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Original Article

Developing an instrument to measure dental flossing in Iranian adolescents

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Abstract. Preventable risk factors for oral health diseases are linked to related self-efficacy, attitudes and behaviors. The purpose of this study was to develop an instrument to measure oral self-care, based on the Transtheoretical model and to report on the psychometric testing of the instrument. The findings from qualitative research from Sanandaj, Iran, was used to generate the initial items. Construct validity was tested using principal component analysis to extract factors. Results: Factor analysis yielded 7 factors (28 items) related to interdental cleaning: 1 self-efficacy factor, 3 factors related to perceived benefits and 3 factors related to perceived barriers. Cronbach alpha reliability coefficient ranged from .83 to .87. These preliminary results provide support for using the instrument to measure decisional balance and self-efficacy of interdental cleaning in Iranian adolescents.

Kew words: Dental floss, transtheoretical model, reliability, validity, iranian adolescents

1. Introduction

A healthy mouth is an important part of a healthy body. Poor oral health can affect a person's quality of life. Oral pain, missing teeth or oral infections can influence the way a person speaks, eats and socializes. These oral health problems can reduce a person's quality of life by affecting their physical, mental and social well-being (1). Oral disease, like any other disease, needs to be treated. A chronic infection, including one in the mouth, is a serious problem that should not be ignored. Many people think that if their gums bleed a little while they are brushing their teeth, then they are doing a good job of cleaning the teeth so bleeding or tender gums are often overlooked (1).

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Research has suggested there is an association between oral disease and other health problems such as diabetes, heart disease and stroke, as well as pre-term and low-birth-weight babies. To help reduce the risk of oral disease, good oral health behaviours should be adhered to (1). Such behaviours include regular checkups, tooth and tongue brushing twice a day, and daily flossing (2). Flossing removes plaque and bacteria that cannot be reached with a toothbrush. If one doesn't floss, more than one-third of the tooth surface may be missed and plaque, which is the main cause of gum disease, will form (1). Plaque hardens into tartar (also called calculus), which can only be removed by professional cleaning.

Despite the benefits of brushing and flossing, adherence to these behaviors is often low (3,4). For example, many people in the world believe losing their teeth is normal (5,6). In Iran, 50% of children 12 years old had teeth decay with a mean decay missing filled teeth (DMFT) index of 2.46 which rose in adolescents aged 15 and 16 years to 2.66 and 2.76 respectively. These are relatively high scores which may reflect poor oral health behavior (7). Other research revealed only 37.5%

of Iranian girls reported using dental floss and 65.5% reported daily tooth-brushing (8).

1.1. Background and conceptual framework

Theoretically based oral health promotion research that includes consideration of the determinants of health have proven to be the most effective. For example, validated constructs associated with oral health include perceived benefits, barriers (9,10) self efficacy, outcome expectancy (11), goal setting (12) and previous flossing. These constructs are included in the Transtheoretical model (TTM) developed by DiClemente and Prochaska (13). The TTM has been useful for guiding research on oral self-care behaviors (13) and provides some useful insights into the behavioral change process. According to the TTM, individuals move through a temporal sequence of five stages of behavior change (14). Tillis and colleagues have expanded the application of these stages to characterize commitment to oral self-care that is defined as cleaning between the teeth by using dental floss, toothpicks or an interdental brush at least once a day (15). According to Tillis's (15) definition, participant's stage of oral health behaviours are: 1- Pre-contemplation - not planning to clean between teeth (CBT) in the next 6 months; 2- Contemplation – planning to CBT in the next 6 months; 3- Preparation planning to CBT in the 30 days; 4- Action – CBT at least once a day for less than 6 months and 5- Maintenance - daily CBT for more than 6 months. In the current study, stages of change for cleaning interdentally (CI) were adapted from Tillis's definition.

While a great deal research has examined oral self care in other countries, theoretically based research examining oral self care behaviors is limited in Iran (8). One difficulty with conducting such research is the lack of a valid and reliable measure that can be used to measure oral health behaviors.

As the TTM model offers unique theoretical strengths for studying oral self care (16,17) and because no researchers have conducted theoretically based studies of Iranian adolescents' oral health behaviors, the present study was designed to 1; develop an instrument based on the Transtheoretical model to measure dental flossing behavior and 2; to evaluate psychometric properties the developed instrument in Iranian adolescents.

1. 2. Procedure for Instrument Development

The first step of this research was to construct a draft questionnaire through a comprehensive literature review related to oral self care practice followed by focus groups with adolescents and consultation with an expert panel. The instrument was then pilot tested.

