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A Health Belief Model-Based Instrument for Assessing Factors Affecting Oral Health Behavior During Pregnancy

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Abstract

Background: Maintaining optimal oral health behavior (OHB) during pregnancy could preserve short-term and long-term health of women and their children.

Objectives: By applying the health belief model (HBM), this study aimed at developing and analyzing the psychometric properties of an instrument evaluating pregnant women's beliefs regarding OHB.

Methods: In this instrument development study that carried out in Tehran (2015 - 2016), a preliminary 134-item questionnaire was developed, and content and face validity were assessed. The construct, convergent, discriminant, and criterion-oriented validity of the questionnaire were evaluated through a pilot study on 221 pregnant women, attending public health centers, by performing confirmatory factor analysis (CFA) and Linear Regression analysis. Cronbach's alpha coefficient, composite reliability (CR) and intra-class correlation coefficient (ICC) were calculated to examine reliability.

Results: The mean age of participants was 27.5 $\pm$ 5.6 years with mean gestational age of 21.5 $\pm$ 8.5 weeks. Based on CFA, the data fitted the HBM model. Root Mean Square Error of Approximation (RMSEA) was 0.052, Non-Normed Fit Index (NNFI) was 0.95, and Comparative Fit Index (CFI) was 0.96. The final HBM-based questionnaire with 79 items was associated with individual OHB (P = 0.001 and B = 0.4). The overall Cronbach's alpha was 0.94 and ICC ranged between 0.84 and 0.99.

Conclusions: This valid and reliable HBM-based questionnaire may identify the potential barriers of optimal OHB among pregnant women.

Keywords: Pregnant Women, Oral Health, Questionnaire, Psychometric, Factor Analysis

1. Background

Pregnant women are susceptible to oral health problems, and their beliefs may hinder receiving dental care and maintaining good oral hygiene (1-3). Poor oral health in pregnant women has shown associations with the risk of adverse pregnancy outcomes (4, 5), and increases the chance of dental caries in their children (6).

Pregnant women's regular tooth brushing and dental attendances are reported to be undesirable worldwide (7-9). In Iran, less than half of women visit dentists during their pregnancy (10, 11). Unawareness about the pivotal role of good OHB during pregnancy leads to ignorance of oral health (12). One of the best-known models that can predict health-related behaviors is the health belief model (HBM) (13).

According to HBM, understanding health beliefs is a prerequisite for improving health behaviors (14). Available studies, however, have used selected questions of previously validated general oral health questionnaires for assessing beliefs of pregnant women without taking advantage of a particular instrument or behavior change model (9, 12, 15, 16). The only standard questionnaire that has already been developed to assess pregnant women's beliefs regarding OHB, have shortcomings such as lack of assessing convergent, discriminant, and criterion-oriented validity (17). Since the women play a critical role in establishing proper health behaviors in their families, understanding their own OHB and its determinants is of great value. Therefore, applying HBM, this study aimed at developing and analyzing the psychometric properties of a specific instrument that measures factors affecting pregnant women's OHB.

2. Methods

This instrument development study was carried out in Tehran, Iran (January 2015 to August 2016) with mixed method design in two phases of qualitative and quantitative assessment:

2.1. Qualitative Phase

The instrument's items were extracted from qualitative data of 22 pregnant women, 12 dentists, and 8 midwives involved in prenatal care at public health centers (unpublished data). Accordingly, the first version of the questionnaire was developed with 134 questions around the 6 constructs of the HBM (see Table 1).

Table 1. Major Themes and Subthemes of Factors Influencing Oral Health Behavior Among Pregnant women, Extracted from Secondary Analysis of Qualitative Data and Literature Review

Major Themes	Subthemes
Perceived sensitivity	Dental caries
	Periodontal diseases
	Dental visit need
Perceived severity	Maternal health complications
	Infantile health complications
Perceived barriers	Lack of knowledge and misbeliefs
	Cost of dental care
	Physiological changes
	Fear and other psychological conditions
	Time constraint
	Dentists' unwillingness to treat pregnant women
	cultural taboos
	lack of intersectoral collaboration
Perceived benefits	Physical
	Mental
	Social
	Economical
Self-efficacy	Oral hygiene practices
	Nutrition and diet
	Regular dental service utilization
Cues to action	External
	Internal

2.2. Content and Face Validity

First, the expert panel of 10 community oral health specialists, 1 reproductive health specialist and 1 epidemiologist evaluated the questionnaire for wording, grammatical points, and allocation of items in constructs. The mean age of this expert panel was 40.3 years old with at least 5 years of academic experiences, and 58% were female. Content validity ratio (CVR) values below 0.56 were removed. The threshold of the Content validity index (CVI) for keeping the items was 0.7 or more (18).

