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Validation of the English and Mandarin versions of the Fear of Cancer Recurrence Inventory in an Asian population

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Abstract

The Fear of Cancer Recurrence Inventory has shown adequate psychometric properties to assess for fear of cancer recurrence among cancer survivors. However, the use of the Fear of Cancer Recurrence Inventory in Asia is limited due to the paucity of validation studies. Participants include 331 cancer survivors who completed the English and newly developed Mandarin versions of the Fear of Cancer Recurrence Inventory. The results revealed that both versions of the Fear of Cancer Recurrence Inventory demonstrated satisfactory internal reliability, test–retest reliability, convergent validity, and concurrent validity. A confirmatory factor analysis provided support for the original seven-factor structure. The validated Fear of Cancer Recurrence Inventory is applicable to cancer survivors in Singapore.

Keywords

Asia, cancer survivors, clinical health psychology, Fear of Cancer Recurrence Inventory, validation

Introduction

Advances in cancer identification and treatment have increased the number of persons living with cancer within 5 years of diagnosis (International Agency for Research on Cancer, 2008). While the majority adapt well, some cancer survivors continue to experience physical, psychological, and social complications and stresses (Armes et al., 2009; Baker et al., 2005; Moser et al., 2014).

One such issue faced by approximately 70 percent of cancer survivors is that of the fear of cancer recurrence (FCR; McGinty et al., 2016; Simard et al., 2013; Yang et al., 2016), which encompasses fears not only of recurrence, but also of the development of new primary tumors, another form of cancer, or metastasis (Lebel et al.,

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2016a; Simard et al., 2013; Thewes et al., 2012). These fears are multidimensional constructs involving cognitions, beliefs, and emotions (McGinty et al., 2016; Simard et al., 2010, 2013). Such maladaptive responses in the survivorship phase hinder adjustment and rehabilitation outcomes in these cancer patients and are often associated with emotional distress, impaired functioning, and impaired family well-being (Crist and Grunfeld, 2013; Humphris et al., 2003; Koch et al., 2013; Shim et al., 2010).

With the increasing international focus on support for cancer survivors even after termination of acute treatment, there is a greater emphasis on better identifying individual needs and tailoring services to achieve patient-centered care (Armes et al., 2009; Beesley et al., 2016; Humphris and Ozakinci, 2008). Unfortunately, at present, there remains no gold standard tool for the measurement of FCR (Simard et al., 2010; Thewes et al., 2012). Many of the current instruments do not have a multidimensional approach to the assessment of FCR, have limited psychometric data, or are specific to cancer site (Simard et al., 2010; Thewes et al., 2012).

The Fear of Cancer Recurrence Inventory (FCRI), however, is a multidimensional assessment of FCR with one of the strongest psychometric qualities (Thewes et al., 2012). The FCRI is suitable for mixed-cancer populations, who could differ in terms of diagnoses, and the time since diagnosis, allowing for comparisons of FCR across different cancer populations (Simard and Savard, 2009). This is especially important as the current literature is limited on comparing FCR across patients with different cancer types (Simard et al., 2013). This self-report questionnaire comprises 42 items across seven components of FCR that evaluate the presence of potential stimuli activating FCR; the presence and severity of intrusive thoughts or images associated with FCR; psychological distress associated with FCR; coping strategies that can be used to cope with FCR; the level of insight toward FCR; reassurance behaviors associated with FCR; and the level of functioning impairment associated with FCR (Simard and Savard, 2009).

