Published in final edited form as:

J Am Geriatr Soc. 2013 October ; 61(10): . doi:10.1111/jgs.12452.

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

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Abstract

Background—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 (HRQOL) and oral health among U.S. older adults with diabetes mellitus.

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

Measurements—Main outcome of interest was HRQOL as measured by the Healthy Days Core Module.

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Paper presentation: Results from this study were presented at the American Geriatrics Society Annual Scientific Meeting in Seattle, WA, in May 2012. This work is a revision of a master's thesis submitted to the University of Washington by Dr. Huang in June 2012.

Conflict of Interest: Dr. Huang reports no financial or personal conflicts of interest. Dr. Chan reports no financial or personal conflicts of interest. Dr. Young reports no financial or personal conflicts of interest.

Author Contributions: Dr. Huang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Huang

Analysis and interpretation of data: Huang, Chan, Young

Drafting of the manuscript: Huang

Critical revision of the manuscript for important intellectual content: Huang, Chan, Young

Statistical expertise: Chan

Approval of final version of manuscript: Huang, Chan, Young

Dr. Huang acknowledges the contributions of H. Asuman Kiyak, PhD, who died May 6, 2011, in conceiving and designing this study. Dr. Kiyak was Professor of Oral and Maxillofacial Surgery at the University of Washington School of Dentistry (Seattle, WA) and received no compensation for her contributions. Written consent is unable to be obtained due to Dr. Kiyak's death.

Results—Older adults with diabetes were more likely to report permanent tooth loss due to caries or periodontal disease compared to those without diabetes (82.3% versus 74.3%, $P<0.001$) and were less likely to receive dental care in the past year (59.0% versus 70.9%, $P<0.001$). Loss of permanent teeth from caries or periodontal disease was associated with 1.25-fold increased odds of worse self-rated general health (95% CI 1.13–1.37). Lack of dental care in the preceding 12 months was associated with 1.34-fold increased odds of worse self-rated general health (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 visit were associated with increased number of physically unhealthy days.

Conclusions—Poor dentition and lack of dental care were associated with worse HRQOL among older adults with diabetes. Further research is needed to determine whether better oral health improves HRQOL in this population.

Keywords

health-related quality of life; oral health; diabetes mellitus

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^{2,3} and subsequent tooth loss.⁴ Studies show U.S. older adults with diabetes have worse dentition and a higher prevalence of edentulism (complete tooth loss) compared to older adults without diabetes.^{4–6} Health-related quality of life (HRQOL) was previously reported to be associated with dentate status (having any teeth or not) and self-perceived oral health in adults with diabetes.⁷ Dentate status also impacts quality of life,^{8,9} chewing function,⁸ and nutritional status,⁹ which affects overall health and functional status in older adults. Moreover, poor oral health was reported to be associated with functional dependence in older adults.¹⁰ Dental care can help prevent tooth loss, yet several studies have reported that U.S. adults with diabetes were less likely to obtain dental care than those without diabetes.^{11,12} This disparity in dental care is further compounded in older adults due to lack of dental insurance¹³ and cost, among other barriers to dental care.

Few studies are available which have investigated the association between HRQOL and oral health of older adults with diabetes.⁷ Prior research in this area has not specifically focused on older adults with diabetes, despite the increased risk of oral disease in this population. Additionally, these prior studies examined oral health-related quality of life, but not the impact of oral health on overall quality of life.^{14,15} We hypothesize that poor oral health is associated with worse quality of life in older adults with diabetes. This study examines the association between HRQOL, dentate status and receipt of dental care among U.S. older adults aged ≥ 65 years with diabetes mellitus using Behavioral Risk Factor Surveillance System (BRFSS) data.

