Poor Oral Health and Quality of Life in U.S. Older Adults with Diabetes

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Abstract

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Context: Older adults with diabetes are at increased risk of periodontal disease and poor dentition, which may affect overall health, functional status and quality of life.

Objective: To determine the association between health-related quality of life and oral health among U.S. older adults with diabetes mellitus.

Design, Setting and Participants: Study of a nationally representative sample of 70,363 U.S. older adults (aged ≥65 years) with diabetes, using data from the Behavioral Risk Factor Surveillance System 2006, 2008 and 2010.

Main Outcome Measures: Health-related quality of life as measured by the Healthy Days Core Module.

Results: Loss of permanent teeth from caries or periodontal disease was associated with increased odds of worse self-rated general health (adjusted OR=1.25, 95% CI 1.13-1.37). Lack of dental care in the preceding 12 months was associated with increased odds of worse self-rated

general health (adjusted OR=1.34, 95% CI 1.25-1.44) compared to receiving dental care in the preceding 12 months. Poor dentition and longer time interval since last dental care were associated with increased number of physically unhealthy days. Older adults with diabetes had worse dentition and were less likely to receive recent dental care than older adults without diabetes.

Conclusions: Health-related quality of life and oral health were worse in older adults with diabetes compared to older adults without diabetes.

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INTRODUCTION

Oral health is an important but frequently overlooked part of overall health that significantly impacts quality of life.[1] Older adults (≥65 years) with diabetes mellitus potentially face a greater burden of oral disease due to increased risk of periodontal disease[2-4] and tooth loss;[5] studies also show that U.S. older adults with diabetes have worse dentition and a higher prevalence of edentulism (complete tooth loss) compared to similarly aged adults without diabetes.[6,7] Oral health quality of life is lower in those with periodontal disease due to increased risk of tooth loss resulting in partial or complete edentulism, as well as chewing difficulty.[8,9] Within the U.S., data on the prevalence of periodontal disease among older adults with diabetes is difficult to establish, since not all adults have access to dental care; however, more adults with diabetes have unmet treatment needs for periodontal disease (36.6%) compared to adults without diabetes (24.3%).[6] Health-related quality of life was previously reported to be associated with dentate status and self-perceived oral health in adults with diabetes.[10] Dentate status impacts chewing function, which is impaired with 20 or fewer teeth.[11] It is also associated with nutritional status,[12] which subsequently affects overall health and functional status in older adults. Moreover, poor oral health was reported to be associated with functional dependence in older adults.[13] Diabetes, periodontal disease, tooth loss, and edentulism all disproportionately affect older adults, as well as racial/ethnic minority groups and low-income persons.[14,15]

Access to dental care is an important factor in maintaining oral health. Several studies reported that U.S. adults with diabetes were less likely to obtain dental care than those without diabetes.[2,16,17] Ethnicity, education, income and insurance status influence obtaining dental care.[1,2,16,18] The majority of older adults lack dental insurance, which also increases risk of tooth loss and oral disease: in 2004, approximately 70% of adults aged ≥65 years had no dental

insurance coverage.[18] Unfortunately, Medicare does not provide preventive dental care services,[19] and other private and public insurance plans may not routinely cover preventive dental care. A 2007 report from the Agency for Healthcare Research and Quality showed that insurance type affected actual visits to a dental provider: those with private insurance coverage were more likely to see a dentist than those with public insurance coverage or no coverage.[18]

Few studies are available which have investigated the association between health-related quality of life and oral health of older adults with diabetes; some of these studies focused on the association between oral health-related quality of life and diabetes in adults.[10,20,21] We hypothesize that poor oral health is associated with worse quality of life in older adults with diabetes compared to older adults without diabetes. This study examines the association between health-related quality of life, dentate status and dental care in U.S. older adults aged ≥65 years with diabetes mellitus using Behavioral Risk Factor Surveillance System (BRFSS) data.

