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Original Article

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Abstract

Purpose: Toothbrushing holds key importance in practical, competent, and efficacious design to limit the formation of dental plaque on the dental tissues, in turn, leading to a decrease in dental diseases. The recent addition to this growing knowledge in health behavior research is the multi-theory model (MTM) which addresses two crucial modules of health behavior: initiation and sustenance. In spite of reinforcing the habit of brushing twice daily, a lack of sustenance is found among young adults; hence, the objectives were to explore the substratal structure of MTM and to test the fit of MTM questionnaire in dental and medical students in India. **Methodology:** A questionnaire aimed at addressing sociodemographic information and MTM was designed. Reliability analysis was performed and explorative analysis was done using principal component analysis as the factor extraction method. Construct validity was investigated using exploratory factor analysis (EFA) to add a level of statistical. **Results:** Reliability analysis revealed a Cronbach's alpha value of 0.892 and split-half reliability value of 0.779. Test–retest reliability was found to be 0.77 ($P < 0.01$). Guttman split-half reliability was found to be 0.677. EFA suggested seven domains. Indices for model fit showed good fit with $P < 0.01$. **Conclusion:** The present study concludes that the Indian version of MTM is a reliable and valid instrument for measuring the initiation and sustenance of toothbrushing behavior in dental and medical students in India.

Keywords: Cross-cultural adaptation, health personnel, multi-theory model, psychometric analysis, toothbrushing, young adults

Introduction

Maintaining oral hygiene is an important aspect of general well-being of an individual. Dental caries and periodontal disease are the two most common dental problems faced by the masses, and evidence suggests that these diseases are caused by dental biofilm called dental plaque. Hence, a well-organized plaque control regimen with twice-daily brushing is essential if not imperative for control and maintenance of a disease-free state. Toothbrushing holds key importance in a practical, competent, and efficacious design to limit the formation of dental plaque on the dental tissues, in turn, leading to a decrease in dental diseases.[1]

A large body of literature under health behavior research has been carried out to test the various theoretical models and their effectiveness to initiate and sustain a positive health behavior among the population. The recent addition to this growing knowledge is the multi-theory model (MTM) of health behavioral change. It addresses the two crucial modules of health behavior, namely initiation and sustenance. It combines various features such as cognitive, conative, and environmental factors from currently functional theories and forms a collative theory of behavior change.[2]

According to MTM, initiation of behavior change is regulated by three constructs and begins with participatory dialog which

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is complementary to the pros and cons of the transtheoretical model and analogous to perceived benefits and perceived barriers in the health belief model. This construct focusses on both the advantages and the disadvantages of the behavior change. The next construct is "behavioral confidence" and is derived from Bandura's self-efficacy and Ajzen's perceived behavioral control.[3] The aim is to have a transformation in health behavior in prospect rather than in the present as compared to formerly adopted theories.[4] The final construct influencing initiation is "changes in the physical environment." It is drawn from Bandura's construct of environment, Prochaska's construct of environmental re-evaluation, and environmental factors in Fishbein's integrative model. This construct concentrates only on the "physical" aspect of the environment and not the social aspect.[5]

Apart from these, three distinct constructs govern the sustenance of behavior change for the long-lasting benefit. The first construct is named "emotional transformation" which is taken from emotional intelligence theory's self-motivation construct. It suggests leading one's emotions to a health behavior change, despite facing obstacles, barriers, and hardships.[6] Practice for change is the next construct and is acquired from the Freire's adult education model's praxis that highlights active reflection and reflective behavior. The final construct in the MTM is "change is social environment" and is taken from the construct of environment, helping relationships, social support. This construct concentrates on the support created by the environment socially.

It is accepted by empirical research that interventions at the public health level for health promotion based on theoretical models from social and behavioral sciences have a higher efficacy and efficiency than those without a theoretical basis.[4] Before designing, implementing, and evaluating any interventions, investigations should be carried out to test these theories/models. Therefore, this study aimed to assess the cross-cultural adaptation and psychometric properties of the novel MTM and test the fit of MTM questionnaire in the prediction of initiation and sustenance of toothbrushing behavior among students pursuing health sciences in an Indian setup.

Methodology

The study was an exploratory cross-sectional study designed to know the adaptability of MTM instrument in the city of Mangaluru in the southern state of Karnataka, India. Participants included undergraduate students ranging from year 1 to year 5 pursuing medicine and dentistry at an urban university in Mangaluru.

