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Original Article

Development and psychometric assessment of a health action process approach (HAPA) inventory for home nutritional behavior among postoperative gastric cancer patients

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ABSTRACT

Objective: The aim of this study was to develop and validate a health action process approach (HAPA) inventory for measuring cognitive belief factors influencing home nutritional behavior among postoperative gastric cancer patients.

Methods: Item pool of the inventory was constructed based on the HAPA, literature review, and qualitative interview. Expert consultations were used for item improvement. Then postoperative gastric cancer patients (n = 404) were surveyed to conduct item analysis, reliability and validity test of the inventory. Reliability was evaluated through internal, split-half, and test–retest reliability. Validity was assessed through content and construct validity.

Results: Starting with 44 items in the item pool, the final inventory comprised 23 items. The exploratory factor analysis identified six dimensions—namely, risk perception, outcome expectancy, self-efficacy, intention, action planning, coping planning. And the cumulative variance contribution rate was 70.676%. Confirmatory factor analysis showed the model fits well (χ^2 = 370.794, df = 214, and χ^2/df = 1.733, root mean square of approximation error = 0.054, comparative fit index = 0.943, Tucker–Lewis index = 0.933, and incremental fitting index = 0.944). The item and scale level content validity were 0.83–1.00, and 0.98, which was considered good. The reliability was acceptable (Cronbach's α = 0.922, split-half reliability = 0.781, test–retest reliability = 0.716).

Conclusions: The developed inventory was valid and reliable to assess HAPA-based cognitive belief factors of home nutritional behavior of postoperative gastric cancer patients. Future research is needed to examine the applicability of the inventory in patients across diverse cultural backgrounds and healthcare systems.

Introduction

Gastric cancer is the fifth most common cancer (968,350 new cases, 4.9% of the total) and the fifth major cause of cancer death (659,853 deaths, 6.8% of the total) worldwide.[1] Surgery plays a key role in the curative treatment of gastric cancer.[2] For postoperative gastric cancer patients, a major challenge is the impact of the anatomy change on decreased oral intake, nutritional status, and ultimately, quality of life.[3] The nutritional complications faced by these patients include weight loss, malnutrition, sarcopenia, and cachexia.[4] It is believed that these nutritional complications can be prevented through better home nutritional behavior, including small and frequent meals (more than 6 meals a day), and adequate oral nutritional supplement to achieve sufficient energy and protein intake (similar to pre-illness levels).[5,6] However, most postoperative gastric cancer patients do not have appropriate nutritional behavior, especially during their early period after surgery and discharge from hospital.[3]

Effective nutritional intervention for postoperative gastric cancer patients is needed to improve their nutritional behaviors and, subsequent health outcomes.[7] Nutritional interventions are more effective when

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based on a behavior change theory, such as the health action process approach (HAPA).[8] HAPA describes the factors influencing health behaviors and has been successfully applied in interventions promoting healthy diet, physical activity, and medication adherence.[9] According to HAPA, the influencing factors of nutritional behavior include risk perceptions, outcome expectancies, self-efficacy, intention, action and coping planning.[10]

With growing interest in HAPA, and its proven effectiveness in various health behavior interventions, numerous HAPA-based assessments for health behaviors (e.g., exercise, smoking cessation and dental hygiene)[11–13] have been developed. However, HAPA-based instruments specially designed for nutritional behavior among postoperative gastric cancer patients are lacking. Therefore, the aim of this study was to develop and validate a HAPA inventory for home nutritional behavior in postoperative gastric cancer patients, with a longer-term goal of providing validated measures to assess the effect of HAPA-based nutritional interventions in these patients.

Methods

This study used an exploratory mixed-method design to develop the HAPA inventory for nutritional behavior in postoperative gastric cancer patients. According to the DeVellis's scale development guidelines,[14] this study has three phases: (1) generation of the item pool, (2) item improvement through expert consultation, and (3) the psychometric tests of the inventory. The three phases are summarized in Fig. 1.

Phase 1: Generation of the item pool

The item pool of the inventory was developed based on three sources: (1) HAPA, (2) findings from in-depth interviews with 15 postoperative gastric cancer patients, (3) comprehensive literature reviews of the cognitive belief factors of home nutritional behaviors in postoperative gastric cancer patients and HAPA assessment tools for other health behaviors.

The item pool of this inventory was based on the HAPA, which is promising for identifying the cognitive belief factors influencing health behaviors and helping to design targeted intervention to bridge the gap of intention and actual health behavior.[9] HAPA characterizes six cognitive belief factors influencing health behaviors: risk perception, outcome expectancy, self-efficacy, intention, action plan and coping plan.[8]

For the in-depth interviews, participants were included if they met the following criteria: (1) histologically confirmed gastric adenocarcinoma; (2) received a partial or total gastrectomy; (3) age ≥18 years; (4) agreed to participate. The exclusion criteria included severe postoperative complications or comorbidities or having other malignancies within the last 5 years. The interview questions were developed based on the six cognitive belief factors identified by HAPA: "a) How was your home nutritional behavior changed after gastrectomy? b) Do you think the prescribed home nutritional behavior can bring you benefits or harm? c) When making decisions about your daily diet, how confident do you feel about following the prescribed home nutritional behavior? d) What kinds of home nutritional behaviors will you adopt or have you adopted? e) What action plans will you make or have you made to follow the prescribed postoperative home nutrition behavior? f) What challenges do you face in adhering to the prescribed postoperative home nutrition behavior?" The collected interview data were analyzed using the directed qualitative content analysis method with HAPA informing the initial direction of qualitative data analysis while allowing for the identification of new themes.[15]

For the literature review, we emphasized the cognitive beliefs of home nutritional behavior in postoperative gastric cancer patients and previous HAPA assessment tools for other health behaviors.

