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Development and validation of a health belief model scale for oral health behaviors among adolescents

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ABSTRACT

Objective: This study aims to develop and validate an Oral Health Beliefs Questionnaire/Scale (OHBQ) based on the Health Belief Model (HBM), focusing on key oral health behaviors such as tooth brushing, dental flossing, and sugar consumption, for measuring adolescents' beliefs related to these behaviors.
Methods: A mixed-method design was employed to validate the OHBQ. Content validity was established by an expert panel who evaluated each item for relevance and clarity. Confirmatory Factor Analysis (CFA) was conducted with a sample of 1124 adolescents to validate the questionnaire structure and model fit. Reliability was assessed using Cronbach's alpha to determine internal consistency. To assess predictive validity, the relationships between each domain of the questionnaire and the three oral health behaviors were analyzed using the logistic regression models.
Results: The final 53-item HBM-based OHBQ confirmed a six-factor structure: perceived severity, perceived susceptibility, perceived benefits, perceived barriers, cues to action, and self-efficacy. The CFA on the three behaviors showed excellent model fit. For tooth brushing, the CMIN/DF = 5.67, CFI = 0.91, GFI = 0.90, RMSEA = 0.064, and SRMR = 0.056; For dental flossing, the CMIN/DF= 6.04, CFI = 0.92, GFI = 0.90, RMSEA = 0.067, and SRMR = 0.046; For sugar consumption, the CMIN/DF = 5.30, CFI = 0.92, GFI = 0.90, RMSEA = 0.062, and SRMR = 0.050. All subscales demonstrated high internal consistency, with Cronbach's alpha coefficients ranging from 0.74 to 0.93. Significant associations ($p<0.05$) were found between specific HBM constructs (perceived susceptibility, perceived barriers, cue to action, self-efficacy) and the respective oral health behaviors, supporting the OHBQ's predictive validity.
Conclusions: The developed HBM-based Oral Health Beliefs Questionnaire/Scale (OHBQ) is a reliable and valid instrument for measuring health beliefs related to oral health behaviors among adolescents.
Clinical Significance: The validated OHBQ can serve as an effective tool to assess beliefs related to oral health behaviors. The robust psychometric properties and high construct validity make it a valuable instrument for researchers and practitioners in planning oral health promotion.

1. Background

Oral health is an essential component of well-being, influencing physical health as well as social and psychological functioning [1,2]. Globally, poor oral health among adolescents (aged 10 to 19, defined by WHO), with high prevalence of dental caries (15% to 84%) and periodontal diseases (around 19% exhibiting bleeding on probing), is a significant public health issue [3,4]. This may due to their unhealthy oral health-related behaviors such as high consumption of sugary foods and beverages, and improper oral hygiene practices [5]. Good oral health habits established during adolescence are essential for maintaining good oral health into adulthood [6].

In Hong Kong, the dental and periodontal status of adolescents is generally unsatisfactory. A cohort study on Hong Kong school students found that the prevalence of dental caries and periodontal problems increased with age, suggesting a deterioration in oral health from

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childhood to early adulthood [7]. Moreover, a study revealed that only 22% of the adolescents in Hong Kong used dental floss weekly, and 38% had annual dental visits [8]. The unsatisfactory oral health behavior may be attributed to insufficient access to dental care services for secondary school students, which limits opportunities for regular dental check-ups and professional guidance on oral hygiene. Additionally, adolescents often show low compliance with recommended oral hygiene practices due to a lack of motivation and difficulty adhering to oral care routines [9]. To address these challenges, a deeper understanding of the factors influencing oral health behaviors during this critical developmental stage is essential.

The Health Belief Model (HBM) is a psychological framework developed to explain and predict health-related behaviors by focusing on individuals' beliefs and attitudes. According to the HBM, a person's engagement in health-promoting actions depends on their perceptions in several key areas: 1) perceived susceptibility: belief about the risk of acquiring a health condition; 2) perceived severity: belief about the seriousness of the health condition and its potential consequences; 3) perceived benefits: belief in the effectiveness of the advised action to reduce risk or severity; 4) perceived barriers: belief about the obstacles or costs associated with taking the action; 5) cues to action: external or internal triggers that prompt engagement in health behaviors (e.g., advice, symptoms); 6) self-efficacy: confidence in one's ability to perform the health behavior successfully. These beliefs and perceptions interact with each other to shape health actions [10,11]. Perceived susceptibility and severity may influence the individual's assessment of their health risk; perceived benefits and perceived barriers may affect the decision-making process regarding engaging in a health behavior; cues to action serve as triggers that motivate action; and self-efficacy directly impacts confidence in performing the behavior. The combined influence of these perceptions determines the likelihood of engaging in the health behavior.

The HBM model has been previously applied to measure perceptions and beliefs related to oral health behaviors such as tooth brushing and dental flossing [12,13]. HBM was also applied in studies to develop and implement interventions aimed at improving oral health behaviors to prevent oral diseases[14,15].

Three key oral health behaviors, namely tooth brushing, dental flossing, and sugar consumption, have significant influences on oral health. Regular tooth brushing and flossing are essential for removing plaque and preventing dental caries and gum disease, while reducing sugar intake lowers the risk of dental caries [16,17]. Despite their importance, many adolescents fail to adhere to recommended guidelines for these behaviors, highlighting the need for targeted interventions [17–19].

Although several studies have investigated oral health beliefs and behaviors, the application of HBM in adolescent populations remains underexplored [20]. Existing questionnaires often focus on adult populations or fail to capture the unique psychosocial and developmental factors that influence adolescents' oral health behaviors [21,22]. This gap may stem from the unique developmental characteristics of adolescents, such as their evolving cognitive abilities, susceptibility to peer influence, and a tendency to prioritize short-term rewards over long-term health benefits [23,24]. Furthermore, previous studies on developing an HBM-based scale for adolescents' oral health have often included 'double-barrel' questions – items that combine two behaviors into a single question, which can be problematic for participants who only engage in one of the behaviors. Applying the HBM to assess multiple specific oral health behaviors simultaneously may limit the development of targeted interventions focusing on a specific oral health behavior [25]. This gap underscores the need for a reliable and valid instrument to measure adolescents' oral health beliefs specifically for the key oral health-related behaviors on an individual basis.

The aim of the present study was to develop and validate an Oral Health Beliefs Questionnaire/Scale(OHBQ) based on the HBM, focusing on three key behaviors: tooth brushing, dental flossing, and sugar consumption. By creating a tool specifically designed for adolescents, this study seeks to provide researchers and practitioners with a robust instrument for assessing oral health beliefs and designing targeted, behavior-specific interventions.

2. Methods

This study received ethical approval from the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (IRB HKU/HA HKW: UW22–098). A cross-sectional design was employed, involving 12 secondary schools in Hong Kong. Prior to participation, written parental consent was obtained, and the confidentiality and privacy of all participants were strictly ensured. Data collection was conducted using both online and offline methods: questionnaires were distributed in hard copy and electronically via Google Forms.

2.1. Questionnaire/Scale development

2.1.1. Initial item generation

A comprehensive literature review was conducted between Sep 2023 to Nov 2023 to identify relevant constructs of the Health Belief Model (HBM), such as perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy that can be applied to oral health. Six databases, namely PubMed, Ovid Medline, Ovid Embase, Cochrane Library, Web of Science, and APA PsycINFO were searched. The following keywords were used for searching: 'health beliefs', 'health belief model', 'adolescents', 'oral health-related behaviors' and 'oral health'. A pool of 61 items related to the three key oral health behaviors was identified for the development of a preliminary questionnaire in traditional Chinese.

