

## Hygiene Self-Care of Older Adults in West Virginia: Effects of Gender

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### Introduction

In 2000, the U.S. spent \$56 billion on dental care for diseases which are generally preventable with good oral hygiene self-care. Oral diseases often have systemic ramifications if they are unchecked.<sup>1-3</sup> Older adults have many oral health diseases and conditions, and particular attention for their oral health care is needed.<sup>4</sup> In addition, older adults are the fastest growing segment of the U.S. population, expected to comprise 16.27% of the population by 2020.<sup>5</sup> In general, older adults frequently have oral health problems and elderly residents of rural areas are more likely to have poor oral health and inadequate utilization of dental care.<sup>6</sup> Neglect may lead to carious lesions and periodontal disease, as well as pain, inflammation, tooth loss, oral dysfunction and a diminished quality of life.<sup>5</sup> Residents of the geographic region of Appalachia, and West Virginia in particular, have significant problems with carious lesions and other oral health concerns, and the degree to which they impact older adults are currently under study.<sup>7</sup>

Periodontitis, carious lesions and tooth loss are caused by destructive oral biofilms.<sup>8-15</sup> Over 700 different bacteria may co-exist in a dynamic oral biofilm matrix community.<sup>8</sup> In a healthy situation, the oral biofilm is potentially protective as indigenous or resident flora may inhibit pathogens.<sup>2,15</sup> Changing the biofilm environment to a lower pH (i.e., with an acidic or highly refined carbohydrate diet, certain medications or changes in saliva) encourages growth of destructive acid-tolerating species (such as cariogenic mutans streptococcus and lactobacil-

lis).<sup>2,15</sup> Local factors in the biofilm influence the type of bacteria in the plaque.<sup>16</sup> Older adults are at particular risk due to the number of medications they use, and the nature and quantity of their saliva. A report using the National Health and Nutrition Examination Survey (NHANES) 1999 to 2004 reported

### Abstract

**Purpose:** This study investigated whether oral hygiene self-care behavior differs between genders in older adults in Appalachia, a geographic area with significant oral health concerns. Identifying the practices of older adults may provide valuable information for designing interventions and improving overall oral health outcomes.

**Methods:** As part of a larger, on-going study on cognition and oral health in later life in Appalachia, a sample of dentate, older adults without dementia aged 70 and above (n=245, 86 men and 159 women) received an oral assessment by either a dentist or dental hygienist. Psychometricians assessed cognition using a standardized battery of neuropsychological tests. They also administered the General Oral Health Assessment Index and conducted structured interviews concerning diet, oral hygiene practices, oral health, social support, income and years of education

**Results:** Over 80% of women (n=128) and 52.3% of men (n=45) reported brushing their teeth twice daily. Multivariate logistic regression analysis was conducted, controlling for socioeconomic status, social support (i.e., frequency of contacting friends and relatives), general oral health assessment items, number of decayed, missing and filled surfaces, plaque index and having regular dental visits. The results showed that women reported more frequent tooth brushing than their male counterparts (OR=4.04, 95% CI:1.93,8.42).

**Conclusion:** Older women in West Virginia had significantly better oral hygiene practices than older men, particularly regarding tooth brushing. Interventions are needed to improve older men's dental hygiene behaviors to improve overall oral health outcomes.

**Keywords:** Aged, self-care, gender differences, preventive behavior, Appalachia, oral hygiene

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the prevalence of periodontitis among dentate older adults 65 to 74 years old was 10.20%.<sup>4</sup> This was a significant overall decrease in prevalence from 19.57% in the NHANES (1988 to 1994) report, but there continued to be a greater prevalence of men with periodontal disease (12.97%, 8.56%, respectively,  $p < 0.05$ ).<sup>4</sup> The same study reported prevalence of carious lesions remaining high but stable for older adults (93.25%), with no gender differences.<sup>4</sup> The prevalence of mean number of permanent teeth for older adults 65 to 74 years was stable since 1988 (19.34%), but women had statistically fewer teeth than men (19.03, 18.77, respectively,  $p < 0.05$ ).<sup>4</sup>

