

# Using the Theory of Planned Behavior to Identify Predictors of Oral Hygiene: A Collection of Unique Behaviors

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**Background:** This study aims to identify predictors of performed oral hygiene behaviors (OHBs) based on the Theory of Planned Behavior (TPB), oral health knowledge, and demographic factors.

**Methods:** Using a questionnaire, 381 participants in three general dental offices and one hospital dental department in York, Pennsylvania, were surveyed regarding performed OHB, attitudes, subjective norms, perceived behavioral control, oral health knowledge, income, age, and sex.

**Results:** Three unique elements of OHB were identified for analysis: brushing, interdental cleaning, and tongue cleaning. Regression analysis revealed that attitude was the strongest predictor of brushing behavior, followed by oral health knowledge, perceived behavior control, subjective norms, and income. Perceived behavior control was the strongest predictor of interdental cleaning, followed by increased age and attitude. Female sex was the strongest predictor of tongue cleaning, followed by subjective norms, decreased age, and perceived behavior control. Respectively, these three groups of predictive variables explained 22.5% of brushing behavior, 22.7% of interdental cleaning behavior, and 9.5% of tongue cleaning behavior.

**Conclusions:** The present findings highlight the utility of viewing OHB as a set of unique behaviors with unique predictive variables and provide additional support for use of TPB in predicting OHB. Periodontal practitioners should consider the strong associations of attitude and perceived behavioral control with brushing and interdental cleaning behaviors when designing interventional efforts to improve patient home care. *J Periodontol* 2016;87:312-319.

## KEY WORDS

Chronic periodontitis; health behavior; health knowledge, attitudes, practice; models, psychological; oral hygiene; self efficacy.

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Oral hygiene behavior (OHB) is closely linked to oral health. Without a proper regimen of self-driven dental care, pathogenic microbial deposits are more likely to accumulate and result in chronic periodontitis (CP). This could lead to significant pain, discomfort, and ultimately, tooth loss—consequences that have debilitating effects on oral function and quality of life.<sup>1</sup> It is not only the health of the oral cavity that suffers in relation to these infections. A 2013 consensus report from the European Federation of Periodontology and American Academy of Periodontology concluded that there is significant epidemiologic evidence that periodontal disease is associated with increased risk of cardiovascular disease.<sup>2</sup> It is therefore important to understand factors that predict or are associated with healthy OHB to contribute to the oral and systemic health of the population.

There are several components of healthy OHB. The American Dental Association advocates brushing teeth twice a day with proper technique, using fluoridated toothpaste, cleaning between teeth every day, replacing used toothbrushes after 3 or 4 months, eating a balanced diet with limited frequency of snacking between meals, and visiting the dentist for regular checkups.<sup>3</sup> Similarly, the American Academy of Periodontology promotes regular visits for oral health evaluation, brushing teeth and the tongue after meals, and flossing at least once a day, but also highlights the regular use of a mouthrinse.<sup>4</sup> Several recent

articles have used a more detailed description of healthy OHB, which includes tongue cleaning; interdental cleaning; fluoride usage; and frequency, duration, force, method, and moments of toothbrushing.<sup>5-8</sup>

It is the goal of periodontal professionals to modify and strengthen these behaviors. This may be accomplished by identifying factors that are most closely associated with healthy OHB and designing interventions based on these relationships to improve oral hygiene. Studies have shown that demographic variables, including socio-economic status and race and ethnicity, are strong predictors of poor periodontal outcomes and tooth loss.<sup>9,10</sup> However, as useful as these associations may be for targeting interventions, the periodontal practitioner cannot directly modify demographic factors. An additional interest of the periodontist is to identify factors susceptible to modification that have greater implications for increasing the use of healthy OHB through targeted interventions.

