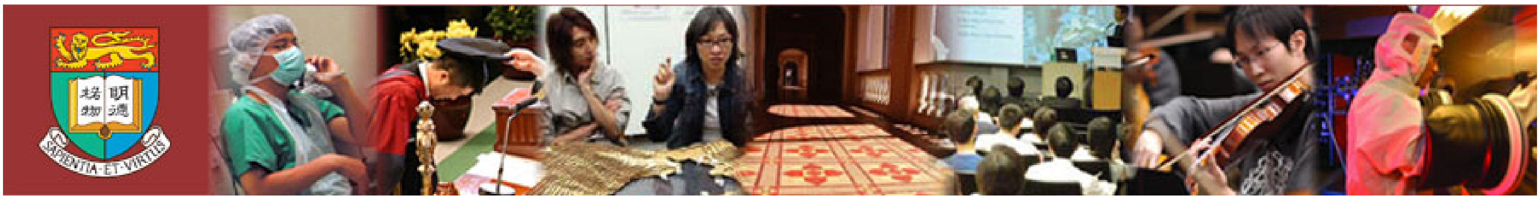

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Title: Re-examining the factor structure and psychometric properties of the Mini-Mental Adjustment to Cancer Scale in a sample of 364 Chinese cancer patients

Authors: Ted C. T. Fong*****, Rainbow T. H. Ho

Affiliation: Centre on Behavioral Health and Dept of Social Work and Social Administration, The University of Hong Kong, Hong Kong

Corresponding author: *****Ted Chun Tat Fong, Centre on Behavioral Health, 2/F, Hong Kong Jockey Club Building for Interdisciplinary Research, 5 Sassoon Road, Pokfulam, HKSAR

Phone no: 852-2831 5174; E-mail: ttaatt@hku.hk; Fax no: 852-2816 6710

Keywords: mental adjustment; cancer; Mini-MAC; factor structure; exploratory factor analysis; Chinese

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Abstract

Purpose: The Mini-Mental Adjustment to Cancer Scale (Mini-MAC) is widely used to evaluate cancer patients' psychological responses. Validation studies of the scale have shown methodological shortcomings and inconsistency in the factor solutions. The aim of this study was to examine the factor structure and psychometric properties of the Mini-MAC.

Methods: A large sample of 364 Chinese patients with breast or colorectal cancer completed the Mini-MAC and psychosocial measures (general health, perceived stress, anxiety, and depression). Exploratory factor analyses examined the relative fit of two- to six-factor models using robust weighted least square estimation and oblique target rotation. Convergent validity was evaluated via correlations between the Mini-MAC factor scores and the psychosocial outcomes.

Results: The five-factor model showed the best model fit and largely replicated the original Mini-MAC's helpless/hopeless (HH), anxious preoccupation (AP), fighting spirit (FS), fatalism (FA), and cognitive avoidance (CA) subscales. The five factors had acceptable reliability (Cronbach's α = .67 - .88) and 4-month test-retest reliability (r = .45 - .64). HH, AP, and CA were positively associated with the psychosocial outcomes (r = .19 - .60). Modest and negative correlations were found between the psychosocial outcomes and FS and FA.

Conclusions: The results support the Mini-MAC's original five-factor structure with satisfactory reliability and convergent validity. The results demonstrate that the Mini-MAC is a valid measure for assessing psychological responses in cancer patients.

Keywords: mental adjustment; cancer; Mini-MAC; factor structure; exploratory factor analysis; Chinese

Introduction

Mental adjustment to cancer is defined as patients' cognitive appraisals of the life-threatening condition and their behavioral coping responses [1]. Coping responses have been associated with various psychosocial outcomes in cancer patients [2,3]. Valid and reliable assessment of the adjustment response to cancer is vital for assessing the risk of later psychological adjustment difficulties and for evaluating how the illness affects clinical practice. The Mental Adjustment to Cancer Scale (MAC) is a 40-item self-rating measure of adjustment styles in cancer patients [4]. It assesses adjustment along five dimensions: helpless/hopeless, anxious preoccupation, fighting spirit, fatalism, and cognitive avoidance. Later, Watson *et al.* [5] included additional items to evaluate cognitive avoidance and performed exploratory factor analysis (EFA) in a larger sample of 573 cancer patients, resulting in the Mini-Mental Adjustment to Cancer Scale (Mini-MAC) as a 29-item shortened version.