The FCRI was initially developed in French and validated in a group of mixed-cancer patients in Canada (Simard and Savard, 2009), with an English version validated in a group of breast, colon, prostate, and lung cancer patients in Canada (Lebel et al., 2016b). Previous validation work done on the FCRI has reported excellent internal consistency, test–retest reliability, and construct validity (Lebel et al., 2016b; Simard and Savard, 2009). For example, the FCRI demonstrated excellent convergent validity due to observed strong correlations ($r = .71$, $p < .001$) with similar constructs (e.g. Fear of Recurrence Questionnaire (FRQ)); good concurrent validity due to observed moderate-to-strong correlations with anxiety ($r = .64$, $p < .001$) and depressive ($r = .43$, $p < .001$) symptoms as measured on the Hospital Anxiety and Depression Scale (HADS); and good divergent validity due to moderate correlations (range $r = -.36$ to $-.20$, $p < .001$) with quality-of-life measures (e.g. European Organization for Research and Treatment of Cancer (EORTC) Quality-of-Life Questionnaire; Lebel et al., 2016b; Simard and Savard, 2009).

However, previous validation work has also highlighted some limitations of the FCRI that should be considered. For example, Item 13 ("I believe that I am cured and that the cancer will not come back") is frequently reported to have inadequate corrected item-total correlation compared to the other items (Lebel et al., 2016b; Simard and Savard, 2009). However, as this is the only reverse-scored item, it is often retained to identify possible automatic responses. In addition, Lebel et al. (2016b) recommended that minor adjustments should be made during confirmatory factor analysis (CFA) of the original seven-factor structure of the FCR (Simard and Savard, 2009) due to possible item redundancy. Specifically, Lebel et al. (2016b) included nine additional residual covariance parameters, between items within the same subscale, which improved the overall model fit without affecting the original seven-factor structure of the FCR (Simard and Savard, 2009).

While the examination of FCR in cancer survivors is crucial in identifying their needs and providing patient-centered care beyond the acute treatment phase, the majority of FCR studies are conducted in Western populations (Simard et al., 2013). There is an unfortunate lacuna of studies in Asian populations, and at present, there are no published cross-cultural studies examining the validity and factor structure of the FCRI in Asia. Previous validation studies had mostly been conducted on Canadian patients, and the developers of the FCRI had recommended that studies be conducted to evaluate the validity of the FCRI in other cultures and languages (Simard and Savard, 2009). Furthermore, there is also a lack of a validated simplified Mandarin version of the FCRI; as simplified written Mandarin is used in China, parts of East Asia, and by some migrant Chinese populations in the West, producing and validating such a version will pave the way for more research with this tool and the subsequent enhancement of care for cancer survivors.

The aims of this study were thus to (1) develop a translated simplified Mandarin version of the FCRI and (2) confirm the factor structure and psychometric properties of the English and Mandarin versions of the FCRI in an Asian cancer population.

Methods

Participants and procedure

This study was part of a larger exploratory study examining post-treatment FCR of cancer outpatients in Singapore, and the potential predictors and comorbidities associated with high levels of FCR. Potential participants were identified during their follow-up appointment at a large cancer center in Singapore. Participants were included if they (a) had a cancer diagnosis, (b) had completed treatment (surgery, chemotherapy, and/or radiotherapy) at least 1 year ago, (c) were Singapore citizens or permanent residents between 21 and 84 years of age, and (d) were able to understand and read either English or Mandarin. The study received ethics approval from the National Healthcare Group Domain Specific Review Board (Reference: 2015/00003), and informed consent was obtained. Participants were instructed to complete two self-report questionnaires two weeks apart.

Of the 865 patients approached, 420 participants (48.6%) were recruited between February 2015 and June 2016, and 348 questionnaires were returned at T1, and 266 participants at T2. Data from some participants were excluded because more than 50 percent of FCRI were uncompleted (T1: $n=7$; T2: $n=2$), two or more FCRI subscales were uncompleted (T1: $n=7$; T2: $n=4$), or they indicated a zero-pattern response, including the reverse-coded question (T1: $n=3$; T2: $n=1$). The final sample consisted of 331 participants at T1 and 259 participants at T2. Of these, 222 (67.1%) and 177 (68.3%) participants completed the English FCRI at T1 and T2, respectively.

Measures

Sociodemographic and medical characteristics. Participants completed a self-report questionnaire of variables comprising gender, age, race, marital status, education, occupation, cancer type and stage, and types of cancer treatment received.