By comparing and analyzing the results derived from HAPA, literature review and qualitative interview, the tentative attributes of the inventory were identified and the item pool was constructed.

Phase 2: Item improvement through expert consultation

Two rounds of expert consultation were performed for item improvement. Fifteen external experts were consulted, including two nursing professors, four nutrition specialist nurses, four nursing manager, two nutritionists, two gastric surgeons, and one statistician. The importance of the scale items was scored using a 5-point Likert scale ranging from 5 (very important) to 1 (very unimportant). An average score of importance assignment > 4.00, and a coefficient of variation (the ratio of the standard deviation to the mean) of < 0.25, was considered the item selection standard.[16] Respectively, we deleted and revised the items according to the scoring and advice from expert consultation.

Phase 3: Psychometric tests

Recruitment

From July 2021 to November 2022, convenience sampling was conducted in the Sixth Affiliated Hospital of Sun Yat-sen University and Sun

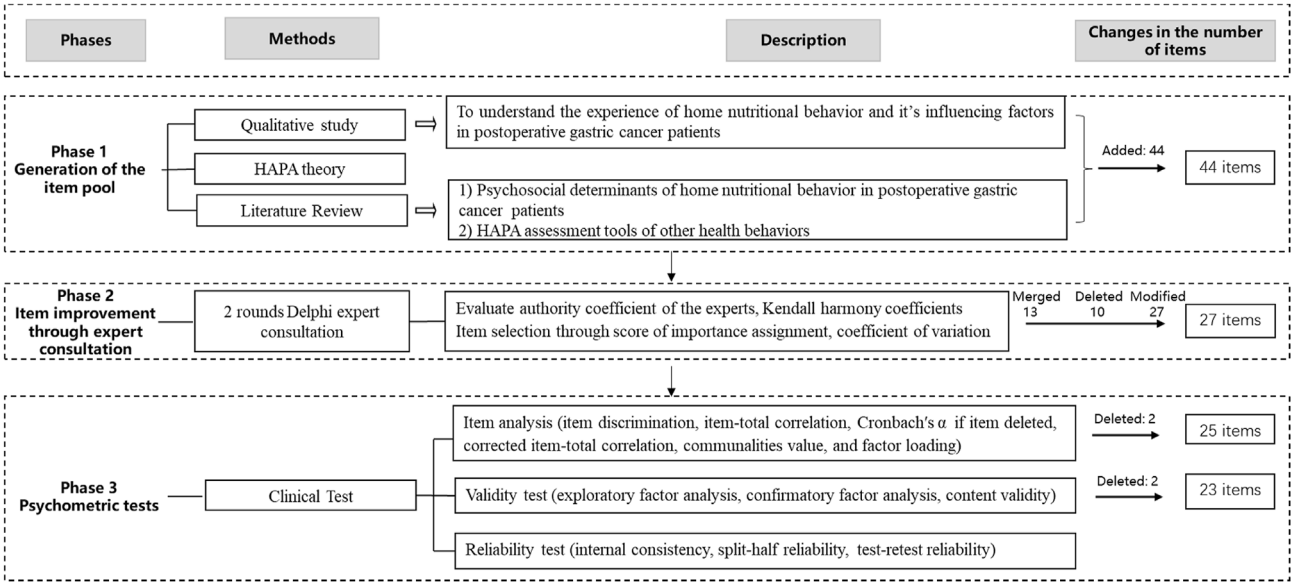

Fig. 1. Summary of the three phases.

Table 1
The attributes and elements of the inventory derived from the literature review and qualitative interview.

Attributes	Elements	Dimensions of the HAPA inventory	Number of initial items	Examples of items
Motivation phase	Perceived increased nutritional risk	Risk perception	8	Item 1: "I'm more likely to become malnutrition" (extracted from literature review[10])
	Outcome expectancy of appropriate nutritional behavior needs to be improved	Outcome expectancies	6	Item 5: "If I follow the prescribed postoperative nutrition behavior, it will help my postoperative recovery" (extracted from qualitative study)
	Task self-efficacy affects postoperative nutritional behavior	Self-efficacy	7	Item 16: "Even if I have to learn more about nutrition, I can stick to the prescribed postoperative nutrition behavior" (extracted from literature review[8])
	Lack of intention to regulate individual's nutritional behavior	Intention	6	Item 7: "For the next few weeks, I intend to take adequate dose of oral nutritional supplement" (extracted from qualitative study)
Volition phase	Lack of action plan	Action planning	4	Item 13: "I already have concrete plans how to arrange the prescribed postoperative nutrition behavior" (extracted from literature review[10])
	Lack of coping plan to overcome barriers	Coping planning	6	Item 15: "I already have concrete plans what to do in difficult situations to stick to my intentions (such as gastrointestinal symptoms)". (Extracted from qualitative study)
	Maintenance self-efficacy affects postoperative nutritional behavior	Self-efficacy	4	Item 18: "Even if the effect is not obvious in the short term (such as no weight gain), I can stick to the prescribed postoperative nutrition behavior". (Extracted from qualitative study)
	Recovery self-efficacy affects postoperative nutritional behavior	Self-efficacy	3	Item 22: "Even if I meet some uncomfortable situation because of the disease or treatment, I can stick to the prescribed postoperative nutrition behavior". (Extracted from qualitative study)

