International Journal of Dental Hygiene

Official Journal of the International Federation of Dental Hygienists

ORIGINAL ARTICLE

SM Strauss
LB Stefanou

Authors' affiliations:
SM Strauss, College of Nursing, New York University, New York, NY, USA
LB Stefanou, College of Dentistry, New York University, New York, NY, USA

Correspondence to:
S.M. Strauss
NYU College of Nursing
726 Broadway
10th floor
New York
NY 10003
USA
Tel.: +1 212 9985280
Fax: +1 212 9953143
E-mail: ss4313@nyu.edu

Dates:
Accepted 6 May 2013

To cite this article:
Int J Dent Hygiene **12**, 2014; 127–132.
DOI: 10.1111/idh.12037
Strauss SM, Stefanou LB. Interdental cleaning among persons with diabetes: relationships with individual characteristics.

Interdental cleaning among persons with diabetes: relationships with individual characteristics

Abstract: *Objectives:* Given the existence of many potential oral health complications for adults with diabetes (especially for those who do not practise regular oral self-care), and the specific importance of regular interdental cleaning, the research determined the proportion of U.S. adults with diabetes who practise daily interdental cleaning and their socio-demographic, economic and oral health characteristics related to this practice. *Methods:* Analyses were conducted using data collected from 573 dentulous adults with diabetes ≥ 30 years who participated in the U.S. 2009–2010 National Health and Nutrition Examination survey. Using complex sample survey software, findings were extrapolated to >15 million U.S. adults. Descriptive statistics were used to determine the frequency of interdental cleaning, and chi-square tests were used to identify salient individual characteristics related to this practice. *Results:* 41.2% reported that they never used any interdental device, while 24.8% indicated that they practised interdental cleaning daily. Statistically significant relationships ($P < 0.05$) with daily interdental cleaning included female sex, ever having had treatment for gum disease and using mouthwash daily for a dental problem. *Conclusions:* Because so many adults with diabetes do not practise regular interdental cleaning, and in view of the important role that dental hygienists fulfil as oral healthcare educators, there is a great need for dental hygienists to teach and motivate adults with diabetes to practise regular interdental cleaning. This need is especially great for subgroups of these adults who are men, have not been treated for periodontitis and do not regularly use a mouthwash for dental problems.

Key words: dental devices; dental hygienists; diabetes mellitus; home care

Introduction

According to the International Diabetes Federation, more than 371 million people worldwide currently have diabetes (1), and that number is continuing to grow. In 2010, 18.8 million people in the United States alone had been diagnosed with diabetes, including 1.9 million ≥20 years who were newly diagnosed that year (2). In addition to being a major cause of renal failure, cardiovascular disease, non-traumatic lower limb amputations and blindness (2), diabetes-related complications include those that impact the oral cavity. Among these are xerostomia and salivary gland dysfunction; impaired ability to wear dental prostheses (related in part to salivary gland dysfunction); increased susceptibility to viral, bacterial and fungal infections (including oral candidiasis); caries;

periapical abscesses; loss of teeth; taste impairment; lichen planus; and burning mouth syndrome (3). Reviews of the literature also generally report evidence of greater risk, prevalence, severity and extent or progression of one or more manifestations of periodontal disease in persons with diabetes (4–7).

In view of the diabetes/periodontal disease relationship, oral self-care to prevent and treat periodontitis is particularly important for patients with diabetes (8, 9). Because tooth brushing is not as effective at cleaning interdental areas, flossing or other methods of interdental cleaning might be necessary (10). In fact, the American Dental Association recommends cleaning between teeth with floss (or another interdental cleaner) on a daily basis (11). Notably, infrequent interdental cleaning has been shown to contribute to periodontal disease among adults with diabetes (12).

Our search of the relevant English language literature from 1980 through 2012 regarding the practice of interdental cleaning involved the Dentistry and Oral Science Source, PubMed, CINAHL, EMBASE and ProQuest databases. This search identified research in countries as diverse as Finland, England, Iran, Libya and the United States that examined the extent to which persons with diabetes practise daily interdental cleaning, generally finding self-reported proportions of this practice to be no more than 35% (13–18). To identify subgroups of persons with diabetes in need of encouragement to implement oral self-care, Karikoski and colleagues determined the significant socio-demographic correlates of daily interdental cleaning and other oral self-care practices among 420 systematically selected adults who were members of a national diabetes register in Finland (17). Findings showed that correlates of interdental cleaning were distinct from those of daily tooth brushing or yearly dental visits. They also showed that persons ≥40 years of age were significantly more likely to practise daily interdental cleaning than those younger than 40 years.