Instrumentation

The questionnaire includes 28 questions that evaluated the initiation and sustenance of twice-daily brushing in a population of young adults. The questions were modified from the original questionnaire designed to test the MTM to predict various health behavior changes by Sharma *et al*. and Nahar *et al*.[4,6] The instrument was designed in English rather than the regional native languages keeping in mind the feasibility and practicality of using the MTM for the very first time in a dental setting and an Indian cultural context.

Data collection procedure

Initial analysis for test–retest analysis

The questionnaires were handed out to thirty participants which were filled by the respondents themselves from the abovementioned institutions and were redistributed to the same thirty participants after 15 days. Participants who were willing to participate and filled out the written informed consent form were included in the initial analysis and were not involved in the main study. Those suffering from any medical conditions that restricted them to brush twice daily were also excluded from the study. The initial sample was followed by the main study sample of 224 participants for factor analysis. As there were 27 items in the study, a more manageable design of having at least eight variables per item was adhered. Hence, the sample size of 224 was deemed sufficient and adequate.

Validity

Item face validity

Face validity focusses on opinions of experts on relevance, appropriateness, extensiveness, and understandability modifications which were made in the instrument according to the advice of the experts. Ten questions were included in the instrument from the "Ten-Item Personality Inventory" and "Sleeping Habits Survey" to decipher the divergent validity of the present scale. Evaluation of validity and reliability was assessed as per the norms described by Rajesh *et al*., 2016.[7]

Factor analysis

Elemental theories and factors in regard to the instrument and items were assessed by factor analysis. The factor analysis with using varimax rotation with Kaiser normalization of the instrument was carried out on a sample of 224 participants. Factor extraction was determined by eigenvalues above 1 in the factor analysis.[8]

Model fit was assessed using the null and implied model (Bartlett's test and goodness-of-fit Chi-square values) to calculate fit indexes such as (i.e., Tucker–Lewis index, comparative fit index (CFI), and the root mean square error of approximation (RMSEA).

Ethical statement

An ethics committee clearance was obtained before the study process from Institutional Ethics Committee (Protocol ref. no. 17133). Informed consent: Informed consent was obtained from all individual participants as written consent before the distribution of questionnaire.

Results

The participants were from the dental and medical fraternity detailed description of the participants, as given in Table 1. Reliability and internal consistency: The reliability of factors

Table 1: Gender-wise demographic distribution of participants with twice-daily brushing frequency showing academic affiliation

	Gender		Total (*n*)
	Female	Male	
Course			
Medical	42	26	68
Dental	114	47	161
Academic year			
1	43	22	65
2	27	16	43
3	41	18	59
4	29	10	39
5	16	7	23
Twice-daily brushing frequency			
0	40	29	69
1	18	9	27
2	12	1	13
3	10	4	14
4	9	4	13
5	11	2	13
6	7	3	10
7	49	20	69

extracted from a formatted multi-point questionnaire is assessed by Cronbach's alpha, its value varying between 0 and 1.[9] Reliability analysis reported Cronbach's alpha value of 0.892. Split-half reliability and Guttman split-half reliability were documented as 0.779 and 0.677, respectively. Test–retest reliability suggests any variations if present in the questionnaire by evaluating the answered questionnaires of the same participants in similar circumstances after a period of 15 days[7] and was 0.779 ($P < 0.01$). Inter-item correlations values ranged from −0.712 to 0.950.

Item-total statistics revealed that questions 5, 9, and 22 have corrected item-total correlation below 0.3, and by eliminating these questions, the overall Cronbach's alpha value aggregated to 0.899 as compared to the original Cronbach's alpha value of 0.892, as shown in Table 2.

Content validity

It was evaluated by measuring inter-item correlations. The values range from −0.712 to 0.950, with a mean of 0.191 and a variance of 0.138.

Factor analysis

The factor analysis demonstrated seven domains, with initial eigenvalues ranging from 9.276 to 1.040 which manifested a cumulative variance of 73.65%. The seven factors accounted for the following variances: (i) 34.354%, (ii) 11.25%, (iii) 6.929%, (iv) 6.655%, (v) 6.362%, (vi) 4.346%, and (vii) 3.853%, as shown in Table 3.