Three focus group interviews were conducted with a convenience sample of 28 adolescents (13 girls and 15 boys, mean age= 13.63, SD=1.4) in high school from Sanandaj, Iran. Focus group interviews took place in the school and were about 90 minutes long. They were audio recorded and transcribed verbatim. They were asked to talk about their beliefs concerning perceived benefits, barriers and self efficacy to overcome barriers related dental flossing. They also were asked to review the first draft of the dental flossing questionnaire. Based on the transcripts, we extracted 35 items (ten pros items, 13 cons items and 12 self efficacy items).

The items generated from the focus groups were tested for content validity with a panel of experts, which included two dentists, an instrument development expert, two health educator professors, and two public health professors. They were asked to evaluate the initial items' relevance to their associated concept domain based on the conceptual definition of perceived benefits, barriers and self efficacy to engage in interdental cleaning. Each item was rated on two 4-point rating scales (1=very irrelevant to 4=very relevant and 1=very inappropriate to 4=very appropriate). Those items receiving a rating of 3 or higher on either relevancy or appropriateness were retained. On recommendation of the expert panel, two items were deleted (flossing makes a space between my teeth, flossing is expensive) and one item was added to perceived barriers (need to look in a mirror to clean interdentally). Some changes were made in wording (e.g. "when I travel" was replaced with "when I am away from home"). In addition, the response format was changed from a 5-point to a 4-point scale.

A pilot study was conducted with a convenience sample of 53 high school students to test whether the items have meaning and are easy to comprehend. Some of the students suggested the term "gingival diseases" should be changed to bleeding and inflammation of the gums. Most students proposed that having a subject in sentences is more meaningful than sentences without a subject. After making the suggested changes, the final version of the instrument

Table 1. Rotated Factor loading analysis of the dental flossing

Factor 1 CI SE	Factor 2 CI CON	Factor 3 CI PRO	Factor 4 CI CON	Factor 5 CI PRO	Factor 6 CI PRO	Factor 7 CI CON
SE 2 0.79	CON9 0.69	PRO3 0.78	CON6 0.76	PRO4 0.76	PRO8 0.82	CON2 0.80
SE 5 0.77	CON8 0.66	PRO2 0.76	CON4 0.73	PRO1 0.67	PRO6 0.62	CON7 0.44
SE 7 0.73	CON3 0.65	PRO5 0.67	CON10.61	PRO6 0.47	PRO5 0.51	
SE1 0.71	CON7 0.65	PRO7 0.47	CON1 0.41			
SE3 0.70	CON10 0.52					
SE10 0.65	CON5 0.43					
SE 6 0. 64						
SE8 0.64						
SE9 0.48						
SE4 0.40						
Eigenvalue 4.47	2.89	2.33	2.07	2.01	1.76	1.47
Variance explained 15.98	10.32	8.32	7.40	7.21	6.30	5.25

CI indicates clean interdentally; SE, Self-efficacy; CON, Negative aspects; PRO, Positive aspects

Table 2. Item-Total Correlation and Cronbach α for Subscales

Scales	No. Items	Item-Total Correlation	Subscale	Cronbach α
Self –efficacy CI	10	0.40-0.72		0.85
Pros CI	8	0.51-0.64		0.83
Cons CI	10	0.50-0.65		0.87

CI indicates clean interdentally; CON, Positive aspects; PRO, Negative aspects

contained 34 items including 10 items on perceived benefits (Pros), 12 items on perceived barriers (Cons) and 12 items on perceived self – efficacy.

The stage of oral self care change for each focus group participant was assessed by an adapted two question measure (15). In the first question, participants were asked to rate the following statement on a yes/no scale: "how frequently do you clean between teeth by dental floss sufficiently (at least once daily)". In the second question, participants who answered "yes" were asked to select one of the following two options: I'm currently doing it, but I have been for less than 6 months (action); or I'm currently doing and I have been for more than 6 months (maintenance). Those who answered "no" were asked to select one of the following three options: I don't dental floss sufficiently, and I have no intention to start (pre-contemplation); I don't dental floss sufficiently, but I intend to start in the next 6 months (contemplation); or I don't dental floss, but I intend to start in the next month (preparation). Test–retest reliability of this staging algorithm was k = 0.45 to 0.87 (15). In the current study, the kappa index of reliability for stage of change over a 2-week period was 0.83 (n = 53).

