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THE ASSOCIATION BETWEEN FLOSSING TEETH AND ORAL HEALTH IN ADULTS

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Abstract

Background: In older people, the impact of oral habits is largely unknown. The goal of this study was to see if there was a link between flossing at home and the prevalence of periodontal disease in older people.

Methodology: The incidence of tooth loss over a five-year period was also examined. Pearson chi-square tests and covariate-adjusted Cochran-Mantel-Haenszel tests were used to evaluate dichotomous and categorical variables. Clinical factors were compared using multiple linear regression depending on flossing practice. Molars exhibited the greatest benefit (>40%) for flossing practice (P = 0.0005) among all teeth. In conclusion, flossers had much less oral illness than non flossers when it came to older people. Over a 5-year period, flossers had decreased periodontal disease, dental caries, and tooth loss. These findings add to the growing body of evidence that flossing is an important oral hygiene habit for older persons who want to avoid the progression of oral disease.

Keywords: OHI, interdental cleaning, elderly, prevention, periodontal disease, caries.

Introduction

As the world's population ages, more attention is being paid to what defines health in older adults [1]. In older persons, good oral health is linked to better general health, lower morbidity, and lower mortality [2]. Because serious tooth loss has peaked at the age of 65 for the previous two decades, it's crucial to know if preventive oral hygiene regimens in older persons can enhance oral health and tooth retention [3]. Controlling its two most frequent disorders, periodontal disease and caries, which are chronic multifactorial diseases with microbial biofilm as a core cause, is the key to achieving optimal oral health in older persons [4]. Controlling its two most frequent disorders, periodontal disease and caries, which are chronic multifactorial diseases with microbial biofilm as a core cause, is the key to achieving optimal oral health in older persons. The path from oral health to disease is continuously linked to a change in the microbial populations (dysbiosis) of the tooth-adherent dental plaque [5]. As a result, tooth brushing and interdental cleaning are recommended as part of home care to disrupt the microbial biofilm's adherence to the tooth [6]. In older populations, epidemiological surveillance of oral disease and tooth loss is required [7]. We and others have previously discussed the difficulties of performing randomized clinical studies to assess the effectiveness of flossing/interdental cleaning in preventing oral disease. a) the length of time it takes for caries and periodontal disease to develop, and b) the cost of conducting this type of research [8]. Randomized controlled trials (RCTs) can be costly, and some of them fail to produce valuable information for therapeutic practice [9]. Observational studies, which represent non-experimental "real world" events at the population level, are another form of study used to assess the success of an intervention [10]. Our group's previous analyses of accessible cross-sectional data from the National Health and Nutrition Examination Survey [11]. found that interdental cleaning was linked to decreased oral disease, including caries, periodontal disease parameters, and the number of teeth [12]. Despite the fact that this study analyzed a significant number of people (n = 6,891), it did not provide longitudinal data. Furthermore, the NHANES study focuses on adults over 30 years old, with a mean age of 50 years old [13], and does not directly address senior residents of the community. Professional flossing for 1.7 years reduced the chance of developing caries by 40% in children [14], and a recent analysis of various RCTs found that using floss in addition to tooth brushing may reduce gin-givitis or plaque in adults at 1, 3, and 6 months compared to brushing alone [15]. Flossing is

now being supported by new research as an effective intervention for lowering the burden of oral disease. The goal of this study was to see if there was a link between flossing at home and the prevalence of periodontal disease and caries in older people. The incidence of tooth loss over a five-year period was also examined. When compared to nonflossers, we expected that elderly people who flossed had better dental health and lost fewer teeth during a 5-year period. In this investigation, we used longitudinal data from the Piedmont 65+ Dental Study (Dental PDS), which collected data from people aged 65 and up over a five-year period. When compared to brushing alone, we looked at whether flossing was related with a) less periodontal disease, b) fewer coronal and interproximal cavities, and c) fewer teeth lost during a 5-year period.