Yat-sen University Cancer Center, which are two top-ranked diagnosis and treatment hospitals for gastric cancer. The specific inclusion criteria were as same as those for the in-depth interviews described above.

According to the Kendall criterion, the sample size of item analysis and exploratory factor analysis (EFA) should be 5–10 times the number of the scale items, and a 10% loss to follow-up was considered.[17] A sample size of 150 for the item analysis and EFA was calculated. Because the data from the EFA could not be duplicated with the confirmatory factor analysis (CFA), considering the principle that the sample size of CFA should not be less than 200, a 10% loss to follow-up was considered.[18] CFA required at least 223 participants, resulting in 373 participants needed for psychometric tests. Finally, we enrolled 404 participants: 152 cases from July 2021 to December 2021 for item analysis and EFA; 252 cases from January 2022 to November 2022 for CFA.

Data collection

The first author recruited patients and collected data in one research center (Sun Yat-sen University Cancer Center), and the second author in the other research center (the Sixth Affiliated Hospital of Sun Yat-sen University). Questionnaires were distributed face-to-face by the investigators, after an explanation of the purpose of the study, and after obtaining informed consent. All questionnaires were completed by the patients themselves, or with assistance from the investigators if the patient did not understand the questionnaire well or had a physical disability. The investigators collected the questionnaires immediately after patients filled them out, and then examined the completeness of the questionnaires.

Research tools

Patients' general characteristics questionnaire was used to investigate the patients' demographic and sociological information, including sex, age, and education level, as well as disease-related information, such as tumor location. The first draft of the HAPA inventory was used for psychometric test.

Data analysis

The data were analyzed through SPSS version 25.0 and AMOS version 26.0 (IBM Corp., Armonk, NY, US). The demographic characteristics of the participants were calculated according to frequency (%), mean, and standard deviation using descriptive statistics. Details of the specific item analysis, validity and reliability testing methods are as follows:

Item analysis. In this study, critical ratio (CR), item-total correlation, Cronbach's α if item deleted, corrected item-total correlation (CITC), communalities value, and factor loading were used to analyze and screen the items.[17,19]

Validity test. Content and Construction validity were used to test the validity of the scale. Content validity was tested by six experts (2 nurses, 1 nursing professors, 1 nurse manager, 1 nutritionist, 1 gastric surgeon).

Table 2
Examples of items improvement through expert consultation.

	Items	Expert advice	Results
Example of merged items	"Even if the effect is not noticeable in the short term, I can still maintain a healthy diet Even if my weight does not increase immediately, I can still maintain a healthy diet"	The items are duplicate, it is recommended to merge them	"Even if the effect is not obvious in the short term (such as no weight gain), I can stick to the prescribed postoperative nutrition behavior."
Example of deleted item	"Malnutrition has a significant impact on my blood pressure and blood sugar levels".	It is recommended to delete, as blood pressure and sugar levels are not so relevant to the inventory's main theme	Deleted the item
Example of modified item	"I already have concrete plans to implement the prescribed postoperative nutrition behavior in various locations".	It is recommended to add some examples to make the situations clearer, e.g. at home, work, out to dinner, etc.	"I already have concrete plans to implement the prescribed postoperative nutrition behavior in various locations (e.g. at home, work, out to dinner, etc.)".

Table 3
Characteristics of study participants ($N = 404$).

Characteristics		*n*	%
Sex	Male	260	64.4
	Female	144	35.6
Age	< 40	19	4.7
	40~49	57	14.1
	50~59	143	35.4
	60~69	114	28.2
	≥ 70	71	17.6
BMI	< 18.5	67	16.6
	18.5–23.9	258	63.9
	≥ 24.0	79	19.6
Work status	Employed	122	30.2
	Unemployed[a]	282	69.8
Marital status	With spouse	340	84.2
	No spouse	64	15.8
Education	Primary school or below	63	15.6
	Junior high school	104	25.7
	High school	100	24.8
	College or above	137	33.9
Tumor location	Proximal	72	17.8
	Middle	126	31.2
	Distal	206	51.0
Pathological stage	I	130	32.2
	II	90	22.3
	III	139	34.4
	IV	45	11.1
Resection extend	Partial gastrectomy	291	72.0
	Total gastrectomy	113	28.0
Number of comorbid chronic diseases	0	106	26.2
	1–2	164	40.6
	≥ 3	134	33.2

[a] unemployed including homemaker and retired patients.