The NHANES survey, along with other studies, indicate that more older adults are preserving their natural teeth and maintaining functional dentition.<sup>4,17,18</sup> However, there is dissatisfaction with oral function related to eating problems (the number and location of teeth) xerostomia, use of partial dentures and poor esthetics.<sup>19</sup> Adherence to the American Dental Association and the US Surgeon General Oral Hygiene Self-care recommendations to brush twice and floss at least once a day (good oral hygiene self-care) and have regular prophylactic dental hygiene visits have been associated with improving the plaque-mediated conditions of periodontal disease and dental caries, as well as improving tooth retention.<sup>20-22</sup> Nevertheless, as noted above, there are gender differences in oral health and disease. Studies indicate that oral hygiene self-care can manage the biofilm by mechanically removing the oral plaque biofilm mass, lowering the bacterial load, oxygenating the site and changing the ecology of the biofilm.<sup>11</sup> The process can be achieved with good oral hygiene self-care – brushing, rinsing, scraping and flossing or using other inter-dental cleaning.<sup>11</sup> There is little available research on differences in older adult oral hygiene self-care behavior between genders in their management of the plaque biofilm. One Danish study, which included adults of all ages, found women reported better oral hygiene self-care (e.g., frequency of tooth brushing and daily flossing) than men while controlling for socioeconomic status and dental status.<sup>23</sup> A Kuwaiti study of adults of all ages also indicated women reported better oral hygiene self-care.<sup>24</sup>

Given the importance of oral hygiene self-care with regard to oral health, and the scarcity of research concerning older adult gender differences in self-care behaviors, this study was undertaken to assess the differences between older men and women in a region in the U.S. with limited access to dental professionals. From results of previous studies on adults of all ages, it was hypothesized older women would have more frequent oral hygiene self-care than men. Poor oral hygiene self-care results in poor

oral health, and it is a modifiable health behavior, thus, having the knowledge of any differences in behavior between older men and women can be useful in designing appropriate interventions and programs specific to the at-risk population.<sup>20-22</sup> Having the information may also be helpful in developing policies concerning the use of limited dental resources.

## Methods and Materials

Participants were part of a larger study on oral health and cognition among older adults in West Virginia. The West Virginia University Institutional Review Board approved all procedures, and informed consent was obtained from participants. Participants were compensated with a \$50 gift certificate to a local merchant. A convenience sample of non-institutionalized older adults aged 70 and above was recruited using statewide newspaper and television advertisements, fliers placed in primary care offices, libraries and churches, and given to directors of senior citizen centers, retirement homes and senior assisted-living homes. The research team made presentations at various locations throughout the state to inform older adults about the relationship between oral health and systemic diseases, details of the proposed research study on oral health and cognition in older adults and the importance and benefits of participating in research. Details of the recruitment process have been described elsewhere.<sup>25</sup> The participants were dentate and each had at least 4 natural teeth. Psychometricians administered batteries of neuropsychological instruments to determine the cognitive status of participants. The sample consisted of 245 non-demented older adults from various locations across West Virginia.

Psychometricians administered a 12 item General (previously Geriatric) Oral Health Assessment Index (GOHAI) to identify the impact of each participant's dental condition on specific issues (functional limitations, pain and discomfort and psychological impacts). Participants were interviewed, using a structured questionnaire. The questionnaire included questions on socio-demographics, social support, self-rated oral health status, physical status, health behaviors and oral hygiene self-care behaviors.

### Measures

#### Dependent variables

Oral hygiene self-care was measured by self-reported frequency of tooth brushing, flossing and use of mouth rinse. The scale was 1=twice a day

or more, 2=once a day, 3=several times a week, 4=once or less than once a week or 5=intermittently or hardly ever.

### Independent variable and other covariates

Socio-demographic characteristics included age, gender, marital status (married or living with partners=1, and otherwise=0), education and annual income. Social support included contact with relatives and friends. Contact with relatives was measured by number of family members that the respondents saw or heard from at least once a month, with a response from none to 9 or more contacts. The same response options were offered for the question concerning monthly contacts with friends. The study assessed dietary behavior using 3 questions that asked about the frequency of consumption of vegetables, fish and sweets. Each question had responses from never to 5 or more times a day. These questions were designed to briefly assess key dietary components and were drawn from the NHANES 2003 to 2004, in consultation with geriatricians, geriatric dentists and dental researchers.