The Mini-MAC, often adopted in preference to the MAC, is widely used to measure psychological responses to cancer in research and clinical settings. Researchers have translated the Mini-MAC into Chinese [6], Italian [7], Greek [8], Korean [9], and Norwegian [10] and examined its psychometric properties in different contexts. The results of these validation studies indicate that the scale has adequate test-retest reliability and convergent validity with psychosocial outcomes. Despite the proposed five-factor structure for the Mini-MAC [5], various factor structures have emerged in the validation studies (Table 1), including three- [6], four- [9,10], and five-factor solutions [7,8]. Four of the validation studies [6,7,9,10] obtained the results via principal component analysis and varimax rotation. Principal component analysis fails to differentiate between shared and unique variance [11], and thus is a biased estimator for factor analysis [12]. The assumption of uncorrelated factors in varimax rotation is often unrealistic and can result in misleading factor structures [12].

The inappropriate use of the extraction and rotation methods casts considerable doubts over the credibility of the results.

[Insert Table 1 about here]

The most recent validation study [13] adopted more psychometrically sound criteria (principal axis factoring and oblimin rotation) for the Mini-MAC and found support for a four-factor structure. In particular, oblique rotation provides a precise and realistic representation of the factor structure. However, similar to previous studies [6,8,9], this study had a small sample size ($n \leq 200$), which was sub-optimal. A larger sample size is preferable to produce a more accurate and robust factor solution [11]. Overall, the methodological limitations of existing validation studies point to the need for further psychometric analysis of the scale. The present study aimed to systematically examine the factor structure of the Mini-MAC among a large sample of 364 Chinese cancer patients. The psychometric properties in terms of internal consistency, test-retest reliability, and convergent validity were scrutinized for the best factor solution.

Methods

Sample

The data used in this study were taken from a larger data set collected for a clinical psychotherapy trial among cancer patients over a 24-month period. Eight hundred and seventy-two cancer patients who had their treatment completed were invited to join the study via mail and phone calls. In the invitation mail, the study's purpose, procedures, and potential risks were explained. The exclusion criteria included a recurrent cancer diagnosis, inability to understand Chinese, or life expectancy of less than 6 months. A total of 364 cancer patients were recruited post treatment from four community cancer support centers in Hong Kong, indicating a response rate of 41.7%. The participants completed a paper-and-pencil questionnaire at baseline and a subsample of 291 patients provided follow-up data 4 months later. Ethical approval was obtained from the local institutional review board and the participants provided written informed consent.

Measures

The Chinese Mini-MAC [6] is a 29-item, 4-point self-report instrument for assessing the cognitive and behavioral responses of cancer patients with five proposed factors: helpless/hopeless (HH, 8 items), anxious preoccupation (AP, 8 items), fighting spirit (FS, 4 items), fatalism (FA, 5 items), and cognitive avoidance (CA, 4 items). Satisfactory reliability was found for HH (α = .83 - .87), AP (α = .81 - .88), and CA (α = .65 - .82) while marginal reliability was found for FS (α = .21 - .76) and FA (α = .52 - .71) in previous studies [6-10]. A series of psychosocial outcomes, namely general health, perceived stress, anxiety, and depression, was evaluated in this study. General health was assessed by the 12-item Chinese General Health Questionnaire [14]. Item responses were rated using a 2-point format, with the total scale score ranging from 0 to 12. Perceived stress was measured by the 10-item Chinese Perceived Stress Scale [15]. Item responses were rated using a 5-point format, with the total scale score ranging from 0 to 40. Anxiety and depression were assessed using the 14-item Chinese Hospital Anxiety and Depression Scale [16]. Item responses were rated using a 4-point format, with the total scores for anxiety (7 items) and depression (7 items) ranging from 0 to 21. Higher scores denoted higher levels of distress for the psychosocial outcomes. Cronbach's alpha (α) coefficient values were satisfactory for the measurement scales of general health (α = .875), perceived stress (α = .788), anxiety (α = .848), and depression (α = .742).