Theoretical and operational definitions of the concepts were presented to the six experts and, thereafter, they were asked to rate the clarity and relevance of each item on a four-point scale ranging from 4 (strongly relevant) to 1 (weakly relevant). The item-level content validity index (I-CVI) and the scale-level CVI (S-CVI/Ave) were calculated separately. The content validity of the scale was considered good if I-CVI ≥ 0.78 and S-CVI/AVE ≥ 0.9.[20]

Construct validity of the scale was evaluated by exploratory and confirmatory factor analyses. First, the total data were randomly classified into data set A ($n = 152$) and data set B ($n = 252$). The EFA was conducted with data set A and the CFA was conducted with data set B. Prior to the EFA, the Kaiser-Meyer-Olkin (KMO) index and Bartlett's sphericity test were applied to confirm that the data were appropriate for factor analysis. If the cumulative explanatory variation of common factors extracted in the exploratory factor analysis was > 50%, χ^2/df in the confirmatory factor analysis was < 3, the root mean square error of approximation (RMSEA) was < 0.1, and the confirmatory fit index (CFI), Tucker–Lewis index (TLI) and incremental fitting index (IFI) were > 0.9, the construct validity of the scale was considered to be good.[21–23]

Reliability test. Internal consistency reliability, split-half reliability, and test–retest reliability were used to test the reliability of the scale.[17]

For the test-retest reliability, a sample of 100 patients retook the scale 1 month after their first assessment. The test-retest reliability of the subscales of the questionnaire was assessed by Pearson correlation coefficients.

Results

Generation of the item pool

By comparing and analyzing the results derived from the literature review and interview data, the two attributes and eight elements were identified (Table 1). The item pool of 6 dimensions and 44 items with a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) were formed.

Item improvement through expert consultation

Of the 15 included experts aged 30–59 (44.93 ± 11.02) years with more than 7 years of work experience, 10 of them had titles of senior

Table 4
Results of Item analysis.

Item	CR	Item–total correlations	Cronbach's α if item deleted	CITC	Communality	Factor loading	Notes
1	7.172**	0.480**	0.899	0.430	0.217	0.466	Reserve
2	7.839**	0.525**	0.900	0.450	0.226	0.475	Reserve
3	9.269**	0.534**	0.900	0.458	0.229	0.479	Reserve
4	6.618**	0.543**	0.898	0.499	0.300	0.548	Reserve
5	4.028**	**0.242****	**0.905**	**0.167**	**0.034**	**0.185**	**Delete**
6	6.193**	0.534**	0.899	0.494	0.307	0.554	Reserve
7	6.421**	0.595**	0.898	0.560	0.382	0.618	Reserve
8	6.091**	0.439**	0.901	**0.370**	**0.164**	**0.405**	**Delete**
9	7.001**	0.551**	0.898	0.501	0.303	0.550	Reserve
10	8.507**	0.647**	0.896	0.595	0.410	0.641	Reserve
11	7.284**	0.603**	0.897	0.565	0.366	0.605	Reserve
12	9.644**	0.590**	0.898	0.523	0.334	0.578	Reserve
13	8.212**	0.594**	0.897	0.540	0.349	0.590	Reserve
14	10.158**	0.635**	0.896	0.593	0.395	0.629	Reserve
15	7.915**	0.600**	0.897	0.557	0.361	0.601	Reserve
16	6.612**	0.517**	0.899	0.465	0.264	0.513	Reserve
17	5.720**	0.498**	0.899	0.448	0.245	0.495	Reserve
18	5.823**	0.475**	0.900	0.416	0.220	0.469	Reserve
19	4.427**	0.478**	0.900	0.422	0.229	0.479	Reserve
20	7.602**	0.640**	0.896	0.598	0.438	0.662	Reserve
21	6.669**	0.602**	0.897	0.556	0.399	0.631	Reserve
22	6.650**	0.546**	0.898	0.503	0.314	0.560	Reserve
23	4.953**	0.466**	0.900	0.417	0.232	0.482	Reserve
24	6.896**	0.654**	0.896	0.613	0.469	0.685	Reserve
25	5.727**	0.517**	0.899	0.481	0.310	0.557	Reserve
26	6.078**	0.606**	0.897	0.569	0.399	0.632	Reserve
27	4.883**	0.516**	0.899	0.468	0.301	0.548	Reserve

Notes: 1–3: Risk perception, 4–8: Outcome expectancy, 9–13: Intention, 14–16: Action planning, 17–19: Coping planning, 20–27: Self-efficacy.
**$P < 0.01$.

associate or higher. The authority coefficient of the experts was 0.79. The response rates of 2 rounds of expert consultation were 93.75% and 100%, respectively. The Kendall harmony coefficients were 0.141 and 0.318. After 2 rounds of expert consultation, 13 items were merged 10 items were deleted, and 27 items were modified (Table 2) and remaining in the first draft of the HAPA inventory, using a 5-point Likert rating system, involving: strongly disagree = 1, disagree = 2, uncertain = 3, agree = 4, and strongly agree = 5.

Psychometric tests

Characteristics of the participants

A total of 404 postoperative gastric cancer patients, aged 52.77 ± 14.45 years, were enrolled in this study. 64.4% of them were male. The average body mass index (BMI) of the participants was 21.26 ± 2.68 kg/m^2. 72.0% of the participants received partial gastrectomy. Participants' characteristics are presented in Table 3.