Oral health measurements included a respondent's self-rating of oral hygiene self-care, as well as the results from the clinical assessment. The clinical assessment measurements were plaque index, number of decayed, missing and filled surfaces (DMFS), as well as the 12 items of GOHAI. The GOHAI items were summed for the multivariate analysis with a possible range of scores between 1 and 60. A higher score indicated better self-rated oral health. For the descriptive analysis, the GOHAI items were dichotomized as having symptoms vs. not having symptoms.

A dental scientist provided training on the evaluation procedures to the examiners (3 dentists and a dental hygienist) based on guidelines from the NHANES. Each examiner evaluated the same patient and then the dental scientist called all of the examiners to the patient to resolve any discrepancies and to determine final outcomes. The buccal surface of the most anterior molar in each quadrant and the facial surfaces of the maxillary right central incisor and the mandibular left central incisor were visually assessed as a part of the dental evaluation. Scores ranged from 0 (no plaque) to 3 (an abundance of soft matter within the gingival pocket and gingival margin).<sup>26,27</sup> As an assessment of inter-rater reliability, the average percent agreement for the number of missing teeth, the number of caries or restorations and the extent of periodontal disease (using the usual method of within +/-1 mm leeway) were calculated. The

average inter-rater agreement was 98.1% for the number of missing teeth, 95.6% for the number of caries or restorations and 95.1% for the extent of periodontal disease.

SAS 9.1 (SAS Institute Inc. Cary, NC) was used to analyze the data. T-test and Chi-square procedures were conducted to compare frequency and mean differences between male and female respondents in oral health preventive practices. Ordinal logistic regression was performed for the outcomes: frequency of tooth brushing, use of mouth rinse and frequency of tooth flossing.

## Results

The sample included 86 men and 160 women who were non-institutionalized older adults without dementia. The mean age was 78 years of age. Fewer women were married or lived with a partner than men (33.1% and 62.8%,  $p < 0.0001$ ). More women had less than 12 years of education than men (19.4% and 5.8%,  $p = 0.004$ ). More women had an income of under \$20,000 than men (47.6% and 19.5%,  $p < 0.0001$ ).

Men and women did not differ significantly in DMFS (Table I). The 2 groups did not differ significantly in self-rated oral health. Nearly 26% of males and 31% females reported their overall oral health as fair or poor.

Gender differences in oral hygiene self-care indicated a higher proportion of older adult women brushed their teeth more frequently than their male counterparts (Chi-square=23.19,  $p < 0.001$ , Table I). Eighty-one percent of women reported brushing their teeth twice a day, while the percentage for males was 52%. Compared to brushing, participants reported lower frequency of flossing and mouth rinsing. Forty-four percent of males and 32% females reported flossing intermittently, and the percentage for mouth rinsing was 41% and 37%, respectively.

Ordinal logistic regression results also showed females reported more frequent tooth brushing than their male counterparts (OR=4.04; CI:1.93, 8.42, Table II). Other factors, such as more regular dental checkups, were associated with more frequent tooth brushing (OR=1.29, 95% CI:1.02,1.64). A lower plaque index score was also related to higher frequency of tooth brushing (OR=0.53, 95% CI: 0.32, 0.86).

Similar to brushing, compared to males, females also reported a higher frequency of tooth flossing (OR=2.03, 95% CI:1.14, 3.63, Table III). Individ-

uals with higher income and more recent dental check-ups were also more likely to have a higher frequency of flossing. No significant differences in mouth rinsing between males and females were found in the multivariate analysis model.

## Discussion

In this study, women were more likely to brush their teeth twice a day than men. This supports a similar study which indicated that females, higher education, certain oral health beliefs, income and a source of care had higher oral hygiene scores than those who did not.<sup>28</sup>

The majority of respondents rated their oral health as good to excellent, despite the respondents having, on average, a large number of DMFS. This apparent inconsistency may be reflective of age, geographic location and/or cultural influences of the population studied. The geographic region of Appalachia has significant problems with carious lesions and other oral health concerns.<sup>7</sup> Moreover, the discrepancy between perceived oral health and DMFS suggests a culture in which the participants have unique oral health values, where retention of natural dentition may not be a priority.<sup>29</sup>

