eye care visit in the preceding year included those who reported having had an eye examination at "less than 1 month" and "1 to 12 months." For each of the health care visit variables, the corresponding "did not have a visit" category included everyone else (representing those who had any visit more than 12 months earlier or who never had a visit).

The main independent variable for this analysis was self-reported diabetes status. These data came from a question that asked, "(Other than during pregnancy), have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?" Responses to this question included: "yes," "no," and "borderline." Only respondents who answered affirmatively were considered to have diabetes for this analysis.

Covariates included age (25-44, 45-64, 65 years or older), sex, race/ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic other, Hispanic), poverty status [<100% of the federal poverty level (FPL), 100-199% FPL, 200-299% FPL, 300-399% FPL, ≥400% FPL], education level (<12, 12, >12 years), and private health insurance status (yes, no). The "non-Hispanic other" race/ethnicity category combined persons of "Asian only," "American Indian/Alaska Native," and "race group not releasable" designations.

Missing data for family income and personal earnings originally located in the 2003 NHIS were imputed using multiple imputation methods. A detailed description of the multiple imputation process used in the 2003 NHIS is available elsewhere (18). All other variables were merged with this imputed data set to form the final analytical file.

Analysis. Because visiting a dentist is strongly associated with having teeth (19,20), analyses were restricted to dentate persons. In order to maximize the likelihood that respondents were making decisions about their own health care, as opposed to a parent or guardian, analyses were also restricted to adults aged 25 years or older. The 2003 NHIS contained 24,945 dentate sample adults aged 25 years or older.

Analysis involved two stages: a) testing the relation between diabetes status and dental care visits; and b) describing health care visit rates among dentate adults with diabetes only. In testing the relation between diabetes status and dental care visits, we excluded sample persons with unknown diabetes status ($n = 11$), unknown dental care visit history ($n = 454$), unknown education level ($n = 338$), and unknown private health insurance status ($n = 109$). The final sample for this analytical component included

Table 1
Sample Size and Weighted Prevalence of Selected Characteristics for Dentate Adults Aged ≥25 Years, by Diabetes Status: United States, 2003 (*n* = 24,189)

	Diabetes status			
	With diabetes		Without diabetes	
Characteristic	Sample size	Weighted % (standard error)	Sample size	Weighted % (standard error)
Overall	1,656	100.0 (n/a)	22,533	100.0 (n/a)
Age (years)				
25-44	263	16.8 (1.1)	11,247	50.1 (0.4)
45-64	781	48.2 (1.5)	7,847	36.3 (0.4)
≥65	612	35.0 (1.4)	3,439	13.6 (0.3)
Sex				
Male	742	51.2 (1.5)	9,823	47.9 (0.4)
Female	914	48.8 (1.5)	12,710	52.1 (0.4)
Race/ethnicity				
Hispanic	293	11.6 (0.9)	3,894	12.0 (0.3)
Non-Hispanic other*	58	3.8 (0.6)	806	4.2 (0.2)
Non-Hispanic Black	312	15.4 (1.0)	2,852	10.3 (0.3)
Non-Hispanic White	993	69.2 (1.3)	14,981	73.6 (0.4)
Poverty status				
<100% FPL	304	13.0 (0.9)	2,870	9.5 (0.3)
100-199% FPL	402	22.5 (1.2)	4,076	15.8 (0.3)
200-299% FPL	304	18.7 (1.3)	3,895	16.9 (0.3)
300-399% FPL	204	13.9 (1.2)	3,107	14.1 (0.3)
≥400% FPL	441	31.8 (1.5)	8,585	43.7 (0.5)
Education level				
<12 years	450	22.3 (1.2)	3,669	13.6 (0.3)
12 years	459	28.9 (1.3)	6,380	29.0 (0.4)
>12 years	747	48.8 (1.5)	12,484	57.4 (0.5)
Private health insurance				
No	953	36.6 (1.4)	7,053	26.6 (0.4)
Yes	703	63.4 (1.4)	15,480	73.4 (0.4)

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
n/a, not applicable; FPL, federal poverty level.

24,197 persons. In describing health care visit rates among dentate adults with diabetes, we used a smaller sample because the 2003 NHIS asked questions about diabetes care visits, foot care visits, and eye care visits only among those with diabetes. As such, the final sample for this analytical stage included 1,590 persons.