METHODS

The BRFSS is a state-based telephone survey of non-institutionalized adults aged ≥ 18 years in the United States sponsored by the Centers for Disease Control and Prevention (CDC) 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.¹⁶ 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 publicly available cross-sectional data from the 2006, 2008 and 2010 BRFSS, which included the oral health questionnaire among the core questions administered to all survey participants.¹⁶ Survey questionnaires, operations manuals and information regarding BRFSS data validity are available on the BRFSS website.¹⁶

The survey subpopulation of interest was defined as adults ≥65 years of age with self-reported diabetes due to their increased risk of periodontal disease and tooth loss. 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).¹⁷ Poorly fitting dentures are reported to impact food intake and quality of life.⁹

Survey Data Measures

The primary outcome of interest was HRQOL as measured by the Healthy Days Core Module. This is a 4-question validated survey measure developed by the CDC and its partners to monitor population HRQOL.^{18,19} Questions include 1) self-rated general health with responses given on a Likert 5-point scale, 2) number of days of poor physical health in the past 30 days (hereafter referred to as “physically unhealthy days”), 3) number of days of poor mental health in the past 30 days (“mentally unhealthy days”), and 4) number of days usual activities were limited by poor physical or mental health in the past 30 days (“activity limitation days”).¹⁸ 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.¹⁸ A calculated binary variable of self-rated health (0 = good or better health; 1 = fair or poor health) was provided in the dataset. The binary self-rated health variable was used because fair or poor self-rated health was previously shown to be associated with diabetes complications among U.S. adults with diabetes²⁰ and is a foundation health measure of *Healthy People 2020*.²¹

Primary predictors of interest were the following oral health measures: 1) Length of time since last dental visit (categorical variable: past year, 1–2 years, 2–5 years, >5 years or never), 2) number of permanent teeth removed due to caries or periodontal disease, including wisdom teeth (categorical variable: none, 1–5 teeth, ≥6 but not all teeth, or all), and 3) length of time since last dental cleaning for dentate subjects (categorical variable: past year, 1–2 years, 2–5 years, >5 years or never).¹⁶ Calculated binary variables for permanent tooth loss status, edentulous status and any dental care in the past year were provided in the dataset.

Covariates included health care access, demographics and smoking status. Health care access variables were: 1) possessing any health care coverage and 2) whether cost was a barrier to obtaining health care in the past 12 months. Demographic covariates included age, sex, race/ethnicity, education, 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 after determining that prevalence of self-reported diabetes among older adults and demographics

were similar in each year (results not shown). The standard sampling weight provided in the dataset was used in survey analyses.²² Descriptive analyses of the above variables were performed to compare older adults with and without diabetes. Inferential analyses of subjects with diabetes included logistic regression to determine the association between self-rated health and each oral health measure using the binary self-rated health variable 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.²³ Inferential analyses were also performed for only dentate subjects and only edentulous subjects with diabetes. These regression models were based on our conceptual model of the relationship between quality of life, oral health and diabetes. Analyses were adjusted for age, sex, race/ethnicity, education, 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.

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. While 97.8% of older adults had health care coverage, a larger proportion of those with diabetes reported a cost barrier to health care (6.3%) compared to those without diabetes (4.4%).

Older adults with diabetes had a greater proportion of permanent tooth loss due to caries or periodontal disease (82.3%) compared to older adults without diabetes (74.3%), 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%).

HRQOL was lower in older adults with diabetes. A greater proportion of older adults with diabetes reported fair or poor self-rated health (47.7%) compared to older adults without diabetes (22.7%). The mean number of physically unhealthy days (8.35 ± 0.09), mentally unhealthy days (3.03 ± 0.06) and activity limitation days (3.03 ± 0.06) were also higher among older adults with diabetes compared to those without diabetes (Table 1).

Loss of any permanent teeth was associated with 1.25 greater odds of fair or poor self-rated health among older adults with diabetes (95% CI 1.13–1.37), or 25% greater likelihood of fair or poor self-rated health. Having fewer permanent teeth was associated with increased odds of worse self-rated health (Table 2). Receipt of dental care more than 1 year previously was associated with increased odds of worse self-rated health among all older adults with diabetes (past year: reference; 1–2 years; OR = 1.29, 95% CI 1.14–1.46; 2–5 years: OR = 1.33, 95% CI 1.18–1.50; >5 years: OR = 1.30, 95% CI 1.19–1.42; never: OR = 1.07, 95% CI 0.77–1.48). Results by dentate status are shown in Table 2: receipt of dental care >1 year prior to the survey was associated with increased likelihood of worse self-rated health among dentate subjects, but not edentulous subjects.