Among the most influential social science theories used to understand forces such as these is the Theory of Planned Behavior (TPB).<sup>11</sup> The theory posits that three components account significantly for the intentions of people to engage in a wide variety of behaviors: 1) attitudes: positive or negative sentiments with reference to a behavior; 2) subjective norms: perceptions of the expectations of significant others, including partners, immediate family, and friends, regarding a behavior; and 3) perceived behavioral control: belief in one's ability to perform a specific behavior (a concept closely related to the concept of self-efficacy).<sup>12</sup>

Whereas the components of TPB and its predecessor, the Theory of Reasoned Action,<sup>13</sup> have been used to predict a wide variety of OHBs, their application for the benefit of the periodontal practitioner is not common in the literature. Among the examples of these relationships in the periodontal literature, attitudes and subjective norms were shown to be related to increased reported toothbrushing in a 2002 study of patients with insulin-dependent diabetes mellitus.<sup>14</sup> Additionally, a 2012 study<sup>15</sup> using an extended Theory of Reasoned Action explained 56% of variation in interproximal cleaning behaviors at 12 months after non-surgical periodontal debridement and oral hygiene education in a group of 113 patients with CP. The research also found that increased levels of self-efficacy before treatment were associated with higher frequencies of interproximal cleaning at the 3-month recall. These studies<sup>14,15</sup> examined specific elements of OHB, as opposed to a broader, more comprehensive assessment of oral hygiene. In contrast, in the Netherlands, Buunk-Werkhoven et al.<sup>7</sup> used TPB, oral health knowledge, and expected social outcomes to explain variation in a more complete measure of performed OHBs called the behavior index (BI).

The BI incorporates a variety of key behavioral components. These behaviors include tongue cleaning;

interdental cleaning; fluoride usage; and frequency, duration, force, method, and moments of toothbrushing.<sup>7</sup> This research has also been conducted in other parts of the world, including the Dominican Republic,<sup>5</sup> Nepal,<sup>6</sup> and Aruba and Bonaire,<sup>6</sup> with significant cultural differences discovered concerning the variables that predicted the culturally adapted measures of behavior used in each location. In the Netherlands,<sup>7</sup> all components of TPB and oral health knowledge were significant predictors of behavior, whereas in the Dominican Republic,<sup>5</sup> no meaningful correlation among any of these variables was found. Attitudes and social norms proved to be significant predictors of OHB in the sample from Aruba and Bonaire;<sup>6</sup> only perceived behavioral control and expected social outcomes were significant predictors in the Nepal sample.<sup>6</sup>

The present research aims to further explain variation in a broad set of OHBs through application of TPB. Significant cultural differences have been detected in previous studies<sup>5-7</sup> using TPB and BI; in addition, there remains a lack of research applying TPB to an index of key, performed oral health behaviors in the United States, and little research of this kind is intended for the periodontal practitioner. Thus this investigation fills a gap in our understanding of behavior and its determinants in the field of periodontology.

## MATERIALS AND METHODS

The protocol for the study was approved by the Harvard Medical School institutional review committee for human subjects (protocol number IRB13-0493), and the study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013.

Adapted from the instrument designed by Buunk-Werkhoven,<sup>7</sup> a questionnaire was devised and administered during the summer of 2013 to patients and patient companions in the offices of three private-practice general dentists' offices and the dental department of York Hospital in York, Pennsylvania. In three offices, individuals were approached only while sitting in the waiting room. One office preferred that patients respond both in the waiting room and while waiting for the dentist after hygiene appointments. In all, 381 participants (137 males and 244 females) agreed to complete the questionnaire with oral informed consent.

### Demographic Information

Age, sex, ethnicity, race, annual household income, and highest level of education were assessed. Respondents selected from seven options for age and six options for both annual household income and highest level of education. Responses for these three questions were recoded into four categories each to create approximately equal groups for analyses.

### Behavior Index

The measure of OHB was adapted from the instrument used by Buunk-Werkhoven.<sup>7</sup> As had been done previously, scores were calculated by first assigning weighted values to patient responses for each of the eight items within the index. A sum was then calculated for each respondent (range 0 to 16). A low score represented poor oral hygiene self-care, and a high score represented excellent self-care. The point values assigned to certain answers for a small number of items within the BI were adjusted based on differences in patient response patterns relative to the original study. The primary author of the original work was consulted on these issues and gave approval of the changes.