1. 3. Participants

By using a stratified random sampling according to school districts and different classes, 786 adolescents in junior and high schools in Sanandaj, Iran were recruited. The data from 61 participants were not used due to missing data. The remaining 725 participants were divided randomly into two samples. Sample 1 included 365 adolescents 12-17 years old (Mean age =14, SD=1.47; 49% female and 51% male) and data from this group were used for explanatory factor analysis. Sample 2 consists of 360 adolescents 12-17 years (M= 14.25 SD= 1.69; 49.6% male

and 50.4% female) and the data from this group were used for the second step of the analysis plan (the known-group technique). Prior to data collection, human participants approval was obtained from The Kurdistan university of Medical Sciences Review Board.

1.4. Data analysis

Two steps were used in the psychometric testing. In step 1, an exploratory factor analysis (EFA) using principal component analysis (PCA) with Varimax rotation was performed to extract factors using loading criteria of 0.40 and above (18). The reliability coefficient for each scale was calculated using: (a) Cronbach **α**, (b) Corrected item-total correlation at least 0.30 and (c) no increase in Cronbach **α** of more than .10 when an item was dropped from the scale (18). Test-retest reliability was used for the stage of change algorithm with a two-week interval. In step 2, using another sample of students (N=360) the known-group technique was used to further test construct validity. One way analysis of variance was applied to examine the relationships between the five stages of dental flossing and the pros, cons, and self efficacy subscales, in addition to the derived measure of the decision balance. Descriptive statistics and X^2 analyses were computed to describe the distribution across the stages of change for sex and two age groups.

2. Results

2. 1. Construct Validity

Twenty-eight items related to oral self-care loaded on 7 factors with eigen-values greater than 1.00 and an explained variance of 60.80%. The range of factor loadings for the items as well as the Eigen values and variance explained are shown in Table 1.

The Kaisor-Meyer-Olkin (KMO) index was .883 for the EFA sample and Bartlett's test of Sphericity was significant, p<0.01) thus, the obtained data were suitable for a factor analysis. All 7 factors loaded on expected factors. Factor 1, perceived self-efficacy, was the strongest factor, explaining the greatest percentage of variance (15.98%). Ten items loaded on this factor: even when I am feeling lazy (SE2), even if I have other things I wanted to do (SE5), I am sure to do it daily (SE7), even when I feel tired (SE1), even when I am away from home (SE3), even if others see me when I am doing it (SE10), sure to perform it correctly (SE6), even when I am upset (SE8), even without looking in the mirror(SE9), and even if I was not in the mood (SE4). The items "even if it makes my gums bleed" and "even if it is painful" didn't reach minimum loading criteria.

Items related to the negative aspects of interdental cleaning (Cons) loaded on three different factors: 2, 4 and 7. Items "I am lazy" (Con9), "not having enough time" (Con8), "cannot remember" (Con3), "difficulty of the technique" (Con7), "there is no need if I brush regularly" (Con10), and "being too tired" (Con5) loaded on factor 2. Factor 4 included "not expected from my parents" (Con6), "gums bleeding" (Con4), "flossing is painful" (Con1) and "no need to brush regularly" (Con10). Two of the cons items of interdental cleaning (CI): "I don't know how to perform" (Con2) and Con7 (which cross-loaded on factor 2) loaded on factor 7. Correlations between the 10 items were significant (r=0.23- 0.60, p <0.001), the Cronbach **α** =0 .87, and the item-total correlation ranged from 0.50 to 0.65 providing enough evidence to combine the 3 factors in 1 factor related to the cons of flossing. Two items were deleted because of low criteria loading: "cleaning between teeth is messy" and "don't like the feel of dental floss".

The items that reflected the positive aspects (Pros) loaded on factors 3, 5 and 6. Factor 3 included the items: "to reduce cavities" (Pros3), "to prevent gum disease" (Pros2), "to keep my teeth" (Pros5) and "to improve my oral health" (Pros7). Items that loaded on factor 5 included: "nice smile" (Pros4), "whiter teeth" (Pros1), and "improved self confidence" (Pros6). Factor 6 included "remove bad breath" (Pros8), and the items Pros6 and Pros5 that also loaded on other factors. Although the pros subscale loaded on Factors 3, 5 and 6 we considered them to be 1 scale because the item showed internal subscale homogeneity (Cronbach α =0 .83, item-total correlation= (0.51- 0.65) and correlation between 8 of the Pros items ranged from 0.24 to 0.54. The Items "to save my money" and "to reduce visit by dentist" were removed because of loading less than 0.40. See Table 1 for the factor analysis table.

2.2. Reliability

The reliability of an instrument refers to the extent to which an instrument is internally consistent; that is, the instrument's components measure the same thing (18). Internal consistency for each of the three measures was estimated by Cronbach's coefficient alpha. The indices ranged from 0.83-0.87. Table 2 shows the α coefficients for the 8 subscales retained for the final version of the questionnaire.