2.1.2. Expert panel review and pilot testing

A panel of five experts (authors) – two experts in dental public health (ECML, CHC); one expert in statistics and questionnaire validation (MCMW); and two experts in Pediatric Dentistry and adolescents' oral health promotion (CKYY, PL) evaluated the content validity of the initial questionnaire draft. Content validity refers to the degree to which the items adequately represent the target constructs or concepts being measured [26]. Each item was independently assessed for relevance and clarity. In the pilot test, individual interviews with 10 Cantonese participants (aged 12 to 15 years) were conducted to ensure the items (in traditional Chinese) were understandable. In addition, three dental undergraduate students were invited to assist in the translation and back-translation of the Cantonese and English HBM questionnaire, to improve the language accuracy and validity of the scale. All the items were assessed for relevance and clarity.

Based on the feedback received from all the mentioned experts, study participants, and translators, seven items were revised for clarity, and four items were removed due to redundancy. The final version of the Health Belief Model Scale for assessing oral health behaviors among adolescents, for validity and reliability testing, comprised a total of 57 items (Table 1), which were categorized into six domains:

1) Perceived severity for oral diseases (SEV1 to SEV9).
2) Perceived susceptibility for dental caries and gingivitis/periodontitis (SUS1 to SUS4).
3) Perceived benefits for tooth brushing (BEN1-1 to BEN1-3)/ for dental flossing (BEN2-1 to BEN2-3)/ for reducing sugar consumption (BEN3-1 to BEN3-3).
4) Perceived barriers for tooth brushing (BAR1-1 to BAR1-7)/ for dental flossing (BAR2-1 to BAR2-5)/ for reducing sugar consumption (BAR3-1 to BAR3-5).
5) Cues to action for tooth brushing (CUE1-1 to CUE1-3)/ for dental flossing (CUE2-1 to CUE2-3)/ for reducing sugar consumption (CUE3-1 to CUE3-3).

Table 1
Distribution and item-total correlation and internal consistency of health belief model scale (53 items).

Items of subscale	Mean	SD	Skewness	Kurtosis	Item-total correlation	Cronbach's α If item deleted (n = 1124)	Cronbach's α of the subscale (n = 1124)
Subscale of perceived severity not serious(1), less serious(2), partially serious(3), serious(4), very serious (5)							0.91
SEV1: If my teeth do not look good because of oral diseases, for me that is …	3.06	1.17	0.07	-0.86	0.64	0.90	
SEV2: If I have bad breath because of oral diseases, for me that is …	3.46	1.14	-0.37	-0.59	0.72	0.90	
SEV3: If I cannot sleep well because of oral diseases, for me that is …	3.71	1.34	-0.77	-0.59	0.72	0.90	
SEV4: If I cannot eat my favorite food because of oral diseases, for me that is …	3.78	1.32	-0.79	-0.57	0.71	0.90	
SEV5: If my regular social activities were affected by oral diseases, for me that is...	3.75	1.24	-0.76	-0.42	0.82	0.88	
SEV6: If my studies are affected by oral diseases, for me that is...	3.48	1.36	-0.46	-0.98	0.71	0.90	
SEV7: If my mood is affected by oral diseases, for me that is...	3.67	1.32	-0.65	-0.75	0.77	0.89	
Subscale of perceived susceptibility strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.76
SUS1: There is a chance that I may get tooth decay.	3.12	1.02	0.20	-0.29	0.57	0.70	
SUS2: There is a chance that I may have gum disease.	2.64	0.93	0.00	-0.12	0.60	0.69	
SUS3: Tooth decay is common among us teenagers.	3.09	0.96	0.13	-0.01	0.55	0.71	
SUS4: Gum disease is common among us teenagers.	2.77	0.90	-0.08	0.40	0.53	0.72	
Subscale of perceived benefits for tooth brushing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.91
BEN1-1: Proper toothbrushing habits can reduce the risk of having tooth decay.	4.32	0.78	1.24	2.19	0.85	0.84	
BEN1-2: Proper toothbrushing habits can prevent gum disease.	4.29	0.80	1.13	1.65	0.87	0.82	
BEN1-3: Proper toothbrushing habits can help me avoid spending extra time and money on dental treatment.	4.2	0.86	1.09	0.95	0.74	0.94	
Subscale of perceived barriers for tooth brushing strongly disagree(5) disagree(4), neutral(3), agree(2), strongly agree(1)							0.84
BAR1-2: It is difficult for me to maintain a habit of brushing my teeth twice per day for two minutes each time.	3.64	1.05	-0.48	-0.28	0.53	0.84	
BAR1-4: I feel discomfort when brushing my teeth.	4.04	0.89	-1.01	1.36	0.55	0.83	
BAR1-5: When I am facing stress, I don't want to brush my teeth.	3.88	1.06	-0.88	0.29	0.78	0.77	
BAR1-6: When I am in a bad mood, I don't want to brush my teeth.	3.83	1.09	-0.81	0.05	0.79	0.76	
BAR1-7: When I am tired, I don't want to brush my teeth.	3.23	1.24	-0.13	-1.03	0.60	0.83	
Subscale of cues to action for tooth brushing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							
CUE1-1: My parents often remind me to maintain good toothbrushing habits.	3.75	1.03	0.62	0.04	0.45	0.79	0.74
CUE1-2: My friends, classmates or teachers often remind me to maintain good toothbrushing habits.	2.87	1.05	0.00	-0.20	0.65	0.56	
CUE1-3: Mass media (e.g., social media, TV) often reminds me to maintain good toothbrushing habits.	3.09	1.05	0.15	-0.24	0.62	0.60	
Subscale of self-efficacy for tooth brushing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.80
SEL1-1: I am able to brush my teeth properly.	3.60	0.84	0.17	0.16	0.47	0.88	
SEL1-2: Even when I am in a bad mood, I can still brush my teeth twice per day for two minutes each time.	3.44	1.05	0.20	-0.56	0.74	0.61	
SEL1-3: I believe I can maintain a habit of brushing my teeth twice daily for two minutes each time.	3.58	1.00	0.23	-0.41	0.75	0.61	
Subscale of perceived benefits for dental flossing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.93
BEN2-1: I think dental flossing can reduce the risk of having tooth decay.	3.46	0.82	-0.08	0.09	0.85	0.90	
BEN2-2: I think dental flossing can prevent gum disease.	3.43	3.42	-0.18	0.13	0.88	0.87	
BEN2-3: I think dental flossing can help me avoid spending extra time and money on dental treatment.	0.81	0.83	-0.15	0.12	0.82	0.92	
Subscale of perceived barriers for dental flossing strongly disagree(5) disagree(4), neutral(3), agree(2), strongly agree(1)							0.86
BAR2-1: For me, it is difficult to use dental floss every day.	2.92	0.99	0.06	-0.14	0.72	0.83	
BAR2-2: I think cleaning my teeth with dental floss is a waste of time.	3.28	0.95	-0.22	-0.01	0.64	0.85	
BAR2-3: I don't know how to use dental floss properly to clean my teeth.	2.92	1.03	-0.04	-0.40	0.70	0.83	
BAR2-4: I think that the process of dental flossing is troublesome.	2.93	1.01	0.02	-0.27	0.78	0.81	
BAR2-5: I don't know which type of dental floss is suitable for me.	2.64	1.00	0.21	-0.16	0.58	0.86	
Subscale of cue to action for dental flossing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.85
CUE2-1: My parents often remind me to use dental floss.	2.63	1.06	-0.30	-0.32	0.68	0.84	
CUE2-2: My friends, classmates, or teachers often remind me to use dental floss.	2.31	0.96	-0.43	0.16	0.80	0.73	
CUE2-3: Mass media (e.g., social media, TV) often remind me to use dental floss.	2.53	0.99	-0.26	-0.14	0.70	0.82	
Subscale of self-efficacy for dental flossing strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.89
SEL2-1: I am able to use dental floss properly.	2.93	0.99	-0.02	-0.10	0.69	0.91	

(*continued on next page*)

Table 1 (*continued*)