For all analyses, SUDAAN statistical software (21) was used to derive bivariate and multiple logistic regression estimates. SUDAAN was used because it accounted for the multistage sampling method of the 2003 NHIS when deriving standard errors and confidence intervals. Sample weights were used so that statistical estimates would be representative of the target population, and an alpha value of 0.05 was used to determine statistical significance.

Results

According to the 2003 NHIS, 6.5 percent of dentate adults aged 25 years or older reported having diagnosed diabetes. Table 1 lists the population characteristics for dentate adults, by diabetes status. Those with diabetes were most likely to be males aged 45 to 64 years. Those without diabetes were most likely to be females aged 25 to 44 years. For those with and without diabetes, the majority were also non-Hispanic White, at ≥400% FPL, and with >12 years of education.

Table 2 presents the weighted prevalence estimates and crude odds of having at least one dental care visit in the preceding year for dentate adults, by diabetes status. In general, dentate adults with diabetes were significantly less likely than those without diabetes to have had a dental care visit in the preceding year. In addition, adults aged 25 to 44 years, men, Hispanics, those with the lowest poverty status and education level, and those with no private health insurance were least likely to have had a dental care visit.

In order to control for potential confounders of the association between diabetes status and dental care visits, we tested the association between diabetes status and dental care visits in the presence of relevant covariates. In a series of multiple

Table 2
Weighted Prevalence and Crude Odds of a Dental Care Visit in the Preceding Year among Dentate Adults Aged ≥25 Years, by Selected Characteristics: United States, 2003 (*n* = 24,189)

Characteristic	Percentage (95% CI)	Crude OR (95% CI)	Wald-*F* *P*-value
Overall	67.5 (66.7-68.3)	–	–
Diabetes status			
With	60.7 (57.7-63.6)	0.72 (0.64-0.83)	<0.01
Without	68.0 (67.2-68.8)	Reference	–
Age (years)			
25-44	63.9 (62.9-65.0)	0.70 (0.64-0.77)	<0.01
45-64	70.5 (69.3-71.6)	0.95 (0.86-1.04)	0.27
≥65	71.6 (69.8-73.2)	Reference	–
Sex			
Male	63.7 (62.6-64.9)	0.72 (0.67-0.77)	<0.01
Female	71.0 (70.0-71.9)	Reference	–
Race/ethnicity			
Hispanic	50.3 (48.2-52.4)	0.40 (0.36-0.44)	<0.01
Non-Hispanic other*	64.6 (61.2-67.9)	0.72 (0.62-0.84)	<0.01
Non-Hispanic Black	58.8 (56.8-60.8)	0.56 (0.51-0.62)	<0.01
Non-Hispanic White	71.7 (70.8-72.6)	Reference	–
Poverty status			
<100% FPL	42.8 (40.7-44.9)	0.19 (0.17-0.21)	<0.01
100-199% FPL	51.2 (49.1-53.3)	0.26 (0.24-0.30)	<0.01
200-299% FPL	64.0 (62.1-65.9)	0.45 (0.40-0.50)	<0.01
300-399% FPL	69.7 (67.8-71.6)	0.58 (0.52-0.65)	<0.01
≥400% FPL	79.9 (78.8-81.0)	Reference	–
Education level			
<12 years	44.1 (42.1-46.2)	0.25 (0.23-0.27)	<0.01
12 years	62.0 (60.7-63.3)	0.51 (0.48-0.55)	<0.01
>12 years	76.1 (75.3-77.0)	Reference	–
Private health insurance			
No	45.7 (44.4-47.0)	0.27 (0.25-0.29)	<0.01
Yes	75.7 (74.9-76.5)	Reference	–

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
CI, confidence interval; OR, odds ratio; FPL, federal poverty level.

logistic regression models (data not shown), we tested for significant interactions between diabetes status and dental care visits. The interaction with age yielded a Wald-*F* *P*-value of 0.37; with race/ethnicity, 0.23; with poverty status, 0.41; with education level, 0.09; and with private health insurance, 0.36. The interaction with sex yielded a significant Wald-*F* *P*-value of <0.01. Consequently, the weighted prevalence (Table 3) and adjusted odds (Table 4) of a dental care visit in the preceding year were stratified by sex to show the effects of this interaction.

Table 4 shows that among men, there was no significant association (Wald-*F* *P*-value = 0.79) between diabetes status and a dental care visit in the preceding year, controlling for relevant covariates. Table 4 also shows that among women, there was a significant association between diabetes status and dental care visits, controlling for relevant covariates (Wald-*F* *P*-value < 0.01). Specifically, dentate women with diabetes were 37 percent less likely to have had a dental care visit in the preceding year, controlling for age, race/ethnicity, poverty status, education level, and private health insurance status.

