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Original Article

# Psychometric validation of the modified Chinese version of the personalized psychological flexibility index in patients with cancer

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ABSTRACT

*Objective:* The aim of this study was to perform across-cultural adaptation of the English version of the personalized psychological flexibility index (PPFI) into Chinese, and to evaluate its psychometric properties in patients with cancer.

*Methods:* This study was conducted in two phases. In phase 1, we followed Beaton's guidelines for cross-cultural adaptation of PPFI. In phase 2, we conducted a cross-sectional study to assess the validity and reliability of the PPFI among a total of 455 patients with cancer in Hunan Province of China. Item analysis was used to evaluate and screen items, while content validity, construct validity, convergent validity, and concurrent validity were used to evaluate the validity. Reliability was assessed using Cronbach's α coefficient, retest reliability, and composite reliability.

*Results:* The item-level content validity index of the modified Chinese version of PPFI (PPFI-C) ranged from 0.89 to 1.00, the scale-level CVI/universal agreement was 0.87, and the S-CVI/average was 0.99. Exploratory factor analysis identified a 14-item, three-factor structure of PPFI (item 11 deleted). Confirmatory factor analysis showed $\chi^2/df = 2.42$, RMSEA = 0.07, GFI = 0.92, NFI = 0.91, TLI = 0.93, CFI = 0.95, and IFI = 0.95. PPFI-C demonstrated positive correlations with the 8-item Commitment Action Questionnaire, and negative correlations with Acceptance and Action Questionnaire-II, Hospital Anxiety and Depression Scale, and Short Form Quality Life Scale. The Cronbach's α coefficient of modified PPFI-C stood at 0.84.

*Conclusions:* The results suggest that the 14-item PPFI-C is a reliable and valid tool for measuring PF in Chinese patients with cancer. However, additional studies are needed to validate the psychometric properties of PPFI-C in other populations.

## Introduction

Psychological flexibility (PF) is a key contributor to overall health and well-being, as it enables individuals to pursue worthwhile life goals despite the presence of distress. PF consists of six key components such as cognitive integration, acceptance, staying present in the moment, viewing the self as a context, and taking committed action. These components help individuals develop effective coping strategies when faced with negative thoughts, memories, and emotions.[1,2] PF can also help patients reduce the degree of experiential avoidance (EA), defined as "the tendency to avoid negative internal experiences,"[3] allowing them to be more adaptable in their behavior, better move toward their value goals, and create a more fulfilling and meaningful life.[4] Patients with high PF tend to accept unpleasant emotions, memories, or physical pain and pay less attention to controlling the form or frequency of uncomfortable internal states. They are also more likely to stay away from intrusive thoughts that can affect their functioning (eg, cognitive fusion) and keep pleasure maximized and unpleasantness minimized.[5] On the other hand, patients with low PF tend to indulge in negative memories, emotions, or pain and are more prone to escape these experiences altogether. In

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extreme cases, such as critical illness strikes, patients with low PF often struggle to manage and cope with painful thoughts and feelings caused by illness and may lose their motivation for engaging in value-seeking activities. Such performance is a sign of lack of PF, whose end point is psychological rigidity or inflexibility, often indicative of psychopathology (such as anxiety and depression).

Cancer is a critical illness affecting patients' physical and psychological well-being. Of all those diagnosed with cancer, approximately one-third are susceptible to developing mental health comorbidities, such as major depression, generalized anxiety disorder, or adjustment disorder. Previous studies have shown that patients with cancer, who are burdened with both physical and psychological pressure, often struggle to control and escape from distress, leading to a loss of motivation and enthusiasm to pursue the value of life, implying a lack of PF.[6,7] Therefore, it is urgent to improve the PF of patients with cancer. Numerous studies have found that PF is associated with improved coping abilities and enhanced overall well-being in patients with cancer, including their physical health, quality of life, and emotional state.[7–9] For instance, Berrocal conducted a study on 70 patients with breast cancer at an Italian hospital cancer center, assessing their PF and levels of anxiety, depression, and negative and positive emotions using self-reported measures at baseline and 6 months later. The results showed that higher PF at baseline significantly helped predict lower levels of anxiety, depression, and negative affect at the follow-up assessment.[10] McAteer et al. examined the PF of men living with prostate cancer and found that PF moderated the predictive effect of both physical symptoms of prostate cancer and masculine self-esteem in predicting distress levels.[11] The quantitative evaluation of PF is of great importance to predict individuals' psychological state and quality of life and formulate corresponding intervention measures.

At present, there are several scales used to assess PF, which can be divided into indirect and direct measures. The indirect measures of PF include the Acceptance and Action Questionnaire (AAQ-II),[12] the Cognitive Fusion Questionnaire (CFQ),[13] and the Comprehensive Assessment of ACT process (CompACT).[14] The AAQ-II and CFQ measure the EA and cognitive fusion, respectively, so as to indirectly reflect individuals' PF. Although CompACT takes into account the six aspects of PF, it is still measured from a model of psychological inflexibility. Hence, it can be seen that the most commonly used tools for quantitative measurement of PF are a direct reflection of psychological inflexibility. Acceptance commitment therapy (ACT) argues that psychological inflexibility disrupts the process of PF, resulting in individuals' inability to connect with the present in a flexible manner. As such, psychological inflexibility will inevitably lead to a low level of PF although research has yet to prove that individuals with low levels of PF necessarily exhibit psychological inflexibility.[15] The Commitment Action Questionnaire (CAQ) directly measures PF by focusing on commitment action as a key aspect.[16] However, it assesses PF from a single dimension that fails to fully reflect the state of PF. Furthermore, these existing tools for measuring PF overlook the most important part of the PF definition: the willingness to endure distress while pursuing worthy goals.[5] Therefore, there is an urgent need for a value-goal-oriented psychological assessment tool to measure PF.