Linear regression analysis of unhealthy days (Table 3) showed that each oral health measure was significantly associated with additional physically unhealthy days. Older adults with diabetes and any permanent tooth loss experienced 0.81 additional physically unhealthy days (95% CI 0.32–1.29, $P = 0.001$), and edentulous participants experienced 1.54 additional physically unhealthy days (95% CI 0.93–2.15, $P < 0.001$) in the past 30 days

compared to dentate older adults with diabetes. Those who visited a dentist >1 year previously had 1.27 additional physically unhealthy days (95% CI 0.87–1.68, $P < 0.001$) in the past 30 days compared to older adults with diabetes who visited a dentist in the past year. Oral health measures were not consistently associated with additional mentally unhealthy days (Table 3). Among dentate older adults with diabetes, those missing 6 but not all teeth had 0.71 additional mentally unhealthy days (95% CI 0.33–1.09, $P < 0.001$) in the past 30 days compared to individuals without permanent tooth loss; individuals with a dental visit or dental cleaning 1–2 years previously also experienced additional mentally unhealthy days in the past 30 days (dental visit estimate = 0.70, 95% CI 0.12–1.29, $P = 0.02$; dental cleaning estimate = 0.56, 95% CI 0.03–1.09, $P = 0.04$) compared to those with a dentist visit or dental cleaning in the past year. There was a significantly different association between mentally unhealthy days and longer time since last dental visit among edentulous older adults with diabetes (0.30 fewer mentally unhealthy days, estimate = -0.30 , 95% CI -0.51 , -0.09 , $P = 0.005$). Dentition and time since last dental visit were significantly associated with additional activity limitation days (Table 3). Any permanent tooth loss was not significantly associated with additional activity limitation days in the past 30 days (estimate = 0.43, 95% CI -0.29 –1.15, $P = 0.24$), but edentulous participants experienced 0.99 additional activity limitation days (95% CI 0.17–1.81, $P = 0.02$) in the past 30 days compared to dentate participants. Older adults with diabetes who received dental care >1 year prior to the survey experienced 0.75 additional activity limitation days (95% CI 0.25–1.25, $P = 0.003$) in the past 30 days compared to those who received dental care in the past year.

DISCUSSION

Oral health is traditionally perceived and treated as a separate entity in clinical practice, though the general population may not share this perspective. Our study showed that HRQOL was associated with dentate status and dental care visits 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: those with any permanent tooth loss had 25% greater risk of worse self-rated health compared to those without any permanent tooth loss. Risk of worse self-rated health was also greater with increasing number of missing teeth: 8% for older adults with diabetes missing 1–5 teeth (non-significant association), 34% for those missing 6 but not all teeth and 40% for edentulous participants (Table 2). Furthermore, permanent tooth loss was associated with additional unhealthy days. This association was most consistent for physically unhealthy and activity limitation days among older adults missing 6 teeth. This may represent a threshold level for number of missing permanent teeth to impact HRQOL. This threshold is also consistent with prior reports that possessing <20 permanent teeth negatively affects chewing function in older adults,²⁴ which impacts nutritional and functional status.⁹

Our finding that dentition was associated with worse self-rated health, increased number of physically unhealthy days and activity limitation days is similar to results from a 2003 study of Swedish adults with diabetes (N=102): number of teeth affected overall HRQOL scores measured by the Short Form-36 (SF-36) Health Survey, and worse dentition was associated with lower SF-36 scores for physical functioning, physical role functioning and emotional role functioning.⁷ In addition to these findings, our study found that worse dentition was most consistently associated with additional physically unhealthy days, followed by additional activity limitation days (Table 3). This may be due to oral disease and tooth loss causing more physical symptoms (e.g., pain, xerostomia). These findings further

demonstrate that dentate status affects overall perception of health among U.S. older adults with diabetes.