Tables 5 and 6 list the weighted prevalence estimates of visits for diabetes care, foot care, eye care, and dental care in the preceding year among dentate adults with diabetes. Given the significant interaction with sex noted earlier, the prevalence estimates for men (Table 5) are listed separately from women (Table 6). Among both sexes, the prevalence of a diabetes care visit was highest and the prevalence of a dental care visit was lowest.

In general, the disparities for dental care visits were greater than they were for other health care visits. Among men (Table 5), 21.4 percentage points separated the prevalence of a dental care visit for non-Hispanic White adults with diabetes (representing the highest value) from that of non-Hispanic Black adults with diabetes (representing the lowest value). By contrast, the disparity between highest and lowest values for diabetes care visits, foot care visits, and eye care visits were notably lower. There was also a greater disparity for dental care visits

Table 3
Weighted Prevalence of a Dental Care Visit in the Preceding Year among Dentate Adults Aged ≥25 Years, by Selected Characteristics, Diabetes Status, and Sex: United States, 2003 (*n* = 24,189)

	Diabetes status			
	With diabetes		Without diabetes	
	Male	Female	Male	Female
Characteristic	Weighted % (95% confidence interval)			
Overall	64.0 (60.0-67.9)	57.2 (53.0-61.2)	63.7 (62.5-64.9)	71.9 (70.9-72.8)
Age (years)				
25-44	54.7 (44.3-64.6)	45.0 (35.8-54.5)	58.8 (57.1-60.4)	69.6 (68.2-70.9)
45-64	63.4 (57.4-69.0)	58.9 (53.1-64.6)	68.1 (66.2-69.9)	74.4 (72.8-75.9)
≥65	68.7 (61.8-74.9)	61.2 (54.8-67.3)	71.7 (68.6-74.5)	73.4 (71.3-75.5)
Race/ethnicity				
Hispanic	52.0 (41.4-62.4)	42.5 (33.2-52.4)	45.6 (42.6-48.6)	55.7 (53.0-58.3)
Non-Hispanic other*	57.8 (38.1-75.2)	30.1 (15.2-51.0)	61.3 (55.4-66.8)	69.8 (64.7-74.4)
Non-Hispanic Black	47.3 (36.8-58.1)	59.4 (51.3-67.0)	54.5 (51.2-57.7)	63.2 (60.5-65.9)
Non-Hispanic White	69.6 (64.7-74.1)	60.3 (55.1-65.4)	68.2 (66.9-69.5)	75.8 (74.7-76.9)
Poverty status				
<100% FPL	42.2 (29.0-56.6)	42.3 (34.2-50.7)	36.3 (32.6-40.1)	47.5 (44.7-50.3)
100-199% FPL	44.6 (35.9-53.6)	46.5 (37.8-55.4)	45.7 (42.5-49.0)	56.6 (54.0-59.1)
200-299% FPL	68.3 (57.5-77.3)	62.2 (50.1-72.9)	58.1 (55.1-61.1)	69.3 (66.9-71.6)
300-399% FPL	67.4 (54.7-78.0)	59.7 (44.6-73.2)	65.0 (62.0-67.9)	74.9 (72.3-77.4)
≥400% FPL	75.2 (68.9-80.6)	73.7 (64.5-81.2)	76.0 (74.4-77.5)	84.5 (83.1-85.8)
Education level				
<12 years	45.5 (36.9-54.5)	43.4 (36.6-50.5)	40.4 (37.5-43.2)	47.9 (44.9-50.8)
12 years	54.1 (46.1-61.9)	54.2 (46.8-61.3)	57.6 (55.6-59.5)	67.1 (65.5-68.7)
>12 years	75.6 (70.5-80.0)	67.3 (61.5-72.6)	72.7 (71.3-74.0)	79.8 (78.6-80.8)
Private health insurance				
No	47.6 (41.1-54.1)	38.3 (33.0-43.9)	40.8 (38.8-42.9)	50.7 (48.8-52.6)
Yes	72.3 (67.5-76.6)	69.7 (64.7-74.3)	71.9 (70.7-73.1)	79.7 (78.7-80.7)

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
FPL, federal poverty level.

across poverty status categories (range = 32.1 percentage points for dental care visits), across education level categories (range = 28.6 percentage points for dental care visits), and across private health insurance status categories (range = 23.3 percentage points for dental care visits) than there was for the other types of health care visits. For women (Table 6), the same pattern of disparities existed. Specifically, across race/ethnicity, poverty status, education level, and private health insurance categories, the disparity was greater for dental care visits than it was for any of the other diabetes-related health care visits.