FCRI. Patients completed the FCRI in either English (Lebel et al., 2016b) or Mandarin. The authors translated the FCRI to a simplified Mandarin version, with reference to an unpublished Taiwanese version of the FCRI (Lee, personal communication, 2015). As the Taiwanese version used the traditional Chinese script, the script was first converted to the simplified Chinese script. As some phrases and linguistic patterns were peculiar to Taiwanese Mandarin, minor amendments were made to ensure that the scale had cross-cultural and conceptual equivalence and was appropriately adapted for use in the local population. The simplified Mandarin version was then back-translated to English by two independent reviewers, blinded to the original English version, to ensure that

both versions were equivalent. A panel then reviewed the back-translations for a final simplified Mandarin version. Three bilingual patients also reviewed both versions independently and deemed them as equivalent. Participants rated the items on a Likert-type scale from 0 (not at all or never) to 4 (a great deal or all the time). One item (Item 13) was reverse-scored, and total scores were obtained for each subscale and for the entire scale by summing up the items, with higher scores indicating higher levels of FCR.

FRQ. The FRQ assessed the level of fear cancer patients have regarding the probability of illness recurrence (Northouse, 1981). Participants rated 22 items on a Likert-type scale from 1 (strongly agree) to 5 (strongly disagree). Eleven items were reverse-scored, and the sum of all items yielded a total score, with higher scores indicating higher FCR.

Fear of Progression Questionnaire. This 43-item questionnaire was developed to measure the fear of disease progression (FoP) in chronically ill patients, using a Likert-type scale from 1 (never) to 5 (very often; Herschbach et al., 2005). FoP was measured on four components: affective reactions, partnership and family, occupation, and loss of autonomy. The scores for these first four subscales were summed to produce a total FoP score, with higher scores indicating a higher level of fear. A fifth subscale measured an individual's level of coping with FoP.

HADS. This 14-item questionnaire assessed symptoms of distress through a four-point Likert-type scale (Zigmond and Snaith, 1983). The items were loaded onto two separate subscales: anxiety (HADS-A) and depression (HADS-D). The sum of all items produced a total distress score (ranging from 0 to 42), with higher scores indicating higher levels of distress.

World Health Organization Quality-of-Life Instrument–short version. The 26-item questionnaire, an abbreviated version of the World Health Organization Quality of Life (WHOQOL) Instrument, measured quality of life (QoL) through a four-point Likert scale (World Health Organization, 1996). Two items assessed overall QoL and general health, while the remaining items examined four domains of QoL: physical, psychological, social relations, and environment. The scores for each subscale were obtained through summing up the items before being transformed. Transformed scores ranged from zero to 100, with higher scores indicating a better self-perceived QoL.

Statistical analyses

Reliability. To assess internal reliability, coefficient alphas and corrected item-total correlations were calculated for the total FCRI scale and seven subscales at both T1 and T2 and for both the English and Mandarin versions. A Cronbach alpha coefficient of more than .70 was considered satisfactory internal consistency (Nunnally et al., 1967). To assess test–retest reliability, intraclass correlations were calculated between the FCRI scores at both time-points.

Criterion validity. The convergent validity, concurrent validity, divergent validity, and discriminant validity were assessed. Convergent validity was assessed by examining the correlations of FCRI and other instruments measuring FCR (i.e. Fear of Progression Questionnaire (FoP-Q) and FRQ). Concurrent validity was examined by comparing the correlations between FCRI and emotional distress (i.e. HADS score). Divergent validity was examined through correlations between FCRI and measurements of QoL (i.e. World Health Organization Quality-of-Life Instrument–short version (WHOQOL-BREF) scores). The total FCRI score was deemed normal based on Kolmogorov–Smirnov test ($p = .20$) and Q-Q plot, thus the data were analyzed with parametric tests; tests of Pearson correlations or one-way analyses of variance (ANOVAs) were conducted. To reduce family-wise Type I errors, Bonferroni corrections were employed for each set of comparisons.