Time since last dental visit was also associated with worse HRQOL in our study. This finding supports a prior study of UK community-dwelling adults which reported that regular dental visits positively impacted quality of life.²⁵ Interestingly, greater length of time since last dental visit did not show a “dose-response” change in risk of worse self-rated health: 29% for 1–2 years since last dental visit, 33% for 2–5 years since last dental visit and 30% for >5 years since last dental visit. However, increased length of time since last dental visit was associated with a greater number of physically unhealthy days in the past 30 days (dental visit in past year: reference; 1–2 years since last dental visit: 0.72 additional physically unhealthy days; 2–5 years: 0.92 additional days; >5 years: 1.54 additional days), but no similar dose-response relationship was found for mentally unhealthy or activity limitation days. This is one of the first studies to our knowledge to report the association between overall quality of life and dental care utilization among adults with diabetes or older adults.

The association between HRQOL and the different oral health measures demonstrated in this study challenges the current paradigm dividing medical and dental care. Self-rated health was previously shown to be a predictor of health outcomes, including mortality.^{26,27} As U.S. older adults with diabetes with worse dentition and less recent dental care had increased risk of worse self-rated health, we can infer that both poor dentition and less recent dental care are predictors of worse health outcomes in older adults with diabetes. Additionally, we can infer from the association between increased unhealthy days and worse oral health that this population may potentially have greater future health care needs, since individuals may be more likely to obtain health care when they feel unhealthy.¹⁸ These findings illustrate the need for increased integration of oral health into health care. This could potentially decrease mortality and health care needs of this population.

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. Diabetes prevalence may be under-estimated due to the greater prevalence of undiagnosed diabetes in older adults.²⁸ We are unable to determine causality between poor oral health and HRQOL due to the cross-sectional study design. Additionally, BRFSS does not currently survey respondents about insurance coverage for dental care: type of dental insurance (e.g., public versus private) affects ability to obtain dental care.¹³

Nevertheless, significant strengths of this study include that it is a large cross-sectional study of a nationally representative sample of U.S. older adults with diabetes in which the association between both dentate status and receipt of dental care with HRQOL were evaluated. Both oral health measures were significantly associated with HRQOL, especially self-rated general health and physically unhealthy days. Overall, this demonstrates that oral health impacts perceived general health and potential health needs as measured by HRQOL. These results reinforce the need for expanding health care coverage to include dental care, considering the known bidirectional relationship between diabetes and periodontal disease.^{2,3}

In conclusion, poor oral health, specifically fewer permanent teeth and lack of recent dental care, were associated with worse HRQOL in U.S. older adults with diabetes. Both poor dentition and less recent dental care were significantly associated with worse self-rated general health as well as increased number of unhealthy days. This study highlights potential areas to improve quality of life and oral health for older adults with diabetes. Future research

should focus on prospective studies of oral health on both subjective and objective health outcomes. 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.

Acknowledgments

Funding/Support: This material is the result of work supported by resources from the VA Puget Sound Health Care System in Seattle, WA. Dr. Huang receives salary support from the Department of Veterans Affairs Advanced Fellowship in Geriatrics. Dr. Young receives support from the Department of Veterans Affairs, from the VA Puget Sound Health Care System, Seattle, WA, and NIH grant NIDDK R01DK079745-01. The funders had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; or preparation, review, or approval of the manuscript.

Sponsor's Role: The funders had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data; or preparation, review, or approval of the manuscript. This material is the result of work supported by resources (Dr. Huang and Dr. Young) from the VA Puget Sound Health Care System in Seattle, Washington.

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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 $\pm$ SE	74.03 $\pm$ 0.05	74.72 $\pm$ 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	
Time since last dental visit (%)			<0.001
<1 year	57.1	69.5	
1 to <2 years	10.5	8.6	
2 to <5 years	10.4	7.5	
5+ years	20.7	13.8	
Never	1.3	0.7	