Items of subscale	Mean	SD	Skewness	Kurtosis	Item-total correlation	Cronbach's α If item deleted (n = 1124)	Cronbach's α of the subscale (n = 1124)
SEL2-2: Even when I am in a bad mood, I can still floss my teeth after eating.	2.77	1.01	-0.15	-0.18	0.84	0.78	
SEL2-3 I believe I can maintain a habit of flossing after eating.	2.86	1.04	-0.12	-0.23	0.81	0.81	
Subscale of perceived benefits for reducing sugar consumption strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.92
BEN3-1: Reducing sugar intake can reduce the risk of having tooth decay.	4.15	0.79	0.79	0.93	0.85	0.88	
BEN3-2: Reducing sugar intake can prevent gum disease.	4.02	0.83	0.50	0.00	0.85	0.88	
BEN3-3: Reducing sugar intake can help me avoid spending extra time and money on dental treatment.	4.02	0.86	0.58	0.20	0.82	0.91	
Subscale of perceived barriers for reducing sugar consumption strongly disagree(5) disagree(4), neutral(3), agree(2), strongly agree(1)							0.76
BAR3-1: I find it difficult to have less sugary food and drinks.	3.37	1.03	-0.46	-0.14	0.47	0.74	
BAR3-2: I don't pay attention to my daily sugar intake because there are more important things in my life.	2.91	1.08	0.02	-0.54	0.58	0.70	
BAR3-3: When I am in a bad mood, I need to have sugary drinks or snacks.	2.72	1.11	0.23	-0.61	0.61	0.69	
BAR3-4: Having sugary drinks or snacks does not have an immediate adverse effect on my oral health.	2.83	1.00	0.03	-0.36	0.42	0.75	
BAR3-5: If sugary snacks or drinks are on promotion, I cannot resist buying them.	2.91	1.10	0.03	-0.58	0.57	0.70	
Subscale of cue to action for reducing sugar consumption strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.78
CUE3-1: My parents often remind me to reduce my sugar intake.	2.92	1.03	-0.02	-0.29	0.65	0.67	
CUE3-2: My friends, classmates, or teachers often remind me to reduce my sugar intake.	3.48	1.06	0.37	-0.35	0.60	0.73	
CUE3-3: Mass media (e.g., social media, TV) often reminds me to reduce sugar intake.	3.03	1.02	0.10	-0.06	0.62	0.71	
Subscale of self-efficacy for reducing sugar consumption strongly disagree(1) disagree(2), neutral(3), agree(4), strongly agree(5).							0.90
SEL3-1: I am able to reduce my sugar intake in my daily life.	3.38	0.99	0.27	-0.09	0.77	0.89	
SEL3-2: Even when I'm in a bad mood, I'm able to avoid having sugary drinks or snacks.	3.19	1.02	0.09	-0.26	0.80	0.86	
SEL3-3: I believe I can maintain the habit of consuming less sugar in my daily life.	3.34	1.02	0.26	-0.12	0.85	0.82	

*Skewness < 2 and kurtosis < 3 suggest an acceptable level of non-normality.*SEV=perceived severity of oral diseases; SUS=perceived susceptibility of oral diseases.* BEN1=perceived benefits of regular toothbrushing behavior; BAR1=perceived barriers of regular toothbrushing behavior; CUE1=cue to action of regular toothbrushing behavior; SEL1=self-efficacy of regular toothbrushing behavior.*BEN2=perceived benefits of dental flossing behavior; BAR2=perceived barriers of dental flossing behavior; CUE2=cue to action of dental flossing behavior; SEL2=self-efficacy of dental flossing behavior.*BEN3=perceived benefits of less sugar consumption; BAR3=perceived barriers of less sugar consumption; CUE3=cue to action of less sugar consumption; SEL3=self-efficacy of less sugar consumption.
Questions Deleted during the Process of Validation: SEV8: If I need to spend extra time on dental treatment, for me that is…. SEV9: If I need to spend extra money on dental treatment, for me that is…. BAR1-1: I do not know what good toothbrushing habits are. BAR1-3: I do not know how to brush my teeth properly.

6) Self-efficacy for tooth brushing (SEL1-1 to SEL1-3)/ for dental flossing (SEL2-1 to SEL2-3)/ for reducing sugar consumption (SEL3-1 to SEL3-3).

Responses were recorded using a five-point Likert scale. For the 'perceived severity' domain, the options ranged from "not serious" (score 1) to "very serious" (score 5) – "not serious" (score 1), "less serious" (score 2), "partially serious" (score 3), "serious" (score 4), and "very serious" (score 5). For the other five domains, response options ranged from "strongly disagree" (score 1) to "strongly agree" (score 5) –"strongly disagree" (score 1), "disagree" (score 2), "neutral" (score 3), "agree" (score 4), and "strongly agree" (score 5). Notably, for perceived barriers, the scoring was reversed, with "strongly disagree" indicating fewer perceived barriers. The total score for each domain was calculated by summing the individual item scores, with higher scores indicating more positive beliefs regarding the respective oral health behavior.

2.2. Questionnaire structure and data collection

The questionnaire consisted of three parts. Part I collected information on the socio-demographic background of the participants. Part II consisted of questions on the three key oral health behaviors, including frequency of tooth brushing, frequency of dental flossing, and frequency, timing and amount of sugar consumption. Part III comprised 57 questions about oral health beliefs, based on the HBM, related to these key oral health behaviors.

To determine the minimum sample size required, the general rule of thumb of a participant-to-item ratio of 10:1 was applied [27]. Thus, for testing the 57-item questionnaire, this study required a minimum of 570 participants. Adolescents in poor general health and those undergoing orthodontic treatment were excluded from this study.

This study was conducted on students in grades 7 to 9 across twelve secondary schools in various districts in Hong Kong. The questionnaire was self-administered under the supervision of a trained Cantonese research assistant. Participants were encouraged to seek clarification if they encountered any difficulties in understanding the questions.

2.3. Validation process

1) Construct validity—the degree to which a measurement instrument accurately measures its intended theoretical construct—was assessed using confirmatory factor analysis (CFA) [28]. Maximum likelihood (ML) estimation was employed to assess the multivariate normality of the data. When the data exhibit mild non-normality—specifically, skewness < 2 and kurtosis < 3, the estimates of model parameters and fit indices are still reliable and can be interpreted confidently [29]. Model fit indices such as the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR) were used to assess how well the model fit the data. The criteria for

determining a good model fit included a CFI and TLI greater than 0.90, as well as a RMSEA less than 0.08 and SRMR less than 0.06 [30].

2) Reliability testing—the consistency and stability of an instrument in measuring the same construct across repeated administrations or varying conditions—was evaluated via internal consistency using Cronbach's alpha (α), with a threshold of ≥0.70 considered acceptable [31]. Convergent validity indicates that different indicators or items that theoretically should be related to the same underlying construct actually show strong statistical associations. For example, if a questionnaire is designed to measure "self-efficacy," then all items intended to assess self-efficacy should be strongly correlated with each other. Average Variance Extracted (AVE) was used to measure the convergent validity in this study. An AVE value above 0.50 generally indicates good convergent validity [32].
3) Predictive validity—the extent to which a measurement instrument predicts future performance or behavior—was evaluated by analyzing three oral health behaviors [28]. The measurements of oral health behaviors were dichotomized into "good" versus "poor" categories, for example, brushing twice or more per day, using dental floss daily, and consuming less than 100ml of sugary beverages per day were defined as good behaviors. The relationships between each domain of the questionnaire and these behaviors were analyzed using logistic regression models to assess the instrument's predictive validity. Multicollinearity (a situation in data analysis where two or more predictor variables in a multiple regression model are highly correlated) was assessed using Variance Inflation Factor (VIF), measuring how much the variance of a regression coefficient is inflated due to multicollinearity. High VIF values indicate a high degree of multicollinearity (VIF >5, moderate multicollinearity; VIF >10, severe multicollinearity) [33].

