BRIEF REPORT

# Patients' Understanding of the Relationship Between Their Diabetes and Periodontal Disease

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***Introduction:*** **There is a paucity of research on awareness, education, and interventions that address increased risk of developing periodontal disease, the sixth complication of diabetes. Examining the knowledge of patients with diabetes and understanding of the bidirectional relationship between periodontal disease and diabetes could inform future diabetes self-management care. We assessed the knowledge and understanding of the bidirectional relationship between diabetes and periodontal disease; examined gender, education, and income differences in this knowledge and understanding, as well as other differences in dental hygiene practices.**

***Methods:*** **A Web-based survey was conducted using a convenience sample of patients with diabetes.**

***Results:*** **A total of 927 patients with diabetes participated in the study. Gender and education were significantly associated with knowledge and understanding of the bidirectional relationship between diabetes and periodontal disease in patients with diabetes. After controlling for diabetes duration, dental insurance status, and other covariates, males had less knowledge and understanding of the bidirectional relationship between diabetes and periodontal disease compared with females ($P < .0001$). Those with higher education ($P < .002$) and those who received health care provider recommendations to obtain regular dental visits ($P < .00001$) had greater understanding of the association between diabetes and periodontal disease.**

***Conclusions:*** **This study highlights the need for 1) educating male and low-education patients with diabetes in particular about their increased risk of periodontal disease and the need for regular dental visits, and 2) health care providers and dental health providers to work together to address the needs of their diabetic patients. (J Am Board Fam Med 2020;33:1004–1010.)**

*Keywords:* **Diabetes Mellitus, Health Behavior, Health Personnel, Oral Hygiene, Patient Navigation, Periodontal Diseases, Self-Management, Surveys and Questionnaires**

## Introduction

### *Background*

In 2017, 83,564 Americans died from diabetes, making it 1 of the 10 leading causes of death.[1] Diabetes management reached $327 billion ($237 billion direct medical costs and $90 billion indirect costs).[2] These exorbitant costs are related to diabetes comorbidities: hypertension, heart disease, stroke, kidney disease, amputation, blindness, and periodontal disease.[3] Currently, there are 30 million Americans living with diabetes.[4]

Research has assessed the knowledge and understanding of patients with diabetes of their increased risk for chronic diseases and complications.[5–8] However, few studies have examined awareness, education, and interventions that address increased risk of developing periodontal disease, the sixth complication of diabetes.[9,10] Diabetes and periodontal disease have a bidirectional relationship.[11–17]

Based on this bidirectional relationship, periodontal disease is more prevalent among patients

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with diabetes. National Health Nutrition Examination Survey data suggest that prevalence of severe periodontitis in patients with diabetes was significantly higher than that of people without diabetes.[18] Similarly, periodontitis is a predictor of diabetes death. One study of patients with diabetes found age- and sex-adjusted death rates were 3.7 for those with no or mild periodontitis, 19.6 for moderate periodontitis, and 28.4 for severe periodontitis. Periodontitis predicts death from diabetic nephropathy ($P < .01$) and ischemic heart disease ($P = .04$).[19] Poorer periodontal health leads to poorer glycemic control.[20–24] Thus, by treating periodontal disease, a positive effect on glycemic control is observed in patients with type 1 and type 2 diabetes.[25–30] One meta-analysis (9 studies; 485 patients with diabetes) reported a significant reduction in $HbA_{1c}$ of 0.46% (95% CI, 0.11-0.82; $P = .01$) following periodontal treatment.[31] Despite evidence supporting a diabetes and periodontal disease bidirectional relationship, few studies have assessed the knowledge and understanding of the bidirectional relationship between these 2 diseases in patients with diabetes. This information is important for health care providers. It can shape their diabetes education messages for patients. The study reported here examined knowledge and understanding of the bidirectional relationship between diabetes and periodontal disease (hereafter, bidirectional relationship) and factors associated with this knowledge in patients with diabetes.

## Methods

### *Study Design*

In August 2019, we conducted a Web-based survey to understand the knowledge and understanding of the bidirectional relationship in adult patients with diabetes. We assessed gender, education and income, differences, and gender, education, and income differences regarding health care providers recommending regular dental visits. All data were self reported.

### *Sample and Procedure*

Participants were ≥ 18 years old, living with type 1 or type 2 diabetes, read, spoke, and understood English. They were recruited from a marketing research company's online patient panel because of its efficiency with reaching a broad population.[32,33] Each participant provided consent, completed the survey, and received a $6 gift card for participating. The University of Maryland–College Park Institutional Review Board approved this research.