Discussion

According to the Healthy People 2010 midcourse review of the diabetes focus area, the nation has lost ground regarding its objective for annual dental care visits among those with diagnosed diabetes (22). Between 1997 and 2003, the prevalence of an annual dental care visit among persons aged 2 years or older has decreased by 27 percent. This movement away from the 2010 target was particularly surprising, given the Centers for Disease Control and Prevention's (CDC) recommendation that persons with diabetes should have their teeth cleaned and checked at their dental office at least once every 6 months (23). The American Diabetes Association (ADA) has also encouraged persons with diabetes to have a complete diabetes care plan that includes caring for one's teeth and visiting the dentist at least two times per year (24).

In light of the said recommendations by the CDC and the ADA, one might have expected dental care visit rates for dentate adults with diabetes to be at least as high as those for dentate adults without diabetes, and preferably higher. According to the findings in this report, however, the dental care visit rate for dentate adults with diabetes was never higher. In fact, contrary to the said recommendations, this report showed that dentate women with diabetes were significantly less likely to have had a dental care visit than were dentate women without diabetes, even after controlling for relevant covariates.

Explaining why dental care visit rates among dentate adults with diabetes would be similar to rates among dentate adults without diabe-

Table 4
Weighted Adjusted Odds of Having a Dental Care Visit in the Previous Year among Dentate Adults Aged ≥25 Years, by Selected Characteristics and Sex: United States, 2003 (*n* = 24,189)

	Male		Female	
Characteristic	Adjusted OR (95% CI)*	Wald-*F* *P*-value	Adjusted OR (95% CI)*	Wald-*F* *P*-value
Diabetes status				
With	0.97 (0.80-1.18)	0.79	0.63 (0.53-0.76)	<0.01
Without	Reference	Reference	Reference	Reference
Age (years)				
25-44	0.49 (0.42-0.57)	<0.01	0.64 (0.57-0.73)	<0.01
45-64	0.61 (0.52-0.71)	<0.01	0.70 (0.62-0.80)	<0.01
≥65	Reference	Reference	Reference	Reference
Race/ethnicity				
Hispanic	0.82 (0.71-0.94)	0.01	0.89 (0.77-1.03)	0.13
Non-Hispanic other*	0.79 (0.62-1.02)	0.07	0.77 (0.60-0.99)	0.04
Non-Hispanic Black	0.75 (0.64-0.88)	<0.01	0.88 (0.77-1.01)	0.07
Non-Hispanic White	Reference	Reference	Reference	Reference
Poverty status				
<100% FPL	0.44 (0.36-0.55)	<0.01	0.41 (0.34-0.49)	<0.01
100-199% FPL	0.49 (0.41-0.59)	<0.01	0.41 (0.35-0.48)	<0.01
200-299% FPL	0.64 (0.55-0.74)	<0.01	0.54 (0.46-0.63)	<0.01
300-399% FPL	0.72 (0.62-0.83)	<0.01	0.63 (0.52-0.76)	<0.01
≥400% FPL	Reference	Reference	Reference	Reference
Education level				
<12 years	0.46 (0.40-0.54)	<0.01	0.45 (0.39-0.53)	<0.01
12 years	0.63 (0.57-0.70)	<0.01	0.64 (0.58-0.71)	<0.01
>12 years	Reference	Reference	Reference	Reference
Private health insurance				
No	0.44 (0.39-0.50)	<0.01	0.44 (0.40-0.50)	<0.01
Yes	Reference	Reference	Reference	Reference

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
OR, odds ratio; CI, confidence interval; FPL, federal poverty level.

tes might be explained by a number of factors, including knowledge of the diabetes–periodontitis link. If dentate adults with diabetes were unaware that they were at increased risk for periodontitis, they would not seek out dental care services at a greater rate. Persons with diabetes would be unaware of the diabetes–periodontitis link if they never received the information or did not understand the information when it was provided.