The overall oral hygiene self-care of the participants indicated a need for both men and women to improve in their frequency of brushing and flossing. Dentists and dental hygienists are aware that poor oral hygiene, inappropriate diet, smoking, drinking, hyposalivation and poor host defenses are some of the causes of local changes in plaque leading to the com-

Table I: Self-reported Oral Health Preventive Practices

n=245	Male (86)	Female (159)	Chi-square/T value	p-value
<b>Toothbrushing frequency</b>				
			23.19	<0.001
<ul style="list-style-type: none"> <li>• Twice daily</li> <li>• Daily</li> <li>• Several times/week</li> <li>• Once/week</li> <li>• Intermittent</li> </ul>	52.3% 43.0% 2.3% ---- 2.3%	80.5% 18.9% ---- ---- 0.6%		
<b>Flossing frequency:</b>				
			6.91	0.14
<ul style="list-style-type: none"> <li>• Twice daily</li> <li>• Daily</li> <li>• Several/week</li> <li>• Once/less/week</li> <li>• Intermittent</li> </ul>	12.8% 30.2% 7.0% 5.8% 44.2%	12.0% 32.1% 17.6% 6.3% 32.1%		
<b>Mouthrinse frequency:</b>				
			8.00	0.09
<ul style="list-style-type: none"> <li>• Twice daily</li> <li>• Daily</li> <li>• Several/week</li> <li>• Once/week</li> <li>• Intermittent</li> </ul>	20.9% 22.1% 9.3% 7.0% 40.7%	10.7% 32.7% 14.5% 5.0% 37.1%		
<b>Last dental checkup</b>				
			6.57	0.25
<ul style="list-style-type: none"> <li>• 0-6 months ago</li> <li>• 6-12 months ago</li> <li>• 1-2 years ago</li> <li>• 2-3 years ago</li> <li>• 3-5 years ago</li> <li>• More than 5 years</li> </ul>	73.3% 15.1% 2.3% 2.3% 3.5% 3.5%	63.5% 13.2% 6.3% 6.3% 2.5% 8.2%		
<b>Frequency of sugary foods</b>				
			7.76	0.26
<ul style="list-style-type: none"> <li>• Never</li> <li>• 1-3/month</li> <li>• 1-2/week</li> <li>• 3-4/week</li> <li>• 5-6/week</li> <li>• 1/day</li> <li>• 2/day</li> </ul>	23.5% 35.3% 28.2% 7.1% 1.2% 4.7% 0.0%	37.5% 33.8% 18.1% 3.8% 1.3% 5.0% 0.6%		
<b>Self assessment of Oral Health</b>				
<ul style="list-style-type: none"> <li>• Sum of GOHAI (12 Items)</li> </ul>	58.4	58.8	3.28	0.51
<b>Overall oral health</b>				
<ul style="list-style-type: none"> <li>• Excellent</li> <li>• Very good</li> <li>• Good</li> <li>• Fair</li> <li>• Poor</li> </ul>	7.0% 34.9% 32.6% 22.1% 3.5%	10.7% 25.2% 33.3% 25.8% 5.0%		
<b>Functional limitations (GOHAI items dichotomized)</b>				
<ul style="list-style-type: none"> <li>• Trouble biting/chewing</li> <li>• Uncomfortable swallowing</li> <li>• Impacts speaking</li> </ul>	9.3% 8.1% 1.2%	5.0% 5.0% 1.9%	1.70 0.96 0.18	0.19 0.33 0.67
<b>Pain and discomfort</b>				
<ul style="list-style-type: none"> <li>• Discomfort eating</li> <li>• Use of medication for pain</li> <li>• Sensitivity to hot/cold</li> </ul>	16.3% 0.0% 4.7%	13.1% 1.3% 12.5%	0.46 1.08 3.91	0.50 0.30 0.048
<b>Psychological impact</b>				
<ul style="list-style-type: none"> <li>• Unhappy with appearance</li> <li>• Self-conscious</li> <li>• Uncomfortable eating socially</li> </ul>	14.0% 0.0% 1.2%	13.8% 6.3% 2.5%	0.00 5.60 0.50	0.96 0.018 0.48
<b>Behavioral impacts</b>				
<ul style="list-style-type: none"> <li>• Limitation of food</li> <li>• Limitation of social contacts</li> </ul>	4.7% 0.0%	3.1% 1.3%	0.37 1.08	0.54 0.30
<b>Clinical assessment</b>				
<ul style="list-style-type: none"> <li>• DMFS</li> <li>• Plaque score</li> </ul>	83.2 0.7	80.2 0.5	0.78 2.12	0.44 0.033