Model structure confirmation. Confirmatory factor analyses (CFAs) were conducted to examine the construct validity and to replicate the original factor structure, of the FCRI, which comprised three levels: 42 items, seven primary factors, and one secondary factor (Simard and Savard, 2009). The goodness-of-fit for each model was assessed based on the following fit indices: chi-square likelihood ratio test (χ^2), comparative fit index (CFI), root-mean-square error of approximation (RMSEA), and standard root-mean-squared residual (SRMR), with these recommended criteria: CFI $\geq$ .90, RMSEA $\leq$ .06, and SRMR $\leq$ .08 (Hu and Bentler, 1999). The fit of the model was improved by freeing fixed parameters according to the sequence implied by the modification indices. However, if two or more modification indices were approximately equal, fixed parameters in the residual covariance matrix were given precedence over, for instance, those in the factor-loading matrix. Before each modification, the conceptual meaningfulness of the change was considered. After each modification, the extent to which the fit of the model was improved was determined based on the changes in each of the fit indices.

The CFA included both the English and the Mandarin versions of the FCRI because the sample size for the Mandarin version ($n = 109$) was too small for the estimation procedure to arrive at a reasonably stable set of solutions. Such an inclusion is based on the assumption that the two versions of the FCRI are equivalent. To test for this assumption, a multiple indicators multiple causes (MIMIC) model was used because of its small sample advantage and increased parsimony (Muthén, 1989). This model provided support for the measurement intercept invariance across both the English and Mandarin versions of the FCRI: a model in which the direct effects of the language indicator (0 = English, 1 = Mandarin) on all 42 items were constrained to zero, conditional on the respective primary factors (Muthén, 1989), demonstrated CFI (.91), RMSEA (.06), and SRMR (.08) that met that recommended criteria.

All analyses were conducted using SPSS 23 (Chicago, IL, USA), with the exception of CFA, which was conducted using Mplus version 6.12 (Muthén and Muthén, 2015).

Results

Descriptive data

Table 1 presents participants' socio-demographic and medical characteristics. A majority of the participants ($M_{age} = 55.31 \pm 11.48$) were female (81.3%) and had early-stage cancer (57.6%). Breast (37.8%) and gynecological cancers (27.2%) were the most prevalent cancer types; 73.1% of the participants had undergone surgery, 57.4 percent had undergone chemotherapy, while 45.0 percent had undergone radiotherapy.

Reliability

Both versions of the FCRI demonstrated satisfactory internal reliability (Table 2). The Cronbach's alphas for the FCRI scale were .96 and .95 for the English and Mandarin versions, respectively. Cronbach's alphas of the subscales also met standards of reliability (English version: .84–.95; Mandarin version: .78–.95). Test–retest reliability was demonstrated for total FCRI score (English version: $r = .92$; Mandarin versions: $r = .86$, $ps < .001$) and the subscales (English version: $r = .85$–$.90$; Mandarin version: $r = .66$–$.91$, $ps < .001$). Given the internal reliability of both versions, the following analyses were conducted on the combined dataset.

Overall, the FCRI met the standards of reliability, $\alpha = .95$ for total score, and coefficients range from .82 to .94 for the subscales (Table 2). All items, with the exception of Item 13, had acceptable corrected item-total correlations of above .50. Item 13 had inadequate corrected item-total correlations ($r = .07$). However, the only reverse-scored item, Item 13, was retained to allow for identification of an automatic response. Test–retest reliability was demonstrated, with strong correlations between the

Table 1. Descriptive data.