Material and Methods

Participants and study design

The Piedmont Health Study of the Elderly (PHSE) was a cohort study of the health status of a random sample of non-institutionalized persons aged 65 in five contiguous North Carolina counties and was the parent study of the Piedmont 65+ Dental Study (Dental PDS) (Brown et al. 1994; Beck et al. 1997). In 1988, the University of North Carolina began Dental PDS with a random sub-sample stratified by dentate status and race from the parent population. The research follows STROBE criteria. One of five calibrated examination teams comprised of a dentist-examiner and a recorder conducted dental examinations and interviews at the participants' homes (private residence). The same protocol was used to conduct dental examinations at baseline (1988) and at 5 years (1993). The study sampling procedures have been described in detail elsewhere (Graves et al. 1992; Drake et al. 1994). At the mesial-buccal and buccal regions of all extant teeth, clinical measurements (probing depth and clinical attachment level) were analyzed (up to 32 teeth). A total of 686 people were assessed using clinical data such as the percentage of sites with interproximal clinical attachment levels (iCAL) of 3 mm, the percentage of sites with interproximal probing depth (iPD) of 4 mm, the number of coronal and interproximal caries (unfilled), and the number and type of lost teeth over a 5-year period. Prior research employing these as factors for periodontal pathologic characteristics, including our previous study that evaluated the interdental cleaning behavior of NHANES participants, led to the selection of a PD4 mm and a CAL3 mm (Moss et al. 2009; Akinkugbe et al. 2017; Marchesan et al. 2018). We used the PPC-Stages classification created at the University of North Carolina at Chapel Hill to assess the impact of behavior on current peri-odontal illness categorization methods (Morelli et al. 2017; Beck et al. 2018; Morelli et al. 2018). The PPC-Stages classification is based on the number of teeth, crowns, probing depth, clinical attachment level, bleeding on probing, plaque index, and gingival index, which are all factored into an algorithm that divides people into seven categories [from PPC-Stage I (Health) to Stage VII (Severe tooth loss)] (Morelli et al. 2017; 2018). For 686 people, data on decaying, interproximally decayed, and missing teeth was analyzed. The tooth loss analysis (n = 375) was based on longitudinal data on the number of teeth at 60 months (5 years). The question "Do you use dental floss?" was used to assess flossing exposure. “How often do you do it?” As choices, the following responses were provided: “A) Not at all, B) Every day (7 times a week), C) Several times a week (2 to 6 times), D) Once a week, E) “Only once or twice a week.” Nonflossers (answer A) Didn't floss at all) and flossers (responses B–E) were divided into two groups. “Only once or twice a week.” Nonflossers (answer A) Didn't floss at all) and flossers (responses B–E) were divided into two groups. A) On a regular basis, B) Only when in pain, C) When anything needs to be addressed, D) Don't go to the dentist,” the possibilities were. Regular users (response A) and episodic users (responses B–D) were separated into two categories. The demographic factors of flossers and nonflossers were compared using Pearson chi-square testing. To assess clinical factors based on flossing behavior, researchers utilized multiple linear regression adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental usage. To account for persons who were lost to follow-up at the 5-year visit, a Flossing and Elderly Adult Oral Health 1049analysis was conducted.

Results

Demographics and Clinical Characterization

The inverse of the expected likelihood of being followed vs dropout using study demographics was used to weight five-year tooth loss models. The demographics of those who took part in the study differed depending on how often they flossed (Table 1). Nonflossers were slightly older than flossers (73.6 vs. 72.3, P = 0.002). Non-flossers were more likely to be African Americans, males, diabetics, had a basic education, and have fewer dental visits than flossers. When compared to nonflossers, flossers were more likely to be Caucasians, females, non-diabetics, have a higher level of education, and attend the dentist on a regular basis (Table 1). Nonflossers were more likely than flossers to be smokers, but the difference was not statistically significant (P = 0.57). 311 (45.3%) people were lost to follow-up in the five-year analysis. Younger people, women, and people who had regular dental visits were statistically more likely to complete the 5-year follow-up (Appendix Table 1). Death was the most common reason for people failing to complete the 5-year follow-up visit (n = 121, 38.9%; Appendix Table 2).