Item analysis

Data from 152 cases from July 2021 to December 2021 were selected for item analysis. Item 5 had an item-total correlation coefficient of 0.242, falling short of the desired threshold of 0.4.[23] The Cronbach's α coefficient of the overall inventory was 0.902, and removing items 5 and 8 further increased this coefficient. The commonality of items 5 and 8 were 0.034 and 0.164, respectively, which were below the acceptable limit of 0.2.[17] Additionally, their CITC were 0.167 and 0.370, again failing to meet the required standard of 0.4.[23] Their factor loadings were 0.185 and 0.405, which should be more than 0.45.[17] These findings indicated that items 5 and 8 had low homogeneity with other items (Table 4). Consequently, item analysis led to the removal of item 5 ("If I follow the appropriate postoperative nutritional behaviors, the food won't taste good") and item 8 ("If I follow the appropriate postoperative nutritional behaviors, it will increase my financial burden"). After item analysis, the inventory included 25 items and 6 dimensions.

Table 5
Exploratory factor analysis.

Item No.	Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1: Self-efficacy							
16	Even if I have to learn more about nutrition, I can stick to the prescribed postoperative nutrition behavior[a]	**0.662**					
17	Even if I have to pay more attention to my diet, I can stick to the prescribed postoperative nutrition behavior[a]	**0.652**					
18	Even if the effect is not obvious in the short term (such as no weight gain), I can stick to the prescribed postoperative nutrition behavior[a]	**0.640**					
19	Even if I have to make nutrition plans by myself, I can stick to the prescribed postoperative nutrition behavior[a]	**0.671**					
20	Even if the food (and/or nutritional supplements) don't taste good, I can stick to it	**0.658**					
21	Even if it takes time to adjust to the postoperative changes, I can stick to the prescribed postoperative nutrition behavior[a]	**0.632**					
22	Even if I meet some uncomfortable situation because of the disease or treatment, I can stick to the prescribed postoperative nutrition behavior[a]	**0.662**					
23	Even if without the help of others (family or friends), I can stick to the prescribed postoperative nutrition behavior[a] by myself	**0.709**					
Factor 2: Coping planning							
13	I already have concrete plans when to especially watch out in order to stick to the prescribed postoperative nutrition behavior		**0.866**				
14	I already have concrete plans what to do if something intervenes		**0.883**				
15	I already have concrete plans what to do in difficult situations to stick to my intentions (such as gastrointestinal symptoms)		**0.925**				
Factor 3: Intentions							
7	For the next few weeks, I intend to take adequate dose of oral nutritional supplement			**0.849**			
8	For the next few weeks, I intend to get enough energy and protein (that is, try to keep the similar intake as the intake before the illness)			**0.819**			
9	For the next few weeks, I intend to eat small and frequent meals			**0.789**			
Factor 4: Action planning							
10	I already have concrete plans how to arrange the prescribed postoperative nutrition behavior				**0.845**		
11	I already have concrete plans when to start the prescribed postoperative nutrition behavior				**0.774**		
12	I already have concrete plans to implement the prescribed postoperative nutrition behavior in various locations (e.g., at home, work, out to dinner, etc.)				**0.781**		
Factor 5: Risk perception							
1	I'm more likely to become malnutrition					**0.679**	
2	Malnutrition can hinder recovery after surgery					**0.858**	
3	Inappropriate postoperative nutritional behavior can lead to the occurrence or development of malnutrition					**0.860**	
Factor 6: Outcome expectancy							
4	If I follow the prescribed postoperative nutrition behavior[a], I will not be worried about malnutrition						**0.815**
5	If I follow the prescribed postoperative nutrition behavior[a], it will help my postoperative recovery						**0.828**
6	If I follow the prescribed postoperative nutrition behavior[a], it will improve my quality of life						**0.638**

[a] For postoperative gastric patients, the prescribed postoperative nutrition behavior includes small and frequent meals (more than 6 meals a day), and adequate oral nutritional supplement in order to achieve adequate energy and protein intake per day (that is, keep the total daily intake similar as the intake before illness).

Validity

The content validity of the inventory was calculated based on the results of expert consultation. The item-level content validity index was 0.83–1.00, and the scale-level content validity index (S-CVI/AVE) was 0.98, which indicated that the content validity of the inventory was good.

In the exploratory factor analysis, the KMO index was 0.849 and the Bartlett spherical test reached statistical significance ($\chi^2 = 2127.041$, $P < 0.001$), indicating that the data were appropriate for factor analysis. After principal component analysis and varimax rotation, six factors were extracted, whose eigenvalue for the initial load matrix was > 1, and which accounted for 67.254% of the total variance. Two items with a communality of less than 0.4 were further deleted: "For the next few weeks, I intend to eat more healthily" and "I already have concrete plans how to deal with relapses into my old eating habit". Consequently, 23 items and 6 dimensions were confirmed (Table 5). The cumulative proportion of variance was 70.676%.