### Oral Health Knowledge

Oral health knowledge measures a person's perceptions of what constitutes healthy OHB and healthy appearances of the teeth and gums. A group of nine true/false questions was compiled based on those used by Buunk-Werkhoven<sup>7</sup> and a 2012 consumer survey (American Dental Association; consumer survey with unpublished results). Examples: "When brushing teeth, it is important to use a lot of pressure," and "A little bleeding of the gums after brushing or flossing is normal." Items were scored as correct = 1 and incorrect = 0, and a sum was calculated for each respondent (range 0 to 9).

### Elements of Focal OHBs and TPB

To focus respondents on a focal set of behaviors, they were asked to first read the following list of four healthy OHBs (focal OHBs): 1) "I brush my teeth twice daily—once after breakfast and once before going to sleep"; 2) "I brush my teeth softly, and for at least 2 minutes"; 3) "I brush using small, massaging strokes near my gums on the inside and outside surfaces of my teeth"; and 4) "I clean in between my teeth every day (dental floss, dental water jet, etc.)." In reference to this set of behaviors, respondents were asked 19 questions based on the three elements of TPB: attitudes, subjective norms, and perceived behavioral control. These 19 questions assessed participants' attitudes toward these focal OHBs, their perceptions of how important other groups of people believe these behaviors to be, and their own feelings of perceived behavioral control regarding these behaviors.

Attitudes were assessed using a single question stem: "I feel that performing these oral hygiene practices every day is..." followed by eight seven-point, semantic differential scales. For example, scales ranged from unimportant to important, difficult to easy, and unnecessary to necessary. A sum was calculated (range: 8 to 56), with a higher score indicating a more positive attitude toward proper oral hygiene. Subjective norms were assessed using two stems: 1) "I think that the

**Table 1.**

### Demographic Characteristics of the Sample of Dental Patients and Accompanying Adults in Three General Dental Practices and One Hospital Dental Department Responding to TPB Questionnaire (N = 381)

Characteristic	Percentage
Sex	
Males	36
Females	64
Age (years)	
18 to 29	15
30 to 49	39
50 to 69	37
≥70	9
Annual income (\$)	
<50,000	33
50,000 to 100,000	35
100,000 to 150,000	20
>150,000	12
Education	
High school/GED	31
Some college	26
College graduate	26
Advanced degree	17
Race	
White	96
Black	3
Other	1
Ethnicity	
Hispanic	3
Non-Hispanic	97

GED = general educational development.

person I am closest to (partner, best friend, family member, etc.)..." and 2) "When I was a child, I think that my parents or guardians..." each followed by the same four statements to be rated on a seven-point Likert scale (disagree to agree). Statements included the following: "believes that performing these oral hygiene practices every day is important" and "wants me to perform these oral hygiene practices every day." A sum was calculated (range: 8 to 56), with a higher score signifying that the participant perceived oral hygiene to be more important in the minds of the aforementioned parties. Perceived behavioral control was measured using a five-point Likert scale that assessed the degree to which respondents disagreed or agreed with each of three statements: 1) "If I wanted to, I could take care of my teeth as described by these oral hygiene practices";

**Table 2.**  
**Cronbach's  $\alpha$  for the Elements of TPB and Oral Health Knowledge (N = 381)**

Element	Cronbach $\alpha$	Range	Mean (SD)
Attitude	0.69	20 to 56	48.05 (7.26)
Subjective norms (close person)	0.81	4 to 28	21.86 (5.40)
Subjective norms (parent/guardian)	0.89	4 to 28	20.19 (6.55)
Perceived behavioral control	0.81	5 to 15	13.28 (2.19)
Oral health knowledge	—	3 to 9	7.06 (1.33)

2) "I find it easy to take care of my teeth as described by these oral hygiene practices"; and 3) "I am able to take care of my teeth as described by these oral hygiene practices." A sum was calculated (range: 3 to 15), with a higher score indicating a stronger belief in the participant's own ability to practice healthy OHBs.