All corrected item-total correlations for Pros, Cons and self-efficacy were above 0.30 and

values did not increase by more than 0.010 in Cronbach alpha if any of the items were deleted (18).

Known-group technique was used to further examine construct validity. In this study, differences between stages were found for decisional balance and perceived self-efficacy. As expected, the scores for Pros and perceived self-efficacy were higher in those who were in adoption stages (action and maintenance) than pre-adoption (pre-contemplation, contemplation and preparation), while the scores for Cons were higher in pre-adoption. The results of the ANOVA and post- hoc tests are presented in table 3.

Table 3. Mean (SD) on psychosocial factors for the five stages of using dental floss

Variables	Pre-contemplation	Contemplation	Preparation	Action	Maintenance	F
Perceived benefits (Pros)	2.46(.51) [a]	2.99(.52)[b]	3.18(.39)[b]	3.44(.50)[c]	3.60(.37)[c]	61.30**
Perceived barriers (Cons)	2.91(.64)[a]	2.61(.55)[a]	2.35(.59)[a]	1.90(.53)[b]	1.87(.62)[b]	39.98**
Self-efficacy	2.39(.86)[a]	2.90(.72)[b]	2.74(.73)[b]	3.29(.40)[c]	3.60(.38)[d]	42.72**
Balance (Pros-Cons)	-.45(1.03)[a]	.37(.89)[b]	.82(.75)[c]	1.54(79)[d]	1.73(.80)[d]	73.48**

** p< 0.001, a-d Means with different indices are significantly different in post-hoc tests at the 0.01 to 0.001 level.

Table 4. Prevalence (%) within the stages of change for cleaning interdentally

Group	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
Overall (n=360)	13.6	19.7	21.1	18.3	27.2
Females (n=181)	17.1	18.8	4.4	29.8	29.9
Males (n=179	10.1	20.7	38.0	6.7	24.6

There were significant differences between adoption stage members and pre-adoption stage members for Pros, Cons and self-efficacy. The distribution of the participants across the stages is outlined in table 4. Gender, X^2 (1) =22.07, p<0.001, and age, X^2 (1) = 4.69, p<0.02, differed across stages; older adolescents and girls were more prevalent in the adoption (action and maintenance) stages. Results are outlined in table 4.

3. Discussion

No study has yet assessed oral self care practice in Iranian adolescents based on the TTM frame work. This may be because of the lack of a valid and reliable measure. The aim of the current study was to develop and test the psychometric properties of a measure to assess factors that expected influence dental flossing behaviours among Iranian youth. Other researchers have applied the Transtheoretical model to examine oral self-care behaviors (15,16). This is the first study to test associations between stages of interdentally cleaning, decisional balance and self efficacy among Iranian adolescents. Tillis investigated only the relationship between stages of readiness and decisional balance related to oral self care (15).

The majority of the items generated during the focus groups were retained after the psychometric evaluation. The items reflect confidence, barriers and benefits of proper oral health behaviors. For example, some items from the second factor (“not having enough time,” “being lazy,” “being tired,” and “having more important works“) are related to taking time to address interpersonal barriers rather than extra personal factors. In factor 4, the items “my parents do not expect me” and “there isn’t need” are related. This may indicate there not being the expectation from important others like parents influences flossing behavior. The items “gums bleeding” and “being painful” that

comprise factor 4, shows not having sufficient skills to doing flossing correctly or results periodontal disease that causes bleeding and pain while cleaning teeth internally which are distinct from the items related to skill that make up factor 7: "don't know how to do it" and difficult technique"

It is concluded that factors 2, 4 and 7 are reflect internal barriers related to taking time and lack of knowledge and skills about flossing. The item "difficult technique" cross loaded on factors 2 and 7, because of the skills aspect in those factors. The item "there is nothing that makes it not necessary" in the factors 2 and 4 cross loaded on those factors. The pros items: "reduce cavities," "prevent gum diseases," "to keep teeth," and "improve oral health" related to oral health and clustered together on factor 3. The items "nice smile" and "whiter teeth" reflect appearance concerns and loaded with "improve confidence" on factor 5. For the Iranian adolescents in this study there was a relationship between appearance, bad breath and self confidence given the cross loading of "self confidence" across factors 5 and 6. Thus, the items generated in this study reflect a number of different aspects related to oral health behaviors and would be useful in creating interventions aimed at increasing brushing and flossing.