The construct validity of the scale was further verified by CFA. The results showed that each fitting index in the model met the statistical requirements, indicating that the overall fit of the model was good, with $\chi^2 = 370.794$, $df = 214$, and $\chi^2/df = 1.733$. Additionally, the RMSEA, CFI, TLI and IFI were 0.054, 0.943, 0.933, and 0.944, respectively. All indexes were within the acceptable range. The path coefficients ranged from 0.68 to 0.90; all path coefficients were statistically significant ($P < 0.01$). The model structure is shown in Fig. 2.

Reliability

Cronbach's α for this scale was 0.915. The split-half reliability was 0.757. The test–retest reliability was 0.835 (all the above $P < 0.001$).

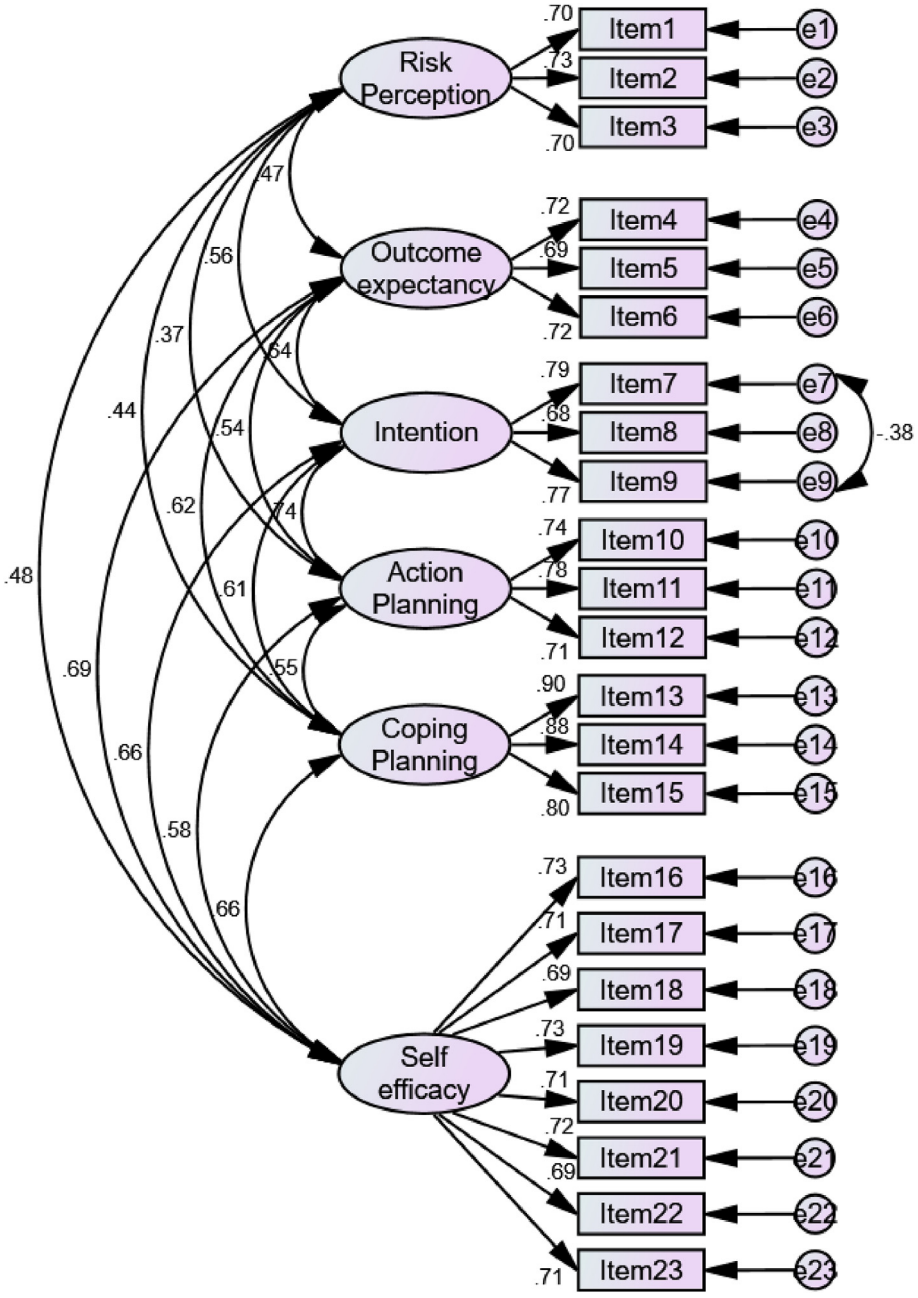

Fig. 2. Confirmatory factor analysis (CFA) measurement invariance (MI) model fit plot.