Data analysis

EFA was performed using Mplus version 7.11 [17] to investigate the factor structure of the Mini-MAC. In preliminary analyses, 13 of the 29 Mini-MAC items exhibited floor and ceiling effects, with the response proportion at both tails exceeding 30%. Given the non-normality, factor extraction was conducted on the categorical indicators using robust weighted least square estimators [18,19] and oblique target rotation [20]. Popular criteria such as Kaiser's eigenvalue greater than 1 and scree tests are prone to factor overextraction. To decide the optimal dimensionality, we systematically specified five EFA models (two- to six-factor models) and compared their model fit.

Model fit was assessed based on the following criteria on the goodness-of-fit indices [21]: comparative fit index (CFI) ≥ .95; Tucker-Lewis index (TLI) ≥ .95; root mean square error of approximation (RMSEA) ≤ .06; and standardized root mean square residual (SRMR) ≤ .08. Chi-square (χ^2) difference tests were conducted to compare the fit of adjacent EFA models (e.g. two- versus three-factor models). Model selection was based on theoretical considerations with reference to the original five-factor structure. Factor loadings greater than 0.40 were considered major and practically significant, and items without any major factor loadings were removed from the model.

The best-fitting factor model was then evaluated using the 4-month follow-up data for model validation. The internal consistency for each factor was assessed by Cronbach's α. Test-retest reliability was evaluated by correlating the derived factor scores at baseline with those at the 4-month follow-up. The convergent validity of the Mini-MAC was examined through correlation analyses of the Mini-MAC factor scores with general health, perceived stress, anxiety, and depression. The rate of missing data was minimal (no more than 2% of any item response). The statistical significance level was set at .01.

Results

Sample characteristics

The study sample comprised patients with breast (n = 196) or colorectal (n = 168) cancer. Of the 364 participants, 69.5% were female and the sample mean age was 53.5 years (SD = 11.0). The majority of the participants was married (79.7%), had completed secondary education (56.3%), and had received chemotherapy (69.0%) and surgery (65.7%). Compared with the participants who provided follow-up data, the participants who did not respond at follow-up were significantly more likely to be male, have colorectal cancer, and have a lower level of anxiety at baseline.

Factor structure

As shown in the goodness-of-fit indices in Table 2, mediocre fit was found for the two- and three-factor models, and the four-factor model displayed a marginally acceptable fit to the data. In contrast, the five-factor model showed an adequate model fit and fitted the data significantly better than the four-factor model via the chi-square difference test ($\Delta\chi^2$ = 166.2, Δdf = 25, p < .01). The six-factor model showed a significantly better fit than the five-factor model ($\Delta\chi^2$ = 81.5, Δdf = 24, p < .01). However, the sixth factor consisted of only one major factor loading from item 21 and was not correlated with any of the other five factors, thus providing little incremental value over the five-factor model.

[Insert Table 2 about here]

The eigenvalues of the five factors were 9.760, 4.386, 1.585, 1.469, and 1.342.

All 29 items showed major factor loadings, ranging from .401 to .820 (Table 3). The factor loading pattern was congruent with the original five-factor structure [5] with two exceptions. Item 7 had a major factor loading on HH rather than AP and Item 26 loaded significantly onto both FS and CA. The five-factor model provided an acceptable fit to the data at follow-up (χ^2 = 519.0, *df* = 271, *p* < .01, CFI = .975, TLI = .962, RMSEA = .056, and SRMR = .038). In view of the findings, the five-factor model was chosen to represent the factor structure and further tests of reliability and convergent validity were conducted.

[Insert Table 3 about here]

Reliability and convergent validity

Cronbach's α coefficient, interfactor correlations, and test-retest reliability were assessed for the five Mini-MAC factors (Table 4). HH and AP were found to exhibit high reliability (α > .85) while acceptable reliability was found for FS, FA, and CA (α ~ .70). Good test-retest reliability was found for the factors across the 4-month interval (*r* = .449 - .640). CA was positively correlated with the other factors except FS (*r* = .188 - .449). FA were positively associated with FS (*r* = .548) and negatively correlated with HH (*r* = -.221).

[Insert Table 4 about here]

Regarding the convergent validity of the Mini-MAC (Table 5), positive and moderately strong correlations were found for HH and AP with the psychosocial outcomes (*r* = .431 - .601). Higher levels of HH and AP were linked to worse general health and higher levels of perceives stress, anxiety, and depression. Both FS and FA were negatively and modestly correlated with the psychosocial outcomes (*r* = -.175 - -.328). Higher levels of FS and FA were associated with better health and lower levels of psychological distress. CA had positive and weak correlations with the outcomes (*r*

= .194 - .277), suggesting higher level of CA to be linked to worse general and mental health.