Another hypothesis explaining similar dental care visit rates among dentate adults with and without diabetes involves barriers to care. Moore and colleagues (25) found that cost was a more significant, self-perceived barrier to dental care services for those with diabetes than it was for those without diabetes. Perhaps adults with diabetes believe they have less discretionary income than do adults without diabetes, or perhaps those with diabetes place dental care lower on a list of health care spending priorities. In addition, it may be more difficult for adults with diabetes, who have limited income, to access specialty care from periodontists.

There were a number of similarities between the results in this report and those of Tomar and Lester (12). Both reports showed that dentate adults with diabetes were significantly less likely than those without diabetes to have had a dental care visit in the preceding year. In addition, both reports showed that there was a greater disparity for dental care visits between those with high and low socioeconomic status. The dental care visit findings reported by Eke and colleagues (13) were also similar to our findings, although specific comparisons were not possible because Eke and colleagues included a younger age group.

Explaining why dentate women with diabetes would be significantly less likely to visit a dentist than would dentate women without diabetes is difficult. Perhaps women with diabetes, more so than men, equated prior negative experiences with reasons to avoid the dentist. For instance, a person with diabetes who also has periodontitis may have equated dental visits with uncomfortable periodontal therapy. This explanation is feasible because women are generally more likely to visit a dentist (26) and may be more familiar with this potentially uncomfortable treatment than would men. In addition, women may have had more competing demands than men, such as

Table 5
Weighted Prevalence of a Health Care Visit for Dentate Men with Diabetes Aged ≥25 Years, by Selected Characteristics and Type of Health Care Visit: United States, 2003 (*n* = 710)

Characteristic	Visited a medical care provider for diabetes care	Visited a medical care provider for foot care	Visited a medical care provider for eye care	Visited a dental provider for dental care
	Weighted % (95% confidence interval)			
Overall	82.0 (78.4-85.1)	72.6 (68.3-76.5)	67.8 (63.6-71.8)	64.4 (60.2-68.4)
Age (years)				
25-44	78.6 (67.2-86.8)	65.7 (53.2-76.4)	52.4 (40.8-63.8)	54.4 (44.2-64.2)
45-64	83.0 (77.8-87.2)	72.7 (66.7-78.0)	66.0 (59.6-71.9)	64.1 (58.0-69.7)
≥65	82.1 (76.1-86.8)	75.3 (69.0-80.7)	76.6 (70.2-81.9)	69.1 (62.0-75.4)
Race/ethnicity				
Hispanic	83.1 (74.5-89.2)	67.0 (57.1-75.6)	59.2 (49.4-68.4)	52.4 (41.8-62.8)
Non-Hispanic other*	81.6 (59.3-93.1)	75.4 (56.4-87.9)	74.2 (53.8-87.7)	57.8 (37.1-76.1)
Non-Hispanic Black	86.5 (78.4-91.8)	85.0 (76.2-90.9)	69.5 (58.3-78.8)	48.4 (37.3-59.7)
Non-Hispanic White	81.0 (76.2-85.0)	71.0 (65.7-75.8)	68.5 (63.4-73.2)	69.8 (64.7-74.4)
Poverty status				
<100% FPL	80.8 (67.0-89.7)	68.5 (54.8-79.6)	60.7 (47.9-72.1)	43.1 (28.9-58.6)
100-199% FPL	81.0 (71.1-88.1)	78.1 (67.2-86.1)	62.7 (52.2-72.1)	43.4 (34.5-52.8)
200-299% FPL	84.5 (75.0-90.9)	72.7 (61.3-81.7)	67.4 (57.6-75.8)	69.8 (59.5-78.4)
300-399% FPL	82.4 (72.1-89.4)	82.8 (71.3-90.4)	72.4 (61.4-81.2)	67.2 (54.9-77.6)
≥400% FPL	81.3 (74.5-86.5)	67.0 (59.3-73.8)	70.3 (61.7-77.6)	75.2 (68.7-80.6)
Education level				
<12 years	78.2 (70.2-84.5)	72.7 (64.1-80.0)	59.2 (50.6-67.2)	47.1 (38.3-56.2)
12 years	83.5 (75.9-89.1)	78.2 (70.4-84.4)	65.1 (56.6-72.8)	53.7 (45.5-61.8)
>12 years	82.6 (77.3-86.9)	69.9 (63.6-75.5)	72.2 (66.5-77.3)	75.7 (70.5-80.2)
Private health insurance				
No	77.1 (79.5-88.1)	72.3 (66.2-77.7)	59.3 (52.2-66.0)	48.6 (41.8-55.4)
Yes	84.3 (71.4-81.9)	72.7 (67.0-77.8)	71.9 (66.7-76.5)	71.9 (67.0-76.4)

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
FPL, federal poverty level.

caring for a child or an aging parent. Additional research is warranted.