In 2020, Kashdan et al. developed the personalized psychological flexibility index (PPFI), which is a reflective self-report index designed to measure how individuals cope with uncomfortable internal states and external obstacles in the pursuit of worthwhile goals. It considers why people are willing to manage painful value goals and relates adaptive emotions, daily goals and life struggle pursuits to stressful events.[5] PPFI consists of three dimensions: avoidance (avoiding negative emotions associated with achieving meaningful goals), acceptance (accepting setbacks or negative emotions encountered in the pursuit of goals), and harnessing (using problems or negative emotions to motivate oneself to pursue meaningful goals),[15] in which participants are requested to think of an important personal goal and respond to the items based on this goal. It has shown good reliability and validity among college students, adults in the community, and working professionals.[5] In 2021, Akbari translated the English version of PPFI into Persian and evaluated its psychometric properties in a community sample of Iranians, showing a good model fit, internal consistencies as well as excellent divergent validity from negative emotionality.[17] Cherry et al.'s review indicated that compared with AAQ-II and CAQ, PPFI is the most superior instrument available for measuring PF.[18] PPFI emphasizes more on PF utilizing painful emotions to pursue worthy goals in the presence of suffering. This new finding highlights the importance of distinguishing between avoidance and acceptance (as opposed to treating them as endpoints on a single continuum)[19] and recognizing the wisdom of using so-called negative emotions, such as anxiety and anger, to facilitate goal pursuit.[20,21] In addition to predicting less difficulty and greater effort and progress in goal pursuit, PPFI generates stronger happiness that encompasses joy, meaning, a sense of control, competence, autonomy, and a wide range of positive emotions, while also reducing negative emotions.[5]

Given the importance of PF for enhancing well-being, it is crucial to provide adequate and psychometrically sound measurements in studies to promote health-related outcomes. However, PPFI, which introduces a new dimension called harnessing to capture the ability of individuals to use certain forms of suffering as fuel to achieve their goals in specific contexts,[20] has not yet been introduced to China. With its robust psychometric performance, PPFI can customize goals to match the specific characteristics of the target population while connecting distress or negative emotions to a personalized and valuable goal, surpassing the familiar theoretical framework of ACT.[17] This study seeks to introduce PPFI into China and to psychometrically assess self-reported PPFI scores in a patient with cancer sample, so as to enable the application of the PPFI in China and provide a valid and reliable measurement tool for PF.

## Methods

### *Study design*

This study consisted of two phases. First, the English version of PPFI was translated into simplified Chinese and a cross-cultural adaptation was conducted. Second, psychometric properties were measured by a cross-sectional survey. Cross-cultural adaptation and psychometric properties designed for convenience sampling were used in this study and verified in patients with cancer in China.

### *Phase 1: Cross-cultural adaption*

#### *Translation and synthesis*

The original developer of PPFI was contacted via email and permission was obtained to translate the English version of PPFI into Chinese. In strict accordance with Beaton's guidelines,[22] this stage was divided into five steps: translation, synthesis, back translation, expert committee review, and pretesting. Two native Chinese translators proficient in English independently completed the forward translation from English to simplified Chinese. One of the translators had expertise in PF and psychological research, while the other was an English teacher without psychological background. The two translators weighed the two versions verbatim and merged them into one version after reaching a consensus. The synthesis process was documented by a third person who recorded each issue and its resolution by consensus.

#### *Back translation*

This version was then translated back into English by two native English speakers with no psychological background to avoid information bias and ensure that the meaning of the original scale was correctly expressed.

#### *Expert committee review*

Two rounds of expert consultation were conducted using the Delphi method, with inclusion criteria requiring a minimum of 10 years of

experience in psychology-related clinical consultation and research work, an associate high or above title, and a master's degree or above. Twelve experts were invited to evaluate the degree of relevance and importance of each item, using a four-point Likert scale ranging from 1 (not relevant) to 4 (very relevant) and a five-point Likert scale from 1 (not important) to 5 (very important).

*Pilot testing*

Twenty patients with cancer from the aforementioned hospitals were randomly selected as research objects to test the comprehensibility of the PPFI-C. Patients took about 10–15 min to complete the questionnaire, and the feedback from patients was positive. The questionnaire was considered smooth and easy to understand, with no instances of incomprehension or misunderstanding noted.

*Phase 2: Psychometric testing*

*Sample*

Convenient sampling was performed at a cancer hospital in Hunan Province, China, between October and December 2022. The hospital is equipped with 1490 beds and serves approximately 444,159 outpatients and emergency patients annually from surrounding urban and rural areas. To ensure an appropriate sample size, the Kendall sample estimation method was used, which recommends that the sample size be 5–10 times larger than the number of items in the scale.[23] It was also considered that there might be a 20% invalid questionnaires in the sample recovery process. As PPFI consists of 15 items, the sample size was ranged from 94 to 188 for exploratory factor analysis (EFA). The data from EFA cannot be repeated for confirmatory factor analysis (CFA). According to the principle that the sample size of CFA should be no less than 200 and should be greater than that of EFA,[24,25] it is calculated that 250 is required for CFA. Therefore, a minimal of 344 patients with cancer participated in the questionnaire survey. The inclusion criteria were as follows: (1) malignancy confirmed by pathological results; (2) $\geq$ 18 years of age; and (3) clear consciousness and normal cognitive function. Patients with mental illness, visual, hearing, communication, or reading impairments, as well as those with serious illnesses, were excluded. To obtain retest reliability, a second questionnaire was administered to 10% of the total sample size randomly selected from the sample two weeks later.