METHODS

BRFSS is the largest telephone survey of non-institutionalized adults aged ≥18 years in the United States that provides cross-sectional national and state-level data related to chronic diseases, preventive measures, health care access and demographic information to reduce health care disparities.[22] Survey data are collected monthly by state health departments from a representative sample of non-institutionalized adults. The BRFSS survey questionnaire core components are asked by all states; optional modules covering other health topics or more detailed questions may also be asked by individual states. This study utilized cross-sectional data from the 2006, 2008 and 2010 BRFSS, which included the oral health questionnaire among the rotating core questions administered to all survey participants every other year.[23]

The survey subpopulation of interest was defined as adults ≥65 years of age with self-reported diabetes. Subjects who answered yes to the question "Have you ever been told by a doctor that you have diabetes?" were included. Those with pre-diabetes or gestational diabetes were classified as not having diabetes for this study. All older adults with diabetes were included in analyses regardless of dentate status, because edentulous older adults may still benefit from dental care. Examples of dental care for edentulous adults include oral cancer screening, especially in those who use tobacco or drink alcohol, and monitoring those with dentures in order to assess denture fit and evaluate for any denture-related conditions (e.g., denture stomatitis, denture hyperplasia and traumatic ulcers).[24] Poorly fitting dentures are reported to impact food intake and quality of life.[12]

SURVEY DATA MEASURES

The following self-reported data measures were used: the Healthy Days Core Module (primary outcome of interest), global life satisfaction, oral health measures (primary predictors of interest), diabetes diagnosis, health care access, demographics and smoking status. The Healthy Days Core Module is a 4-question validated survey measure developed by the Centers for Disease Control and Prevention (CDC) and its partners to monitor population health-related quality of life.[25,26] It is also used in other national surveys, including the National Health and Nutrition Examination Survey (NHANES) and the Medicare Health Outcome Survey. Questions include self-rated general health, number of days of poor physical health in the past 30 days (hereafter referred to as "physically unhealthy days"), number of days of poor mental health in the past 30 days ("mentally unhealthy days") and number of days usual activities were limited by poor physical or mental health in the past 30 days ("activity limitation days").[25] The summary index of unhealthy days is calculated by combining the number of physically unhealthy and mentally unhealthy days, with a maximum calculated index of 30 days.[25] Global life satisfaction is used to assess well-being using a single question: "In general, how satisfied are you with your life?";[27] responses are recorded on a Likert scale ranging from 1=very satisfied to 4=very dissatisfied.

The oral health measures consists of 3 questions: 1) "How long has it been since you last visited a dentist or a dental clinic for any reason?"; 2) "How many of your permanent teeth have been removed because of tooth decay or gum disease?"; and 3) "How long has it been since you had your teeth cleaned by a dentist or dental hygienist?".[23] Calculated binary oral health measure variables available include those for permanent tooth loss status, edentulous status and any dental care in the past year.

Additional variables included diabetes, health care access and demographics. The definition of diabetes was discussed above. Health care access variables included possessing any health care coverage (yes/no response) and whether cost was a barrier to obtaining health care in the past 12 months (yes/no response). Demographic covariates included age, sex, self-reported race/ethnicity, education level, employment status and income. The computed smoking status measure was used (daily smoker, some days smoker, former smoker and non-smoker).

STATISTICAL ANALYSES

Data from the 2006, 2008 and 2010 BRFSS surveys were combined for all analyses. The standard sampling weight provided by the National Center for Health Statistics was used in survey analyses.[28] Descriptive analyses of the above variables were performed to compare older adults with and without diabetes. Inferential analyses included logistic regression to determine the association between self-rated general health and each oral health measure; a calculated binary variable of self-rated general health (good or better health; fair or poor health) was provided in the dataset. Linear regression analyses were performed to estimate the association between each measure of the number of unhealthy days (physically unhealthy, mentally unhealthy and activity limitation days) and each oral health measure. Linear regression was used due to the large sample size allowing the normal approximation by the Central Limit Theorem.[29] Two-way factor variable interactions between 1) permanent tooth loss status and receiving any dental care in the past year, and 2) edentulous status and receiving any dental care in the past year were tested for association with each of the Healthy Days Core Measures. Analyses were adjusted for age, sex, race/ethnicity, education level, employment status, income, health care coverage, cost barrier to health care and smoking status. STATA 12 (StataCorp, College Station,

TX) was used to perform analyses. Human subjects approval was not required as BRFSS is a publicly available data set.