Table 1. Demographics According to Flossing Behavior (n = 686).

	Nonflossers	Flossers	*P* Value
Age, y, mean (SD)	73.6 (5.9)	72.3 (5.0)	0.002
African American	315 (68.2)	64 (28.6)	<0.0001
Caucasian	147 (31.8)	160 (71.4)	
Female	247 (53.5)	153 (68.3)	0.0002
Male	215 (46.5)	71 (31.7)	
Diabetics	92 (20.0)	27 (12.1)	0.01
Nondiabetic	369 (80.0)	197 (88.0)	
Smoker	93 (20.1)	41 (18.3)	0.57
Nonsmoker	369 (79.9)	183 (81.7)	
Basic Education	395 (85.9)	109 (48.7)	
Intermediate Education	29 (6.3)	44 (19.6)	<0.0001
Advanced Education	36 (7.8)	71 (31.7)	
Episodic dental utilization	362 (80.8)	49 (21.9)	<0.0001
Regular dental utilization	86 (19.2)	175 (78.1)	

Table 2. Clinical Parameters (mean, SE) of Periodontal Disease, Caries, and Number of Missing Teeth Stratified by Flossing Behavior (n = 686).

	Nonflossers	Flossers	*P* Value
iCAL≥3mm (% sites)	48.8 (1.56)	38.2 (2.38)	0.0008
iPD≥4mm (% sites)	14.4 (0.93)	8.70 (1.41)	0.002
Coronal caries (surfaces)	1.16 (0.10)	0.66 (0.16)	0.02
Interproximal caries (surfaces)	0.56 (0.06)	0.35 (0.08)	0.06
Missing teeth (n)	14.7 (0.38)	11.8 (0.58)	0.0001
Missing teeth (n excluding third molars)	11.5 (0.35)	8.6 (0.53)	<0.0001

Means adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental utilization; *P* values based on multiple linear regression.
iCAL, interproximal clinical attachment level; iPD, interproximal probing depth.

Flossing and Oral Disease

Our analysis shows that individuals identified as flossers dem-onstrated a statistically significant lower number of sites with

interproximal clinical parameters of periodontal disease (iCAL≥3 mm, iPD≥4 mm; Table 2).

Our findings demonstrate that flossers had a statistically significant lower number of sites with interproximal clinical markers of periodontal disease (iCAL3 mm, iPD4 mm; Table 2) than non-flossers. Furthermore, flossers had fewer coronal caries (P = 0.02) and a trend for fewer interproximal caries (P = 0.06, Table 2) than non-flossers. Even when third molars were eliminated, people who flossed had a considerably decreased number of missing teeth (P 0.0001). The average number of missing teeth, excluding third molars, was 11.5 (0.35) in non-flossers compared to 8.6 (0.53) in flossers (Table 2). Table 3 divides the associations in Table 2 into two categories: regular and episodic dental use. Episodic dental users, on average, have more disease than regular dental users. Table 3 shows that flossers had significantly lower iCAL and iPD periodontal parameters than nonflossers who were frequent dental users, with a similar trend that did not achieve statistical significance for episodic dental users. On the other hand, flossers who were episodic dental users had considerably less coronal carious lesions, while frequent dental users had a non-significant similar trend. Although there were no significant differences in interproximal caries surfaces between flossers and nonflossers, there was a strong trend favoring flossers in episodic dental users (Table 3, P = 0.06). Flossing behavior was associated with a higher number of teeth, regardless of dental usage, with flossers having an extra 2 teeth if they were episodic dental users and 3.5 teeth if they were regular dental users (Table 3). The distribution of individuals was then assessed using several periodontal disease classification systems, and these classes were stratified depending on flossing practice. Flossers were more likely to have PPC-Stage I Health when comparing flossing behavior groups using the PPC-Stages classification method (Table 4). Nonflossers were more likely to have illness stages V, VI, and VII (Table 4).