*Study instruments*

*Self-designed demographic and clinical characteristics questionnaire.* The study team compiled the general demographic data (age, gender, marital status, education level, economic status, etc.) and disease-related information (tumor location, tumor stage, and treatment methods). The age categories were based on the World Health Organization (WHO) standard, dividing participants into young people (18–44 years old), middle-aged people (45–59 years old), and elderly people (over 60 years old).[26] The marital status included unmarried, married, divorced, or widowed, while education level was categorized as illiterate or primary school, secondary school, senior high school or junior college, and bachelor degree or above. Tumor location included intracranial tumor, head-neck tumors, breast tumor, respiratory tumors, digestive system tumors, tumors of the urinary system, and gynecological tumor, and tumor stage ranged from I to IV. Treatment methods included operation, chemotherapy, radiotherapy, and targeted/biological immunotherapy.

*Chinese version of personalized psychological flexibility index (PPFI-C).* The PPFI, developed by Kashdan et al, in 2020, was used to measure the way people respond to uncomfortable internal states and external obstacles in the pursuit of valued goals.[5] The PPFI includes three dimensions of acceptance, avoidance, and harnessing, with a total of 15 items. Participants rated their level of agreement on a Likert 7-level scale, with scores from 1 to 7, representing "completely disagree" to "fully agree," respectively. The avoidance subscale was reverse scored. In a sample of adults from 303 communities in the Mid-Atlantic region of the United States, the Cronbach's ɑ coefficient for the total scores was 0.84, and the retest reliability was 0.59. The CFA model fit was satisfactory ($\chi^2 = 222.99$, $P < 0.001$, RMSEA = 0.07, SRMR = 0.07, TLI = 0.90, CFI = 0.92).

*The Acceptance and Action Questionnaire II (AAQ-II).* AAQ-II, consisting of seven entries and formed from the revision of AAQ developed by Bond et al, in 2011, was used to measure psychological inflexibility, defined as "rigid dominance of psychological reactions over chosen values and contingencies in guiding actions."[10] At the same time, the Likert 7-level scoring method was adopted, with points from 1 to 7 indicating "never" to "always" A higher the score indicates a higher degree of experience avoidance and worse PF of the individual. Cao Jing introduced it to China in 2013 and verified among college students.[19] Its internal consistency coefficient stood at 0.88, and its retest reliability at 0.80. The Cronbach's α coefficient in this study was 0.94.

*The 8-item committed Action Questionnaire (CAQ-8).* The CAQ-8, developed by Mc Cracken in 2015 as a simplified version to CAQ-24 in 2013, measures PF using both positive and negative dimensions.[16,27] The Likert 7-level scoring method is also used, with "never" to "always" counted as 0–6 points, respectively, and negative items scored in reverse. A higher score indicates a better PF. In 664 chronic pain patients, the total Cronbach's α coefficient was 0.87, and the retest reliability was 0.86. Wang Fen introduced it to China in 2020 and applied it to 266 elderly patients with chronic pain.[15] The total Cronbach's α was 0.89, and the Spearman–Brown coefficient was 0.93. The retest reliability ranged from 0.70 to 0.94, with good criterion-related validity. The Cronbach's α coefficient in this study was 0.86.

*Hospital Anxiety and Depression Scale (HADS).* HADS is an international self-rating scale developed by Zigmond and Snaith to screen inpatients for nonpsychotic symptoms of anxiety and depression.[28] It consists of 14 items, with each item scoring 0–3 points. The scale is divided into two subscales: Self-rating Anxiety Scale (SAS) and Self-rating Depression Scale (SDS). Scores of the two subscales are classified as asymptomatic (0–7), suspicious symptoms (8–10), and symptomatic (11–21). The internal consistency coefficient of the total scale was 0.89, and the Cronbach's α coefficient in this study was 0.93.

*Short form quality Life Scale (SF-12).* The SF-12 scale is a simplified version of SF-36, a universal concise health-related Quality of Life Scale developed by the Institute of Health Education in Boston, USA.[29] The SF-12 is used to evaluate physiological and psychological conditions, and consists of 12 items, including 8 dimensions: physical component summary (PCS), physiological function (RP), vitality state (VT), social function (SF), body pain (BP), emotional function (RE), mental health (MH), and general health (GH). Each item is scored on a Likert 5 level and converted into a standard value score. The scale can be summarized into two comprehensive indicators: physical component summary (PCS) and mental component summary (MCS). The total score ranges from 0 to 100 points, and the higher the score indicates that the better the subjective feeling of the survey subjects is, the better the life quality becomes. The Cronbach's α coefficient of the total volume table was 0.84, and the Cronbach's α coefficient in this study was 0.85.

*Data collection*

Data from phase 2 were collected between October and December 2022. All researchers underwent uniform training. After screening patients with pathologically diagnosed malignancies through electronic medical records, researchers explained the purpose of the study, obtained informed consent and guided the patients on how to complete the

questionnaire. About one-third of the patients with cancer had poor vision and insufficient literacy, and the researchers assisted them in understanding the items and recording their answers objectively. To evaluate the test–retest reliability, 45 patients who had completed the questionnaire were randomly selected to complete a second questionnaire through telephone interview 2 weeks later.

*Data analysis*

The data were analyzed using IBM SPSS version 26.0 and SPSS AMOS version 26.0. Continuous variables that fit the normal distribution were reported as mean (SD), and categorical variables were reported as whole numbers and proportions.