For qualitative face validity, 10 pregnant women assessed the clarity of each item and the impact score was calculated (minimum 1.5) in the quantitative approach (19).

2.3. Quantitative Phase

2.3.1. The Cross Sectional Study and Data Collection

With a multi-stage cluster sampling, the instrument was distributed to pregnant women attending public health centers (all governmental) in Tehran from January to March, 2016. Firstly, Tehran city was divided to 4 geographical regions and from each, 3 health centers were selected by simple random sampling. The sampling frame was the list of public health centers located in the aforementioned regions that were under supervision of 3 main universities of Shahid Beheshti, Tehran, and Iran University of Medical Sciences. The minimum sample size of 204 pregnant women was calculated by the following equation:

$$n = \frac{Z\left(1 - \frac{\alpha}{2}\right)^2 pq}{d^2} \quad (1)$$

"n" was the sample size, "p" prevalence of desirable oral health beliefs in pregnant women in the pilot study (0.15), "q" = (1 - p), "α" = (0.05), and "d" was the standard error (0.05). To achieve a statistical power of 80% and considering 25% attrition, it was planned to recruit a sample of 252 pregnant women. Inclusion criteria were age of 18 or more, gestational age of least 8 weeks. Four pregnant women were excluded for having a history of systemic diseases.

The version of the questionnaire used in this part of the study, contained 89 items measuring 6 constructs of HBM as follows:

Perceived sensitivity or "Sn1-14" (14 items), perceived severity or "Sv1-8" (8 items), perceived barriers or "Br1-34" (34 items), perceived benefits or "Bn1-8" (8 items), self-efficacy or "Sf1-8" (8 items), and cues to action or "Cu1-17" (17 items).

Except dichotomous scoring of perceived benefit, all other items were scored on a Likert scale of 1 to 5, from strongly disagree to strongly agree. Reverse scoring was applied for negative items and for perceived barrier construct. For perceived benefit, dichotomous values were recoded as 1 and 5, in order to have similar weights with other constructs. Finally, sum of the variables of the HBM was calculated. In addition, demographics including age, education, income, gestational age by weeks, parity, height, and weight were also recorded. The OHB of the participants was explored by questions about frequency of tooth brushing, flossing, using toothpaste, eating sugary junk foods, smoking, visiting the dentist before and during pregnancy,

and the visit reasons. Possible answers to the questions were scored from 0 to 3, and were summed to develop individual OHB scores.

2.4. Construct Validity

To assess construct validity, confirmatory factor analysis (CFA), convergent, and discriminate validity were performed (20). Fit indices including ratio of Chi-square to degrees of freedom (X^2/DF), root mean square error of approximation (RMSEA), comparative fit index (CFI), and non-normed fit index (NNFI) were used. The values of at least 0.90 for CFI and NNFI, and below 0.05 for RMSEA indicated good fit (< 0.08 acceptable) (20, 21).

2.5. Convergent, divergent and Criterion-oriented validity

Methods to assess convergent validity were: Standardized estimates equal to or higher than 0.5, average variance extracted (AVE) of 0.5 or higher, and CR of 0.7 or higher (20).

The AVE for 2 constructs should exceed their maximum shared variance (MSV) and average shared variance (ASV) for having discriminant validity (22). Criterion-oriented validity was explored by examining the association between total HBM and individual OHB score controlling for demographics.

2.6. Reliability

Cronbach's alpha coefficient and composite reliability (CR) were calculated for testing internal consistency of the questionnaire with threshold of 0.7 (20). Cronbach's alpha calculation prior to CFA revealed omission of some items to increase the scale reliability. After performing CFA, internal consistency was re-evaluated (20). Intra-class correlation coefficient (ICC) with acceptable value of at least 0.5 was calculated in a sub-sample of pregnant women (n = 30), who completed the questionnaire twice with an interval of 2 weeks.