Findings regarding interdental cleaning among adults without regard to their diabetes status have shown that this cleaning is more likely among persons who are women (19, 20) and have more education (20–22). Daily interdental cleaning has also been shown to be more likely among persons who perceive themselves to have better periodontal health (23), those who have undergone periodontal treatment (24) and those who use mouthwash regularly (25). Some results of these studies are inconsistent. Although Ronis and colleagues found that older adults were more likely to practise interdental cleaning than younger adults (20), Hugoson and colleagues did not find a significant age difference in this practice (26). Similarly, Chen and Stone found that those with higher family income were more likely to practise interdental cleaning (21), but Ronis and colleagues did not find such a significant correlation (20). In addition, while Davidson and colleagues found that persons who are members of racial/ethnic majority groups are more likely to practise regular interdental cleaning (27), Kiyak reported that Asians were more likely than Caucasians to do so (28).

The research concerning individual characteristics related to interdental cleaning is dated and somewhat inconsistent. In addition, there is very limited research in this regard for adults with diabetes. Thus, it is vitally important to use recent data collected from a representative sample of the U.S. adult population to identify subgroups of persons with diabetes who do and do not adhere to the recommendation to practise daily interdental cleaning (11). The results of such an examination will enable the targeting of groups of adults with diabetes who can most benefit from education and support to increase this adherence. This study reports results of analyses using data from dentulous adults at least 30 years of age who took part in the U.S. 2009–2010 National Health and Nutrition Examination survey (NHANES 2009–2010), including a determination of the proportion of these adults who practise interdental cleaning on a daily basis, and guided by past research, the individual characteristics related to this practice.

Methods

NHANES 2009–2010, conducted by the U.S. National Center for Health Statistics, Centers for Disease Control and Prevention, was intended to assess the health status of a nationally representative sample of civilian, non-institutionalized adults and children in the United States through interviews and direct physical examinations (29). NHANES is explicit in excluding persons residing in nursing homes, those who are institutionalized or U.S. nationals living abroad. To have adequate sample size to obtain stable estimates for many population subgroups, NHANES data are released in 2-year cycles.

Sample selection for NHANES does not use random sampling. Rather, a complex, multistage, probability sampling design is used to select participants, involving several stages (29). First, primary sampling units (PSUs) are selected from strata defined by geography and proportions of minority populations (usually single counties, but sometimes involving contiguous counties). The PSUs are then divided into segments (i.e. city blocks or equivalents of city blocks), and a random sample of households within each segment is drawn. Finally, individuals are chosen from all persons residing in these households, drawn at random within designated age–sex–race/ethnicity screening subdomains.

To have the participants selected under the complex NHANES survey design be representative of the U.S. non-institutionalized civilian population, each person is assigned a numerical sample weight. This weight measures the number of people in the U.S. civilian non-institutionalized population represented by that particular sampled person. These sample weights incorporate adjustments for unequal selection probabilities and non-response and adjust for independent estimates of population sizes for specific age, sex and race/ethnicity categories.

Because of the multistage, probability sampling design of NHANES, individuals are selected as part of groups defined by the strata and by the PSUs and secondary sampling units, rather than as specific individuals. Thus, the sampling variance of NHANES estimates is not based on the counts of individuals, but rather on the counts of the groups. To account for the

NHANES sampling design, special complex sample software must be used when analysing NHANES data. This software uses sample design variables (provided by NHANES) that enables the correct application of special variance estimation techniques to obtain correct measures of sampling variance so that significance levels are not overstated (30, 31). The use of the complex sample software, together with the sampling weights and sample design variables, enables the reporting of results using the sample so that they represent the U.S. Census civilian non-institutionalized population.

The public use, de-identified NHANES 2009–2010 data set comprised a total sample of 10 537 individuals, 5161 of whom were women. A total of 739 of the 10 537 NHANES 2009–2010 participants completed the NHANES questionnaire and responded positively to the question, '[Other than during pregnancy], have you ever been told by a doctor or health professional that you have diabetes or sugar diabetes?' Oral health exams that included tooth counts and participant self-report questions concerning periodontal disease were administered to participants at least 30 years of age. Of the 739 individuals who reported that they had been told that they had diabetes, 719 were at least 30 years of age, 709 had an oral exam and 621 were found not to be edentulous. A total of 92.3 per cent (573) of these 621 individuals also responded to the question, 'In the last 7 days, how many days did you use dental floss or any other device to clean between your teeth?' Responses to this last question varied from 0 to 7 and were also dichotomized into 'less than daily' and 'daily'. These 573 individuals comprise the study sample.