mon plaque-mediated diseases of caries and periodontal disease.<sup>2</sup> Of those factors listed, interventions may be possible to modify diet and drinking, reduce smoking, aid with salivary moisturizers or medications to improve salivary flow and to improve oral hygiene self-care. There is a need for clinicians to develop and promote holistic, patient-specific strategies to maintain homeostasis with appropriate oral self-care behaviors for older adults.<sup>2</sup> The strategies need to address gender differences in tooth brushing and flossing behavior for both older men and women, as well as disparities that may exist due to location or culture. Historically, for the men and women in this sample, there may have been less emphasis on oral hygiene self-care when they were children in the 1940s or earlier. The DuPont company began to mass produce nylon toothbrushes in 1938, and although Dr. Levi Spear Parmly suggested silk thread use to clean teeth in 1815, nylon floss and flossing only became widely available and used after World War II, primarily through the efforts of Dr. Charles C. Bass.<sup>30</sup> Socialization to oral hygiene self-care is thought to be most efficacious early in life, and self-care habits are resistant to change.<sup>31</sup> As a result, older adults may need more time, help, encouragement and modifications when given oral hygiene instructions for self-care, and more time may be needed with older men to impress the need for more frequent and better tooth brushing to prevent carious lesions and periodontal disease.

The study results are consistent with the literature on preventive medical care.<sup>32,33</sup> Some researchers speculate that women's more frequent preventive health behaviors relate to their acceptance of help-seeking and compliance with treatment regimens.<sup>34</sup> These speculations are further tested by empirical studies that these differences may result from individuals' health beliefs and help-seeking behavior.<sup>32,33</sup> Thus, targeting health attitudes and behaviors that vary with gender might be the most effective strategies for producing changes in dental self-care.

Limitations to the study include the use of a cross sectional design, which does not permit causal analysis. Therefore, any attempt to generalize this study's findings should be interpreted with caution. Similar to another studies of this type, the self-reported information is subject to recall error. Although not a limitation, per se, it should be noted that the study consisted of more females than males. The ratio of females to males (64.9%) was similar to that in the U.S. overall, where, for those aged 65 and older almost 60% are women.<sup>35</sup>

Table II: Logistic Regression Results on Tooth Brushing

	Odds Ratio (95% CI)
<b>Demographic Factor</b>	
• Age	1.00 (0.94 1.07)
• Female	4.04 (1.93 8.42)
• Married Status	0.54 (0.24 1.20)***
• Education	1.03 (0.74 1.42)
• Income	1.16 (0.89 1.51)
<b>Social Support</b>	
• Frequency of contacting friends	1.21 (0.11 1.61)
• Frequency of contacting relatives	1.22 (0.91 1.63)
<b>Dietary Behavior</b>	
• Vegetable	0.93 (0.75 1.16)
• Fish	0.72 (0.44 1.18)
• Sweet consumption	0.78 (0.60 1.01)**
<b>Oral Health</b>	
• Sum of GOHAI (12 items)	1.03 (0.97 1.10)
• DMFS	0.99 (0.98 1.01)
• Plaque Index	0.53 (0.32 0.86)*
• Last dental checkup	1.29 (1.02 1.64)*

Note: \*p<0.05, \*\*p<0.01, \*\*\*p<0.001

Table III: Logistic Regression Results on Tooth Flossing

	Odds Ratio (95% CI)
<b>Demographic Factor</b>	
• Age	1.01 (0.97 1.06)
• Female	2.03 (1.14 3.63)*
• Married Status	1.16 (0.64 2.11)
• Education	1.01 (0.79 1.29)
• Income	1.28 (1.05 1.57)*
<b>Social Support</b>	
• Frequency of contacting friends	1.01 (0.80 1.27)
• Frequency of contacting relatives	0.87 (0.70 1.08)
<b>Dietary Behavior</b>	
• Vegetable	1.06 (0.89 1.25)
• Fish	1.17 (0.82 1.69)
• Sweet consumption	0.82 (0.66 1.02)
<b>Oral Health</b>	
• Sum of GOHAI (12 items)	1.02 (0.97 1.07)
• DMFS	1.00 (0.99 1.01)
• Plaque Index	0.83 (0.56 1.25)
• Last dental checkup	1.37 (1.13 1.66)**

Note: \*p<0.05, \*\*p<0.01

## Conclusion

As the U.S. population ages, more emphasis will be placed upon the health needs of older adults, particularly those in geographic areas with limited access to care and unique oral health perspectives.