2.7. Statistical Analysis

The CFA, convergent, and discriminant validity were performed by means of Amos SPSS version-24 (IBM Corporation, Chicago, USA) software, and Mahalanobis distance command in Amos served to detect multiple outliers. The assumption test included tests of Normality, skewness, kurtosis and Histogram, and Normal Q- Q Plot indicated normal distribution of the data. The IBM SPSS statistics version-24 was used to perform descriptive, chi-square, independent t test, linear regression analyses, and Cronbach's Alpha. P values of < 0.05 were considered significant.

2.8. Ethics

This study was approved by the research ethics committee of Tehran University of Medical Sciences (code of IR.TUMS.REC.1394.855) during September 2015. All participants provided an informed written consent with the right to withdraw at any time. In the first part of the questionnaire, there was a paragraph introducing the study aim and assuring confidentiality of data by anonymous questionnaires.

3. Results

3.1. Extracted Items from Qualitative Phase, Content, and Face Validity

From 606 codes obtained from qualitative data, 311, which were most relevant, were selected for an item pool. Similar codes were merged for the 134-item questionnaire. Following the content validity, 45 items were removed, while in face validity assessment, only minor changes were applied to the 3 items. Eventually, the pre-final questionnaire consisting of 89 items was formed for assessing construct validity.

3.2. Collected Data for Construct Validity

Among all, the data of 221 women were analyzed, and 31 were excluded because of incomplete questionnaires, missing or outliers in data. The demographic variables of excluded cases, showed no difference in the remaining sample (P > 0.05). The age of the participants was on average 27.5 $\pm$ 5.6 years. About half of the women had diploma or academic education (52%). Most of them (80%) reported their income as poor or medium. The mean gestational age of pregnant women was 21.5 $\pm$ 8.5 weeks. The mean height and weight of participants before pregnancy were 161.1 $\pm$ 5.8 centimeters and 62.4 $\pm$ 10.9 kilograms. Among all, 55% had normal BMI and 41% experienced their first pregnancy (See Table 2).

3.3. Primary Internal Consistency

Cronbach's Alpha (> 0.7) indicated acceptable internal consistency of multiple items for each construct. However, it was predicted that omission of 7 items would increase Cronbach's Alpha: 2 items in perceived sensitivity (Sn6, Sn8), 1 in perceived severity (Sv5), 2 in perceived barriers (Br8, Br14), and 2 items in self-efficacy construct (Sf2, Sf8). These items were deleted and the remaining 82-item questionnaire was then analyzed by CFA to determine a model with appropriate fitness.

Table 2. Socio-Demographic Characteristics of the Study Participants (N = 221)

Variables	%
Age group	
< 30	62
≥ 30	38
Education	
Under diploma	48
diploma	38
Academic education	14
Income	
poor	28
medium	52
good	20
Parity	
First	41
Else	59
BMI	
Under weight	6
Normal weight	55
Over weight	30
Obesity	9

3.4. Construct Validity

At first, the measurement model did not fit the data. Overall, 3 items (2 items in perceived sensitivity (Sn9, Sn10) and 1 item in perceived barriers construct (Br29) showed loading factors of < 0.5. Therefore, they were omitted to form the final 79-item questionnaire. Moreover, some correlations between the variables' errors of the same factor were added to the model based on the modification indices. After the modifications, the model fitted the data (Figure 1).

X^2/DF was 1.6 (P > 0.05), CFI was 0.96, NNFI was 0.95, and Root Mean Square Error of Approximation was 0.052 (90% CI 0.049 to 0.055) (Table 3). Also Table 4 represents the estimate coefficients.

All the estimate coefficients were significant (P < 0.001) and were more than 0.50 (Table 4). Moreover, the AVE of all constructs exceeded 0.5, and CRs of each construct was also larger than 0.7, suggesting convergent validity (See Table 5). The AVEs of all constructs were greater than their MSV and ASV, suggesting discriminant validity (Table 5).