*Item analysis*

The item analysis was used to evaluate and screen items. The total PPFI scores of the sample size were sorted using Excel, and the 27% with the lowest and 27% with the highest scores were categorized as the low and high groups, respectively.[30] The data from both groups were then imported into IBM SPSS software, and a normality test was conducted. If the data were normally distributed, the two independent-samples *t*-tests and Pearson correlation method would be selected. Otherwise, the Wilcoxon rank sum test and Spearman correlation method would be selected. If $P > 0.05$, it indicates that the coefficient between this item and other items was too small, and therefore, the item would be eliminated. The Pearson correlation method was used to calculate the correlation between each item and the total score of the scale, and the correlation coefficient greater than 0.3 and $P < 0.05$ were used as the criteria for screening items.

*Content validity*

First, the Kendall coordination coefficient was used to reflect the coordination degree of expert opinions. Second, the content validity index (CVI) was divided into item-level content validity index (I-CVI) and scale-level content validity index (S-CVI). I-CVI was calculated by summarizing the number of experts who rated each item as 3 or 4, divided by the total number of experts. The S-CVI includes two components: S-CVI/UA (universal agreement), the proportion of items on the scale for which all experts gave a relevance rating of 3 or 4; and S-CVI/Ave (average), the average of the I-CVIs for all items on the scale. According to Polit and Beck,[31] an I-CVI greater than 0.80, an S-CVI/UA greater than 0.80, and an S-CVI/Ave greater than 0.90 indicate good content validity.

*Construct validity*

*Exploratory factor analysis (EFA).* Kaiser-Meyer-Olkin (KMO) and Bartlett spherical test were performed using IBM SPSS 26.0 statistical software to verify the authenticity and reliability of the data. A KMO value greater than 0.70 and significance less than 0.05 indicated a strong correlation between the observed variables, which is suitable for factor analysis. Factors were extracted using the principal component analysis, and the eigenvalue greater than 1.00 was used as the criteria for interception factors. The maximum variance orthogonal rotation method was used for analysis.[32]

*Confirmatory factor analysis (CFA).* CFA was performed by importing data into SPSS AMOS version 26.0 to establish a preliminary model and then fitting the model to further test the structure of PPFI-C. The following indices were used to evaluate the model fit: Chi-square freedom ratio (CMIN/df) $< 3.00$, comparative fit index (CFI) $> 0.90$, normal of fit index (NFI) $> 0.90$, goodness-of-fit index (GFI) $> 0.90$, and root-mean-square error of approximation (RMSEA) $< 0.08$.[33]

*Converge validity and concurrent validity*

Converge validity refers to the degree of similarity of measurement results when different measurement methods are used to measure the same feature. In other words, different measurement methods should be aggregated in the determination of the same feature. In this study, CAQ-8 was used to measure the convergent validity of PPFI. AAQ-II, HADS, and SF-12 were taken as the concurrent validity of the criterion-related validity of PPFI. Pearson correlation coefficient was used to evaluate the convergent validity and concurrent validity. Generally, $r \geq 0.60$ indicates strong correlation between scales, $0.30 < r < 0.60$, moderate, and $r \leq 0.30$, weak.

*Cronbach's α coefficient*

Cronbach's α coefficient and retest reliability were used to assess PPFI reliability. Cronbach's α coefficient was used to evaluate the internal consistency of each dimension of the scale, including acceptance, avoidance, and harnessing. Internal consistency coefficients were calculated for the total table and each of the three dimensions. Cronbach's α coefficient $\geq$ 0.70 was considered an acceptable internal consistency level.[34]

*Retest reliability*

Retest reliability referred to the degree of consistency of measurement results of the same group of study population at different times. The 445 patients were assigned numbers according to their recruitment order. Random numbers were generated for each participant using Excel, ranging from 1 to 455. The random numbers were rearranged in descending order, and the first 45 participants were selected. To evaluate the reliability of the scale over time, 45 patients (10% of the total sample size) were retested after 14 days, and the Pearson correlation coefficient was used for evaluation. A value of $r \geq 0.70$ indicates strong temporal stability of the scale.[35]

*Composite reliability*

Composite reliability (CR) refers to the reliability of a composite variable, which is a new variable composed of more than one variable. The higher the CR value, the greater the degree of correlation between the items in the group and the greater the consistency of the underlying factors being measured. In general, CR values should be greater than 0.60.

*Ethical considerations*

The study was approved by Xiangya School of Nursing, Central South University (IRB No. E2022148). All participants were informed of the study purpose, content, confidentiality considerations, and anonymity before the investigation. The investigators will assist them to complete the questionnaire, and unified, standard instructions were used during the survey to explain items they did not understand. All participants provided written informed consent.

## Results

*Phase 1: Cross-cultural adaption*

Four bilingual experts were invited to translate the English version of PPFI into Chinese, and 12 experts were invited to review the translation for enhanced professionalism. In terms of cross-cultural adaptation, 20 patients with cancer were invited to assess the read ability and comprehensibility of the translated questionnaire. Based on expert opinions and sociocultural factors, minor adjustments were made to the translated questionnaire. Specifically, the phrase “this goal” in items 2 and 13 was replaced with “intended goal” to refer to the goal filled in the guidance. The word “can” was added before “accept” in entries 6 and 9 for emphasis, and “harnessing” was translated as “utilization”. Furthermore, item 11 “my frustration serves to energize me” was revised to “I will become increasingly brave” to accommodate Chinese conventions.