As suggested by the literature, the current analyses also included a variety of socio-demographic and economic variables that may be associated with the frequency of interdental cleaning. These variables included participants' sex and their race/ethnicity (Mexican American, Other Hispanic, non-Hispanic White, non-Hispanic Black, Other race including multiracial). Also included was participants' age, collected in NHANES as a continuous variable, but coded as under 40 years or at least 40 years as considered by Karikoski and colleagues in their research on the correlates of daily interdental cleaning among persons with diabetes (17). In our analyses, we also included participants' education level and their family income relative to the poverty level. With regard to education, participants indicated the highest grade or level of school they completed (less than ninth grade, 9–11th grade, high school graduate or equivalent, some college or associate's degree and college graduate or above). Consistent with a Centers for Disease Control and Prevention (CDC) report involving people with diabetes (32), we recorded participants' education level as: less than high school graduate or equivalent, high school graduate or equivalent or beyond high school graduate or equivalent. NHANES computed participants' family income relative to the poverty threshold as a continuous variable, but consistent with the CDC report referenced above (32), this ratio was coded into three categories for the present analyses: below 100% of the poverty threshold, between 100% and 200% of that threshold and over 200% of the poverty threshold.

The current analyses also included a variety of oral health-related variables that may be associated with the frequency of interdental cleaning. Participants were asked whether they thought they might have gum disease. To focus responses to this question, the NHANES questionnaire indicated that 'people with gum disease might have swollen gums, receding gums sore or infected gums or loose teeth'. Participants were also asked whether they ever had treatment for gum disease. To clarify the meaning of this question, NHANES participants were provided with specific examples of gum disease treatment, including 'scaling and root planning, sometimes called "deep cleaning"'. Regarding the use of mouthwash and dental rinses, participants were asked to report how many of the last 7 days they used 'mouthwash or another dental rinse product,' with the survey explicitly asking them to consider the purpose of this use 'to treat dental disease or dental problems'. Responses to this last question were dichotomized into 'less than daily' and 'daily', as interest in the current work was in comparing regular and non-regular use.

The primary purpose of this investigation was to determine the proportion of dentulous adults at least 30 years of age in the United States who conduct interdental cleaning on a daily basis, as well as the correlates of this practice. Descriptive statistics were calculated both for the proportion that conducted interdental cleaning and for the possible individual characteristics related to this practice on a daily basis. Using chi-square tests, these possible relationships were then examined to determine whether they were statistically significant. In the analyses, NHANES' analytic guidelines were followed (30, 31), including the use of the examination weights provided. SPSS Complex Samples, version 20 software (IBM SPSS, Armonk, NY, USA) was used to enable analyses of NHANES data, as these data were collected using a complex sampling design. We note that NHANES is among the sources of public use data approved by the University Committee on Activities Involving Human Subjects at New York University, thereby allowing New York University investigators to use the database without review and approval by that committee.

Results

The 573 dentulous persons ≥ 30 years of age who self-reported having been told that they had diabetes and who reported the frequency with which they practised interdental cleaning are estimated to represent 15 132 568 such persons in the United States. When extrapolated to the U.S. population, 47.2% was women and 93.6% was at least 40 years of age. While 58.1% was non-Hispanic White, close to the same proportion was Mexican or other Hispanic (15.0%) and non-Hispanic Black (17.3%), and 9.5% were of other races/ethnicities or were multiracial. About half had been educated beyond high school (53.9%), and an additional fifth (20.2%) had earned a high school diploma or its equivalent. Although the annual family income of 12.6% of these individuals was below the poverty threshold, close to two-thirds (62.4%) had incomes that were at least 200% of that threshold.

Concerning their oral health, about one-fourth (24.6%) thought that they might have periodontal disease, and about the same proportion (25.3%) reported that they had treatment for periodontal disease in the past. With regard to the frequency of their interdental cleaning, 41.2% reported that they never used floss or another interdental device, while about one-fourth (24.8%) indicated that they practised interdental cleaning each day (see Table 1).

Table 2 describes the relationships between daily interdental cleaning and each individual characteristic considered in the analyses. It shows the percentage of persons in each group that practised interdental cleaning on a daily basis and the *P*-value corresponding to each chi-square test used to determine the variables that were statistically significantly related to this form of oral self-care. Variables significantly related to daily interdental cleaning ($P < 0.05$) include female sex, ever having had treatment for gum disease and using mouthwash daily for a dental problem.

Discussion

Consistent with international research regarding daily interdental cleaning among adults with diabetes (13–18), our findings indicate that only a minority of American adults with diabetes who are at least 30 years of age report that they practise interdental cleaning on a daily basis. Despite the fact that infrequent interdental cleaning has been shown to contribute to periodontal disease among adults with diabetes (12), 41.2% report that they *never* practise this aspect of oral self-care. Notably, many adults with diabetes have limited awareness of the importance of good oral health and oral self-care (13, 18, 33, 34). For example, in one study, only 27.1% of the patients with diabetes indicated that they had been told by a general healthcare professional that it is especially important that they brush, floss and see a dentist often because they have diabetes (18). In addition, lack of regular interdental cleaning among adults with diabetes is not surprising in the light of the research regarding the priority that these adults place on this oral self-care practice, viewing it as being of considerably less priority than exercising regularly, maintaining a healthy diet, visiting a general healthcare provider regularly, having regular visits with a dental provider and brushing teeth regularly (18, 35). Additional education about the importance of regular interdental cleaning is clearly needed to support the oral health of these vulnerable patients.