### *Measures*

The survey was developed using validated questions and scales from previous surveys. We included diabetes and periodontal disease questionnaire of Smith and colleagues[34] to measure knowledge and understanding of the bidirectional relationship.[34] Demographic questions (gender, age, race/ethnicity, education, employment, marital status, income, smoking habits) were from the Behavioral Risk factor Surveillance System (BRFSS).[35] Participants' diabetes type, family history, treatment regimen, diabetes education session attendance, and health care provider recommendations for regular dental visits were queried.

For analysis, education was dichotomized into 12th grade and below versus above 12th grade, and annual income into low (≤ $50,000), middle ($51,000-$100,000), or high (≥ $101,000) to better reveal the association between health care providers dental visit recommendations and outcomes of interest. Brushing and flossing questions were obtained from the existing literature.[36–38] One BRFSS question captured participants dental visit practices.[35]

### *Analytic Procedures*

Descriptive statistics were used to describe the demographic information for categorical variables proportions, survey responses on the 5-point Likert scale (percentages) were reported, and continuous variables were reported as means with standard deviations. Multiple linear regression was used to evaluate the association of gender, education, and income with knowledge and understanding of the bidirectional relationship. Chi-squares determined gender, education, and income differences in health care providers' dental visit recommendations. Statistical analyses were performed using SPSS version 25 (IBM, Armonk, NY).

## Results

Of the 1587 participants who consented to participate, 927 (58%) completed the survey, 223 (14.0%) were excluded because the quota for female participants was met, and 437 (27.5%) did not complete the survey. Participants were majority female (n = 527; 56.9%) with a mean age of 54.63 (± 14.56) years. More than half of the participants were white (n = 581;

62.7%), 341 (36.8%) had a high-school diploma or GED, 297 (32.0%) were retired, 441 (47.6%) were married, and 468 (50.5%) had attended a diabetes education session in the past. Knowledge and understanding of the bidirectional relationship was 5.79 ± 2.366 (range, 0 to 10). Overall, 52.5% reported brushing their teeth more than once a day, 42.4% visited the dentist twice a year, and 38.6% flossed once or more per day (Table 1).

### *Health Care Provider Recommending Regular Dentist Visits*

Forty-one percent indicated their health care provider recommended regular dental visits. Education and income differences were associated with health care provider recommending regular dental visits; 38.6% with a high school diploma or less indicated that their health care provider recommended regular dentist visits compared with 45.5% of participants with more than a high school diploma ($P = .037$). Only 37.1% of low-income participants indicated that their health care provider recommended regular dentist visits, whereas 48.3% of middle-income and 53.8% high-income participants ($P = .0001$) received dental visit recommendations.

### *Health Care Provider Recommending Dental Visits' Associations: Gender, Education, Income*

The association of gender, education, and income with knowledge and understanding of the bidirectional relationship was examined using linear regression (Table 2). We controlled for diabetes type, disease duration, education session, treatment, family history, smoking status, marital status, dental insurance, and health care provider recommending dental visits.

Gender was significantly associated with diabetes and periodontal diseases' bidirectional relationship (b = −0.038; $P < .0001$; 95% CI, −0.056 to −0.019) (Table 2). Males had less knowledge and understanding of the bidirectional relationship. Education was also associated with knowledge and understanding of the bidirectional relationship after controlling for covariates (b = 0.030, $P < .002$; 95% CI, 0.011-0.049) (Table 2). Participants with more than a high school diploma had more knowledge and understanding of the bidirectional relationship than those with less education. In addition, health care provider recommending regular dental visits was positively associated with knowledge and understanding (b = 0.036; $P < .0001$; 95% CI, 0.018-0.054) of the bidirectional