### Statistical Analyses

Analyses of data were completed with statistical analysis software.<sup>§</sup> Frequency tables were generated on the parameters of demographics and personal characteristics, as well as the BI. Cronbach's  $\alpha$ , range, mean, and standard deviation (SD) were calculated for the parameters of TPB. Based on the low Cronbach's  $\alpha$  calculated for the BI, three components of the index were selected for further analysis. Three separate stepwise multivariate linear regression analyses were performed on the three parameters of the BI: brushing index, interdental cleaning, and tongue cleaning.

## RESULTS

Three hundred eighty-one people participated in the study. Although a precise count of those who agreed and refused to participate in the study was not collected, refusals were quite infrequent, with an estimated response rate of 85% to 90%. Table 1 contains a description of the characteristics of the population. As indicated in Table 1, the sample was >95% white and non-Hispanic, with a nearly 2:1 representation of females to males. The sample did contain a fairly broad representation of people in terms of age, income, and education.

As shown in Table 2, attitudes toward healthy OHBs (focal OHBs) were positive, as were feelings of perceived behavioral control toward completing behaviors described in the focal OHBs. Participants perceived those close to them and parents/guardians as valuing healthy hygiene behaviors. True/false scores indicated that respondents had basic knowledge of oral health, with a mean of 7.06 (SD 1.33) of 9 questions answered correctly. Cronbach's  $\alpha$  for components of TPB, attitudes (0.69), subjective norms of a close person (0.81), subjective norms of a parent/guardian (0.89), and

perceived behavioral control (0.81) were satisfactory, with values equal to or above the generally accepted threshold value of 0.7 required for internal consistency.

Cronbach's  $\alpha$  of the eight-item BI (Table 3) yielded a value of 0.529, well below this threshold. Therefore, it was decided that continued analysis would focus on individual elements of the BI as opposed to the index as a whole. Of the eight items in the index, five measured toothbrushing. Preliminary analysis suggested that only two of these could be combined into a single brushing index with acceptable internal consistency. Frequency of toothbrushing and moments of toothbrushing, which produced an  $\alpha$  of 0.78, were therefore used for subsequent analyses as the new brushing index. For this index, variable frequency of toothbrushing was reweighted so that the two items carried equal weight in the final composite. Of the three remaining items, interdental cleaning and tongue cleaning were used as separate outcomes. The remaining item, use of fluoride toothpaste, was eliminated as an outcome owing to limited variability in responses (i.e., >90% of respondents either did use or did not know if they used fluoridated toothpaste).

Three separate stepwise multivariate linear regression analyses were performed on the three outcomes: brushing index, interdental cleaning, and tongue cleaning. For each, the same 11 predictors were entered: 1) attitudes; 2) subjective norms for close person; 3) subjective norms for parents/guardians; 4) perceived behavioral control; 5) oral health knowledge; 6) age; 7) sex; 8) annual household income; 9) highest level of education; 10) race; and 11) ethnicity. The stepwise method reduced the number of predictors in the model to only those that contributed significantly to the amount of explained variance in each of the outcomes.

Attitudes, oral health knowledge, perceived behavioral control, subjective norms regarding a close person, and annual household income were significant predictors of variance, explaining a total of 22.5% of the variance in brushing behaviors (Table 4). Perceived behavioral control, increased age, and attitudes were

§ SPSS Statistics for Windows, v.22.0, IBM, Armonk, NY.