RESULTS

Comparison of characteristics of older adults with diabetes (*n*=70,363) to older adults without diabetes (*n*=308,658) is shown in Table 1. A greater proportion of older adults with diabetes were male, racial/ethnic minorities, had lower education and income levels, and were retired or unable to work compared to those without diabetes (*p*-value <0.001). While 97.8% of older adults had health care coverage, a larger proportion of those with diabetes reported a cost barrier to health care (*p*-value <0.001).

Older adults with diabetes had a greater proportion of permanent tooth loss due to caries or periodontal disease compared to older adults without diabetes, as well as a longer reported time interval since their last dental visit or dental cleaning (Table 1). Fewer older adults with diabetes and any permanent tooth loss received dental care in the past year (53.4%) than older adults with diabetes and no permanent tooth loss (74.5%) (*p*-value <0.001).

Health-related quality of life was lower in older adults with diabetes (Table 1). A greater proportion of older adults with diabetes reported fair or poor self-rated general health compared to older adults without diabetes (*p*-value <0.001). The mean number of physically unhealthy days (8.35 ± 0.09), mentally unhealthy days (3.03 ± 0.06) and activity limitation days (7.78 ± 0.11) were also higher among older adults with diabetes compared to those without diabetes (*p*-value <0.001). Self-rated global life satisfaction was generally lower among older adults with diabetes compared to those without diabetes.

Loss of permanent teeth was associated with increased odds of fair or poor self-rated general health (Table 2) (adjusted OR for any permanent teeth removed=1.25, 95% CI 1.13-1.37). Having fewer permanent teeth was associated with increased odds of worse self-rated general health (dentate: reference; missing 1-5 teeth: adjusted OR 1.08, 95% CI 0.97-1.20;

missing 6+ teeth but not all: adjusted OR 1.34, 95% CI 1.20-1.49; edentulous: adjusted OR 1.40, 95% CI 1.25-1.57). Receiving dental care more than 1 year previously was associated with increased odds of worse self-rated general health (past year: reference; 1-2 years: adjusted OR 1.29, 95% CI 1.14-1.46; 2-5 years: adjusted OR 1.33, 95% CI 1.18-1.50; 5+ years: adjusted OR, 1.30, 95% CI 1.19-1.42; never: adjusted OR 1.07, 95% CI 0.77-1.48). There was no significant interaction between permanent tooth loss status and receiving any dental care in the past year (adjusted OR 0.93, 95% CI 0.75-1.17, *p*-value 0.57). There was a significant interaction between edentulous status and receiving any dental care in the past year (adjusted OR 0.79, 95% CI 0.66-0.96, *p*-value 0.02).

Analysis of unhealthy days by linear regression (Table 3) showed that each oral health measure was significantly associated with increased number of physically unhealthy days. Increased number of permanent teeth removed was the only oral health measure significantly associated with increased number of mentally unhealthy days (adjusted linear regression coefficient 0.18, 95% CI 0.04-0.32, *p*-value 0.01). All of the oral health measures except permanent tooth loss status were significantly associated with increased number of activity limitation days. The only significant interaction found was between edentulous status and receiving any dental care in the past year for mentally unhealthy days (adjusted linear regression coefficient -1.06, 95% CI -1.83, -0.29, *p*-value 0.007); the interaction between permanent tooth loss status and receiving any dental care in the past year was not significant for mentally unhealthy days (adjusted linear regression coefficient 0.15, 95% CI -0.62-0.92, *p*-value 0.71). There were no significant interactions between permanent tooth loss status and receiving any dental care in the past year, or edentulous status and receiving any dental care in the past year for physically unhealthy days or activity limitation days.