**Table 1. Characteristics of Patients with Diabetes (n = 927)**

| Characteristics | Total Response, N (%) |
|---|---|
| Gender | |
| Female | 527 (56.9) |
| Male | 400 (43.1) |
| Age, years, mean (SD) | 54.63(14.6) |
| Ethnicity and race | |
| Non-Hispanic White | 581 (62.7) |
| Black/African American | 147(15.9) |
| Hispanic, Latino, Spanish origin | 142(15.3) |
| Pacific Islander | 25 (2.7) |
| Asian | 17(1.8) |
| Other | 11 (1.2) |
| Education | |
| Never attended school or only attended kindergarten | 2(0.2) |
| Grades 1 to 8 | 27(2.9) |
| Grades 9 to 11 | 146(15.7) |
| Grade 12 or GED | 341 (36.8) |
| College years 1 to 3 | 207 (22.3) |
| College 4 years or more | 130 (14.0) |
| Masters | 53 (5.7) |
| Doctoral/professional degree | 21(2.3) |
| Employment | |
| Employed | 266 (28.7) |
| Self employed | 46 (5.0) |
| Out of work for 1 year or more | 25(2.7) |
| Out of work for less than 1 year | 7 (0.8) |
| Homemaker | 73 (7.9) |
| Student | 15 (1.6) |
| Retired | 297(32.0) |
| Unable to work | 195(21.0) |
| Prefer not to answer | 3 (0.3) |
| Income | |
| $25000 or less | 312(33.7) |
| $26000 to $35,000 | 105 (11.3) |
| $36000 to $50,000 | 147 (15.9) |
| $51000 to $75,000 | 39 (15.0) |
| $76000 to $100,000 | 76 (8.2) |
| $101000 to $150,000 | 81 (8.7) |
| $151000 to $200,000 | 21 (2.3) |
| $201000 or more | 15 (1.6) |
| Don't know/not sure | 7(0.8) |
| Prefer not to answer | 24(2.6) |
| Marital status | |
| Married | 441 (47.6) |
| Never married | 192 (20.7) |
| Divorced | 129 (13.9) |
| Widowed | 73 (7.9) |
| A member of an unmarried couple | 56 (6.0) |

*Continued*

**Table 1. Continued**

| Characteristics | Total Response, N (%) |
|---|---|
| Separated | 31(3.3) |
| Prefer not to answer | 5 (0.5) |
| Self efficacy | |
| Mean ± SD (range) | 23.04 ± 4.48 (4 to 29) |
| Diabetes type | |
| Type 1 | 95 (10.2) |
| Type 2 | 832 (89.8) |
| Diabetes treatment | |
| Yes | 917 (98.9) |
| No | 10 (1.1) |
| Family history of diabetes | |
| Yes | 712 (76.8) |
| No | 207 (22.3) |
| Don't know/not sure | 8 (0.9) |
| Diabetes education session in the past | |
| Yes | 468 (50.5) |
| No | 455 (49.1) |
| Prefer not to answer | 4 (0.4) |
| Healthcare provider recommended regulardentist visit | |
| Yes | 380 (41.0) |
| No | 532 (57.4) |
| Don't know/not sure | 8 (0.9) |
| Prefer not to answer | 7 (0.8) |
| Dental insurance | |
| Yes | 577 (62.2) |
| No | 347 (37.4) |
| Prefer not to answer | 3 (0.3) |
| Diabetes and periodontal disease knowledge and understanding scale | |
| Mean ± SD (range) | 5.79 ± 2.366 (0 to 10) |
| Dentist visit frequency | |
| Once a year | 200 (21.6) |
| Twice a year | 393 (42.4) |
| Once every 2 years | 52 (5.6) |
| Only for emergency treatment | 69 (7.4) |
| Years ago | 53 (5.7) |
| More than 5 years ago | 114 (12.3) |
| Never been | 18 (1.9) |
| Prefer not to answer | 28 (3.0) |
| Brushing frequency | |
| Once a day | 331 (35.7) |
| More than once a day | 487 (52.5) |
| Once/twice a week | 59 (6.4) |
| Flossing frequency | |
| Never | 161 (17.4) |
| Hardly ever | 204 (22.0) |
| Once/twice a week | 176 (19.0) |
| Once a day | 221 (23.8) |
| More than once a day | 137 (14.8) |
| Prefer not to answer | 28 (3.0) |

SD, standard deviation; GED, General Equivalency Diploma.

relationship. However, income was not significantly associated with knowledge and understanding of the bidirectional relationship, after controlling for covariates ($P = .068$).

## Discussion

To our knowledge, this is the first study that examined patients with diabetes' characteristics (gender, education, income), health care providers' recommending regular dental visits and knowledge and understanding the diabetes and periodontal disease bidirectional relationship. We identified factors that predicted less understanding, which is important for targeted prevention/education efforts. Gender, education, health care providers' recommending regular dental visits and diabetes treatment were all associated with knowledge and understanding of the bidirectional relationship; interestingly, income was not associated with knowledge and understanding. It is imperative for health care providers to educate their prediabetics and patients with diabetes, about their increased risk of developing periodontitis. Educational sessions should include preventing periodontitis by brushing twice a day, flossing at least once a day, and obtaining routine dental care.[39] Only 41.0% of participants indicated their health care provider recommended regular dentist visits because of their diabetes. Our findings underscore the critical role of health care providers regarding oral health education in diabetes self management. Research has shown that receiving dental hygiene information from health care providers after diabetes diagnosis was significantly associated with dental hygiene knowledge and practices.[40] Providers ought to recommend diabetes education sessions to newly diagnosed patients with diabetes and refresher sessions for current patients with diabetes. Because periodontal disease exacerbates diabetes, they should encourage all diabetic patients to have regular dentist visits.