**Table 3.**  
**Frequencies of Respondent Reports for all Components of the Behavior Index (N = 381)**

Item and Performed Behavior	Percentage
Frequency of toothbrushing*	
"Twice a day" or "More than twice a day"	72
"Once a day"	26
"Not every day"	2
Moments of toothbrushing*	
Three times a day, including "Morning after breakfast" and "Just before going to sleep" or "After dinner" and "Just before going to sleep"	9
Twice daily	
"Morning after breakfast" and "Just before going to sleep" or "After dinner in the evening"	32
"Before breakfast" or "Morning after breakfast" and "Midday"	1
"Before breakfast" or "Midday" and "Just before going to sleep"	27
"Before breakfast" and "After dinner in the evening"	2
Once a day (any single time)	29
Force of toothbrushing	
Softly ("1, 2, 3")	28
Softly/Forcefully ("4, 5")	65
Forcefully ("6, 7")	7
Duration of toothbrushing	
"2 minutes" or "3 minutes"	61
"Longer than 3 minutes" or "1 minute"	35
"Shorter than 1 minute"	4
Method of toothbrushing	
"Massaging movements near the gum line"	6
"Back and forth movements" or "Combination of movements"	72
"Up and down movements" or "Circular movements"	22
Fluoride toothpaste	
"Toothpaste with fluoride"	83
"Toothpaste without fluoride"	9
"I don't know"	8
Interdental cleaning*	
"At least once a day"	38
"A few times a week"	32
"Rarely" or "Never"	31
Tongue cleaning*	
"At least once a day"	53
"A few times a week"	16
"Rarely" or "Never"	31

\* Outcome measures selected for analysis.

significant predictors of variance in interdental cleaning behaviors, explaining 22.7% of the variance. Female sex, subjective norms regarding a close person, decreased age, and perceived behavioral control were significant predictors in tongue cleaning behavior and explained 9.5% of the variance.

## DISCUSSION

The intent of this research was to use TPB as a framework for identifying the extent to which attitudinal,

environmental, knowledge-based, and personal factors accounted for a broad set of OHBs in a US-based study for the benefit of the periodontal practitioner.

The authors began with the assumption that the BI, a broad measure of oral hygiene, would be appropriate to use as a single measure of behavior, as culturally adapted versions of the BI have been used in the literature multiple times in other contexts.<sup>5-8</sup> However, once it was determined that the combined index did not have adequate internal consistency in the population

**Table 4.****Results of Regression Analyses for Brushing Index, Interdental Cleaning, and Tongue Cleaning Measures (N = 381)**

Variable	$\beta$	Significance	Model $R^2$
Brushing index			
Attitudes	0.236	<0.001	0.135
Oral health knowledge	0.180	<0.001	0.176
Perceived behavioral control	0.172	0.002	0.206
Subjective norms (close person)	0.108	0.03	0.217
Annual household income	0.092	0.046	0.225
Interdental cleaning			
Perceived behavioral control	0.265	<0.001	0.136
Age	0.236	<0.001	0.205
Attitudes	0.176	0.001	0.227
Tongue cleaning			
Sex	-0.175	0.001	0.047
Subjective norms (close person)	0.130	0.01	0.071
Age	-0.145	0.004	0.086
Perceived behavioral control	0.117	0.03	0.095

studied ( $\alpha = 0.53$ ), the authors revised their approach and analyzed separately each of three elements (toothbrushing, interdental cleaning, and tongue brushing).

The regression analyses indicated that each of these outcomes had somewhat different predictors. Toothbrushing was most strongly predicted by three modifiable elements: attitudes, knowledge, and perceived behavioral control. Perceived behavioral control was the single strongest factor predicting interdental cleaning, meaning that those who felt they could successfully clean between their teeth were the most likely to do so. Increased patient age was the second most influential determinant, with attitudes also playing a role. In contrast to brushing and interdental cleaning behaviors, in which  $\approx 23\%$  of the variance could be accounted for by the predictors, only 9.5% of the variance in tongue cleaning could be accounted for by all of the predictor variables. In addition, the major determinants were different, with female sex being the strongest predictor. Females were 61% more likely to report cleaning their tongues.

This study has implications for both current clinical practice and future efforts in understanding and modifying oral hygiene through behavioral research. First, the findings highlight the multifaceted nature of OHBs. The lack of internal consistency among individual oral hygiene components in the BI shows that OHB is a multidimensional concept in the population studied, demonstrating that although there is value in approaching oral hygiene as a single entity, there is additional utility gained by viewing OHB as a set of unique behaviors with unique predictors.