All statistical analyses were performed using SPSS 27.0 and AMOS 21.0 (IBM, Armonk, New York, USA). A p-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Participants

A total of 1,124 study participants completed the questionnaires (Table 2), with a mean age of 13.8 years (SD = 0.9). The sample consisted of 45% males (n = 500) and 55% females (n = 624). Regarding their oral health-related behaviors, 70% (n = 778) of the participants reported brushing their teeth at least twice daily; 46% (n = 520) reported flossing daily; 79% (n = 886) indicated that they consumed sugary snacks/drinks less than once per day averagely, 75% (n = 843) reported that they never consume sugary snacks/drinks before sleep; and 24% (n = 265) indicated that they consume less than 100ml sugary drinks per day.

Table 2
Socio-demographic characteristics of the participants (n=1124).

Socio-demographic variables	Frequency (Percentage)
Age Mean (SD) = 13.8 (0.9)	
Gender	
Male	500 (45%)
Female	624 (55%)
Tooth brushing frequency	
Less than twice per day	342 (30%)
Twice or more per day	778 (70%)
Dental floss frequency	
No interdental use	604 (54%)
Interdental use	520 (46%)
Sugary snacks/beverage consumption	
Less than once per day	886 (79%)
Once or more per day	238 (21%)
Sugary snacks/beverage consumption before bedtime	
Never	843 (75%)
More than once per week	278 (25%)
Sugary beverage consumption	
<=100ml per day	265 (24%)
More than 100ml per day	858 (76%)

3.2. CFA results

1) Validation of HBM beliefs on tooth brushing behavior

The confirmatory factor analysis (CFA) was conducted to validate the factor structure of the questionnaire. Initially, the model on the 29 items related to tooth brushing did not fit the data well, as indicated by poor fit indices (χ^2/df > 3, CFI < 0.90, RMSEA > 0.08). To improve the model fit, four items with factor loadings below 0.5 were removed. The revised model included 25 items, all with factor loadings exceeding 0.5, indicating strong item reliability. Moreover, based on modification indices, correlations between the error terms of several items were added to further improve the model fit. The final model demonstrated acceptable fit indices: CMIN/DF = 5.67, CFI = 0.91, GFI = 0.90, RMSEA = 0.064, SRMR = 0.056. These results suggested that the final model adequately represents the underlying structure of the HBM questionnaire. The final model for tooth brushing behavior included six domains: perceived severity, perceived susceptibility, perceived benefits, perceived barriers, cue to action and self-efficacy (Fig. 1).

2) Validation of HBM beliefs on dental flossing behavior

For dental flossing behavior, the initial CFA model on the 27 items also exhibited poor fit (χ^2/df > 3, CFI < 0.90, RMSEA > 0.08). Two items in the domain of perceived severity with factor loadings below 0.50 were removed, and correlations between the error terms of two more items were added based on modification indices. The revised model showed improved fit indices: CMIN/DF= 6.04, CFI = 0.92, GFI = 0.90, RMSEA = 0.067, SRMR=0.046. The factor loadings for the remaining 25 items ranged from 0.63 to 0.93, confirming their relevance to the underlying constructs. The final model for dental floss behavior included the same six domains as above (Fig. 2).

3) Validation of HBM beliefs on sugar consumption behavior

The CFA model for the 27 items related to sugar consumption also initially demonstrated poor fit (χ^2/df > 3, CFI < 0.90, RMSEA > 0.08). Two items in the perceived severity domain with factor loadings below 0.50 were excluded. After adding correlations between the error terms of two items, the model fit improved. The final model exhibited acceptable fit indices: CMIN/DF= 5.30, CFI = 0.92, GFI = 0.90, RMSEA = 0.062, SRMR=0.050. The factor loadings for the remaining 25 items ranged from 0.61 to 0.90, indicating strong construct validity. The final model for sugar consumption also comprised the six domains outlined above (Fig. 3).

3.3. Reliability and validity

The reliability (internal consistency) of the HBM scale was assessed using Cronbach's alpha. All subscales demonstrated high internal consistency, with alpha coefficients ranging from 0.74 to 0.93. Convergent validity was assessed via the Average Variance Extracted (AVE), with all constructs exceeding the recommended threshold of 0.5 [32]. These findings demonstrated that the questionnaire is both reliable and valid for measuring the targeted constructs.

3.4. Predictive validity

To evaluate predictive validity, logistic regression models were used to evaluate the association between each of the three key oral health

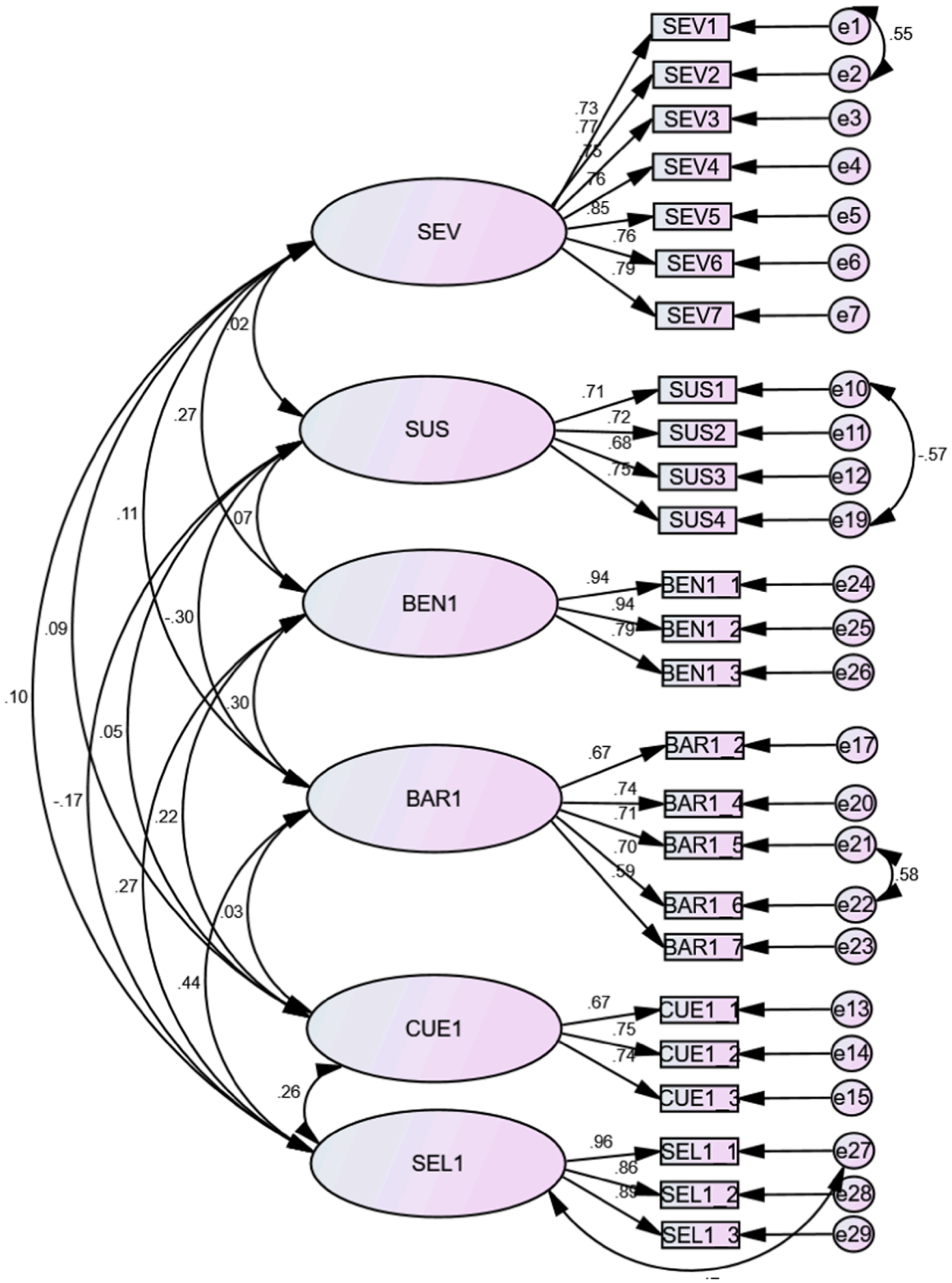

Fig. 1. Factor loadings from the confirmatory factor analysis of tooth brushing.
*SEV=perceived severity of oral diseases; SUS=perceived susceptibility of oral diseases.
*BEN1=perceived benefits of regular toothbrushing; BAR1=perceived barriers of regular toothbrushing; CUE1=cue to action of regular toothbrushing; SEL1=self-efficacy of regular toothbrushing.

behaviors and the HBM components (Table 3). The Variance Inflation Factor (VIF) values for all predictors range from 1 to 1.5, indicating negligible multicollinearity and all predictors are almost perfectly independent.