[Insert Table 5 about here]

Discussion

Given the inconsistency in the factor solutions and the methodological shortcomings of previous validation studies of the Mini-MAC, we performed a systematic investigation of its factor structure using a robust weighted least square estimator with an oblique target rotation. Comprehensive analyses and comparisons of various factor structures lend support to the five-factor solution as the underlying factor structure. The five-factor model, which provides a significantly better fit than the three- and four-factor models, largely replicates the original five-factor structure proposed by Watson *et al.* [5]. The modest to moderate inter-factor correlations support adequate discriminant validity for the structure.

In our five-factor model, all 29 items contributed significantly to a clear factor structure, with only Item 26 ("I make a positive effort not to think about my illness") loading significantly on both FS and CA. Item 7 ("It is a devastating feeling"), which was originally hypothesized as an AP indicator, may better measure the dimension of HH. Despite these minor disparities, HH and AP showed good reliability and convergent validity with general health, perceived stress, anxiety, and depression. These results are in line with previous findings and support the two factors as good indicators of poor adjustment. Despite the recent concerns [10,13] over the utility of FS due to its low reliability and lack of convergent validity, this subscale showed adequate reliability and convergent validity as measured against the psychosocial outcomes.

Cronbach's α for the FA subscale (.674) was slightly better than those in the original study [5] and other validation studies [7,9,10,13]. Researchers [6,9,10] have posited that fatalism may reflect not only the acceptance of an unavoidable fate, but also an optimistic and active form of coping. Similarly, Fitzpatrick *et al.* [22] found FA to be positively correlated with spirituality in a sample of breast cancer patients. In the present study, FA was negatively associated with general health, perceived stress, anxiety, and depression. This finding suggests that fatalism does not necessarily mean resignation coping, but could enable patients to endure the situation better, thereby reducing their level of distress. Given the distinct feature of this subscale in assessing potentially positive coping styles, future studies could adopt this subscale and examine its predictive validity on psychosocial outcomes.

The CA subscale showed satisfactory reliability and was positively associated with HH, AP, FA, and the psychosocial outcomes. These results, which are generally in line with the findings of the original study [5], appear to suggest that CA is an indicator of poor adjustment in Chinese cancer patients. As Bredal [10] points out, CA is not necessarily detrimental to patients. The CA items have been described as distractions and mental disengagements of active thinking about the illness and can be viewed as emotion-focused coping strategies [6]. The effective use of such strategies can assist in affective regulation and problem-focused coping in certain situations.

From an analytical perspective, it should be noted that eight of the ten inter-factor correlations were significant (r = .188 - .677) in our factor solution, confirming the use of an oblique rotation. We agree with the view of Hulbert-Williams *et al.* [13] that orthogonal rotations (e.g. varimax rotation) should no longer be used with these data to avoid distorting the underlying factor structure. Despite its common use in previous studies, principal component analysis has been shown to be a biased and outdated extraction method in the psychometric literature [11,12,19], and its future use is highly discouraged. It is recommended that researchers adopt more up-to-date estimators such as principal axis factoring or maximum likelihood for continuous indicators, or robust weighted least square estimation for categorical indicators.

A limitation of the present study is that it was based on Chinese patients with breast or colorectal cancer. The findings may not be generalizable to patients with other types of cancer or in other cultural contexts. The present study was based on self-report data and may be subject to common method bias. Future longitudinal studies could elucidate the predictive validity of the scale with psychosocial outcomes. Despite these limitations, the present study is the first of its kind to apply systematic factor analysis in evaluating the scale's factor structure. The results demonstrate the original five-factor structure with satisfactory reliability and convergent validity. Confirmatory factor analysis in further research is recommended to verify the psychometric properties of the Mini-MAC and to assess the measurement invariance of the scale across gender, cancer type, and cultural context.

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Conflict of Interest: There are no potential conflicts of interest.