Characteristic	Diabetes N=70,363	No Diabetes N=308,658	P-Value
Time since last dental cleaning (%)			<0.001
<1 year	65.0	75.5	
1 to <2 years	10.8	8.6	
2 to <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 $\pm$ SE	8.35 $\pm$ 0.09	4.70 $\pm$ 0.03	<0.001
Number of days with poor mental health in the past 30 days, mean $\pm$ SE	3.03 $\pm$ 0.06	1.97 $\pm$ 0.02	<0.001
Number of days poor physical or mental health limited activity in the past 30 days, mean $\pm$ SE	7.78 $\pm$ 0.11	5.22 $\pm$ 0.05	<0.001
Summary index of unhealthy days, mean $\pm$ SE	9.51 $\pm$ 0.09	5.84 $\pm$ 0.03	<0.001

SE: standard error

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

Oral Health Measure	Unadjusted			Adjusted ^a		
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Permanent teeth removed (reference: none)	1.36 (1.32–1.40)	<0.001	1.14 (1.10–1.18)	<0.001	---	---
Any	1.68 (1.55–1.82)	<0.001	1.25 (1.13–1.37)	<0.001	---	---
1–5 teeth	1.19 (1.09–1.31)	<0.001	1.08 (0.97–1.20)	0.17	---	---
6 but not all teeth	1.79 (1.64–1.97)	<0.001	1.34 (1.20–1.49)	<0.001	---	---
All	2.36 (2.15–2.60)	<0.001	1.40 (1.25–1.57)	<0.001	---	---
			Dentate		Edentulous	
Last dental visit (reference: within 1 year)	1.28 (1.25–1.31)	<0.001	1.09 (1.05–1.14)	<0.001	1.05 (0.99–1.11)	0.08
<1 year	1.96 (1.85–2.08)	<0.001	1.36 (1.24–1.49)	<0.001	1.10 (0.92–1.30)	0.29
1 to <2 years	1.69 (1.53–1.88)	<0.001	1.35 (1.18–1.55)	<0.001	0.94 (0.71–1.24)	0.66
2 to <5 years	1.90 (1.72–2.10)	<0.001	1.29 (1.12–1.49)	<0.001	1.08 (0.85–1.38)	0.54
5+ years	2.08 (1.93–2.24)	<0.001	1.28 (1.12–1.46)	<0.001	1.14 (0.95–1.36)	0.17
Never	1.77 (1.36–2.08)	<0.001	0.65 (0.39–1.08)	0.10	1.23 (0.79–1.91)	0.35
Last dental cleaning (reference: within 1 year)	1.31 (1.27–1.35)	<0.001	1.13 (1.09–1.18)	<0.001	N/A	---
1 to <2 years	1.90 (1.68–2.15)	<0.001	1.49 (1.29–1.71)	<0.001	N/A	---
2 to <5 years	2.27 (2.01–2.55)	<0.001	1.61 (1.39–1.85)	<0.001	N/A	---
5+ years	2.02 (1.82–2.23)	<0.001	1.32 (1.17–1.49)	<0.001	N/A	---
Never	2.58 (1.96–3.40)	<0.001	1.37 (0.99–1.91)	0.06	N/A	---

^a Analyses adjusted for age, sex, race/ethnicity, education, employment status, income, health care coverage, cost barrier to health care and smoking status.

Table 3
Regression Coefficients for Number of Additional Unhealthy Days Associated with Oral Health Measures in Older Adults with Diabetes.