This report also showed that, of the four types of health care visits, dentate adults with diabetes were least likely to have visited a dentist than they were to have had a diabetes care, foot care, or eye care visit. One possible explanation for this finding is the ease of referring for treatment services such as eye and foot care within the medical care system versus the difficulty of referring for dental services outside of the medical system. A physician may also be more comfortable testing for nervous system disease of the foot or diabetic retinopathy than he or she is to examine for periodontitis or other oral conditions.

This report also showed that socioeconomic disparities were more exaggerated for dental care visits than they were for any of the other health care visits. One likely explanation is the existence of safety net programs for low-income adults in the medical care system versus the relative lack of such programs in the dental care system. In medicine, Medicaid and Medicare provide benefits for those who cannot otherwise afford medical care. In dentistry, Medicaid and Medicare currently provide few benefits for adults (27,28). Furthermore, adults who are fortunate enough to reside in states that provide Medicaid dental benefits may find it difficult to locate dentists who are willing to accept Medicaid patients into their practices (29,30).

Disparities across different racial and ethnic groups were also more exaggerated for dental care visits than they were for the other health care visits. Given the close correlation between race/ethnicity and socioeconomic status in the United States, this disparity was also likely explained by the availability of safety net programs and access to practitioners, among others.

This analysis had at least three limitations. The first limitation was the lack of a dental insurance variable. Although poverty status is highly correlated with insurance coverage, having dental insurance is a stronger determinant of dental visits and might have served as a more useful covariate in the multivariable analyses. The second limitation was the inability to characterize the services that were completed during each dental visit. It is possible that some of the adults with diabetes who visited a dentist did not receive periodontal evaluation and/or treatment during the appointment. If this scenario occurred, then the disparity in receipt of treatment between adults

Table 6
Weighted Prevalence of a Health Care Visit for Dentate Women with Diabetes Aged ≥25 Years, by Selected Characteristics and Type of Health Care Visit: United States, 2003 (*n* = 880)

Characteristic	Visited a medical care provider for diabetes care	Visited a medical care provider for foot care	Visited a medical care provider for eye care	Visited a dental provider for dental care
	Weighted % (95% confidence interval)			
Overall	83.8 (80.6-86.6)	69.6 (65.9-73.0)	64.6 (60.8-68.2)	57.3 (53.1-61.4)
Age (years)				
25-44	79.7 (71.4-86.0)	54.9 (45.7-63.8)	45.1 (36.1-54.4)	44.5 (35.4-54.0)
45-64	83.5 (78.8-87.3)	73.8 (68.1-78.7)	65.5 (59.9-70.8)	58.5 (52.6-64.3)
≥65	86.6 (81.6-90.4)	71.6 (65.5-77.1)	74.3 (68.8-79.1)	62.8 (56.2-69.0)
Race/ethnicity				
Hispanic	77.8 (69.0-84.6)	70.6 (61.5-78.4)	53.6 (44.5-62.5)	42.8 (33.3-52.8)
Non-Hispanic other*	66.5 (43.6-83.7)	58.7 (37.0-77.5)	50.3 (32.5-68.1)	30.1 (15.2-51.0)
Non-Hispanic Black	82.8 (75.5-88.2)	78.1 (69.5-84.8)	69.4 (61.2-76.6)	59.4 (51.1-67.3)
Non-Hispanic White	85.9 (82.1-89.0)	67.7 (62.9-72.1)	65.9 (60.8-70.6)	60.5 (55.1-65.6)
Poverty status				
<100% FPL	75.0 (67.2-81.4)	61.9 (52.2-70.8)	56.8 (47.6-65.6)	42.4 (33.9-51.3)
100-199% FPL	81.9 (75.3-87.0)	72.8 (63.4-80.6)	59.8 (51.1-67.8)	45.3 (37.0-54.0)
200-299% FPL	87.3 (78.3-92.9)	72.7 (62.3-81.1)	67.0 (56.5-76.0)	63.1 (50.7-73.9)
300-399% FPL	86.6 (76.2-92.9)	65.9 (54.4-75.7)	66.6 (53.5-77.5)	59.7 (44.4-73.2)
≥400% FPL	87.6 (80.5-92.4)	70.9 (62.8-77.8)	71.8 (63.2-79.0)	73.8 (64.4-81.3)
Education level				
<12 years	80.6 (74.2-85.7)	70.3 (63.4-76.4)	59.1 (51.8-66.1)	43.8 (36.5-51.4)
12 years	85.1 (80.0-89.1)	71.5 (64.1-77.9)	62.5 (54.7-69.7)	53.8 (46.3-61.1)
>12 years	84.6 (79.8-88.4)	67.7 (62.1-72.9)	69.0 (63.2-74.4)	67.2 (61.4-72.5)
Private health insurance				
No	77.9 (72.5-82.5)	68.0 (61.5-73.9)	56.7 (50.5-62.6)	37.2 (31.7-43.0)
Yes	87.6 (83.5-90.7)	70.5 (66.0-74.7)	69.6 (64.8-74.0)	70.1 (65.1-74.8)