For tooth brushing, higher cue to action with lower odds of good tooth brushing behavior (OR (95% CI) = 0.92 (0.90-0.98), p=0.010). Conversely, fewer perceived barriers (OR (95% CI) = 1.06 (1.02-1.10), p=0.002) and higher self-efficacy (OR (95% CI) = 1.39 (1.29,1.49), p<

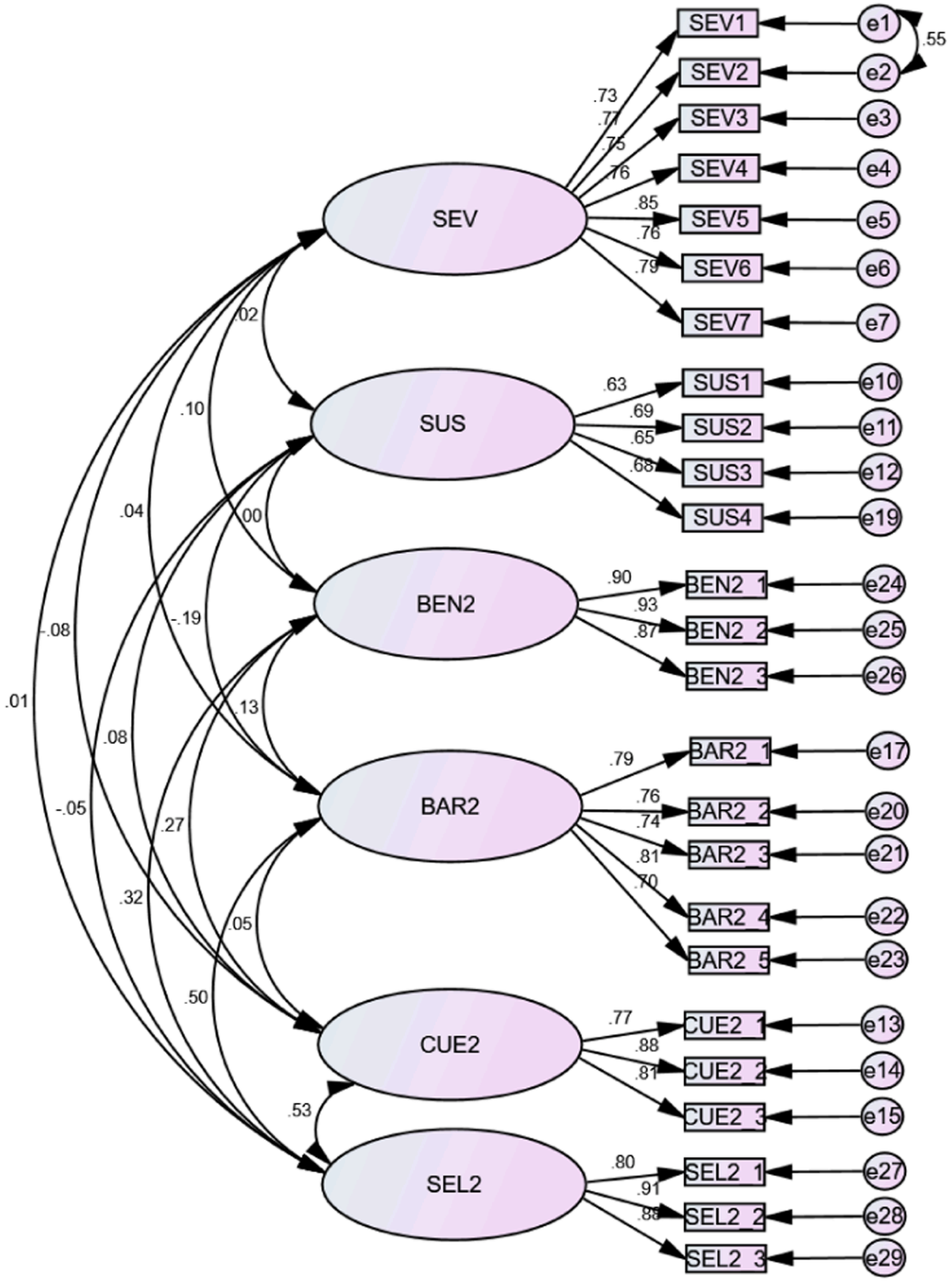

Fig. 2. Factor loadings from the confirmatory factor analysis of dental flossing.
*SEV=perceived severity of oral diseases; SUS=perceived susceptibility of oral diseases.
*BEN2=perceived benefits of dental flossing behavior; BAR2=perceived barriers of dental flossing behavior; CUE2=cue to action of dental flossing behavior; SEL2=self-efficacy of dental flossing behavior.

0.001) were positively associated with good tooth brushing behavior.

For dental flossing behavior, fewer perceived barriers (OR (95% CI) = 1.15 (1.11-1.20), p<0.001) and higher self-efficacy (OR (95% CI) = 1.24 (1.17-1.31), p<0.001) increased the likelihood of good dental flossing behavior.

For the three sugar consumption behaviors, fewer perceived barriers (OR (95% CI) = 0.88 (0.84-0.92), P<0.001) and higher self-efficacy (OR (95% CI) = 0.83 (0.78-0.88), P<0.001) were associated with lower