Sociodemographic and medical variables	Mean (SD)/*N* (%[a])
Age (years)	55.31 (11.48)
Gender	
Male	61 (18.7)
Female	269 (81.3)
Race	
Chinese	261 (78.9)
Malay	37 (11.2)
Indian	20 (6.0)
Others	12 (3.6)
Marital status	
Single	47 (14.2)
Married	234 (70.7)
Divorced/separated	25 (7.6)
Widowed	25 (7.6)
Education	
No formal education	10 (3.0)
Primary education	56 (16.9)
Secondary/GCE "N"/"O" levels/vocational education	146 (44.1)
GCE "A" levels/polytechnic diploma	57 (17.2)
Bachelor's degree	47 (14.2)
Postgraduate education	10 (3.0)
Occupation	
Full-time	141 (42.6)
Part-time	46 (13.9)
Retired	52 (15.7)
Homemaker	82 (24.8)
Cancer type	
Breast	125 (37.8)
Gynecological	90 (27.2)
Gastro-intestinal	45 (13.6)
NPC/throat/oral	12 (3.6)
Hemotological/leukemia/lymphoma/myeloma	11 (3.3)
Lung	9 (2.7)
Brain	2 (0.6)
Pancreas	1 (0.3)
Others	12 (3.6)
Multisite	14 (4.2)
Cancer stage	
Early (stages 0–2)	191 (57.6)
Late (stages 3–4)	88 (26.6)
Underwent chemotherapy	
Yes	190 (57.4)
No	133 (40.2)
Underwent radiotherapy	
Yes	149 (45.0)
No	174 (52.6)
Underwent surgery	
Yes	236 (71.3)
No	87 (26.3)

SD: standard deviation; GCE: General Certificate of Education; NPC: nasopharyngeal cancer.
[a]Percentages might not add up to 100 percent due to missing data or rounding difference.

two time-points reported for the total score ($r = .83$, $p < .001$) and the subscales ($r = .71–.80$, $ps < .001$).

Validity

Criterion validity. Convergent validity, concurrent validity, and divergent validity were examined by measuring Bonferroni-corrected Pearson correlations between FCRI scores and other measures (Table 3). The FCRI total score was strongly correlated with the FoP-Q's FoP subscale ($r = .69$, $p < .001$) as well as the FRQ total score ($r = .61$, $p < .001$), demonstrating convergent validity. Concurrent validity was also supported; FCRI total score was strongly correlated to the HADS total score ($r = .58$, $p < .001$) and HADS-A ($r = .66$, $p < .001$) while moderately associated with HADS-D ($r = .35$, $p < .001$). Significant, albeit weak-to-moderate, negative correlations were also demonstrated between FCRI total score and conceptually distinct constructs, namely, overall QoL ($r = -.22$, $p < .001$) and QoL in three different domains: physical health ($r = -.21$, $p < .001$), psychological health ($r = -.27$, $p < .001$), and social relationships ($r = -.19$, $p < .01$). No significant correlation was demonstrated between FCRI total score and QoL in the environment domain ($r = -.14$, $p = .56$).

Model structure confirmation. The goodness of fit for the original and final models is summarized

Table 2. Psychometric properties of the Fear of Cancer Recurrence Inventory (FCRI).

FCRI factors	English			Mandarin			Combined			
	Cronbach's alpha		Test–retest	Cronbach's alpha		Test–retest	Cronbach's alpha		Test–retest	Corrected item-total correlations
	T1	T2		T1	T2		T1	T2		
Total	.96	.95	.92*	.95	.93	.86*	.95	.95	.91*	.07–.74
Triggers	.91	.91	.85*	.88	.80	.66*	.90	.88	.80*	.53–.80
Severity	.84	.85	.88*	.82	.79	.91*	.84	.84	.89*	.07–.78
Psychological distress	.93	.93	.89*	.96	.96	.83*	.94	.94	.87*	.84–.90
Functioning impairments	.95	.95	.86*	.95	.93	.75*	.95	.94	.83*	.83–.89
Insight	.88	.90	.87*	.92	.90	.88*	.89	.90	.87*	.78–.80
Reassurance	.85	.84	.88*	.78	.79	.75*	.82	.82	.84*	.61–.76
Coping strategies	.92	.90	.90*	.90	.92	.86*	.91	.91	.89*	.50–.79