Total HBM-based questionnaire score was significantly associated with individual OHB (standardized coefficient Beta was 0.4 and P = 0.001), controlling for age, education, income, gestational age, and parity by linear regression analysis, suggesting criterion-oriented validity.

3.5. Final Internal Consistency and Instrument's Stability

Cronbach's alphas computed after CFA ranged between 0.92 and 0.98 for each construct and 0.94 for total HBM. The CR of constructs ranged from 0.92 to 0.97. The ICCs of the questionnaire items ranged between 0.84 and 0.99, and ICC of the constructs between 0.93 and 0.99, indicating that the questionnaire had a good internal consistency and stability (Table 5).

The final 79-item questionnaire consisted of the following constructs with their possible score ranges:

1. Perceived sensitivity (10 items, 10 to 50), 2. Perceived severity (7 items, 7 to 35), 3. Perceived barriers (31 items, 31 to 155), 4. Perceived benefits (8 items, 8 to 40), 5. Cues to action (17 items, 17 to 85), and 6. Self-efficacy (6 items, 6 to 30).

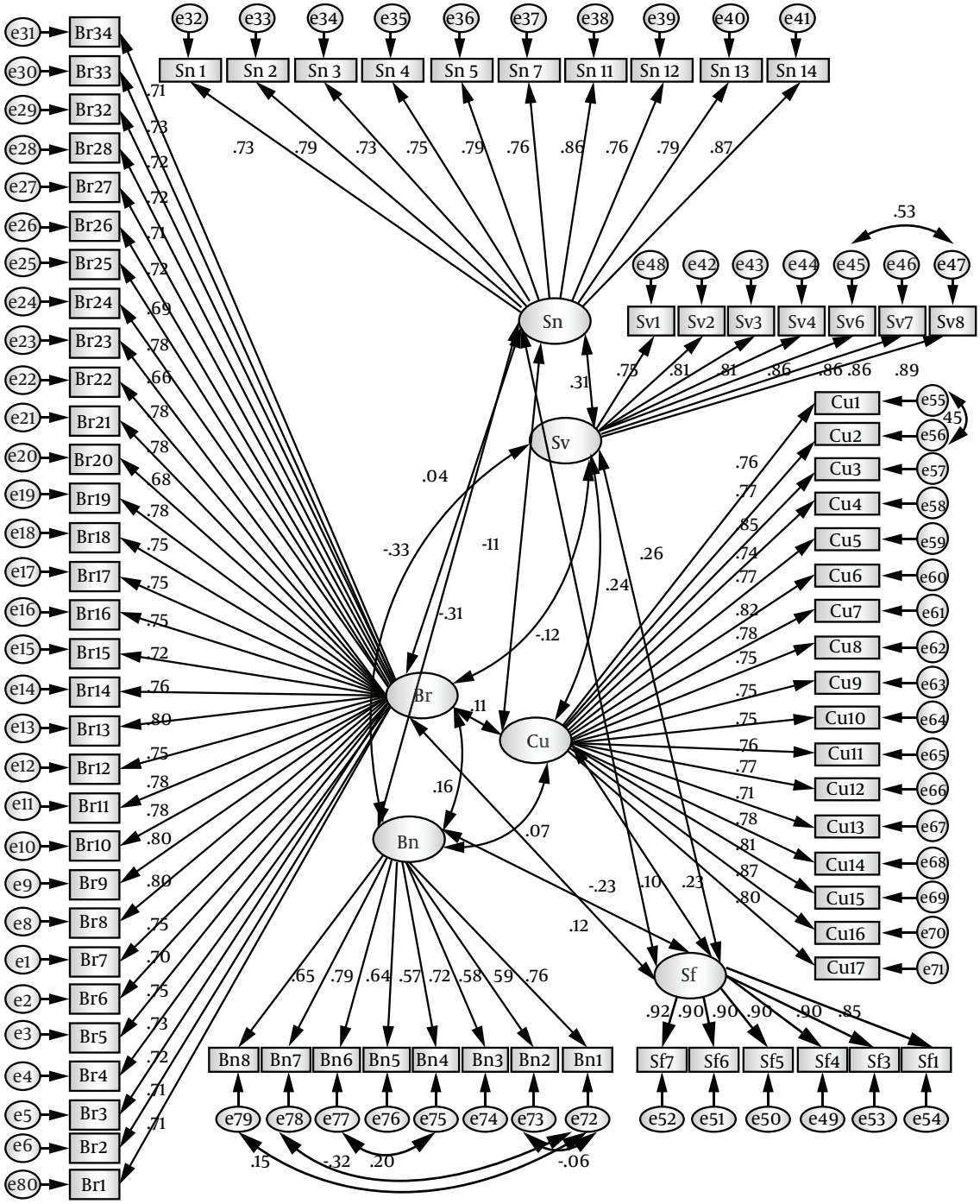
The Total HBM score of the questionnaire could range from 79 to 395. Scores of 79 to 111 were considered as floor and 363 to 395 as ceiling of answers. No ceiling and floor effects existed, as less than 10% of patients scored less than 111 or more than 363 (23).