*Phase 2: Psychometric testing*

*Demographic characteristics*

The 195 samples for EFA and 260 samples for CFA were collected at different times and not from the same sample. A total of 455 patients

were included in this study, with an average PPFI-C score of 66.32, and an average age of 54.13 years. The male/female percentage was 47.5%–52.5%, and the majority of patients (93.0%) were married. Most patients had varying degrees of education, and 82.9% had a monthly household income of less than ¥5000. Additionally, 96.0% were supported by various insurance policies, 65.9% had advanced cancer, and 54.5% mainly received chemotherapy (Table 1).

*Item analysis*

The total PPFI scores were sorted in ascending order into high and low subgroups based on the upper 27% and lower 27%. An independent sample *t*-test was performed on both groups (Table 2), and the results showed that all 15 PPFI items had a $P$ value $< 0.05$, and there were significant differences between high and low subgroups of Q1-Q15, indicating good item differentiation. The Pearson correlation coefficient between each item and the total score of the scale was 0.55–0.80, all of which were less than 0.30, and $P$ value was less than 0.01.

**Table 1**
Sociodemographic characteristics of the participants ($n = 455$).

| Variable | Participants, *n* (%) |
|---|---|
| Gender | |
| Male | 216 (47.5) |
| Female | 239 (52.5) |
| Age (years) | |
| 18–44 | 80 (17.6) |
| 45–59 | 235 (51.6) |
| ≥ 60 | 140 (30.8) |
| Marital status | |
| Unmarried | 12 (2.6) |
| Married | 423 (93.0) |
| Divorced or widowed | 20 (4.4) |
| Education level | |
| Illiterate or primary school | 114 (25.1) |
| Secondary school | 212 (46.6) |
| Senior high school or junior college | 87 (19.1) |
| Bachelor degree or above | 42 (9.2) |
| Per capita household income monthly (RMB) | |
| < 1000 | 130 (28.6) |
| 1000–4999 | 247 (54.3) |
| 5000–9999 | 56 (12.3) |
| ≥10,000 | 22 (4.8) |
| Type of health insurance | |
| Medical insurance for urban residents | 173 (38.0) |
| Medical insurance for urban employees | 264 (58.0) |
| Self-paying | 18 (4.0) |
| Career | |
| Public functionary | 19 (4.2) |
| Professional and technical staff | 51 (11.2) |
| Worker | 38 (8.4) |
| Peasant | 150 (33.0) |
| Liberal professions | 57 (12.5) |
| Retired | 53 (11.6) |
| Unemployed | 73 (16.0) |
| Other | 14 (3.1) |
| Tumor location | |
| Intracranial tumor | 5 (1.1) |
| Head-neck tumors | 76 (16.7) |
| Breast tumor | 56 (12.3) |
| Respiratory tumors | 100 (22.0) |
| Digestive system tumors | 136 (29.9) |
| Tumors of the Urinary System | 4 (0.9) |
| Gynecological tumor | 78 (17.1) |
| Tumor staging | |
| I | 67 (14.7) |
| II | 88 (19.3) |
| III | 155 (34.1) |
| IV | 145 (31.9) |
| Treatment methods | |
| Operation | 166 (36.5) |
| Chemotherapy | 248 (54.5) |
| Radiotherapy | 30 (6.6) |
| Targeted/Biological immunotherapy | 11 (2.4) |

*Content validity*

Consistency among 12 experts on the importance of the 15 indicators was evaluated using Kendall coordination coefficient ($W = 0.14$, $\chi^2 = 24.19$, $P < 0.05$). One expert assigned a score of 2 to items 13 and 15, while the rest gave 4 or 3 points to each item. I-CVI was calculated to be 0.89–1.00, while S-CVI/UA was 0.87 and S-CVI/Ave was 0.99. The same experts were invited to reassess the revised version, and each item was given a score of 3 and 4. I-CVI, S-CVI/UA, and S-CVI/Ave were all 1.00, indicating a good content validity for PPFI-C.

*Construct validity*

*Exploratory factor analysis.* A total of 195 patients with cancer were enrolled in the study in October 2022. Prior to EFA, KMO and the Bartlett's test of sphericity were carried out, resulting a KMO value of 0.84 and a Bartlett's test value of 1550.69 ($P < 0.01$), supporting the feasibility of EFA. Principal component analysis followed by the maximum residual method was used to analyze all EFAs. The EFA of 15 items identified three common factors with eigenvalues above 1.00. The rotated component matrix showed that the 11th term appeared in both the first and second dimensions, so it was deleted (Table 3).

*Confirmatory factor analysis.* A total of 260 patients with cancer participated in the study in October and December 2022. Upon the findings drawn from EFA, a CFA was performed to confirm the three-factor structure. As can be seen from Fig. 1, in this CFA model, all items have statistically significant parameters on the designated factor ($P < 0.01$). The data-model fit demonstrated that the model has a good fit, with $\chi^2/df = 2.42$, RMSEA = 0.07, GFI = 0.92, NFI = 0.92, TLI = 0.93, CFI = 0.95, and IFI = 0.95.[33]

*Converge validity and concurrent validity*

Bivariate correlation using Pearson *(r)* was performed to explore the relationship between PPFI and four psychometric scales, namely CAQ-8, AAQ-II, HADS, and SF-12. The results revealed that the total score of PPFI was significantly positively correlated with CAQ-8 ($r = 0.69$, $P < 0.01$), moderately negatively with AAQ-II ($r = -0.53$, $P < 0.01$), and HADS ($r = -0.49$, $P < 0.01$), and weakly negatively with SF-12 ($r = -0.15$, $P < 0.01$). The avoidance dimension was negatively correlated with CAQ-8 and positively correlated with AAQ-II, HADS, and SF-12. The dimensions of acceptance and harnessing were positively correlated with CAQ-8, negatively with AAQ-II and HADS, and not statistically significant with SF-12 (Table 4).