*$p < .001$.

in Table 4. This model (χ^2 (812) = 2398.59, $p < .001$) demonstrated CFI (.85), RMSEA (.07), and SRMR (.09) that did not meet the recommended criteria (CFI ≥ .90; RMSEA ≤ .06; SRMR ≤ .08; Hu and Bentler, 1999). The sources of misfit were subsequently examined. All parameter estimates and their corresponding standard errors fell within an acceptable range and were statistically significant, except Item 13 (i.e. *I believe that I am cured and that cancer will not come back*; Est. = .06, SE = .04, $p = .12$). However, as this item was determined to be conceptually meaningful to the construct of FCR, it was retained in subsequent iterations. Modification indices suggested that the model fit could be significantly improved by freeing parameters in the resdidual covariance matrix, while leaving the original seven-factor structure intact. As such, 11 additional residual covariance parameters, between items within the same subscale, were freely estimated in the final model. The final model (χ^2 (801) = 1803.54, $p < .001$) yielded a statistically significant improvement over the initial model. In support of the modifications, all 11 additional residual covariance parameters were statistically significant ($ps < .001$), and their correlations were moderately high (.23–.64). The CFI (.91) achieved the recommended criterion, and both the RMSEA (.06) and SRMR (.09) were slightly above the recommended criteria. However, given the complexity of the original factor structure, and the cultural and linguistic differences between Singapore and Canada, such a model fit was deemed appropriate, if not remarkable; post hoc model fitting was therefore ceased.

Discussion

This study is the first to examine the factor structure and validity of the FCRI in an Asian cancer population. This potentially provides a validated tool that may be used in future studies examining the multidimensional aspect of FCR in Singapore and other similar Asian cancer populations. The results of this study demonstrate that the English and Mandarin versions of the FCRI are reliable and valid measures of FCR that are applicable to mixed-cancer survivors in Singapore, with the original seven-factor structure of FCR (Simard and Savard, 2009) replicated in this study.

The psychometric properties of both the English and Mandarin versions of the FCRI were similar to that of the French (Simard and Savard, 2009) and English versions (Lebel et al., 2016b) previously validated in Canada. In this study, both versions of the FCRI displayed high internal reliability, with reliability coefficients greater than the cut-off criteria of .70. Test–retest

Table 3. Correlations between FCRI and other validation scales.

Measures	Cronbach's alpha	*M* (SD)	Correlations with FCRI score and subscales							
			Total	F1	F2	F3	F4	F5	F6	F7
Convergent validity										
FoP-Q										
Fear of progression	.89	71.62 (23.20)	.69***	.56***	.63***	.65***	.56***	.58***	.33***	.35***
Affective reactions	.89	29.28 (9.50)	.71***	.58***	.68***	.70***	.53***	.60***	.30***	.36***
Partnership/family	.79	14.07 (5.16)	.55***	.42***	.52***	.50***	.43***	.44***	.27***	.30***
Occupation	.88	14.99 (6.50)	.51***	.44***	.45***	.44***	.44***	.41***	.26***	.26***
Loss of independence	.87	13.28 (5.34)	.58***	.46***	.48***	.54***	.51***	.54***	.32***	.27***
Coping	.71	28.33 (5.80)	.27***	.15*	.15*	.05	.06	.01	.28***	.49***
FRQ										
Total score	.90	69.95 (11.65)	.61***	.52***	.62***	.58***	.41***	.43***	.23***	.34***
Concurrent validity										
HADS										
Total score	.88	8.59 (6.53)	.58***	.44***	.52***	.61***	.56***	.62***	.26***	.23***
HADS–anxiety	.87	5.06 (4.00)	.66***	.51***	.59***	.67***	.58***	.64***	.32***	.32***
HADS–depression	.78	3.53 (3.32)	.35***	.25***	.32***	.39***	.39***	.44***	.14	.07
Divergent validity										
WHOQOL–BREF										
Overall quality of life	.66	60.02 (15.59)	−.22***	−.18**	−.26***	−.33***	−.27***	−.27***	−.05	.05
Physical health	.79	68.65 (14.93)	−.21***	−.13	−.19**	−.27***	−.26***	−.32***	−.16*	.00
Psychological	.83	66.70 (15.10)	−.27***	−.21***	−.27***	−.38***	−.33***	−.40***	−.12	.04
Social relationships	.73	64.82 (17.28)	−.19**	−.16*	−.15*	−.27***	−.27***	−.28***	−.11	−.06
Environment	.87	66.29 (15.43)	−.14	−.12	−.09	−.21***	−.23***	−.25***	−.08	−.08