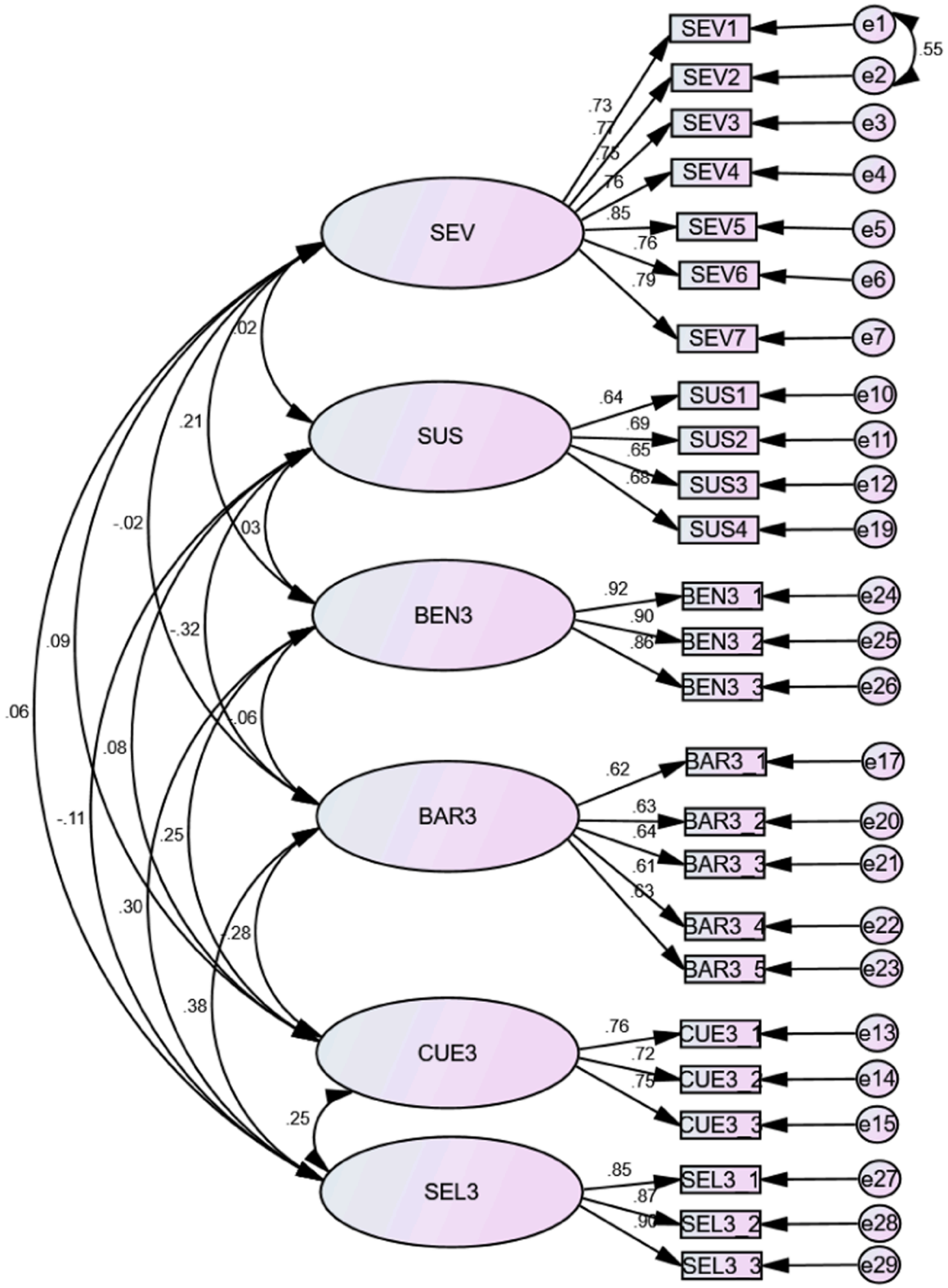

Fig. 3. Factor loadings from the confirmatory factor analysis of sugar consumption.
*SEV=perceived severity of oral diseases; SUS=perceived susceptibility of oral diseases.
*BEN3=perceived benefits of less sugar consumption; BAR3=perceived barriers of less sugar consumption; CUE3=cue to action of less sugar consumption; SEL3=self-efficacy of less sugar consumption.

Table 3
HBM factors for predicting favorable oral health behaviors.

	B	SE	Wald statistics	OR (95% CI)	P-value
Toothbrushing twice daily					
BAR1: Perceived barriers	0.06	0.02	9.65	1.06 (1.02-1.10)	0.002
CUE1: Cue to action	-0.08	0.03	6.56	0.92 (0.90-0.98)	0.010
SEL1: Self-efficacy	0.33	0.04	79.82	1.39 (1.29-1.49)	<0.001
Proper dental flossing					
BAR2: Perceived barriers	0.14	0.02	52.96	1.15 (1.11-1.20)	<0.001
SEL2: Self-efficacy	0.22	0.03	58.21	1.24 (1.17-1.31)	<0.001
Limited intake frequencies of sugary snacks/ beverage					
BAR3: Perceived barriers	-0.13	0.02	35.55	0.88 (0.84-0.92)	<0.001
SEL3: Self-efficacy	-0.19	0.03	40.43	0.83 (0.78-0.88)	<0.001
Avioding sugary snacks/ beverage before bedtime					
SUS: Perceived susceptibility	0.06	0.03	5.09	1.06 (1.01-1.11)	0.024
BAR3: Perceived barriers	-0.08	0.02	15.29	0.93 (0.89-0.96)	<0.001
Limited daily consumption of sugary beverage (total intake)					
BAR3: Perceived barriers	-0.10	0.02	23.83	0.90 (0.87-0.94)	<0.001
SEL3: Self-efficacy	-0.16	0.03	29.40	0.85 (0.80-0.90)	<0.001

* SUS=perceived susceptibility of oral diseases.
* BAR1=perceived barriers of toothbrushing behavior; CUE1=cue to action of toothbrushing behavior; SEL1=self-efficacy of toothbrushing behavior.
*BAR2=perceived barriers of dental flossing behavior; SEL2=self-efficacy of dental flossing behavior.
*BAR3=perceived barriers of less sugar consumption behavior; SEL3=self-efficacy of less sugar consumption behavior.

frequency of sugary snacks consumption. Additionally, higher perceived susceptibility (OR (95% CI) = 1.06 (1.01-1.11), P=0.024) was positively associated, as well as fewer perceived barriers (OR (95% CI) = 0.93 (0.89-0.96), P<0.001) were associated with a higher frequency of having sugary snacks before bedtime. Fewer perceived barriers (OR (95% CI) = 0.90 (0.87-0.94), P<0.001) and higher self-efficacy (OR (95% CI) = 0.85 (0.80-0.90), P<0.001) were associated with lower total intakeof sugary beverage per day. These results supported the predictive validity of the questionnaire, as the HBM constructs were significantly associated with the three oral health behaviors.

4. Discussion

This study developed a validated tool—the Oral Health Beliefs Questionnaire/Scale (OHBQ) — that comprehensively assesses oral health beliefs among adolescents. Notably, this is the first questionnaire grounded in the HBM theory that focused on three key oral health behaviors simultaneously: tooth brushing, dental flossing, and sugar consumption. It addresses a significant gap in existing tools by including sugar consumption behaviors – an aspect often overlooked in other theory-based scales. For example, previous tools primarily focused on tooth brushing, dental flossing, dental visits, neglecting the critical role of dietary habits in oral health [25,42].

In the present study, the developed Oral Health Beliefs Questionnaire (OHBQ) demonstrated strong reliability and validity in measuring adolescents' beliefs related to the three primary oral health behaviors, toothbrushing, dental flossing and sugar intake. The results indicate that perceived barriers, cue to action and self-efficacy significantly predicted tooth brushing behavior, whereas only perceived barriers and self-efficacy influenced dental flossing habits. For sugar consumption behaviors, perceived susceptibility also played a role alongside perceived barriers and self-efficacy.

Based on the present study results, it was found that adolescents who perceived fewer barriers and had higher self-efficacy tend to exhibit better oral health behaviors. This aligns with the HBM theoretical framework [34], suggesting that adolescents confident in their ability to perform proper oral health behaviors and perceive fewer barriers (e.g., lack of time, feel stressed from studies, lack of knowledge on proper tooth brushing) are more likely to maintain good habits consistently. The findings are consistent with previous research [12,35,36], emphasizing the importance of addressing practical barriers and enhancing self-efficacy in interventions aimed at improving oral health behaviors.

Interestingly, our study found that having more external cues to action was associated with poorer tooth brushing behavior, which is contrary to the HBM framework. One possible explanation is that adolescents who heavily rely on external cues may lack intrinsic motivation [37]. Besides, the nature of the cues matters – if cues are perceived as nagging or controlling (e.g., constant reminders from parents), it may lead to resistance and result in reduced adherence. Excessive or poorly timed reminders could also be perceived negatively, potentially leading to decreased motivation [38]. These findings suggested that behavioral interventions focusing on enhancing self-efficacy rather than relying solely on external cues may be more effective in promoting good oral hygiene practices among adolescents.

According to the HBM framework, individuals who perceive themselves as more susceptible to oral health problems are expected to be more inclined to avoid risky behaviors, like excessive sugar intake [34]. However, our findings suggest an opposite trend: adolescents perceived themselves as more susceptible to oral diseases are under higher sugar consumption. One possible explanation is that these adolescents were aware that frequent sugar intake increases the risk of tooth decay, thus perceiving themselves at higher susceptible to caries. Moreover, perceived susceptibility alone may not be a strong motivator; its influence on health behaviors can be moderated by other factors. For instance, a study found that perceived benefits significantly moderated the effect of perceived susceptibility on COVID-19 preventive behaviors [39]. Similarly, another study on smoking cessation found that the combination of perceived severity and susceptibility had a multiplicative effect on behavior change [40]. These studies suggest a complex interplay among the HBM constructs, indicating that perceived susceptibility may need to be complemented by perceived severity and benefits to effectively motivate health behaviors.