Note: Persons with unknown diabetes status, dental care visit history, education level, and private health insurance status were excluded from the analysis.
* Includes "Asian only," "American Indian/Alaska Native," and "race group not releasable" categories.
FPL, federal poverty level.

with diabetes and adults without diabetes might have been greater than was suggested in this analysis. The third limitation was the self-reporting of diabetes status, health care visit histories, and insurance status, potentially leading to a misclassification in the analysis. Despite these limitations, this report provided estimates that were nationally representative and it revealed a significant interaction for dental care visits (between diabetes status and sex) that has not been reported previously.

In summary, adults with diabetes may be underutilizing oral health care services, particularly as it relates to periodontal health. Until research explaining this underutilization is conducted, dentists and other oral health care providers are urged to discuss the links between diabetes and periodontitis with their adult patients with diabetes. All health care providers should also remind their patients with diabetes that they need to have their periodontal tissues examined by a dentist regularly. At a community level, the creation of health care practitioner networks (including physicians, dentists, and other health care providers) for those with diabetes could also serve to make referrals easier and more accountable. In addition, community clinics could tie the provision of dental screening examinations to diabetes care so that adults with diabetes know their individual risk for periodontitis. These and other public health measures would be a welcome addition to the care of diabetes and periodontitis. Given the bidirectional association between diabetes and periodontal health, policymakers should remember that lacking access to dental services for low-income adults not only affects oral health, but may also have an indirect impact on diabetes management and its complications in the United States.