SD: standard deviation; FoP-Q: Fear of Progression Questionnaire; FRQ: Fear of Recurrence Questionnaire; HADS: Hospital Anxiety and Depression Scale; WHOQOL-BREF: World Health Organization Quality of Life Instrument (short version); FCRI: Fear of Cancer Recurrence Inventory; F1: Triggers; F2: Severity; F3: Psychological Distress; F4: Functioning Impairments; F5: Insight; F6: Reassurance; F7: Coping Strategies.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 4. Fit indices for the second-order models of the Fear of Cancer Recurrence (FCRI).

Models tested and the items that error of covariance were released		Fit indices				
		χ^2	df	CFI	RMSEA	SRMR
Initial FCRI—second-order model		2398.594	812	0.853	0.077	0.085
Item 39	I try to understand what is happening and deal with it	2242.839	811	0.867	0.074	0.085
Item 40	I try to find a solution					
Item 34	I try to distract myself	2152.977	810	0.876	0.071	0.087
Item 35	I try not to think about it, to get the idea out of my mind					
Item 15	How often do you think about the possibility of cancer recurrence?	2066.219	809	0.883	0.069	0.087
Item 16	How much time per day do you spend thinking about the possibility of cancer recurrence?					
Item 22	My social or leisure activities	2015.467	808	0.888	0.068	0.087
Item 23	My work or everyday activities					
Item 2	An appointment with my doctor or other health professionals	1982.788	807	0.891	0.067	0.086
Item 3	Medical examinations					
Item 20	Frustration, anger, or outrage	1952.003	806	0.894	0.066	0.086
Item 21	Helplessness or resignation					
Item 16	How much time per day do you spend thinking about the possibility of cancer recurrence?	1915.9	805	0.897	0.065	0.086
Item 17	How long have you been thinking about the possibility of cancer recurrence?					
Item 15	How often do you think about the possibility of cancer recurrence?	1864.804	804	0.902	0.064	0.086
Item 17	How long have you been thinking about the possibility of cancer recurrence?					
Item 3	Medical examinations	1838.761	803	0.904	0.063	0.085
Item 4	Conversations about cancer or illness in general					
Item 23	My work or everyday activities	1820.974	802	0.906	0.062	0.085
Item 24	My relationships with my partner, my family, or those close to me					
Item 24	My relationships with my partner, my family, or those close to me	1803.542	801	0.907	0.062	0.085
Item 25	My ability to make future plans or set life goals					

CFI: comparative fit index; RMSEA: root-mean-square error of approximation; SRMR: standard root-mean-squared residual.

reliability was also supported, with strong agreement between T1 and T2 FCRI scores, including the subscales.

The criterion validity of the FCRI was also supported. Convergent validity was supported through strong correlations with other constructs measuring FCR. While both the FoP-Q and FRQ measured FCR, and it was expected that the total scores of FCRI and these two scales would be more strongly correlated, the strong correlations in this study paralleled those of the two previous validation studies (Lebel et al., 2016b; Simard and Savard, 2009). The concurrent validity of the FCRI was also supported. FCR was expected to be significantly associated with psychological distress,

especially anxiety (Crist and Grunfeld, 2013; Humphris et al., 2003; Koch et al., 2013). In this study, FCRI was strongly correlated with overall psychological distress and anxiety, and a moderate correlation with depression was observed. The FCRI had weak-to-moderate correlations with QoL, demonstrating divergent validity and supporting FCRI as a distinct construct separated from its potential consequences (Simard and Savard, 2009).