Table 3. Clinical Parameters (mean, SE) of Periodontal Disease, Caries, and Number of Missing Teeth Stratified by Dental Visits and Flossing Behavior (n = 686).

	Episodic Dental Users			Regular Dental Users		
	Nonflossers	Flossers	*P* Value	Nonflossers	Flossers	*P* Value
iCAL≥3mm (% sites)	56.3 (1.72)	46.2 (4.86)	0.051	38.1 (2.90)	25.7 (1.99)	0.0007
iPD≥4mm (% sites)	17.8 (1.11)	13.1 (3.13)	0.17	9.46 (1.29)	3.02 (0.88)	<0.0001
Coronal caries (surfaces)	1.64 (0.13)	0.63 (0.38)	0.01	0.23 (0.06)	0.13 (0.04)	0.20
Interproximal caries (surfaces)	0.81 (0.07)	0.39 (0.20)	0.06	0.12 (0.04)	0.05 (0.02)	0.15
Missing teeth (n)	15.9 (0.42)	13.4 (1.17)	0.049	13.3 (0.70)	9.70 (0.48)	<0.0001
Missing teeth (n excluding third molars)	12.7 (0.38)	10.5 (1.08)	0.054	10.0 (0.67)	6.35 (0.46)	<0.0001

Means adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental utilization; *P* values based on multiple linear regression.
iCAL, interproximal clinical attachment level; iPD, interproximal probing depth.

During a 5-year period, we counted the number of people who had lost teeth in each oral hygiene routine group (flossers and nonflossers). The majority of people (regardless of flossing behavior) kept their teeth rather than losing one or more, with a range of 58.6 percent to 91.9 percent of those in both flossing categories keeping their teeth (Table 5). Overall, flossers had a significantly higher percentage of people keeping their teeth. Persons who retained all incisors, canines, and 1050 Journal of Dental Research 99(9) premolars showed this pattern (P 0.0001 for each group), with a similar trend for individuals who retained all molars (P = 0.08). (Table 5). In addition, we looked at the impact of flossing habit on the average number and kind of teeth lost during a 5-year period. We report the weighted sensitivity analysis results in Table 6 because we detected a rather high number of dropouts. The results of an unweighted analysis are substantially comparable (data not shown). Across all tooth types (molars, premolars, canines, and incisors), elderly flossers lost fewer teeth, with an average loss of 1 tooth compared to 4 teeth lost in nonflossers during a 5-year period (P 0.0001, Table 6). Non-flossers had an elevated tooth loss rate of 18.7%, 23.9 percent, and 21.8 percent for premolars, canines, and incisors, respectively (Table 6). Molars showed the most significant difference across groups, with a 41.6 percent increase in loss among non-flossers compared to flossers over a 5-year period (Table 6).

Table 4. Periodontal Disease Classification Systems by Flossing Behavior (n = 686).

PPC-Stages	Nonflossers	Flossers	Chisq/CMH *P* Value
n	462	224	
Stage I (health)	45 (9.7)	90 (40.2)	<0.0001/<0.0001
Stage II Mild	19 (4.1)	12 (5.4)	
Stage III Moderate	4 (0.9)	2 (0.9)	
Stage IV Severe	41 (8.9)	7 (3.1)	
Stage V Mild TL-Hi GI	128 (27.7)	56 (25.0)	
Stage VI Mod TL-Red	121 (26.2)	34 (15.2)	
Stage VII Severe TL	104 (22.5)	23 (10.3)	

Comparison of observed frequencies is based on unadjusted Pearson chi-square tests (first *P* value) and Cochran-Mantel-Haenszel (CMH) tests (second *P* value) adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental utilization. Data are presented as *n* (%).
GI, gingival index; Hi, high; Mod, moderate; Red, reduced periodontium; TL, tooth loss.