We also identified a lack of association between perceived severity and oral health behaviors, consistent with findings from previous studies. A systemic review with meta-analysis found that perceived severity is generally a weaker predictor of health behaviors compared to other HBM constructs like perceived barriers and self-efficacy [41]. This indicates that individuals are more likely to engage in preventive behaviors if they believe in the effectiveness of these actions and feel capable of performing them, rather than simply fearing the severity of potential health outcomes.

Additionally, a major strength of our study lies in the large sample size of over 1,100 participants from 12 schools. This substantial sample

not only enhances statistical power but also allows for a more rigorous evaluation of the questionnaire's psychometric properties. Large sample sizes are rare in the development of health belief questionnaires, as many studies rely on smaller, convenience samples [22,42]. Furthermore, our study innovatively incorporated three distinct measures of sugar consumption – sugary snacks, sugary beverages, and pre-sleep sugar intake – to validate the tool's predictive accuracy. This approach provides a more comprehensive understanding of how oral health beliefs influence dietary habits, which has not been adequately addressed in prior research [25,43].

Our findings have important implications for practice and policy. Firstly, interventions aimed at improving oral health behaviors among adolescents should focus on enhancing self-efficacy and addressing perceived barriers. School-based programs could include practical demonstrations, interactive sessions, and regular follow-ups to build confidence in oral health practices and enhance self-efficacy [44–46]. Investigating the effectiveness of interventions targeting specific HBM constructs, such as self-efficacy or perceived barriers, would provide valuable insights for designing effective strategies. Secondly, the inclusion of sugar consumption behaviors in our questionnaire highlights the need for targeted interventions to reduce sugar intake among adolescents. Policies could include restricting access to sugary snacks and beverages in schools, such as stricter regulations on vending machines, to promote oral health. In Hong Kong, collaboration among the Health Department, schools, and dental professionals will be essential to implement these strategies effectively.

However, this study has several limitations. Firstly, the cross-sectional study design limits the ability to establish causal relationships between oral health beliefs and oral health behaviors. Longitudinal studies are needed to explore how changes in beliefs influence behaviors over time, and to assess the responsiveness validity of this scale. Secondly, self-reported data may introduce bias, as adolescents may over-report healthy behaviors or provide socially desirable responses. Thirdly, since the study participants were from Hong Kong and of Cantonese ethnicity, the findings may not be generalizable to other populations, such as individuals of different racial or linguistic backgrounds. Validation of the OHBQ in diverse cultural or socioeconomic backgrounds is needed. Future research should also explore additional factors influencing oral health behaviors, such as peer influence, and examine the nature of cues to action (e.g., whether they are supportive or controlling), which may explain some unexpected negative associations with good behaviors.

5. Conclusion

The HBM-based oral health beliefs questionnaire/scale (OHBQ) developed in this study is a reliable and valid tool for assessing adolescents' health beliefs related to oral health behaviors. With robust psychometric properties and high construct validity, the OHBQ may serve as a valuable instrument for researchers and practitioners in oral health promotion.

Abbreviations

HBM	Health Belief Model
RCT	Randomized Controlled Trial
SUS	Perceived Susceptibility
SEV	Perceived Severity
BEN	Perceived Benefits
BAR	Perceived Barriers
CUE	Cue to Action
SEL	Self-efficacy
CFA	Confirmatory Factor Analysis
VIF	Variance Inflation Factor

CRediT authorship contribution statement

Isabella Lili He: Writing – review & editing, Writing – original draft, Validation, Methodology, Formal analysis, Data curation. **Pei Liu:** Writing – review & editing, Supervision, Project administration, Investigation, Conceptualization, Funding acquisition. **May Chun Mei Wong:** Supervision, Investigation, Validation. **Chun Hung Chu:** Supervision. **Cynthia Kar Yung Yiu:** Investigation, Supervision, Validation. **Edward Chin Man Lo:** Writing – review & editing, Supervision, Project administration, Conceptualization, Investigation.

Declaration of competing interest

The authors declare that they have no conflicts of interest regarding the publication of this research.

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References

[1] L. Sischo, H.L. Broder, Oral health-related quality of life: what, why, how, and future implications, J. Dent. Res. 90 (11) (2011) 1264–1270.

[2] J.S. Paula, I.C.G. Leite, A.B. Almeida, G.M.B. Ambrosano, A.C. Pereira, F.L. Mialhe, The influence of oral health conditions, socioeconomic status and home environment factors on schoolchildren's self-perception of quality of life, Health Qual. Life Outcomes 10 (2012).

[3] J.E. Frencken, P. Sharma, L. Stenhouse, D. Green, D. Laverty, T. Dietrich, Global epidemiology of dental caries and severe periodontitis – a comprehensive review, J. Clin. Periodontol. 44 (2017) S94–S105.

[4] M. Nazir, A. Al-Ansari, K. Al-Khalifa, M. Alhareky, B. Gaffar, K. Almas, Global prevalence of periodontal disease and lack of its surveillance, Sci. World J. (2020), 2020.

[5] H. Silk, A. Kwok, Addressing adolescent oral health: a review, Pediatr. Rev. 38 (2) (2017) 61–68.

[6] N. Ab Mumin, Z.Y.M. Yusof, J. Marhazlinda, U. Obaidellah, motivators and barriers to oral hygiene self-care among adolescents in Malaysia: a qualitative study, Int. J. Dent. Hyg. 20 (4) (2022) 678–688.

[7] H.X. Lu, M.C.M. Wong, E.C.M. Lo, C. McGrath, Trends in oral health from childhood to early adulthood: a life course approach, Community Dent. Oral Epidemiol. 39 (4) (2011) 352–360.

[8] K.K. Mak, J.R. Day, Dental health behaviours among early adolescents in Hong Kong, Int. J. Dent. Hyg. 9 (2) (2011) 122–126.