4. Discussion

This study developed a standard HBM-based instrument for assessing factors associated with OHB during pregnancy, as HBM is one of the effective models to predict oral health (14). Several studies have shown the relationship between HBM dimensions and general or oral health behavior (24-26). Health belief model-based health education programs can promote oral health performance in pregnant women (27); therefore developing a standard means to assess their current beliefs is crucial. In agreement with Solhi et al., the OHB of participants were affected by their individual perceptions (24) and the ability of HBM factors in our questionnaire to predict participants' OHB was good.

To the best of the authors' knowledge, this is the first study worldwide that has provided a standardized scale to assess HBM-based factors influencing OHB during pregnancy attempting to correlate the questionnaire score with OHB by performing criterion-oriented validity. This aspect was less noticed in similar studies even in other health scopes. Previously, another questionnaire, measuring oral health beliefs of Iranian pregnant women, was psychometrically evaluated that lacked a comprehensive approach in the qualitative phase and therefore according to our appraisal, the content and face validity were compromising. Moreover, its construct validity was performed

Figure 1. The Final Pattern of 79-Item Questionnaire Following Confirmatory Factor Analysis of 221 Pregnant Women Data Fitted the Health Belief Model and Its Constructs. Standardized Coefficients Were Illustrated on the Arrows



Error variances (e1 - e79) were ranged between 0.006 and 1.335. Sn, Sensitivity; Sv, Severity; Br, Barriers; Bn, Benefits; Sf, Self-Efficacy; Cu, Cues to Action.

Table 3. Model Fit Indices in Confirmatory Factor Analysis of Total HBM Model and its Constructs Before and After Applying Modifications in a Pilot Study on Iranian Pregnant Women (N = 221)

Construct	Modification	X^2/DF	CFI	NNFI	RMSEA	90% CI for RMSEA	P Value
Perceived sensitivity	Before	1.99	0.87	0.82	0.067	0.043 - 0.091	0.113
	After	1.95	0.98	0.97	0.066	0.041 - 0.090	0.138
Perceived severity	Before	2.27	0.90	0.84	0.076	0.039 - 0.113	0.109
	After	2.39	0.98	0.97	0.08	0.044 - 0.116	0.08
Perceived barriers	Before	2.06	0.67	0.64	0.07	0.063 - 0.076	< 0.05
	After	2.41	0.90	0.90	0.08	0.074 - 0.86	< 0.05
Perceived benefits	Before	1.71	0.95	0.93	0.057	0.020 - 0.088	0.334
	After	2.96	0.92	0.90	0.094	0.067 - 0.123	< 0.05
Cues to action	Before	2.17	0.87	0.84	0.073	0.061 - 0.085	0.002
	After	2.58	0.94	0.93	0.085	0.073 - 0.097	< 0.05
Self - efficacy	Before	2.95	0.95	0.89	0.094	0.049 - 0.143	< 0.05
	After	0.92	1	1	0.00	0 - 0.079	0.782
Total HBM Model	Before	1.96	0.56	0.54	0.056	0.054 - 0.059	< 0.05
	After	1.6	0.96	0.95	0.052	0.049 - 0.055	< 0.05

Abbreviations: CFI, Comparative Fit Index; NNFI, Non-Normed Fit Index; RMSEA, Root Mean Square Error of Approximation; X^2/DF, Relative Chi-square.

by EFA instead of CFA, and convergent, discriminant, and criterion-oriented validities were not performed (17).