**Table 2**
Independent-sample *t*-tests ($n = 246$).

| Items | High score group | | Low score group | | *t* value | Pearson correlation coefficient |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Q1 | 6.48 | 0.69 | 3.70 | 1.52 | 18.57[a] | 0.78[b] |
| Q2 | 6.23 | 0.71 | 3.81 | 1.42 | 17.09[a] | 0.77[b] |
| Q3 | 6.39 | 0.75 | 3.46 | 1.51 | 19.46[a] | 0.80[b] |
| Q4 | 6.04 | 0.92 | 3.69 | 1.30 | 16.54[a] | 0.76[b] |
| Q5 | 6.26 | 0.93 | 3.55 | 1.42 | 17.87[a] | 0.76[b] |
| Q6 | 5.67 | 0.97 | 4.38 | 1.29 | 8.95[a] | 0.56[b] |
| Q7 | 5.78 | 0.66 | 4.31 | 1.14 | 12.53[a] | 0.70[b] |
| Q8 | 5.48 | 0.76 | 3.86 | 1.12 | 13.33[a] | 0.74[b] |
| Q9 | 5.78 | 0.59 | 4.30 | 1.15 | 12.78[a] | 0.74[b] |
| Q10 | 5.82 | 0.63 | 4.14 | 1.28 | 13.11[a] | 0.68[b] |
| Q11 | 5.91 | 0.68 | 4.26 | 1.29 | 12.69[a] | 0.71[b] |
| Q12 | 4.75 | 1.34 | 3.10 | 1.21 | 10.26[a] | 0.56[b] |
| Q13 | 4.87 | 0.94 | 3.53 | 1.16 | 10.05[a] | 0.55[b] |
| Q14 | 5.12 | 0.93 | 3.69 | 1.30 | 10.00[a] | 0.58[b] |
| Q15 | 4.54 | 1.43 | 2.85 | 1.30 | 10.34[a] | 0.59[b] |

SD: Standard deviation.
[a] At level 0.05 (two-tailed), the correlation was significant.
[b] At level 0.01 (two-tailed), the correlation was significant.

**Table 3**
Exploratory factor analysis ($n = 195$).

| Items | Total | Percentage of variance | The rotated component matrix | | |
|---|---|---|---|---|---|
| | | | Component 1 | Component 2 | Component 3 |
| Q1 | 5.37 | 35.77 | 0.73 | | |
| Q2 | 2.91 | 19.43 | 0.70 | | |
| Q3 | 1.55 | 10.31 | 0.88 | | |
| Q4 | 0.81 | 5.41 | 0.78 | | |
| Q5 | 0.69 | 4.58 | 0.91 | | |
| Q6 | 0.62 | 4.16 | | 0.67 | |
| Q7 | 0.54 | 3.60 | | 0.79 | |
| Q8 | 0.46 | 3.08 | | 0.73 | |
| Q9 | 0.40 | 2.64 | | 0.78 | |
| Q10 | 0.38 | 2.54 | | 0.72 | |
| Q11 | 0.35 | 2.33 | 0.52 | 0.48 | |
| Q12 | 0.29 | 1.91 | | | 0.87 |
| Q13 | 0.28 | 1.84 | | | 0.81 |
| Q14 | 0.23 | 1.56 | | | 0.76 |
| Q15 | 0.13 | 0.86 | | | 0.85 |

**Table 4**
Relationship between PPFI, CAQ-8, AAQ-II, HADS, and SF-12 ($n = 455$).

| Scale | PPFI | CAQ-8 | AAQ-II | HADS | SF-12 |
|---|---|---|---|---|---|
| PPFI | 1.00 | | | | |
| CAQ-8 | 0.69[a] | 1.00 | | | |
| AAQ-II | −0.53[a] | −0.53[a] | 1.00 | | |
| HADS | −0.49[a] | −0.52[a] | 0.74[a] | 1.00 | |
| SF-12 | −0.15[a] | −0.79 | 0.18[a] | 0.18[a] | 1.00 |
| Avoidance | −0.80[a] | −0.51[a] | 0.61[a] | 0.53[a] | 0.18[a] |
| Acceptance | 0.76[a] | 0.58[a] | −0.36[a] | −0.41[a] | −0.07 |
| Harnessing | 0.54[a] | 0.26[a] | −0.05 | −0.03 | −0.030 |

[a] At level 0.01 (two-tailed), the correlation was significant. PPFI, personalized psychological flexibility index; CAQ-8. The 8-item committed Action Questionnaire; AAQ-II, The Acceptance and Action Questionnaire II; HADS, Hospital Anxiety and Depression Scale; SF-12, Short form quality Life Scale.

*Reliability*

The Cronbach's ɑ coefficients of the scale were 0.84 (total scale) and 0.82–0.90 (subscale), and the CR was 0.76–0.89. The alpha of the deleted item ranged from 0.82 to 0.84, and only the Cronbach's ɑ coefficient of deleted items in item 12 was higher than PPFI as a whole (Table 5). A random sample of 45 patients was retested, with the correlation coefficient of $r = 0.96$ ($P < 0.01$).

## Discussion

Cancer is one of the leading causes of death worldwide, second only to cardiovascular disease. It is common for patients with cancer to experience psychological symptoms, such as anxiety and depression, as a result of their disease or treatment. The question of how to correctly and accurately assess PF in patients with cancer is worth considering. At present, most of the existing tools for measuring PF in China reflect PF indirectly by measuring psychological inflexibility. However, indirect measurements of PF cannot reflect the real level of PF. Therefore, we introduced PPFI, a tool that attempts to directly measure PF, into China. To our knowledge, this study represents the first attempt to translate the English version of PPFI into Chinese and validate it in patients with cancer. The results showed that the modified PPFI-C has satisfactory reliability and effectiveness in Chinese patients with cancer.