Discussion

In this study, we developed and validated the HAPA inventory for cognitive beliefs of home nutritional behavior in postoperative gastric cancer patients. The 23-item inventory is a comprehensive tool including all HAPA constructs which are risk perception, outcome expectancy, self-efficacy, intention, action planning, coping planning.[9]

When constructing the item pool, qualitative research was conducted to clarify the structural composition of the scale and expanded the operational definition of the HAPA concepts in home nutritional behavior of postoperative gastric cancer patients. Previous related studies on home nutritional behaviors of postoperative gastric cancer patients and HAPA assessment tools were combined to develop the items. These items were generated from the previous HAPA-based scales[11–13] and perspective of postoperative gastric cancer patients, and verified by the published literature in the field of expertise. This approach not only conforms to the principles of measurement tool development, but also ensures the content validity of the tool.[24]

The items were verified using the Delphi expert consultation method. Experts from different majors in the field of health management of gastric cancer provided suggestions for item optimization from different perspectives, which strengthens the content validity of the scale.[25]

In this study, we used a variety of methods to verify whether our HAPA questionnaire had the appropriate psychometric properties. Exploratory and confirmatory factor analyses supported the evidence for the construct validity of the scale.[17] This scale extracted six factors through EFA, and the cumulative explanatory variables of the six factors were 70.676%. The model was tested using CFA, which showed a good fit between the model and the data. An RMSEA less than 0.06 is considered a close fit, the CFI, IFI, and TLI of the obtained model are all greater than 0.90, and the values of χ^2/df and RMSEA also supported the acceptable fit of the model. As for the content validity, the I-CVI for the 23 items being 0.83–1.00, S-CVI/AVE being 0.98 (I-CVI $\geq$ 0.78, and S-CVI/AVE $\geq$ 0.9 indicate good content validity). The good content validity of the scale indicated that the content actually measured by the scale was highly consistent with the content to be measured.[20] The questionnaire also showed good reliability with Cronbach's α greater than 0.9. The split-half reliability was 0.947, indicating that the internal consistency of the scale was good. The test–retest reliability of the scale was 0.716 ($>$ 0.7), demonstrating that the scale has good cross- time stability.[17]

From the above results, it can be seen that the inventory we developed is an effective and reliable tool for evaluating the HAPA-related factors influencing home nutritional behavior of postoperative gastric cancer patients. Numerous studies have shown that postoperative gastric cancer patients suffer from inadequate nutritional behavior and therefore leading to inadequate nutritional intake, malnutrition, and ultimately, influencing patients' prognosis.[3,5] How to better manage nutritional behavior is one of the important issues faced by postoperative gastric cancer patients.[6] In the practice of nutrition management in these patients, the inventory we developed can capture significant cognitive belief determinants of improving patients' nutritional behavior based on the HAPA framework. And based on this, we could design targeted interventions to improve their nutritional behavior.[8] And this inventory could also provide validated measures in assessing the effect of the HAPA-based intervention.

Limitations

This study has several limitations. First, owing to the lack of gold standards, we did not test the criterion validity. Future research should aim to establish or identify appropriate gold standards for testing criterion validity to strengthen the reliability of the findings. Moreover, the investigations were conducted only in two tertiary hospitals, which may limit the wider applicability of the findings. Future studies should consider including a more diverse range of hospitals, including secondary and primary care settings, to enhance the generalizability of the results.

Conclusions

This study developed and validated an inventory for measuring the significant cognitive belief determinants of adequate nutritional behavior for postoperative gastric cancer patients. This inventory contains 23 items with six dimensions (risk perception, outcome expectancy, self-efficacy, intention, action planning, coping planning), yielding valid and reliable results. The applicability of this inventory in different social or cultural back grounds should be further investigated.

CRediT authorship contribution statement

Xiaohan Jiang: Conceptualization, Methodology, Data curation, Formal analysis, Writing - Original and Revised draft preparation. **Jiamin Chen:** Conceptualization, Methodology, Formal analysis, Writing- Original draft preparation, **Xiuhong Yuan:** Conceptualization, Methodology, Formal analysis, Writing- Original draft preparation, **Yonghe Chen:** Methodology, Formal analysis, Writing-Original draft preparation, **Qian Sun:** Methodology, Formal analysis, Writing- Revised draft preparation. **Hui Zhao:** Methodology, Investigation, Formal analysis; **Peirong Xu:** Formal analysis, Writing-Original draft preparation. **Ting Luo,** Methodology, Investigation, Formal analysis. **Junsheng Peng:** Conceptualization, Methodology, Supervision, Resources, and Project administration. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethics statement

The study protocol was approved by the Research Ethics Committee of Sun Yat-sen University (IRB No. L2022SYSU-HL-045). All enrolled patients were informed about the aim and methodology of the study, and informed consent was obtained from them.

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Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

Declaration of competing interest

The authors declare no conflict of interest.