However, the goodness-of-fit indices of the original seven-factor model indicated some misfit. The presence of some misfit is unsurprising in CFA (Furr and Bacharach, 2014; Kline, 2011), and especially so in this context given the cultural and linguistic differences between the present sample and the initial validation sample (Lebel et al., 2016b; Simard and Savard, 2009). Furthermore, the initial validation samples included all patients who had undergone cancer treatment for the past 10 years (Simard and Savard, 2009) or 13 years (Lebel et al., 2016b), while this study, a subset of a larger cohort, only included patients 1 year after treatment completion.

A subsequent examination of the modification indices suggested that this misfit could be adequately addressed by freeing a total of 11 parameters in the residual covariance matrix, while leaving the factor-loading matrix intact. This suggests that these pairs of items share something unique (Kline, 2011) and could be an indication of perceived redundancy in item content. For instance, Items 39 (i.e. *I try to understand what is happening and deal with it*) and 40 (i.e. *I try to find a solution*) could have been perceived as similar coping strategies. It is important to note that these modifications do not influence the administration of the measure, but only serve to address possible sources of misfit in the model (Lebel et al., 2016b). Nonetheless, given the presence of some perceived redundancies, future studies should examine whether the number of items can be reduced without significantly changing the substantive content of the measure.

Limitations

An important limitation is the potential difficulty in interpreting the total FCRI score. A recent article by Costa et al. (2016) suggested that FCR may be conceptualized based on severity and/or affective domains. Thus, the authors suggested that the FCRI severity subscale may be used to interpret FCR instead of the total FCRI score. While we agree with the authors that the clinical utility of the FCRI may be increased by reducing the number of items to measure FCR, current empirical evidence shows that FCR is expressed as a complex network of cognitive, affective, and behavioral dimensions. Specifically, recent studies show that the cognitive–behavioral model (CBM) is the most appropriate theoretical model to understand FCR (Cohee et al., 2017; Fardell et al., 2016; McGinty et al., 2016). For example, McGinty et al. (2016) observed that FCR was predicted by both cognitions (e.g. perceived risk) and behavior (e.g. reassurance-seeking behaviors), which provided support for the CBM. More theoretically driven and evidence-based research is needed to ascertain whether FCR may be conceptualized as a unidimensional construct.

A second limitation is the representativeness of the sample. As participation was voluntary, patients who declined participation could potentially have significantly different levels of FCR. Another limitation is literacy; patients not sufficiently proficient in English or Mandarin were unable to participate in the study. Furthermore, a majority of the participants were female and had either breast or gynecological cancer, which might limit the generalizability of the findings.

Future directions

Future studies could seek to examine the cultural sensitivity of the FCRI for use in Asia. For example, some participants had shared their unwillingness to answer certain questions, such as Items 13 (i.e. *I believe that I am cured and that the cancer will not come back*) and 14 (i.e. *In*

your opinion, are you at risk of having a cancer recurrence?), due to a superstitious belief that discussing the topic of cancer recurrence could cause it to happen. These superstitions had been described among Chinese patients, where explicitly mentioning cancer was a taboo and could bring bad luck (Vivien et al., 2013).

This study provided a validated tool to assess the level of FCR in cancer survivors in Singapore, which could allow for the identification of patients with high FCR, and the subsequent enhancement of care. The simplified Mandarin version is also appropriate for use in Mandarin-speaking populations and will thus facilitate research in a wider population.

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Requests for FCRI (any forms and languages) and permission to use it should be addressed to Dr Sébastian Simard: sebastien.simard@criucpq.ulaval.ca.

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