First, EFA helped us establish the three dimensions of PPFI, including avoidance, acceptance, and harnessing, which were consistent with the original scale structure in the English version. After appropriate cross-cultural adaptation, item 11 was removed from the original scale. The CFA display model based on AMOS showed a good fit, indicating good construct validity of the modified PPFI-C. Second, expert consultation confirmed that the modified PPFI-C had good content validity. Finally, the Cronbach's α coefficients (0.77–0.91), item–total correlation coefficients (0.29–0.63), and the alpha of the deleted item (0.82–0.84) indicated that modified PPFI-C had good internal consistency. Although the Cronbach's α coefficient of the deleted item 12 was higher than the Cronbach's α coefficient of the total PPFI, the Cronbach's α coefficient of the total PPFI did not improve significantly after the deletion of item 12, so item 12 was retained. Also, when the same patients were retested 2 weeks later, the retest reliability was 0.96, indicating a strong stability of modified PPFI-C, which was consistent with previous results. For example, the total Cronbach's α coefficient for the Persian PPFI was 0.82, while the Cronbach's α coefficients for the three dimensions of avoidance, acceptance, and harnessing were 0.84, 0.71, and 0.74, respectively. The three-factor model had a good fit ($\chi^2/df = 2.42$, RMSEA = 0.07, GFI = 0.92, NFI = 0.91, TLI = 0.93, CFI = 0.95, and IFI = 0.94)[17].

To evaluate the converge validity and concurrent validity of PPFI, we studied the correlations between PPFI, CAQ-8, AAQ-II, HADS, and SF-12 by the Pearson correlation method. The results showed that the total score of PPFI was significantly and positively correlated with CAQ-8 ($r = 0.69$, $P < 0.01$), reflecting the participants' willingness to commit to action and make efforts to pursue a fulfilling life. In addition, the total PPFI scores were moderately negatively correlated with AAQ-II and HADS and weakly negatively with SF-12. This is consistent with the findings of Lemos et al. that individuals with higher levels of PF exhibit enhanced resilience and emotional regulation and are more capable of experiencing positive emotions. When faced with unnecessary, painful thoughts, feelings, memories, or physical sensations, they choose to accept and act on them and actively pursue more worthwhile goals instead of avoiding them.[36] Even in difficult circumstances, they remain committed to pursuing happiness and improving their quality of life. In this study, CAQ-8 exhibited a moderate negative correlation ($r = -0.51$, $P < 0.01$) with the avoidance dimension of PPFI, and a moderate positive correlation with both the acceptance ($r = 0.58$, $P < 0.01$) and harnessing dimensions ($r = 0.36$, $P < 0.01$), which could also confirm the above conclusions. Meanwhile, a moderate negative correlation ($r = -0.52$, $P < 0.01$) was observed between CAQ-8 and HADS, confirming Mc Cracken' s conclusion that commitment action is significantly associated with PF and psychopathology. Interestingly, AAQ-II was significantly positively correlated with the avoidance dimension of PPFI, moderately negatively correlated with the acceptance dimension, and significantly positively correlated with HADS. These findings aligned with AAQ-II's belief that PF is unidimensional and primarily captures negative emotions or mood disorders and overlooks the core concept of pursuing a meaningful life purpose, which was consistent with the results of Rochefort and Tyndall et al.[37,38]

PPFI is an excellent instrument for measuring PF in all adults. The psychometric characteristics of modified PPFI-C were determined by examining the content validity, structure validity, aggregate validity, calibration correlation validity, internal consistency, and retest reliability. In a Chinese cancer population, the modified PPFI-C has assessed three dimensions with regard to avoiding the obstacles, accepting all the feelings and experience, and harnessing negative feelings. Through translation and cross-cultural adaptation, this tool can bring significant benefits to Chinese cancer people, providing insights into their true PF and helping healthcare professionals identify patients with low PF. It also provides us with an opportunity to better understand how Chinese people diagnosed with cancer cope with and utilize distress to pursue valued goals in the face of the disease. In addition, reliable and effective psychometric tools are essential for evaluating intervention studies. The modified PPFI-C, designed for Chinese patients with cancer, can serve as a valuable psychometric tool, providing evidence for medical and nursing decisions and assessments when healthcare professionals conduct PF-related intervention plans in the future.

While the performance of PPFI in measuring the psychological flexibility index of patients with cancer was satisfactory, the study still has some limitations. First, measuring patients with cancer from October to December in only one cancer hospital in one region cannot represent all