Table 5. Percent of Individuals Losing Teeth Over 5-y by Tooth Type and Flossing Habit (Including Individuals Who Became Edentulous) n = 375.

	Nonflossers	Flossers	Chisq/CMH *P* Values
All molars retained	147 (61.5)	96 (70.6)	0.08/0.01
1+ molar(s) lost	92 (38.5)	40 (29.4)	
All premolars retained	140 (58.6)	112 (82.4)	<0.0001/0.0002
1+ premolar(s) lost	99 (41.4)	24 (17.7)	
All canines retained	148 (61.9)	125 (91.9)	<0.0001/<0.0001
1+ canine(s) lost	91 (38.1)	11 (8.1)	
All incisors retained	141 (59.0)	119 (87.5)	<0.0001/<0.0001
1+ incisor(s) lost	98 (41.0)	17 (11.5)	

Comparison of observed frequencies is based on unadjusted Pearson chi-square tests (first *P* value) and Cochran-Mantel-Haenszel (CMH) tests (second *P* value) adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental utilization. Data are presented as *n* (%).

Table 6. Mean (SE) 5-y Tooth Loss by Tooth Type and Flossing Habit (Including People Who Became Edentulous) n = 375.

	Nonflossers (n = 239)	Flossers (n = 136)	*P* Value	Difference
All Teeth	4.22 (0.34)	1.16 (0.47)	<0.0001	27.49%
Molars	1.20 (0.12)	0.50 (0.14)	<0.0005	41.67%
Premolars	1.28 (0.12)	0.24 (0.16)	<0.0001	18.75%
Canines	0.71 (0.07)	0.17 (0.09)	<0.0001	23.94%
Incisors	1.60 (0.14)	0.35 (0.19)	<0.0001	21.88%

Means adjusted for race, sex, age, diabetes, smoking, education, brushing, and dental utilization via multiple linear regression. Sensitivity analysis accounted for loss to follow-up.

Discussion

As a result of their longer exposure to many risk factors, older people have greater rates of oral illness overall (Tonetti et al. 2017). It is feasible to maintain a functional dentition into old age, which has advantages for an individual's general quality of life (Holm-Pedersen et al. 2008). This study examines a preventive oral health habit among older people, who are still underserved in the dentistry field of the aging population (Tonetti et al. 2017). The impact of flossing practice on community-dwelling people aged 65 years is examined. Flossing was linked to better oral health, according to our findings. This finding is consistent with a previous study that looked at data from the National Health and Nutrition Examination Survey (NHANES) in over 6,000 US adults aged 30 years and found that interdental cleaning was linked to fewer sites with iCAL3 mm, iPD4 mm, coronal caries, icaries, and more present teeth when compared to non-interdental cleaners (Marchesan et al. 2018). It's crucial to remember that flossing is influenced by a healthy lifestyle, which is