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References

1. Bray F, Laversanne M, Sung H, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA A Cancer J Clin*. May-Jun 2024;74(3):229–263. https://doi.org/10.3322/caac.21834.
2. Sun W, Haller DG. Recent advances in the treatment of gastric cancer. *Drugs*. 2001; 61(11):1545–1551. https://doi.org/10.2165/00003495-200161110-00002.
3. Taleghani F, Ehsani M, Farzi S, et al. Nutritional challenges of gastric cancer patients from the perspectives of patients, family caregivers, and health professionals: a qualitative study. *Support Care Cancer : official journal of the Multinational Association of Supportive Care in Cancer*. Jul 2021;29(7):3943–3950. https://doi.org/10.1007/s00520-020-05951-7.
4. Deftereos I, Yeung JMC, Arslan J, et al. Assessment of nutritional status and nutrition impact symptoms in patients undergoing resection for upper gastrointestinal cancer: results from the multi-centre NOURISH point prevalence study. *Nutrients*. Sep 24 2021;13(10). https://doi.org/10.3390/nu13103349.
5. Kubota T, Shoda K, Konishi H, Okamoto K, Otsuji E. Nutrition update in gastric cancer surgery. *Annals of gastroenterological surgery*. Jul 2020;4(4):360–368. https://doi.org/10.1002/ags3.12351.
6. Hsu PI, Chuah SK, Lin JT, et al. Taiwan nutritional consensus on the nutrition management for gastric cancer patients receiving gastrectomy. *J Formos Med Assoc = Taiwan yi zhi*. Jan 2021;120(1 Pt 1):25–33. https://doi.org/10.1016/j.jfma.2019.11.014.
7. Sun V, Kim J, Kim JY, et al. Dietary alterations and restrictions following surgery for upper gastrointestinal cancers: key components of a health-related quality of life intervention. *Eur J Oncol Nurs*. Aug 2015;19(4):343–348. https://doi.org/10.1016/j.ejon.2015.01.008.
8. Zhang CQ, Zhang R, Schwarzer R, Hagger MS. A meta-analysis of the health action process approach. *Health Psychol : official journal of the Division of Health Psychology, American Psychological Association*. Jul 2019;38(7):623–637. https://doi.org/10.1037/hea0000728.
9. Schwarzer R. Modeling health behavior change: how to predict and modify the adoption and maintenance of health behaviors, 57(1):1-29 https://doi.org/10.1111/j.1464-0597.2007.00325.x; 2008.
10. Renner B, Schwarzer R. Risk and health behaviors: documentation of the scales of the research Project "risk appraisal consequences in Korea" (RACK). *Risk and Health Behaviors: Documentation of the Scales of the Research Project "Risk Appraisal Consequences in Korea"(RACK)*. 2005:1–55, 01/01.
11. van Nes KA, van der Ark LA, van Loveren C, Aartman IHA. Construction of a questionnaire based on the Health Action Process Approach for psycho-social cognitive determinants of parents in brushing children's teeth in The Netherlands. *PLoS One*. 2023;18(8):e0289337. https://doi.org/10.1371/journal.pone.0289337.
12. Lin H, Lin H, Zhang L, et al. Development and psychometric assessment of Health Action Process Approach (HAPA) in terms of smoking cessation among Chinese smokers. *Sci Rep*. Feb 19 2024;14(1):4056. https://doi.org/10.1038/s41598-024-54404-2.
13. Rohani H, Eslami AA, Ghaderi A, et al. Validation and psychometric evaluation of physical activity belief scale among patients with type 2 diabetes mellitus: an application of health action process approach. *Health Promot Perspect*. 2016;6(2): 71–79. https://doi.org/10.15171/hpp.2016.13.
14. DeVellis RF. *Scale Development: Theory and Applications*. SAGE Publications; 2016.
15. Assarroudi A, Heshmati Nabavi F, Armat MR, Ebadi A, Vaismoradi M. Directed qualitative content analysis: the description and elaboration of its underpinning methods and data analysis process. *J Res Nurs : JRN*. Feb 2018;23(1):42–55. https://doi.org/10.1177/1744987117741667.
16. He H, Zhou T, Zeng D, Ma Y. Development of the competency assessment scale for clinical nursing teachers: results of a Delphi study and validation. *Nurse Educ Today*. Jun 2021;101:104876. https://doi.org/10.1016/j.nedt.2021.104876.
17. Mokkink LB, Terwee CB, Patrick DL. *The COSMIN Checklist Manual*. 2009.
18. Alavi M, Visentin DC, Thapa DK, Hunt GE, Watson R, Cleary M. Chi-square for model fit in confirmatory factor analysis. *J Adv Nurs*. Sep 2020;76(9):2209–2211. https://doi.org/10.1111/jan.14399.
19. Takeda T, Yoshimi K, Kai S, Inoue F. Development and psychometric testing of a new short-form of the premenstrual symptoms questionnaire (PSQ-S). *Int J Wom Health*. 2022;14:899–911. https://doi.org/10.2147/IJWH.S369151, 07/14.
20. Shi J, Mo X, Sun Z. [Content validity index in scale development]. *Zhong nan da xue xue bao Yi xue ban = Journal of Central South University Medical sciences*. Feb 2012;37(2):152–155. https://doi.org/10.3969/j.issn.1672-7347.2012.02.007.
21. Strauss ME, Smith GT. Construct Validity: Advances in Theory and Methodology. (1548-5951 (Electronic)).
22. Kang H. A guide on the use of factor analysis in the assessment of construct validity. *J Korean Acad Nurs*. 2013;43:587–594. https://doi.org/10.4040/jkan.2013.43.5.587, 10/01.
23. Wu M. *Questionnaire Statistical Analysis and Practice—SPSS Operation and Application*. Chongqing: Chongqing University Press; 2011.
24. Brédart A, Marrel A, Abetz-Webb L, Lasch K, Acquadro C. Interviewing to develop Patient-Reported Outcome (PRO) measures for clinical research: eliciting patients' experience. *Health Qual Life Outcome*. Feb 5 2014;12:15. https://doi.org/10.1186/1477-7525-12-15.
25. Humphrey-Murto S, Varpio L, Wood TJ, et al. The use of the Delphi and other consensus group methods in medical education research: a review. *Acad Med*. 2017; 92(10).