Regarding the individual characteristics related to daily interdental cleaning among adults with diabetes, findings are consistent with research not specifically focused on persons with diabetes in identifying women rather than men as implementing this daily practice (19–22). Not surprisingly, as has been found in general populations (24, 25), daily use of a mouthwash was also strongly associated with daily interdental cleaning, as was past treatment for periodontal disease. However, unlike the findings of some others who examined the correlates of regular interdental cleaning (17, 23, 27, 28, 34, 35), race/ethnicity, income, age or perceived periodontal disease did not differentiate those who implemented this aspect of oral self-care from those who did not. Thus, based on the statistically significant relationships among adults with diabetes found in the current research, men, persons who never had treatment for gum disease and persons who do not regularly use a mouthwash for dental problems especially need to be targeted for education and intervention that encourage daily interdental cleaning. Notably, research has shown that persons with diabetes who receive education on flossing teeth regularly are more likely to do so on a daily basis (13).

Importantly, the dental hygienist's role in education, prevention and therapeutics has expanded to include detection

Table 1. **Interdental cleaning frequency for NHANES participants ≥ 30 years of age who self-reported that they had been told they had diabetes (*n* = 573)**

No of days/ week use floss	Unweighted count	Population estimate	% of population
0	260	6 238 545	41.2
1	32	865 513	5.7
2	40	1 216 503	8.0
3	39	1 075 707	7.1
4	25	781 823	5.2
5	23	930 089	6.1
6	5	276 732	1.8
7	149	3 747 655	24.8

Table 2. **Chi-square tests for significant correlates of daily interdental cleaning**

Variable	% flossing regularly	*P*
Sex		0.001
Male	17.7	
Female	32.6	
Education		0.076
< HS diploma or equivalent	17.1	
HS diploma or equivalent	22.9	
>HS diploma or equivalent	29.2	
Race/Ethnicity		0.224
Mexican	26.5	
Other Hispanic	39.9	
White, non-Hispanic	22.6	
Black, non-Hispanic	21.0	
Other	34.1	
Age		0.226
<40 years	13.0	
≥40 years	25.6	
Family income relative to poverty level		0.704
Below 100%	27.3	
Between 100% and 200%	22.6	
Over 200%	24.1	
Thinks has gum disease		0.239
Yes	29.0	
No	22.7	
Had treatment for gum disease		0.033
Yes	33.3	
No	22.0	
Use mouthwash daily for a dental problem		0.006
Yes	33.6	
No	20.1	

and recognition of oral manifestations of diabetes, and these oral healthcare professionals may be the first to recognize the presence of the disease in their patients (36). Thus, dental hygienists are in a unique position to support oral self-care in adults with diabetes (but especially those who are members of the subgroups of adults with diabetes identified in this research) who need education about the importance of oral health preventive practices, including regular interdental cleaning (37). In fact, many dental hygienists currently provide information and educational materials to patients with diabetes about periodontal disease and oral health (38). Almost all stress the importance of daily brushing and flossing and model the proper flossing technique (13), with the dental hygienist demonstrating as the patient looks on with a mouth mirror. Once demonstrated, the patient should be encouraged to try the technique. Although such an approach is likely to require additional time during the dental visit (39), some patients with diabetes may never learn to perform interdental cleaning adequately and correctly without important feedback from the dental hygienist, thereby limiting their effective regular practice of this important aspect of oral self-care.

Conclusion

Regular interdental cleaning for adults with diabetes is of great importance, but many practise this essential aspect of oral self-care infrequently or not at all. In view of the expert role that dental hygienists play in oral health education and support, this research illuminates the importance of their specific encouragement in the regular use of interdental products (floss and dental tape, interdental brushes and tips, and subgingival irrigation) for all adult patients with diabetes, but especially their diabetic patients who are men, never had treatment for gum disease and do not regularly use a mouthwash for dental problems.

Clinical relevance

Scientific rationale for the study

Daily interdental cleaning is important for adults with diabetes. Past research identifying subgroups least likely to conduct this practice is dated and somewhat inconsistent.

Principal findings

Analyses of data from dentulous U.S. adults with diabetes in 2009-2010 indicate that only 1 of 4 practise daily interdental cleaning. Subgroups least likely to do so include men, those who never had treatment for gum disease and those who do not regularly use mouthwash daily for a dental problem.

Practical implications

Dental hygienists' support for regular interdental cleaning is especially needed for the subgroups identified.

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