determined by socioeconomic position, educational levels, and other factors that influence an individual's behaviors. Although our research cannot prove a causal link, there are a number of challenges in conducting RCTs to investigate the advantages of interdental cleaning, including allowing time for illness to develop. Longitudinal studies are the best quality of evidence available to determine potential risk related with tooth loss until such trials are done. Our findings do not imply that the link we discovered is causal. It simply means that flossing is linked to less future tooth loss when these socioeconomic and demographic factors are taken into account. While the question addressing the practice of the oral regimen differed between studies (the NHANES analysis addressed all forms of interdental cleaning, whereas the current PDS specifically addressed flossing), both studies concluded that someone who flosses at least once a week has less oral disease. As a result, improved oral health metrics were seen in individuals (30 years old) and older persons (65 years old) who reported engaging in some form of interdental cleaning practice. The periodontal disease measures chosen for this investigation, iCAL3 mm and iPD4 mm, have previously been used in other studies (Moss et al. 2009; Akinkugbe et al. 2017; Marchesan et al. 2018). They have the advantage of being able to be converted into clinical meaning regardless of changing disease categories. In addition to the peri-odontal phenotype outlined above, we counted the number of people who flossed and divided them into periodontal disease categories. We used the PPC-Stages classification for this study (Morelli et al. 2017; Beck et al. 2018; Morelli et al. 2018). There are currently few studies using these outcomes to analyze data because this classification was only recently proposed. The majority of flossers were PPC-Stage I (PPC-Stages categorization) and the majority of nonflossers were PPC-Stage V, VI, and VII, according to our findings. Other cross-sectional studies that looked at the relationship between flossing/interdental cleaning and periodontal disease classification include Cepeda's (Cepeda et al. 2017) analysis of the NHANES 2011–2014 population and our own (Marchesan et al. 2018). Flossing was associated with a slightly decreased prevalence of periodontitis when periodontitis was classified by the Centers for Disease Control and Prevention (CDC) definition (combining mild, moderate, and severe periodontitis) (Cepeda et al. 2017). The majority of people fell into the PPC-A Health group when the PPC-Stages classification was applied to the same NHANES dataset (Marchesan et al. 2018). Our findings support an association between healthy periodontal categories and flossing practice, within the constraints of any cross-sectional investigation. We also stratified the clinical data in the current investigation based on the frequency of dental appointments (dental use), as this may have an impact on the oral health of flossers and nonflossers. The findings revealed a link between preventive oral health habits such as dental appointments and flossing and elderly people having less oral illness. These findings are consistent with prior reports (Dolan and Atchison 1993; Yellowitz and Schneiderman 2014; Lee et al. 2019). Brushing frequency and frequent dental checkups (within 1 year) were similarly connected to the number of existing teeth, according to a recent study of 3,255 elderly Koreans (aged 55 to 79 years) (Lee et al. 2019). Caries and periodontal disease can lead to tooth loss, which is the most serious consequence. Masticatory function, self-esteem, and quality of life can all be affected by tooth loss. Due to the multirooted architecture of the teeth and the difficulty of reaching the teeth, the molars have been proven to be the most usually missing teeth (Marcus et al. 1996). According to our findings, molars were the tooth type that benefited the most from flossing during a 5-year period. It's worth noting that the participants in this study all lived in the same neighborhood. Individuals who moved into an assisted living facility (due to physical or mental issues) were not included in the study. As a result, the senior participants in this study were more likely to be adherent with self-oral hygiene routines, making them more comparable to younger adults. Journal of Dental Research, vol. 1052, no. 99 (9) Cognitive impairment and dementia, which can arise as people age, have been linked to an inability to execute correct self-care and an increase in the prevalence of oral illness (Ellefsen et al. 2009; Teng et al. 2016; Delwel et al. 2017). Our research has a few drawbacks. To begin, we must acknowledge that the participants in this study, which began in 1988, presumably had less access to preventative oral health techniques than people have now. As a result, the findings of this study may not accurately reflect those of a current study. Furthermore, death-related loss to follow-up is an undesirable consequence that can occur at a higher rate in elderly people for obvious reasons, resulting in skewed data. As a result, we performed a weighted sensitivity analysis to address this (Table 5). The results remained essentially equal after this adjustment, indicating that older flossers lost fewer teeth across all tooth types (molars, premolars, canines, and incisors), with an average loss of 1 tooth compared to 4 teeth lost in non-flossers over a 5-year period. Finally, the research is based on the individual's feedback on their flossing habits. This strategy has the potential to alter a person's hygienic habits. It also allows people to give untruthful responses, which is something dentists and dental hygienists see all the time. However, flossing was found to be negatively connected to tooth loss in this longitudinal study, and a false report of flossing would skew the results in the opposite direction. As a result, this may be a modest estimate of the flossing-tooth-loss association.

Conclusion

Our findings suggest that older people who live in the community and floss at least once a week have lower clinical indices of periodontal disease, less cavities, and more teeth. At the 5-year follow-up visit, flossers lost an average of one tooth compared to four teeth for nonflossers. These data indicate flossing as an important oral hygiene activity for preventing the progression of dental disease in older persons.

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