The discriminant validity of the scale was measured by checking the correlations of the domains among each other. The domains in the present study were participatory dialogs, behavioral confidence, change in physical environment, emotional transformation, practice for change, and change in social environment. All domains showed good correlations with each other showing high statistical significance ($P < 0.001$), as shown in Table 4. The criterion validity of the scale was evaluated using concurrent validity, which measures how well a new scale compares to a well-established test. As per the suggestions of the experts, the Ten-Item Personality Inventory was added to the questionnaire and a positive correlation between the new MTM instrument and the existing Ten-Item Personality Inventory was reported. The correlation revealed an $r = 0.275$ at $P < 0.001$ which demonstrated statistical significance.

The model fit was assessed that the Chi-square value of the model was 629.02 with Chi-square divided by degree of freedom value of 2.076 ($P \leq 0.001$) which showed absolute fit for the model with GFI = 0.834, AGFI = 0.793, and CFI 0.929 with RMSEA = 0.069 with P value ($P < 0.001$).

Discussion

The study aimed to assess the cross-cultural adaptation and psychometric properties of MTM and test the fit of MTM questionnaire in the prediction of initiation and sustenance of toothbrushing behavior among students pursuing health sciences in a subcontinental setup. This is the first study where the MTM instrument has been evaluated for reliability and validity in a dental setting in a population.

The values of Cronbach's alpha range from 0.878 to 0.904 for the instrument. Sharma *et al*., in their study to predict the initiation and sustenance of water consumption instead of sugary beverages using MTM, reported Cronbach's alpha values of over 0.70.[10] When using the MTM in predicting the initiation and sustenance of physical activity behavior among college students using MTM, Nahar *et al*. revealed the Cronbach's alpha values to be above 0.60.[6] Hayes *et al*. recorded Cronbach's alpha between 0.57 and 0.93 in their analysis of predicting physical activity in African American females using MTM.[11] For small portion size consumption using the MTM, noted Cronbach's alpha between 0.63 and 0.90.[3] The results of the present study are consistently higher than the abovementioned studies and prove that the instrument is reliable when used in a cross-cultural context in India among university students.

The test–retest reliability analysis for the instrument when evaluated was excellent between the two time periods. This is the first study where the test–retest reliability for the MTM has been carried out. The test–retest reliability measures the stability of the instrument, that is, it assesses the measure of consistency when administered on differing time periods.[12] The instrument is rendered reliable if the test–retest reliability values are above 0.70. The test–retest reliability analysis for this instrument revealed values of 0.779, which demonstrated that the constructs evaluated in this study were reliable over time.

Table 2: Item-total correlations - Cronbach's alpha if item deleted for multi-theory model questionnaire with ANOVA with Cochran's test

Serial number	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted
1	77.67	233.747	0.345	0.891
2	77.87	227.844	0.458	0.889
3	77.37	224.447	0.523	0.887
4	77.47	228.120	0.388	0.890
5	77.30	233.528	0.219	0.892
6	80.20	249.752	−0.434	0.902
7	80.03	250.033	−0.387	0.904
8	79.97	251.413	−0.460	0.904
9	79.30	242.700	−0.156	0.899
10	80.03	245.137	−0.253	0.900
11	78.53	212.602	0.607	0.884
12	78.53	211.913	0.735	0.881
13	78.43	213.495	0.661	0.883
14	78.37	204.240	0.823	0.878
15	78.33	209.471	0.738	0.881
16	77.13	221.361	0.589	0.886
17	77.17	220.626	0.573	0.886
18	77.13	222.051	0.521	0.887
19	78.10	206.024	0.841	0.878
20	77.90	208.990	0.770	0.880
21	77.93	207.857	0.802	0.879
22	79.77	230.875	0.279	0.891
23	78.73	211.306	0.700	0.882
24	78.57	214.944	0.621	0.884
25	78.87	206.740	0.711	0.881
26	79.03	210.654	0.623	0.884
27	78.40	211.007	0.636	0.883

	Sum of squares	df	Mean square	Cochran's Q	*P*
Between people	256.795	29	8.855		
Within people					
Between items	711.025	26	27.347	387.030	<0.001
Residual	721.938	754	0.957		
Total	1432.963	780	1.837		
Total	1689.758	809	2.089		

Table 3: Exploratory factor analysis for items of multi-theory model (Extraction method: Principal component analysis)