[9] Z. Eidenhardt, A. Ritsert, S. Shankar-Subramanian, S. Ebel, J. Margraf-Stiksrud, R. Deinzer, Tooth brushing performance in adolescents as compared to the best-practice demonstrated in group prophylaxis programs: an observational study, BMC Oral Health 21 (1) (2021).
[10] A. Muzayyana, Q. Aini, Bibliometric analysis of the health belief model in healthcare workers: trends, insights, and future directions, J. Angiother. 8 (5) (2024).
[11] N. Daniati, G. Widjaja, G.M. Olalla, P. Chaudhary, S.M. Nader, S. Chupradit, M. Y. Fakri, The health belief model's application in the development of health behaviors, Health Educ. Health Promot. 9 (5 Special Issue) (2021) 521–527.
[12] F. Rahmati-Najarkolaei, P. Rahnama, M. Gholami Fesharaki, V. Behnood, Predictors of oral health behaviors in female students: an application of the health belief model, Iran. Red Crescent Med. J. 18 (11) (2016) e24747.
[13] F. Mohammadkhah, A. Ramezankhani, A. Atashpoosh, F. Ahmady Moghadam, M. Bakhtiar, A. Khani Jeihooni, Effect of training based on health belief model and behavioral intention on improving dental and oral self-care behavior in 9-12-year-old Iranian female students, BMC Oral Health 22 (1) (2022) 515.
[14] E. Keyong, S. Thitasomakul, S. Tianviwat, Effectiveness of an oral health promotion program for the elderly in Khiri Mat district, Sukhothai province: a randomized control trial, J. Int. Soc. Prev. Community Dent. 9 (3) (2019) 225–231.
[15] F. Mohammadkhah, A. Ramezankhani, A. Atashpoosh, F. Ahmady Moghadam, M. Bakhtiar, A. Khani Jeihooni, Effect of training based on health belief model and behavioral intention on improving dental and oral self-care behavior in 9–12-year-old Iranian female students, BMC Oral Health 22 (1) (2022).
[16] B. Tseveenjav, A.L. Suominen, H. Hausen, M.M. Vehkalahti, The role of sugar, xylitol, toothbrushing frequency, and use of fluoride toothpaste in maintenance of adults' dental health: findings from the Finnish national health 2000 survey, Eur. J. Oral Sci. 119 (1) (2011) 40–47.
[17] D. Olczak-Kowalczyk, A. Turska, D. Gozdowski, U. Kaczmarek, Dental caries level and sugar consumption in 12-year-old children from Poland, Adv. Clin. Exp. Med. 25 (3) (2016) 545–550.
[18] T. Vaičiūnas, V. Golambiauskas, S. Abdrakhmanova, M. Melkumova, E. Movsesyan, L. Sturua, D. Pavlova, A. Adayeva, K. Šmigelskas, Oral hygiene predicts lower life satisfaction and subjective health: experience of post-Soviet countries, Eur. J. Pediatr. 183 (12) (2024) 5467–5477.
[19] H.M. Elkhodary, M.H. Abdelnabi, A.A. Swelem, H.J. Sabbagh, O.A.E.S. El Meligy, I. M. Talaat, E.B. Abdellatif, Y. Khader, O.B. Al-Batayneh, N.M. Al-Khanati, N. M. Nurelhuda, S. Alhabli, M.H. Mostafa, S. Qureshi, N. Qureshi, M.A. Yousaf, D. Taha, Y.F. Marafi, S.N. Al Harrasi, S. Al-Rai, N. Gomaa, H. Mattar, H. A. Bakhaider, B. Samodien, H. Lő, M. El Tantawi, Individual, familial and country-level factors associated with oral hygiene practices in children: an international survey, BMC Oral Health 23 (1) (2023).
[20] I.L. He, P. Liu, M.C.M. Wong, C.H. Chu, E.C.M. Lo, Effectiveness of psychological intervention in improving adolescents' oral health: a systematic review and meta-analysis, J. Dent. 150 (2024).
[21] M.L. Wong, Y.H. Lee, Y.F. Sim, T.J. Wong, S.H. Soh, B.T. Goh, C.Y. Poon, P.F. Allen, K.S. Chia, C.P.C. Sim, Oral health knowledge, attitudes and behaviours of adults: findings from a national oral health survey in Singapore, Community Dent. Oral Epidemiol. 52 (3) (2024) 292–301.
[22] P.M. Flynn, M.T. John, A. Naik, N. Kohli, J.J. Van Wormer, K. Self, Psychometric properties of the english version of the oral health literacy adults questionnaire - OHL-AQ, Community Dent. Health 33 (4) (2016) 274–280.
[23] C. Lange-McPherson, B. Halpern-Felsher, Adolescent development and its impacts on health-related decision-making, Encycl. Child Adolesc. Health (2023) 186–194. First Edition.
[24] R.A. Sanders, Adolescent psychosocial, social, and cognitive development, Pediatr. Rev. 34 (8) (2013) 354–359.
[25] B. Xiang, H.M. Wong, W. Cao, A.P. Perfecto, C.P.J. McGrath, Development and validation of the oral health behavior questionnaire for adolescents based on the health belief model (OHBQAHBM), BMC Public Health 20 (1) (2020) 701.
[26] J.P. Zapata-Ospina, J. García-Valencia, Validity based on content: a challenge in health measurement scales, J. Health Psychol. 27 (2) (2022) 481–493.
[27] D.B. McCoach, R.K. Gable, J.P. Madura, Instrument development in the affective domain: school and corporate applications, 2013.
[28] C. Greeno, Measurement, or how do we know what we know? Topic one: validity, Fam. Process 42 (3) (2003) 433–435.
[29] S.J. Finney, C. DiStefano, Nonnormal and categorical data in structural equation modeling. Structural Equation Modeling: a Second Course, 2nd ed., IAP Information Age Publishing, Charlotte, NC, US, 2013, pp. 439–492.
[30] L.T. Hu, P.M. Bentler, Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives, Struct. Equ. Model. 6 (1) (1999) 1–55.
[31] T.A. Malapane, N.K. Ndlovu, Assessing the reliability of Likert scale statements in an E-Commerce quantitative study: a Cronbach alpha analysis using SPSS statistics, 2024 systems and information engineering design symposium, SIEDS 2024 (2024) 90–95.
[32] D.T. Campbell, D.W. Fiske, Convergent and discriminant validation by the multitrait-multimethod matrix, Psychol. Bull. 56 (2) (1959) 81–105.
[33] A. Field, Discovering Statistics Using IBM SPSS Statistics (2024).
[34] E.F. Nasir, N.M.A. Suliman, Application of the health belief model in oral hygiene practice (brushing/flossing): a narrative review, J. Int. Oral Health 14 (4) (2022) 342–348.
[35] S.M. Liu, Y.M. Xin, F. Wang, P.C. Lin, H.L. Huang, Parental health belief model constructs associated with oral health behaviors, dental caries, and quality of life among preschool children in China: a cross-sectional study, BMC Oral Health 24 (1) (2024).
[36] F. Rahmati-Najarkolaei, P. Rahnama, M.G. Fesharaki, H. Yahaghi, M. Yaghoubi, Determinants of dental health behaviors of Iranian students based on the health belief model (HBM), Shiraz Med. J. 17 (7–8) (2016).
[37] P. Kumar, D. Doshi, S. Kulkarni, P. Reddy, S. Reddy, A. Srilatha, Effect of motivation on oral hygiene and caries status among young adults in Hyderabad city, Indian J. Dent. Res. 30 (1) (2019) 15–20.
[38] A. Poplinger, [Adherence to oral hygiene and dental self-care], Refuat Ha-Peh Veha-Shinayim 27 (2) (1993) (2010) 38-49,62.
[39] S. Taflinger, S. Sattler, A situational test of the health belief model: how perceived susceptibility mediates the effects of the environment on behavioral intentions, Soc. Sci. Med. 346 (2024).
[40] C. Taniguchi, A. Narisada, H. Ando, A. Hashimoto, A. Nakayama, M. Ito, H. Tanaka, K. Suzuki, Smoking cessation behavior in patients with a diagnosis of a non-communicable disease: the impact of perceived disease severity of and susceptibility to the disease, Tob. Induc. Dis. 21 (10 October) (2023).
[41] C.J. Carpenter, A meta-analysis of the effectiveness of health belief model variables in predicting behavior, Health Commun. 25 (8) (2010) 661–669.
[42] Y. Sun, J. Sun, Y. Zhao, A. Cheng, J. Zhou, A new comprehensive oral health literacy scale: development and psychometric evaluation, BMC Oral Health 21 (1) (2021).
[43] C.Q. Zhang, M.C.Y. Wong, R. Zhang, K. Hamilton, M.S. Hagger, Adolescent sugar-sweetened beverage consumption: an extended health action process approach, Appetite 141 (2019).
[44] M. Atif, N. Tewari, S. Saji, S. Srivastav, M. Rahul, Effectiveness of various methods of educating children and adolescents for the maintenance of oral health: a systematic review of randomized controlled trials, Int. J. Paediatr. Dent. 34 (3) (2024) 229–245.
[45] A. Haleem, M.I. Siddiqui, A.A. Khan, School-based strategies for oral health education of adolescents- a cluster randomized controlled trial, BMC Oral Health 12 (1) (2012).
[46] B. Xiang, H.M. Wong, C.P.J. McGrath, The efficacy of peer-led oral health programs based on social cognitive theory and health belief model among Hong Kong adolescents: a cluster-randomized controlled trial, Transl. Behav. Med. 12 (3) (2022) 423–432.