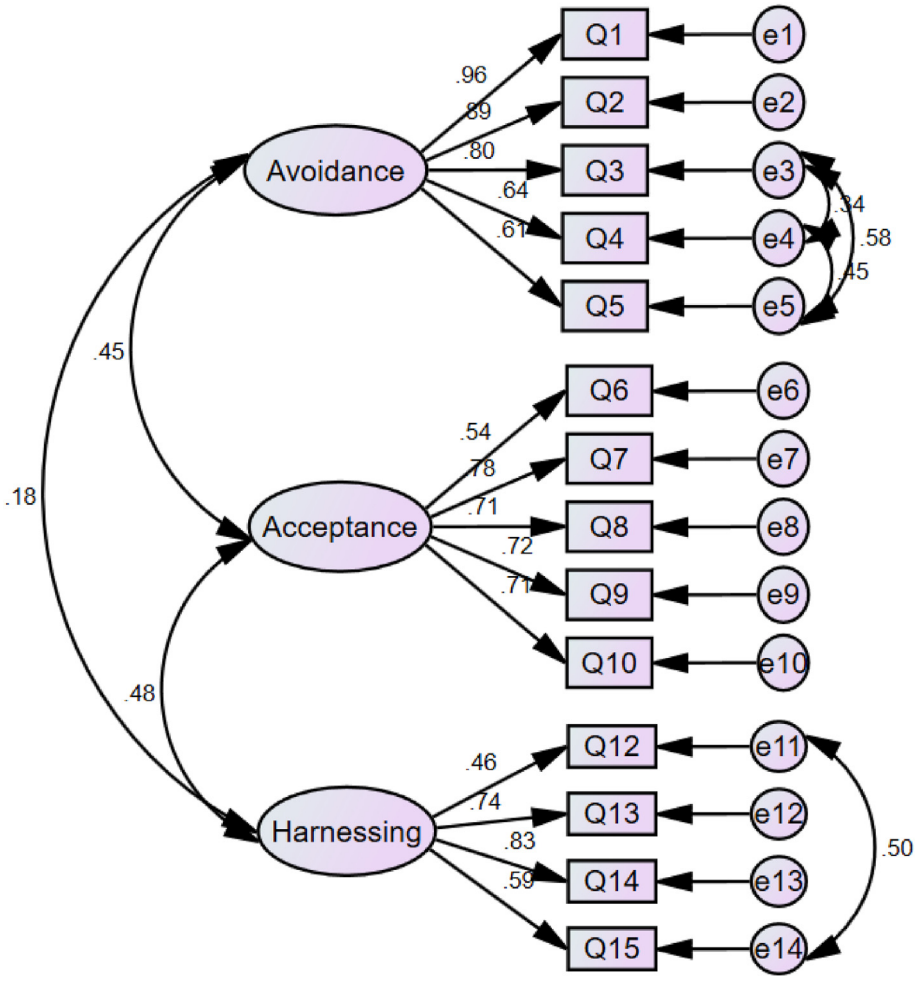


**Fig. 1.** Psychological flexibility index model fitting diagram ($n = 260$).

**Table 5**
Mean, SD, and reliability analysis of PPFI.

| Item | Mean | SD | Corrected item–total correlation | α if item deleted | α | CR |
|---|---|---|---|---|---|---|
| Avoidance | | | | | 0.90 | 0.89 |
| Q1 | 5.32 | 1.56 | 0.63 | 0.82 | | |
| Q2 | 5.21 | 1.42 | 0.63 | 0.82 | | |
| Q3 | 5.09 | 1.70 | 0.59 | 0.82 | | |
| Q4 | 4.99 | 1.45 | 0.57 | 0.83 | | |
| Q5 | 4.93 | 1.68 | 0.53 | 0.83 | | |
| Acceptance | | | | | 0.82 | 0.82 |
| Q6 | 5.17 | 1.16 | 0.32 | 0.84 | | |
| Q7 | 5.18 | 1.05 | 0.55 | 0.83 | | |
| Q8 | 4.80 | 1.16 | 0.46 | 0.83 | | |
| Q9 | 5.17 | 1.08 | 0.45 | 0.83 | | |
| Q10 | 5.07 | 1.13 | 0.42 | 0.83 | | |
| Harnessing | | | | | 0.82 | 0.76 |
| Q12 | 3.72 | 1.48 | 0.29 | 0.84 | | |
| Q13 | 4.04 | 1.25 | 0.34 | 0.84 | | |
| Q14 | 4.24 | 1.33 | 0.34 | 0.84 | | |
| Q15 | 3.40 | 1.47 | 0.33 | 0.84 | | |

SD, Standard deviation; CR, Composite reliability.

patients with cancer in China. Second, the cancer population is relatively a special group compared to college students, military personnel, and civil servants. Most admitted patients choose to receive treatment and have high compliance, which may lead to sampling deviation, such as avoidance and acceptance dimensions. Future studies could test PPFI in patients with cancer by enrolling them in different service settings (e.g., outpatient clinics and community service centers) or using a multicenter approach. At the same time, researchers could recruit subjects from different groups, such as college students, teachers, and civil servants, and conduct reliability and validity verification to expand the use of PPFI-C in China. Despite its limitations, PPFI-C still demonstrates good reliability and validity in patients with cancer, rendering it highly valuable in the psychological evaluation of patients with cancer. In fact, PPFI-C can serve as a viable alternative in evaluating PF in China, where direct assessment of this construct is lacking.

## Conclusions

The results of this study provide evidence for the use of the modified PPFI-C in patients with cancer in China. Reliability and validity analyses showed that the modified PPFI-C is a reliable and valid evaluation tool for the direct measurement of PF.

## CRediT author statement

**Wanting Xia:** Conceptualization, Methodology, Data curation, Formal analysis, Writing. **Mengyao Yan:** Data collection, Formal analysis, Writing – Original draft preparation. **Weilian Jiang:** Conceptualization, Methodology. **Meijun Ou:** Data collection, Writing – Reviewing and Editing. **Chanjuan Xie:** Conceptualization, Data curation. Xiangyu Liu: Writing – Reviewing and Editing. **Xianghua Xu:** Conceptualization, Methodology, Supervision, Funding acquisition, Writing – Reviewing and Editing. 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.

## Declaration of competing interest

The authors declare no conflict of interest.

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## Ethics statement

The study was approved by Xiangya School of Nursing, Central South University (IRB No. E2022148). All participants provided written informed consent.

## Data availability

The data that support the findings of this study are available from the corresponding author Prof. Xu, upon reasonable request.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apjon.2023.100240.

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