DISCUSSION

Health-related quality of life was associated with dentate status and dental care in U.S. older adults with diabetes. We examined six aspects of oral health measures with each outcome of interest using regression analyses (Tables 2 and 3). The main results remained statistically significant at the 0.05 level after adjusting for multiple comparisons using Bonferroni criterion. Permanent tooth loss was associated with increased odds of worse self-rated general health; interestingly, the adjusted odds ratios for those with any permanent tooth loss (OR 1.25, 95% CI 1.13-1.37) and edentulism (OR 1.22, 95% CI 1.13-1.33) were similar. Poor dentition was associated with increased odds of worse self-rated general health, though the adjusted odds ratio was not significant for those missing 1-5 teeth (OR 1.08, 95% CI 0.97-1.20). This result is similar to Sandberg and Wikblad's study of Swedish adults with diabetes showing that number of teeth affected overall health-related quality of life scores measured by the SF-36 Health Survey.[10] Longer time intervals since the last dental visit were also associated with increased odds of worse self-rated general health, although never receiving dental care was not significantly associated with worse self-rated general health (adjusted OR 1.07, 95% CI 0.77-1.48).

Dentate status and dental visits were significantly associated with increased number of physically unhealthy days (Table 3). These oral health measures were also significantly associated with increased number of activity limitation days, with the exception of permanent tooth loss status. Dental visits were not significantly associated with increased number of mentally unhealthy days, but increased number of permanent teeth removed was significantly associated with increased number of mentally unhealthy days. The significant associations between dentate status, physically unhealthy days and activity limitation days supports Sandberg

and Wikblad's finding that worse dentition was associated with lower SF-36 scores for physical functioning, physical role functioning and emotional role functioning.[10] Generally, the linear regression coefficients for the number of unhealthy days were greatest when estimating the association between oral health measures and physically unhealthy days and least when estimating the association between oral health measures and mentally unhealthy days. This may be due to oral disease and tooth loss causing more physical symptoms (e.g., pain, xerostomia). These results showed that worse dentition and less recent dental care generally resulted in <1 additional unhealthy day (Table 3).

Additionally, these study results support previous studies showing that U.S. adults with diabetes have worse dentition than U.S. adults without diabetes. One study using NHANES 1999-2004 data reported that U.S. adults with diabetes had an average of 5.7 missing teeth, compared to 4.1 missing teeth among all U.S. adults;[6] another study from the same NHANES data showed that U.S. older adults with diabetes were missing an average of 15.2 teeth compared to those without diabetes (mean number of missing teeth=12.1).[7] Reducing the "proportion of older adults aged 65 to 74 years who have lost all of their natural teeth" to 21.6% is an objective of Healthy People 2020.[30] While this objective is pertinent but not specific to U.S. older adults with diabetes, our results showed that 23.9% of U.S. older adults with diabetes were edentulous due to periodontal disease or caries, compared to 16.1% of U.S. older adults without diabetes. This result cannot be directly compared with results from NHANES 1999-2004, which reported that 34.1% of adults with diabetes aged 65-74 and 42.4% of adults with diabetes aged ≥75 years were edentulous,[7] because the NHANES examination assesses the number of teeth but not the reason for tooth loss.[31] However, our results reinforce the continued need for interventions to improve dentition and oral health in this population.

Our study results also support prior studies showing that U.S. older adults with diabetes obtained dental care less recently than those without diabetes. One study of older dentate adults with diabetes from BRFSS 1995-1998 data reported that 68.4% of those aged 65-74 years and 64.7% of those aged ≥75 years saw a dentist in the past year.[2] Another study of National Health Interview Survey 2003 data reported that 68.7% of older dentate males with diabetes and 61.2% of older dentate females with diabetes visited the dentist in the past year.[16] CDC previously reported from BRFSS 2004 data that 67.3% of dentate adults with diabetes aged 65-74 years and 70.6% of dentate adults with diabetes aged ≥75 years received dental care in the past year.[32] Our study found that 74.5% of older dentate adults with diabetes received dental care in the past year. This may reflect a trend toward increasing the proportion of "persons with diagnosed diabetes [≥2 years of age] who have at least an annual dental examination" as set by Healthy People 2020.[31]

As with all self-reported surveys, limitations of this study are that BRFSS obtains self-reported information, so answers may be subject to respondent recall bias. This is especially pertinent for the Healthy Days measures, number of permanent teeth removed and time since last dental visit. We are unable to determine causality between poor oral health and health-related quality of life due to the cross-sectional study design. Additionally, BRFSS does not currently survey respondents about insurance coverage for dental care. As previously discussed, type of dental insurance (e.g., public versus private) affects ability to obtain dental care.[18]