5.1. Strengths and Limitations

Data collection using triangulation approach, criterion-oriented, convergent, and discriminant validity assessments were among strengths of this study. However, certain limitations warrant further investigation considering factors other than beliefs, which might contribute to preventing oral health among pregnant women. In addition, mostly low-income pregnant women were considered in this study, as participants were selected form public centers, thus the study is limited in generalizability to all pregnant women. The illiteracy of some of the participants, difficulty in collecting data from usually impatient pregnant women, and low co-operation of some health centers were the study limitations. The sensitivity and specificity of the questionnaire should be evaluated in future diagnostic researches on pregnant women's oral health.

5.2. Conclusion

The present HBM-based valid and reliable questionnaire can be used in future investigations to identify barriers of optimal OHB for pregnant women, and to plan interventions that improve oral health of these vulnerable individuals.

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Table 4. Estimated Coefficients of the Final Confirmatory Factor Analysis Model on Data From a Pilot Study on Iranian Pregnant Women (N = 221)[a]

Constructs	Items	Unstandardized Estimate	Standard Error	Standardized Estimate
Perceived sensitivity	Sn1	1		0.735
	Sn2	0.901	0.076	0.791
	Sn3	0.866	0.079	0.734
	Sn4	0.907	0.081	0.747
	Sn5	1.112	0.094	0.786
	Sn7	0.882	0.078	0.756
	Sn11	0.997	0.076	0.865
	Sn12	1.12	0.098	0.758
	Sn13	1.057	0.089	0.789
	Sn14	1.024	0.078	0.869
Perceived severity	Sv1	1		0.750
	Sv2	1.108	0.088	0.814
	Sv3	1.194	0.095	0.811
	Sv4	1.159	0.084	0.881
	Sv6	1.12	0.084	0.861
	Sv7	1.103	0.083	0.856
	Sv8	1.242	0.089	0.891
Perceived barriers	Br1	1		0.715
	Br2	1.014	0.096	0.714
	Br3	1.017	0.096	0.719
	Br4	1.134	0.105	0.726
	Br5	1.19	0.107	0.754
	Br6	1.092	0.105	0.703
	Br7	1.058	0.095	0.751
	Br9	1.084	0.091	0.804
	Br10	1.102	0.093	0.795
	Br11	0.987	0.085	0.782
	Br12	1.118	0.097	0.776
	Br13	1.104	0.099	0.751
	Br15	1.076	0.090	0.803
	Br16	1.052	0.093	0.765
	Br17	1.012	0.095	0.717
	Br18	1	0.089	0.754
	Br19	1.054	0.095	0.745
	Br20	1.221	0.110	0.748
	Br21	1.143	0.099	0.777
	Br22	1.004	0.100	0.681
	Br23	1.042	0.090	0.777
	Br24	0.975	0.085	0.777
	Br25	0.941	0.074	0.860
	Br26	0.895	0.077	0.783
	Br27	0.97	0.095	0.692
	Br28	1.066	0.101	0.715
	Br30	0.959	0.091	0.709
	Br31	1.019	0.096	0.719
	Br32	1.064	0.100	0.722

Table 5. Convergent and Discriminant Validity and Reliability Indices of the Health Belief Model Constructs in a Pilot Study on Iranian Pregnant Women (N = 221)

HBM Constructs	CR	AVE	MSV	ASV	Cronbach's Alpha Coefficient	ICC
Perceived sensitivity	0.941	0.615	0.107	0.046	0.94	0.97
Perceived severity	0.943	0.704	0.099	0.068	0.94	0.97
Perceived barriers	0.975	0.560	0.021	0.013	0.98	0.96
Perceived benefits	0.922	0.603	0.107	0.052	0.92	0.99
Self-efficacy	0.960	0.799	0.070	0.035	0.96	0.93
Cues to action	0.964	0.610	0.055	0.026	0.96	0.98

Abbreviations: ASV, Average Shared Variance; AVE, Average Variance Extracted; CR, Composite Reliability; ICC, Intra Class Correlation Coefficient; MSV, Maximum Shared Variance.