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References

1. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic

Disease Prevention and Health Promotion. Diabetes public health resource. Publications and products. National diabetes fact sheet. [cited 2007 Jun 23]. Available from: http://www.cdc.gov/diabetes/pubs/estimates05.htm#prev
2. Sima AA. Diabetes underlies common neurological disorders. Ann Neurol. 2004;56(4):459-61.
3. Aiello LP, Gardner TW, King GL, Blankenship G, Cavallerano JD, Ferris FL 3rd, Klein R. Diabetic retinopathy. Diabetes Care. 1998;21(1):143-56.
4. Sanchez-Thorin JC. The epidemiology of diabetes mellitus and diabetic retinopathy. Int Ophthalmol Clin. 1998;38(2):11-8.
5. Yeng YT, Taylor GW, Scannapieco F, Kinane DF, Curtis M, Beck JD, Kogon S. Periodontal health and systemic disorders. J Can Dent Assoc. 2002;68(3):188-92.
6. Taylor GW. Exploring relationships between diabetes and periodontal disease in African Americans. Compend Contin Educ Dent. 2001;22(3 Spec No):42-8.
7. Taylor GW. Bidirectional interrelationships between diabetes and periodontal diseases: an epidemiologic perspective. Ann Periodontol. 2001;6(1):99-112.
8. Taylor GW. Periodontal treatment and its effect on glycemic control: a review of the evidence. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999;87(3):311-6.
9. Thorstensson H, Kuylenstierna J, Hugoson A. Medical status and complications in relation to periodontal disease experience in insulin-dependent diabetics. J Clin Periodontol. 1996;23(3 Pt 1):194-202.
10. Saremi A, Nelson RG, Tulloch-Reid M, Hanson RL, Sievers ML, Taylor GW, Shlossman M, Bennett PH, Genco R, Knowler WC. Periodontal disease and mortality in type 2 diabetes. Diabetes Care. 2005;28:27-32.
11. Shultis WA, Weil EJ, Looker HC, Curtis JM, Shlossman M, Genco RJ, Knowler WC, Nelson RG. Effect of periodontitis on overt nephropathy and end-stage renal disease in type 2 diabetes. Diabetes Care. 2007;30:306-11.
12. Tomar SL, Lester A. Dental and other health care visits among U.S. adults with diabetes. Diabetes Care. 2000;23(10):1505-10.
13. Eke PI, Thornton-Evans GO, Beckles GL. Dental visits among dentate adults with diabetes – United States, 1999 and 2004. MMWR Morb Mortal Wkly Rep. 2005;54(46):1181-83.
14. Nelson DE, Powell-Griner E, Town M, Kovar MG. A comparison of national estimates from the National Health Interview Survey and the Behavioral Risk Factor Surveillance System. Am J Public Health. 2003;93(8):1335-41.
15. Iachan R, Schulman J, Powell-Griner E, Nelson DE, Mariolis P, Stanwyck C. Pooling state telephone survey health data for national estimates: the CDC Behavioral Risk Factor Surveillance System, 1995. In: Cynamon ML, Kulka RA, editors. Seventh conference on health survey research methods, 2001. DHHS Publ No. 01-1013. Hyattsville (MD): National Center for Health Statistics; 2001. p. 189-95.
16. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. 2003 National Health Interview Survey (NHIS) public use data release. NHIS survey description. Hyattsville (MD): National Center for Health Statistics; 2004. p. 1-108.
17. Botman SL, Moore TF, Moriarty CL, Parsons VL. Design and estimation for the National Health Interview Survey, 1995-2004. National Center for Health Statistics. Vital Health Stat. 2000;2(130):1-41.
18. Schenker N, Raghunathan TE, Chiu PL, Makuc DM, Zhang G, Cohen AJ. Multiple imputation of family income and personal earnings in the National Health Interview Survey: methods and examples. [cited 2007 Mar 1]. Available from: http://www.cdc.gov/nchs/data/nhis/tecdoc.pdf
19. Macek MD, Cohen LA, Reid BC, Manski RJ. Dental visits among older U.S. adults: the roles of dentition status and cost. J Am Dent Assoc. 2004;135(8):1154-62.
20. Cook J, Owen P, Bender B, Senner J, Davis B, Pledger E, Johnson C, Steiner B, Costello N, Wineski A, Maines D, Brooks D, Smith P, Melnik T, Kaske J, Indian R, Grant-Worley J, Hesser J, Condon K, Giles R, McIntyre R, Redman L, Wynkoop-Simmons K, Cautley E, Futa M. Behavioral Surveillance Br, Div of Adult and Community Health; Surveillance, Investigations, and Research Br, Div of Oral Health, National Center for Chronic Disease Prevention and Health Promotion, CDC. Dental service use and dental insurance coverage – United States, Behavioral Risk Factor Surveillance System, 1995. MMWR Morb Mortal Wkly Rep. 1997;46(50):1199-203.
21. Research Triangle Institute. SUDAAN®: software for the statistical analysis of correlated data. Version 9.01. Research Triangle Park (NC): Research Triangle Institute; 2001.
22. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. Midcourse review: healthy people 2010. Diabetes. Washington (DC): Government Printing Office; 2006.
23. US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion. Diabetes public health resource. Publications and products. Take charge of your diabetes. 10. Dental disease. [cited 2007 Feb 20]. Available from: http://www.cdc.gov/diabetes/pubs/tcyd/dental.htm
24. American Diabetes Association. Oral health and oral hygiene. [cited 2007 Jun 1]. Available from: http://www.diabetes.org/type-2-diabetes/mouth-care.jsp
25. Moore PA, Orchard T, Guggenheimer J, Weyant RJ. Diabetes and oral health promotion: a survey of disease prevention behaviors. J Am Dent Assoc. 2000;131(9):1333-41.
26. Wall TP, Brown LJ. Recent trends in dental visits and private dental insurance, 1989 and 1999. J Am Dent Assoc. 2003;134(5):621-7.
27. Compton RD. Expansion of dental benefits under the Medicare Advantage program. J Dent Educ. 2005;69(9):1034-44. Comment in J Dent Educ. 2005;69(9):1049-50.
28. Manski RJ. Dental insurance: design, need, and public policy. J Am Dent Assoc. 2001;68(1):9-13.
29. Smith RG, Lewis CW. Availability of dental appointments for young children in King County, Washington: implications for access to care. Pediatr Dent. 2005;27(3):207-11.
30. Seale NS, Casamassimo PS. Access to dental care for children in the United States: a survey of general practitioners. J Am Dent Assoc. 2003;134(12):1630-40.