Nevertheless, significant strengths of this study include that it is a large cross-sectional study of a nationally representative sample in which the association between both dentate status and receiving dental care with health-related quality of life were evaluated. It can also be inferred from our study results that many older adults with diabetes lack dental coverage, given the high

prevalence of reported health care coverage. This shows the potential need for expanding health care coverage to include dental care, considering the known bidirectional relationship between diabetes and periodontal disease.[3,4]

In conclusion, health-related quality of life in older adults with diabetes was worse compared to older adults without diabetes. Dentate status and dental care were significantly associated with self-rated general health as well as number of unhealthy days. This study highlights potential areas to improve quality of life and oral health for older adults with diabetes. Attention to preventing dental caries and periodontal disease in order to decrease tooth loss, as well as methods to increase availability of dental care may help improve oral health and quality of life in this potentially vulnerable population.

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Table 1. Characteristics of Older Adults with Self-Reported Diabetes Compared to Older Adults without Diabetes.

Characteristic	**Diabetes** ***n*=70,363**	**No Diabetes** ***n*=308,658**	***p*-value**
Age in years, mean ± SE	74.03 ± 0.05	74.72 ± 0.02	<0.001
Gender (%)			<0.001
Male	47.7	40.7	
Female	52.3	59.3	
Race/ethnicity (%)			<0.001
White, non-Hispanic	69.7	82.2	
Black, non-Hispanic	13.1	6.7	
Hispanic	11.5	6.7	
Other	5.7	4.3	
Education (%)			<0.001
High school or less	56.2	46.8	
Some college/technical school or greater	43.8	53.2	
Employment status (%)			<0.001
Retired	72.9	70.3	
Employed for wages/self-employed	10.8	16.0	
Unable to work	7.5	3.2	
Homemaker	7.3	8.7	
Income, US$ (%)			<0.001
<$25,000	48.7	36.6	
$25,000-$49,999	30.9	33.4	
>$50,000	20.4	30.0	
Any health care coverage (%)	97.8	97.8	0.99
Unable to see doctor due to cost in past 12 months (%)	6.3	4.4	<0.001
Smoking status (%)			<0.001
Never	46.4	50.0	
Former	46.3	41.2	
Some days	2.0	2.2	
Daily	5.3	6.6	
Number permanent teeth missing due to caries or periodontal disease (%)			<0.001
None	17.7	25.7	
1-5 teeth	29.6	34.4	
≥6 teeth	28.8	23.8	
All (edentulous)	23.9	16.1	

Table 1 continued

Time since last dental visit (%)			<0.001
Within past year	57.1	69.5	
Past 1-2 years	10.5	8.6	
Past 2-5 years	10.4	7.5	
5+ years	20.7	13.8	
Never	1.3	0.7	
Time since last dental cleaning (%)			<0.001
Within past year	65.0	75.5	
Past 1-2 years	10.8	8.6	
Past 2-5 years	8.9	6.2	
5+ years	12.1	8.1	
Never	3.2	1.6	
Self-rated general health (%)			<0.001
Excellent	3.5	14.4	
Very good	14.6	29.5	
Good	34.2	33.3	
Fair	30.7	16.2	
Poor	17.0	6.5	
Number of days with poor physical health in the past 30 days, mean ± SE	8.35 ± 0.09	4.70 ± 0.03	<0.001
Number of days with poor mental health in the past 30 days, mean ± SE	3.03 ± 0.06	1.97 ± 0.02	<0.001
Number of days poor physical or mental health limited activity in the past 30 days, mean ± SE	7.78 ± 0.11	5.22 ± 0.05	<0.001
Summary index of unhealthy days, mean ± SE	9.51 ± 0.09	5.84 ± 0.03	<0.001
Self-rated overall life satisfaction (%)			<0.001
Very satisfied	43.4	51.4	
Satisfied	51.5	45.5	
Dissatisfied	4.1	2.5	
Very dissatisfied	1.0	0.6	

Table 2. Odds Ratios for Fair or Poor Self-Rated General Health Associated with Oral Health Measures.