Oral Health Measure	Physically Unhealthy Days			Mentally Unhealthy Days			Activity Limitation Days		
	Unadjusted		Adjusted ^a	Unadjusted		Adjusted ^a	Unadjusted		Adjusted ^a
	β -coefficient (95% CI)	P-value	β -coefficient (95% CI)	β -coefficient (95% CI)	P-value	β -coefficient (95% CI)	β -coefficient (95% CI)	P-value	β -coefficient (95% CI)
Permanent teeth removed (reference: none)	1.30 (1.14–1.47)	<0.001	0.65 (0.43–0.82)	0.49 (0.37–0.62)	<0.001	0.18 (0.04–0.32)	0.92 (0.70–1.14)	<0.001	0.40 (0.14–0.66)
Any	2.07 (1.63–2.50)	<0.001	0.81 (0.32–1.29)	0.74 (0.43–1.06)	<0.001	0.24 (–0.10–0.57)	1.26 (0.63–1.89)	<0.001	0.43 (–0.29–1.15)
1–5 teeth	0.51 (0.01–1.00)	0.04	0.18 (–0.34–0.70)	0.005 (–0.33–0.34)	0.98	–0.006 (–0.36–0.35)	0.10 (–0.59–0.79)	0.78	0.04 (–0.72–0.80)
6 but not all teeth	2.45 (1.93–2.97)	<0.001	1.32 (0.77–1.87)	1.14 (0.75–1.52)	<0.001	0.71 (0.32–1.09)	1.32 (0.61–2.02)	<0.001	0.79 (0.01–1.57)
All	3.55 (3.02–4.08)	<0.001	1.54 (0.93–2.15)	1.18 (0.77–1.59)	<0.001	0.31 (–0.12–0.75)	2.46 (1.72–3.20)	<0.001	0.99 (0.17–1.81)
Last dental visit (reference: within 1 year)	1.10 (0.96–1.24)	<0.001	0.53 (0.37–0.69)	0.50 (0.35–0.66) ^c	<0.001	0.11 (–0.03–0.25) ^c	0.82 (0.64–0.99)	<0.001	0.35 (0.16–0.55)
<1 year	2.83 (2.47–3.19)	<0.001	1.27 (0.87–1.68)	1.35 (0.96–1.73) ^c	<0.001	0.49 (0.13–0.85) ^c	1.98 (1.54–2.43)	<0.001	0.75 (0.25–1.25)
1 to <2 years	1.85 (1.24–2.46)	<0.001	0.72 (0.07–1.36)	1.15 (0.62–1.69) ^c	<0.001	0.70 (0.12–1.29) ^c	1.22 (0.48–1.96)	0.001	0.34 (–0.43–1.10)
2 to <5 years	2.40 (1.71–3.09)	<0.001	0.92 (0.22–1.62)	1.33 (0.55–2.12) ^c	0.001	0.15 (–0.32–0.65) ^c	1.35 (0.61–2.08)	<0.001	0.55 (–0.23–1.33)
5+ years	3.44 (3.00–3.89)	<0.001	1.54 (1.04–2.03)	1.33 (0.82–1.84) ^c	<0.001	0.29 (–0.20–0.78) ^c	2.62 (2.05–3.20)	<0.001	0.91 (0.31–1.51)
Never	2.27 (0.58–3.96)	0.008	0.95 (–1.00–2.90)	0.91 (–1.08–2.91) ^c	0.37	–1.02 (–3.08–1.04) ^c	2.09 (–0.09–4.27)	0.06	1.67 (–0.88–4.22)
Last dental cleaning (reference: within 1 year)	1.14 (0.95–1.32)	<0.001	0.54 (0.34–0.75)	0.47 (0.35–0.59)	<0.001	0.14 (0.00–0.27)	0.72 (0.50–0.93)	<0.001	0.27 (0.02–0.51)
1 to <2 years	2.08 (1.33–2.83)	<0.001	0.70 (0.04–1.36)	1.40 (0.72–2.07)	<0.001	0.65 (0.12–1.19)	0.87 (0.05–1.69)	0.04	0.32 (–0.51–1.15)
2 to <5 years	2.41 (1.67–3.14)	<0.001	1.24 (0.43–2.06)	1.22 (0.73–1.71)	<0.001	0.34 (–0.17–0.86)	1.65 (0.79–2.51)	<0.001	0.83 (–0.09–1.76)
5+ years	3.51 (2.87–4.16)	<0.001	1.58 (0.92–2.23)	1.35 (0.88–1.81)	<0.001	0.30 (–0.15–0.75)	2.38 (1.60–3.15)	<0.001	0.75 (–0.06–1.56)
Never	3.86 (2.23–5.50)	<0.001	1.03 (–0.72–2.77)	1.50 (0.49–2.50)	0.003	0.19 (–0.93–1.30)	1.99 (0.27–3.72)	0.02	–0.01 (–1.70–1.67)

^aAnalyses adjusted for age, sex, race/ethnicity, education, employment status, income, health care coverage, cost barrier to health care and smoking status.

^bResults from linear trend analyses.

^cDentate subjects only.