Dental hygienists and dentists are in a special position to provide the skills, tools and techniques to improve or maintain oral health in older adults. The older females in this study reported better oral hygiene practices than the males. Therefore, an even greater effort is needed to work closely with older male patients to educate, encourage and motivate them in their oral hygiene practices. As health care providers who have an extended period of time with patients, dental hygienists are able to provide information about nutrition, smoking and lifestyle influences, which can be used by older patients not only to maintain their teeth, but to maintain or improve their quality of life. Older patients provide unique challenges and rewards and understanding their needs will be a particularly important aspect of oral care in the future.

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## References

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1. Clarkson JE, Young L, Ramsay CR, Bonner BC, Bonetti D. How to influence patient oral hygiene behavior effectively. *J Dent Res*. 2009;88(10):933–937.
2. Marsh PD. Are dental diseases examples of ecological catastrophes? *Microbiology*. 2003;149:279–294.
3. Brown E, Manski R. Research Findings #20: dental services: use, expense, and sources of payment, 1996–2000. US Department of Health and Human Services [Internet]. [cited 2009 December 13]. Available from [http://www.meps.ahrq.gov/mepsweb/data\\_files/Publications/rf20/rf20.shtml](http://www.meps.ahrq.gov/mepsweb/data_files/Publications/rf20/rf20.shtml)
4. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988–1994 and 1999–2004. *Vital Health Stat 11*. 2007;248:1–92.
5. Wu B, Plassman BL, Liang J, Wei L. Cognitive function and dental care utilization among community-dwelling older adults. *Am J Public Health*. 2007;97(12):2216–2221.
6. Vargas CM, Yellowitz JA, Hayes KL. Oral health status of older rural adults in the United States. *JADA*. 2003;134:479–486.
7. Polk DE, Weyant RJ, Crout RJ, et al. Study protocol of the Center for Oral Health Research in Appalachia (COHRA) etiology study. *BMC Oral Health*. 2008 Jun 3;8:18.
8. Loe H. Oral hygiene in the prevention of caries and periodontal disease. *Int Dent J*. 2000;50:129–139.
9. Palmer RJ. Supragingival and subgingival plaque: paradigm of biofilms. *Compendium*. 2010;31:104–124.
10. Paramonova E, Kalmykova OJ, van der Mei HC, Busscher HJ, Sharma PK. Impact of hydrodynamics on oral biofilm strength. *J Dent Res*. 2009;88(10):922–926.
11. Shaudinn C, Gorur A, Keller D, Sedghizadeh PP, Costerton JW. Periodontitis: an archetypical biofilm disease. *JADA*. 2009;140:978–986.
12. Shuch DJ. Letters: the biofilm community. *JADA*. 2009;140:1467.
13. Capestany CA, Kuboniwa M, Jung H–Y, Park Y, Tribble GD, Lamont RJ. Role of the Porphyromonas gingivalis InlJ protein in homotypic and heterotypic biofilm development. *Infect Immun*. 2006;74(5):3002–3005.
14. Kidd EAM, Fejerskov O. What constitutes dental caries? Histopathology of carious enamel and dentin related to the action of cariogenic biofilms. *J Dent Res*. 2004;83(Spec Iss C)C35–C38.
15. Garcia–Godoy F, Hicks J. Maintaining the integrity of the enamel surface. The role of dental biofilm, saliva and preventive agents in enamel demineralization and remineralization. *JADA*. 2008;139:255–335.
16. Scheie AAA. Mechanisms of dental plaque formation. *Adv Dent Res*. 1994;8:246–253.
17. Petersen EP, Alwksejuniene J, Christensen LB, Eriksen HM, Kalo I. Oral health behavior and attitudes of adults in Lithuania. *Acta Odontol Scand*. 2000;58:243–248.
18. Wu B, Liang J, Plassman BL, Remle RC, Luo X. Edentulism trends among middle-aged and older adults in the United States: Comparison of five racial/ethnic groups. *Community Dent Oral Epidemiol*. 2012;40(2):145–153.
19. Steele J, Ayatollahi SMT, Walls AWG, Murray JJ. Clinical factors related to reported satisfaction with oral function amongst dentate older adults in England. *Community Dent Oral Epidemiol*. 1997;24:143–149.
20. Kressin NR, Boehmer U, Nunn ME, Spiro A. Increased preventive practices lead to greater tooth retention. *J Dent Res*. 2003;82:223–227.
21. Sharma N, Charles CH, Lynch MC, et al. Adjunctive benefit of an essential oil-containing mouthrinse in reducing plaque and gingivitis in patients who brush and floss regularly: a six-month study. *JADA*. 2004;135:496–504.
22. Sniehotta FF, Soares VA, Dombrowski SU. Randomized controlled trial of a one-minute intervention changing oral self-care behavior. *J Dent Res*. 2007;86:641–645.
23. Christensen LB, Petersen PE, Krustrup U, Kjoller M. Self-reported oral hygiene practices among adults in Denmark. *Community Dent Health*. 2003;20(4):229–235.