	Unadjusted		**Adjusted***	
	OR (95% CI)	***p*-value**	**OR (95% CI)**	***p*-value**
Number of permanent teeth removed	1.36 (1.32-1.40)	<0.001	1.14 (1.10-1.18)	<0.001
Any permanent teeth removed	1.68 (1.55-1.82)	<0.001	1.25 (1.13-1.37)	<0.001
Edentulous	1.76 (1.64-1.88)	<0.001	1.22 (1.13-1.33)	<0.001
Time since last dental visit	1.28 (1.25-1.31)	<0.001	1.10 (1.07-1.13)	<0.001
Dental visit in past year	1.96 (1.85-2.08)	<0.001	1.34 (1.25-1.44)	<0.001
Time since last dental cleaning	1.31 (1.27-1.35)	<0.001	1.13 (1.08-1.17)	<0.001

* Analyses adjusted for health care coverage, cost barrier to health care, sociodemographics and smoking status.

Table 3. Linear Regression Coefficients for Number of Unhealthy Days Associated with Oral Health Measures.

Table 3a. Linear Regression of Oral Health Measures and Association with Physically Unhealthy Days.

	Unadjusted		**Adjusted***	
Oral health measure	**Linear regression coefficient (95% CI)**	***p*-value**	**Linear regression coefficient (95% CI)**	***p*-value**
Increased number of permanent teeth removed	1.30 (1.14-1.47)	<0.001	0.63 (0.43-0.82)	<0.001
Any permanent teeth removed	2.07 (1.63-2.50)	<0.001	0.81 (0.32-1.29)	0.001
Edentulous	2.41 (2.00-2.82)	<0.001	1.05 (0.58-1.53)	<0.001
Greater time since last dental visit	1.10 (0.96-1.24)	<0.001	0.53 (0.37-0.69)	<0.001
No dental visit in past year	2.83 (2.47-3.19)	<0.001	1.27 (0.87-1.68)	<0.001
Greater time since last dental cleaning	1.14 (0.95-1.32)	<0.001	0.54 (0.34-0.75)	<0.001

* Analyses adjusted for health care coverage, cost barrier to health care, sociodemographics and smoking status.

Table 3b. Linear Regression of Oral Health Measures and Association with Mentally Unhealthy Days.

	Unadjusted		**Adjusted***	
Oral health measure	**Linear regression coefficient (95% CI)**	***p*-value**	**Linear regression coefficient (95% CI)**	***p*-value**
Increased number of permanent teeth removed	0.49 (0.37-0.62)	<0.001	0.18 (0.04-0.32)	0.01
Any permanent teeth removed	0.74 (0.43-1.06)	<0.001	0.24 (-0.10-0.57)	0.16
Edentulous	0.75 (0.42-1.08)	<0.001	0.08 (-0.27-0.42)	0.66
Greater time since last dental visit	0.33 (0.23-0.43)	<0.001	-0.03 (-0.13-0.07)	0.58
No dental visit in past year	1.08 (0.80-1.36)	<0.001	0.20 (-0.08-0.48)	0.17
Greater time since last dental cleaning	0.47 (0.35-0.59)	<0.001	0.14 (0.00-0.27)	0.05

* Analyses adjusted for health care coverage, cost barrier to health care, sociodemographics and smoking status.

Table 3c. Linear Regression of Oral Health Measures and Association with Activity Limitation Days.

	Unadjusted		**Adjusted***	
Oral health measure	**Linear regression coefficient (95% CI)**	***p*-value**	**Linear regression coefficient (95% CI)**	***p*-value**
Increased number of permanent teeth removed	0.92 (0.70-1.14)	<0.001	0.40 (0.14-0.66)	0.003
Any permanent teeth removed	1.26 (0.63-1.89)	<0.001	0.43 (-0.29-1.15)	0.24
Edentulous	1.85 (1.33-2.38)	<0.001	0.74 (0.17-1.30)	0.01
Greater time since last dental visit	0.82 (0.64-0.99)	<0.001	0.35 (0.16-0.55)	<0.001
No dental visit in past year	1.98 (1.54-2.43)	<0.001	0.75 (0.25-1.25)	0.003
Greater time since last dental cleaning	0.72 (0.50-0.93)	<0.001	0.27 (0.02-0.51)	0.03

* Analyses adjusted for health care coverage, cost barrier to health care, sociodemographics and smoking status.