The need for such interventions in Iranian adolescents was made clear by our research. To develop effective oral heath interventions, readiness levels need to be understood because unrealistic self-assessment could be a barrier as they see no need to change. Results of our study showed few Iranian adolescents in the adoption stages (action and maintenance 30.7% vs. 69.3% in pre-adoption stages). This is inconsistent with Tillis's study who reported 62.3% in the adoption stages. This may be due to the different definition used in the studies (> 3 times per week in Tillis's study compared to daily in our study). Another related reason is the population in Tillis's study was from the clients/patients dental practices and it is therefore likely that participants received some recommendations to clean interdentally. Also our subjects were adolescents that perceive low risk given periodontal disease compared to adults. Other studies have found few people floss regularly (19,20,21) especially during periods from 15-23 yr of age (21). More than half of the adolescents in the present study were in pre-contemplation, contemplation and preparation stages of cleaning between teeth. Our results also showed that the number of adolescents in the adoption phases of dental flossing was greater in girls (59.7%) than in boys (31.3%). It may be that girls floss because of concerns with appearance. Astrøm showed women floss more than men (20,21).

Dental costs are expensive and there isn't an insurance system for providing these services in Iran. Therefore, there is a need to educate Iranian youth about the importance of oral self care specially flossing to reduce dental care costs and improve dental health. There is a need for further research to explore beliefs about the role and importance of flossing to reduce decay and gum diseases in this population. Further, the findings of this study have provided important information that could be used to develop oral self-care interventions in this and other similar populations. In this study, the strongest barriers faced by Iranian adolescents to flossing were laziness and the perception that it is unnecessary. The greatest perceived benefits were to reduce cavities and bad breath. Appropriate interventions developed to increase oral health practices should address these barriers and benefits.

Based on the TTM, it was hypothesized that mean scores of barriers, benefits and self efficacy would be significantly different for those who were in the action and maintenance to those who are in pre-adoption stages. There were significant differences in the pros, cons and self-efficacy between participants in adoption and pre-adoption. These findings are consistent with other research (15). Similarly, others have shown that self efficacy for oral hygiene was associated with brushing and flossing frequency (11). Our finding showed those in advanced stages (action and maintenance) reported more self efficacy than who did not.

One of the major challenges facing dental practitioners to follow their recommendations about oral hygiene behavior is related to attitude and beliefs. Therefore, to motivate people to follow an oral hygiene regimen there is a need to alter the underlying beliefs and feeling associated with the behavior. Determining readiness for change is a vital part of the behavior change process. If people are in the action stage then discussing with them what to do about their flossing regimen when their routine changes and they go on holiday, for example, can help ease changes in self-care behaviors.

The developed questionnaire in the current study can be used as a tool to assess beliefs of Iranian adolescents' related oral self acre. Although refining and testing this questionnaire in other samples of adolescents are recommended, in particular with the subscales of barriers and benefits to flossing. A Farsi version of this questionnaire is available for Iranian and

immigrant populations. The study provides some support on TTM hypothesized relationship among Iranian adolescents.

3. 1. Implications for research and practice

The Instrument for measuring belies related to flossing behavior in Iranian youth is in developments stage and it is necessary to continue refining and testing this new instrument with other samples of Iranian youth populations in different geographic locations or with other similar cultural values and beliefs.

Appendix

Scale flossing Barriers

1. I am lazy to floss my teeth.
2. I don't have enough time to floss my teeth.
3. I can't remember floss my teeth once a day.
4. Dental flossing is a difficult technique.
5. There is no need dental flossing if I brush regularly.
6. I don't floss my teeth if I am tired.
7. My parents aren't expected me to flossing.
8. Dental flossing makes my gums bleed.
9. Dental flossing is painful.
10. I don't know to perform floss.

Scale flossing Benefits

1. Flossing reduce tooth decay.
2. To prevent gum diseases.
3. Flossing keeps my teeth.
4. To improve my oral health.
5. Having nice smile.
6. Having whiter teeth.
7. To improve self confidence.
8. To removed bad breath.

Scale flossing Self efficacy

1. I floss my teeth even if when I feel lazy.
2. Even I have done other things that I wanted to do.
3. I am sure to do it once a day.
4. Even if when I feel tired.
5. I sure when away from home.
6. I can floss if others see me when I am doing it.
7. I am sure to perform it correctly.
8. Even if when I am upset.
9. I can floss without looking in the mirror.
10. Even if I am not in the mood.

Interventions to increase oral self-care that are culturally-sensitive, developmentally appropriate, gender-specific, and individually tailored to address unique personal needs are urgently needed. Our results indicated that changes in benefits, barriers and self-efficacy significantly differed across stage of readiness to flossing behavior. Finding is particular important when interventions are being tailored to individual beliefs. Tailoring may need to be stratified by stage of readiness, gender and age too.

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