**Table 2. Adjusted Linear Regression Analysis Predicting Knowledge and Understanding of the Bidirectional Relationship between Diabetes and Periodontal Disease (n = 867)**

| Variables | *B* | $SE_B$ | *P*-Value | 95% CI |
|---|---|---|---|---|
| Gender *(reference, Female)* | | | | |
| Males | −0.038 | 0.009 | .0001‡ | −0.054, −0.019 |
| Education *(reference, 12th grade or less)* | | | | |
| Above 12th grade | 0.030 | 0.010 | .002† | 0.011, 0.049 |
| Income *(reference, low)* | | | | |
| Middle | −0.010 | 0.011 | .38 | −0.031, 0.012 |
| High | 0.026 | 0.014 | .07 | −0.002, 0.055 |
| Diabetes treatment *(reference, No)* | | | | |
| Yes | 0.109 | 0.040 | .006* | 0.031, 0.186 |
| HCP recommend dentist visit *(reference, No)* | | | | |
| Yes | 0.036 | 0.009 | .0001‡ | 0.018, 0.054 |
| Employment *(reference, Employed)* | | | | |
| Other | −0.002 | 0.010 | .82 | −0.022, 0.017 |
| Health literacy *(reference, Adequate)* | | | | |
| Marginal/inadequate | −0.056 | 0.011 | .0001‡ | −0.077, −0.034 |
| Diabetes type *(reference, type 2 diabetes)* | | | | |
| Type 1 diabetes | 0.028 | 0.015 | .06 | −0.001, 0.057 |
| Marital status *(reference, Married)* | | | | |
| Not married | −0.002 | 0.011 | .83 | −0.024, 0.019 |
| Previously married | −0.002 | 0.011 | .84 | −0.024, 0.019 |
| Race/ethnicity *(reference, non-Hispanic White)* | | | | |
| Black or African American | 0.046 | 0.073 | .53 | −0.097, 0.188 |
| Hispanic/Latino/Spanish origin | 0.071 | 0.073 | .33 | −0.071, 0.214 |
| Asian | 0.081 | 0.078 | .30 | −0.072, 0.234 |
| Pacific Islander | 0.081 | 0.077 | .29 | −0.070, 0.231 |
| Other | 0.053 | 0.082 | .52 | −0.108, 0.214 |
| Diabetes education session *(reference, Yes)* | | | | |
| No | 0.057 | 0.089 | .32 | −0.118, 0.233 |
| Diabetes duration | 0.004 | 0.003 | .16 | −0.002, 0.010 |
| Dental insurance *(reference, Yes)* | | | | |
| No | −0.013 | 0.009 | .16 | −0.031, 0.005 |
| Smoking status *(reference, Yes)* | | | | |
| No | −0.015 | 0.010 | .16 | −0.035, 0.006 |
| Family history of diabetes *(reference, Yes)* | | | | |
| No | −0.009 | 0.010 | .39 | −0.029, 0.011 |

B, unstandardized regression coefficient; HCP, health care provider; $SE_B$, Standard error of the coefficient.
*$P < .05$; †$P < .005$; ‡$P < .0001$.

As noted, periodontal disease is the sixth complication of diabetes. Thus, as eye exams, podiatrist visits, and nutritionist consultations are incorporated into diabetes management programs, dental visits should also be incorporated.[9,10] During initial and follow-up medical appointments for patients with diabetes, health care providers should refer such patients to a dentist and encourage them to keep regular dental appointments.

We believe this is the first study to assess the characteristics regarding knowledge and understanding of the diabetes and periodontal disease bidirectional relationship among patients with diabetes. Nonetheless, our study has limitations. This study was cross-sectional. Thus, no causal inferences can be made from the results. We could not confirm participant's diabetes diagnosis, whether their diabetes was controlled, their dental hygiene status, or dental care history. Identifying ways of confirming diabetes diagnosis and control, and dental care history (routine and acute care dental visits, cleanings) should be addressed by future research. Since the survey was

online, patients with diabetes without access to a computer, the internet, or a smart phone were excluded. Hence, we recommend a comprehensive survey approach—that is, surveys administered in doctors' and dentists' offices, clinics, and community centers.

This study highlights the importance of informing patients with diabetes about their increased risk for developing periodontal disease. Moreover, there is a need for health care providers to recommend that their diabetic patients regularly see a dentist and for dental health providers to remind their diabetic patients to brush and floss regularly to prevent periodontal disease and improve glycemic control. Both provider types should include one another on their respective care and treatment teams. This can be an important first step in eliminating dental- *and* diabetes-related disparities that leads to patients with diabetes achieving better quality of life.

*To see this article online, please go to: http://jabfm.org/content/33/6/1004.full.*

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