Second, the results provide additional support for use of the variables outlined in TPB in predicting performed

OHB. Most notably, they demonstrate that dynamic factors internal to the individual (e.g., self-perceptions, knowledge, and attitudes) as well as external to the individual (e.g., perceived social norms) have a clear relationship with behavior.

Additionally, although design of the present research does not allow for the inference of causality, it is nonetheless important to consider the possible interplay between the predictors and behaviors. Toothbrushing may be the most amenable behavior to interventional efforts, as its strongest predictors (attitudes, knowledge, and perceived behavioral control) are all modifiable and together account for  $>20\%$  of variation in the behavior. Attitudes alone account for 14% of this variance, providing a meaningful opportunity for influence by the periodontist. Moreover, perceived behavioral control is the strongest predictor of interdental cleaning behaviors. This finding adds to the evidence<sup>14</sup> supporting the idea that increasing periodontal patients' belief in their ability to effectively clean between their teeth may be the most powerful tool to improve compliance with clinical recommendations. Alternatively, tongue cleaning is most strongly predicted by female sex, decreased age, and perceptions of social pressures. Although these are largely unmodifiable characteristics, the findings might guide the periodontist toward those populations that may be the most receptive to considering the sequelae of disregarding this aspect of oral hygiene.

The most critical takeaway for the clinician is that educating patients about their conditions and what makes up healthy homecare is not enough. Practitioners must inquire about patients' attitudes regarding

brushing behaviors and engage them in discussion aimed at adjusting their beliefs and sentiments. Clinicians need to devote time to increasing patients' belief in their ability to successfully clean between their teeth. This, however, cannot be accomplished by simply encouraging a patient to try harder. The feeling of personal mastery of an action is a driving force behind improvements in self-efficacy.<sup>12</sup> Personal mastery is derived from the combination of the abilities to both perform and self-assess an action. Thus, practitioners must teach patients how to properly clean between their teeth and then how to self-evaluate these efforts so that patients understand the cleaning behaviors that lead to successful outcomes. For example, research shows that self-assessment of bleeding and plaque accumulation has led to improvements in gingival health.<sup>16</sup> Finally, clinicians must ask about social pressures experienced by the patient that may explain behaviors directly or indirectly through effects on attitudes. Involving the parties responsible for these pressures, who are often spouses or other family members, in discussions regarding healthy behaviors may provide further benefit. When used, these strategies, in addition to traditional patient education, are likely to result in more robust interventional efforts.

Some limitations of this study should be addressed in future research. Roughly 96% of research participants identified themselves as white and non-Hispanic. Although this sample is fairly representative of the population of York, Pennsylvania,<sup>17</sup> it is not representative of the larger national population. Future studies should aim to increase racial and ethnic diversity, as research shows disparities in dental health among American adults across these demographic characteristics.<sup>9,18</sup> Additionally, the study was conducted within dental practices, which selected for respondents who were either actively seeking dental care or accompanying someone seeking dental care. It is possible that as a result, participants in this study placed more value on oral health and hygiene than members of the general public, which may have positively skewed measurements of OHB. Future studies could benefit from surveying people outside of the dental practice environment. Another limitation of the present study is the single-item behaviors used in analysis of interdental cleaning and tongue cleaning. A stronger measure of these items may include multiple components, capturing a more robust description of the behaviors. However, as these endpoints were selected for analysis after the initial study design, it was not possible to apply this strategy to the current research.

Future research efforts should focus on establishing definitive causal relationships through design of targeted interventions that focus on modifying specific predictors for each of several specific behaviors.

## CONCLUSIONS

Regardless of procedural interventions that occur as a part of periodontal therapy, ultimately periodontal health is largely determined by patients' OHBs. Analysis of these behaviors reveals that OHB is not a unitary concept and should instead be approached as a collection of unique actions. This study suggests that these behaviors are associated with individuals' attitudes, perceived behavioral control, and knowledge, as well as how they respond to perceived social pressures. Because these factors are all potentially modifiable, these findings strongly imply that one critical aspect of periodontal therapy is for clinicians to be aware that not only must they address each element of OHB separately, but also their approach to each factor must be unique. Targeting patient attitudes may be the best way to improve brushing behaviors, and increasing feelings of perceived behavior control may allow for the greatest improvement in interdental cleaning behaviors. Through application of these strategies, periodontology professionals will provide stronger interventional efforts that may result in improved compliance with recommended practices.