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Table

Table 1 Summary of psychometric results on the dimensionality of the Mini-MAC

Study author	Year	*N*	Analysis type	Extraction	Rotation	No. of factors
Watson (UK) [1]	1994	573	Exploratory	PCA+ML	Oblique	5
Ho (Hong Kong) [2]	2003	115	Exploratory	PCA	Varimax	3
Grassi (Italy) [3]	2005	430	Exploratory	PCA	Varimax	5
Anagnostopoulos (Greece) [4]	2006	198	Confirmatory	ML	/	5
Kang (Korea) [5]	2008	201	Exploratory	PCA	Varimax	4
Bredal (Norway) [6]	2010	400	Exploratory	PCA	Varimax	4
Hulbert-Williams (UK) [7]	2012	153	Exploratory	PAF	Oblique	4

PCA, principal component analysis; ML, maximum likelihood; PAF, principal axis factoring. In the confirmatory factor analysis study by Anagnostopoulos [4], six cross-loadings and three residual covariances were additionally estimated.

Table 2 Goodness-of-fit indices for various EFA models of Mini-MAC (n = 364)

Model	χ^2	*df*	CFI	TLI	RMSEA	SRMR	$\triangle\chi^2(\triangle df)$
2-factor	1304.9*	349	.899	.883	.087	.068	
3-factor	983.3*	322	.930	.912	.075	.057	281.7(27)*
4-factor	741.1*	296	.953	.936	.064	.045	218.1(26)*
5-factor	556.3*	271	.970	.955	.054	.035	166.2(25)*
6-factor	490.0*	247	.974	.958	.052	.032	81.5(24)*

df, degree of freedom; CFI, comparative fit index; TLI, Tucker-Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; $\triangle\chi^2$, change in chi-square compared to previous model. * $p < .01$.

Table 3 Factor loading matrix of the five-factor solution using robust weighted least square estimator with target rotation (*n* = 364)

Item		**Factor** HH	AP	FS	FA	CA
4	Giving up	.820*				
6	At a loss	.676*				
12	Can’t handle it	.766*				
14	Not hopeful	.660*				
15	Nothing to help	.783*				
16	End of the world	.658*				
20	Life hopeless	.680*				
21	Can’t cope	.720*				
7	Devastating feeling	.541*				
5	Angry		.409*			
9	Worry cancer worsen		.688*			
13	Apprehensive		.543*			
22	Upset having cancer		.743*			
25	Belief difficult		.423*			
28	Great anxiety		.692*			
29	Frightened		.792*			
2	Challenge			.474*		
10	Fight Illness			.504*		
18	Optimistic			.600*		
23	Beat disease			.781*		
1	One day at a time				.780*	
3	Hands of god				.401*	
8	Count blessings				.512*	
19	Bonus				.792*	
24	Life is precious				.458*	
11	Distract					.417*
17	Not thinking to cope					.745*
26	Try not to think			.541*		.484*
27	Push out of mind					.757*

Item-factor loadings with magnitude less than .40 are not shown.

HH, Helplessness/Hopeless; AP, Anxious Preoccupation; FS, Fighting Spirit; FA, Fatalism; CA, Cognitive Avoidance. * $p < .01$.

Table 4 Cronbach's alpha, correlations, and test-retest reliability among the Mini-MAC factors (n = 364)

Factor	α	HH	AP	FS	FA	CA
HH (9 items)	.876	*.533**				
AP (7 items)	.871	.677*	*.640**			
FS (5 items)	.692	-.410*	-.231*	*.454**		
FA (5 items)	.674	-.221*	.010	.548*	*.449**	
CA (4 items)	.705	.437*	.449*	.024	.188*	*.523**

Test-retest reliability coefficients are shown in italics on the diagonal (n = 291).

α, Cronbach's alpha; HH, Helplessness/Hopeless; AP, Anxious Preoccupation; FS, Fighting Spirit; FA, Fatalism; CA, Cognitive Avoidance. * $p < .01$.

Table 5 Correlations between the Mini-MAC factors and psychosocial outcomes (n = 359-364)

	Factor score				
Outcome	**HH**	**AP**	**FS**	**FA**	**CA**
General health	.441*	.443*	-.240*	-.199*	.194*
Perceived stress	.488*	.512*	-.298*	-.175*	.218*
Anxiety	.563*	.601*	-.328*	-.201*	.277*
Depression	.558*	.431*	-.308*	-.242*	.265*

HH, Helplessness/Hopeless; AP, Anxious Preoccupation; FS, Fighting Spirit; FA, Fatalism; CA, Cognitive Avoidance. * $p < .01$.