Component	Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	Percentage of variance	Cumulative percentage	Total	Percentage of variance	Cumulative percentage
1	9.276	34.354	34.354	5.551	20.558	20.558
2	3.038	11.250	45.605	3.152	11.675	32.233
3	1.871	6.929	52.534	2.672	9.897	42.129
4	1.797	6.655	59.190	2.573	9.530	51.660
5	1.718	6.362	65.552	2.334	8.644	60.304
6	1.146	4.246	69.797	2.050	7.593	67.897
7	1.040	3.853	73.650	1.553	5.753	73.650

Furthermore, the internal consistency reliability of the instrument was evaluated using the split-half reliability, inter-item correlation, and item-total correlation. These measures of reliability have not been tested in any of the studies assessing the MTM questionnaire. The split-half reliability of this instrument was 0.779, which proves that the instrument has good internal consistency. The inter-item correlation values of this instrument range from −0.712 to 0.950 which are considered adequate. The negative values in the findings are due to the second construct of the MTM, i.e., disadvantages of

Table 4: Inter-domain correlations for discriminant validity of multi-theory model scale

	Correlations						
	PD-advantages	PD-disadvantages	B confidence	CP environment	E transformation	P change	CS environment
PD-advantages							
r	1	−0.327**	0.342**	0.274**	0.373**	0.290**	0.206**
P		0.000	0.000	0.000	0.000	0.000	0.002
PD-disadvantages							
r	−0.327**	1	−0.263**	−0.391**	−0.353**	−0.232**	−0.115
P	0.000		0.000	0.000	0.000	0.000	0.086
B confidence							
r	0.342**	−0.263**	1	0.385**	0.769**	0.534**	0.419**
P	0.000	0.000		0.000	0.000	0.000	0.000
CP environment							
r	0.274**	−0.391**	0.385**	1	0.425**	0.200**	0.249**
P	0.000	0.000	0.000		0.000	0.003	0.000
E transformation							
r	0.373**	−0.353**	0.769**	0.425**	1	0.654**	0.488**
P	0.000	0.000	0.000	0.000		0.000	0.000
P change							
r	0.290**	−0.232**	0.534**	0.200**	0.654**	1	0.447**
P	0.000	0.000	0.000	0.003	0.000		0.000
CS environment							
r	0.206**	−0.115	0.419**	0.249**	0.488**	0.447**	1
P	0.002	0.086	0.000	0.000	0.000	0.000	

**Correlation is significant at the 0.01 level (two-tailed). PD-advantages: Participatory dialogs-advantages, PD-disadvantages: Participatory dialogs-disadvantages, B confidence: Behavioral confidence, CP environment: Change in physical environment, E transformation: Emotional transformation, P change: Practice for change, CS environment: Change in social environment

participatory dialog, which is contrary to the other constructs. Hence, the negative values are expected and significant to the results of the study.

The item-total correlation of the instrument reported that all items in the questionnaire had corrected item-total correlations values in the range of 0.4–0.8 except questions 5, 9, and 22. These items showed values below 0.3, which was taken as a minimally acceptable value. After eliminating these items from the instrument, the overall Cronbach's alpha was 0.899 compared to the original value of 0.892. Since the difference was not very remarkable, none of the items were eliminated from the questionnaire.

The principal component matrix with varimax rotation with Kaiser Normalization revealed seven domains. Theory suggests six constructs of which the first construct of participatory dialog had two parts, i.e., advantages and disadvantages, making a total of seven constructs which is analogous to our analysis. While testing the MTM to predict the initiation and sustenance of physical activity behavior among college students, Nahar *et al*. carried out confirmatory factor analysis, revealing seven subsets as suggested in theory.[5] Sharma *et al*. performed confirmatory factor analysis in their study using MTM while predicting the initiation and sustenance of small portion size consumption among college students and reported seven domains, which are similar to the findings of the present study.

The goodness of fit for the model showed a good fit for the model with seven domains where the analysis showed that the construct fitted the theoretical basis MTM as described by Sharma *et al*. and Nahar *et al*. as described previously by the authors.

Conclusion

This present study offers a potent and dynamic blueprint to devise and construct interventions for promoting toothbrushing behavior and assess them for efficacy and effectiveness in young adults. The MTM-based instrument was found to be a valid and reliable tool in predicting the initiation and sustenance of brushing behavior among Indian college students.

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Conflicts of interest

There are no conflicts of interest.

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