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## REFERENCES

1. Tonetti MS, Eickholz P, Loos BG, et al. Principles in prevention of periodontal diseases: Consensus report of group 1 of the 11th European Workshop on Periodontology on effective prevention of periodontal and peri-implant diseases. *J Clin Periodontol* 2015;42(Suppl. 16): S5-S11.
2. Tonetti MS, Van Dyke TE; Working Group 1 of the Joint EFP/AAP Workshop. Periodontitis and atherosclerotic cardiovascular disease: Consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. *J Periodontol* 2013;84(Suppl. 4):S24-S29.
3. American Dental Association. Oral Health. Available at: <http://www.mouthhealthy.org/en/az-topics/o/oral-health>. Accessed: September 6, 2014.
4. American Academy of Periodontology. Preventing periodontal disease. Available at: <http://www.perio.org/consumer/prevent-gum-disease>. Accessed: December 12, 2014.
5. Buunk-Werkhoven YA, Burrekers SY, Jongboer A, Quant DF, van Maanen-Schakel NW. Determinants of oral hygiene behavior in the Dominican Republic. *Int Dent J* 2011;61:328-333.
6. Buunk-Werkhoven YA, Dijkstra A, Bink P, van Zanten S, van der Schans CP. Determinants and promotion of oral hygiene behaviour in the Caribbean and Nepal. *Int Dent J* 2011;61:267-273.
7. Buunk-Werkhoven YA, Dijkstra A, van der Schans CP. Determinants of oral hygiene behavior: A study based

- on the theory of planned behavior. *Community Dent Oral Epidemiol* 2011;39:250-259.
8. Buunk-Werkhoven YA, Dijkstra A, van der Wal H, et al. Promoting oral hygiene behavior in recruits in the Dutch Army. *Mil Med* 2009;174:971-976.
  9. Borrell LN, Burt BA, Warren RC, Neighbors HW. The role of individual and neighborhood social factors on periodontitis: The third National Health and Nutrition Examination Survey. *J Periodontol* 2006;77:444-453.
  10. Buchwald S, Kocher T, Biffar R, Harb A, Holtfreter B, Meisel P. Tooth loss and periodontitis by socio-economic status and inflammation in a longitudinal population-based study. *J Clin Periodontol* 2013;40:203-211.
  11. Ajzen I. *Attitudes, Personality, and Behavior*. Chicago: Dorsey Press; 1988.
  12. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychol Rev* 1977;84:191-215.
  13. Ajzen I, Fishbein M. *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice Hall; 1980.
  14. Syrjälä AM, Niskanen MC, Knuuttila ML. The theory of reasoned action in describing tooth brushing, dental caries and diabetes adherence among diabetic patients. *J Clin Periodontol* 2002;29:427-432.
  15. Jönsson B, Baker SR, Lindberg P, Oscarson N, Ohn K. Factors influencing oral hygiene behaviour and gingival outcomes 3 and 12 months after initial periodontal treatment: An exploratory test of an extended Theory of Reasoned Action. *J Clin Periodontol* 2012; 39:138-144.
  16. Kallio P, Utela A, Nordblad A, Alvesalo I, Murtomaa H, Croucher R. Self-assessed bleeding and plaque as methods for improving gingival health in adolescents. *Int Dent J* 1997;47:205-212.
  17. U.S. Department of Commerce. York County, Pennsylvania. Available at: <http://quickfacts.census.gov/qfd/states/42/42133.html>. Accessed: December 11, 2014.
  18. Liu Y, Li Z, Walker MP. Social disparities in dentition status among American adults. *Int Dent J* 2014;64:52-57.
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