24. Al-Shammari KF, Al-Ansari JM, Al-Khabbaz AK, Dashi A, Honkala EJ. Self-reported oral hygiene habits and oral health problems of Kuwaiti adults. *Med Princ Pract.* 2007;16:15–21.
25. Wu B, Goedereis E, Crout R, et al. Recruitment of rural and cognitively impaired elders for dental research. *Special Care in Dentistry.* 2010;30:193–199.
26. National Center for Health Statistics. National Health and Nutrition Examination Survey: Dental Examiners Procedures Manual. Centers for Disease Control and Prevention [Internet] 2001 [revised 2001 January, cited 2010 December 14]. Available from: <http://www.cdc.gov/nchs/data/nhanes/oh-e.pdf>. Accessed 11/14/2009
27. Chalmers J. Conference on Practical Exercises in Oral Epidemiology. Presented at: West Virginia University School of Dentistry; 2007 August 6. Morgantown, West Virginia.
28. Davidson PL, Rams TE, Andfrsen RM. Socio-behavioral determinants of oral hygiene practices among USA ethnic and age groups. *Adv Dent Res.* 1997;11:245–252.
29. McNeil DW, Crout RJ, Lawrence SM, Shah P, Rupert N. Oral health values in Appalachia: specific dental-related fatalism? *J Dent Res.* 2004;83,A-203.
30. PD Dental Association. The history of dental floss. Pennsylvania Dental Association [Internet]. [cited 2010 December 14]. Available from: [www.padental.org/AM/Template.cfm?Section=Dental\\_History&Template=/CM/HTMLDisplay.cfm&ContentID=13172](http://www.padental.org/AM/Template.cfm?Section=Dental_History&Template=/CM/HTMLDisplay.cfm&ContentID=13172)
31. Payne BJ, Locker D. Oral self-care behaviours in older dentate adults. *Community Dent Oral Epidemiol.* 1992;20:376–380.
32. Bertakis KD, AzariR, Helms LJ, Callahan EJ, Robbins JA. Gender differences in the utilization of health care services. *The Journal of Family Practice.* 2000;49:147–152.
33. Green CA, Pope CR. Gender, psychological factors and the use of medical services: a longitudinal analysis. *Social Science and Medicine.* 1999;48:1363–1372.
34. Verbrugge LM. Gender and health: An update on hypotheses and evidence. *Journal of Health and Social Behavior.* 1985;26:156–182.
35. Wu B. Aging in West Virginia: Findings from the 2000 Census. West Virginia University [Internet]. 2003 [cited 2011 April 14] Available from: [www.hsc.wvu.edu/coa/publications/Wu/Aging\\_in\\_WV-Bei\\_Wu.pdf](http://www.hsc.wvu.edu/coa/publications/Wu/Aging_in_WV-Bei_Wu.pdf)