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ORIGINAL ARTICLE

Factor structure of the Fear of Cancer Recurrence Inventory (FCRI): Comparison of international FCRI factor structure data and factor analysis of the Dutch FCRI-NL using three predominantly breast cancer samples

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Abstract

Objective: Factor structure results of Fear of Cancer Recurrence Inventory (FCRI) translations are inconclusive. Through investigating the factor structure, this study aimed to improve the FCRI and its usability. Therefore, we did a comprehensive comparison of the factor structure results of all translations, by exploring and improving the structure of the Dutch FCRI-NL and by testing this new factor structure in two patient samples.

Methods: To compare factor structure results of FCRI translations, we did a literature search using PubMed and Google Scholar. We performed exploratory factor analysis (EFA) in a mixed cancer sample. The confirmatory factor analyses (CFAs) were secondary analyses performed in two randomized controlled trial samples: consecutive breast cancer patients and distressed, mainly breast cancer patients.

Results: All translations showed comparable and reasonable factor structure results; however, the FCRI factor structure can be improved. The EFA resulted in a four-factor solution: fear of cancer recurrence (FCR) severity, cognitive coping, impact of FCR on functioning and behavioural coping. However, the 4-factor CFAs did not fit the sample 2 and 3 data well.

Conclusion: Further exploring the FCRI-NL factor structure did not result in a psychometrically stronger FCRI-NL. Therefore, we recommend retaining the 7-factor FCRI-NL.

KEYWORDS
breast cancer, fear of cancer recurrence (FCR), Fear of Cancer Recurrence Inventory (FCRI)

1 | INTRODUCTION

Fear of cancer recurrence (FCR) is one of the most reported concerns after surviving cancer and can continue for ten years or more after diagnosis (Koch et al., 2013; Mehnert et al., 2013). FCR is defined as 'fear, worry, or concern about cancer returning or progressing' and is increasingly recognised as a multidimensional construct, including physical sensations, functioning impairments, psychological distress, intrusive thoughts and coping strategies (Fardell et al., 2016; Lebel, Ozakinci, et al., 2016; Simard & Savard, 2009). Across different cancer types, 39–97% of cancer survivors reported some level of FCR, 22–87% reported moderate to high levels of FCR, and 0–15% reported high levels of FCR (Simard et al., 2013). It is important to identify high or clinical levels of FCR, so that psychological treatment can be offered. Therefore, good screening instruments are needed. Currently, at least 34 assessment instruments for FCR exist, including 11 subscales of larger measures, 19 brief questionnaires (2–10 items) and four longer (multidimensional) questionnaires (10+ items). Many of these scales are only available in one language, are cancer site specific or have a limited availability of research and psychometric data (Humphris et al., 2018; Simard et al., 2013; Thewes et al., 2012). The Fear of Cancer Recurrence Inventory (FCRI) is a multidimensional measure intended for use in all cancer patients, translated and validated in several languages, and currently one of the psychometrically strongest measures available (Thewes et al., 2012).

The FCRI is based on the definition of FCR, on DSM-IV diagnostic criteria of anxiety and somatoform disorders, and on a cognitive-behavioural conceptualisation of FCR. The measure was developed by a committee of experts in psycho-oncology. The original French-Canadian version of the FCRI comprises 42 items measuring seven factors (Triggers, Severity, Psychological Distress, Coping Strategies, Functioning Impairments, Insight, and Reassurance) (Simard & Savard, 2009). The Severity subscale can be used as a short form of the FCRI (FCRI-SF) to screen for clinical levels of FCR, whereas the other subscales represent aspects related to FCR, such as antecedents (e.g. Triggers), modifiers (e.g. Coping Strategies) or consequences (e.g. Functioning Impairments; Costa et al., 2016; Simard & Savard, 2015). The original FCRI demonstrated good validity and reliability (internal consistency estimated by Cronbach's α = 0.95; and test–retest reliability r (287) = 0.89, p < 0.001; Simard & Savard, 2009). The psychometric properties of the English translation were similar (α = 0.96; r [135] = 0.88, p < 0.001; intraclass correlation [ICC] = 0.94, p < 0.001), as were those of the recently published Dutch version (FCRI-NL; α = 0.93; ICC [95] = 0.84, p < 0.001), the Mandarin version (α = 0.95; ICC [109] = 0.86, p <0.001), the Korean version (K-FCRI; α = 0.85; ICC [62] = 0.90, p <0.001) and the Danish version (ICC [49] = 0.84, p-value was not reported; van Helmondt et al., 2017; Hovdenak Jakobsen et al., 2018; Lebel, Simard, et al., 2016; Liu et al., 2017; Shin et al., 2017). Results concerning the factor structure of the FCRI, measured by confirmatory factor analyses (CFAs), are inconclusive. Most research papers on the original 7-factor FCRI structure have reported a satisfactory model fit, while a reasonable, yet suboptimal fit was reported for the FCRI-NL (Galica et al., 2018; van Helmondt et al., 2017; Lebel, Simard, et al., 2016; Lin et al., 2018; Liu et al., 2017; Shin et al., 2017; Simard et al., 2010). However, comparing CFAs of the different FCRI translations is hampered by the use of different CFA software, fit indices and cut-off criteria (Galica et al., 2018; van Helmondt et al., 2017).

There has been some discussion about the applicability of the FCRI in its current form. For example, Costa, Smith, et al. (2016) question the use of a combined FCRI total score. They state that a total score represents an uninterpretable combination of concepts given the multidimensional nature of the FCRI (Costa, Smith, et al., 2016). Moreover, the Reassurance and Coping Strategies subscales show problematic features. For most translations, the internal consistency scores of the Reassurance and/or Coping Strategies subscales are slightly lower (but all above 0.70), and for some translations, the test–retest reliability was unsatisfactory (Smith et al., 2020). Also, in analyses based on response theory (IRT), several items were found were respondents tended to use the *rarely* answer category less frequent than the other answer categories, including most items in the Reassurance and Coping Strategies subscales. Additionally, some items can better discriminate between respondents low or high on FCR than others (Costa et al., 2016). These problems motivated research investigating an alternative multidimensional FCR model with 7 first-order factors (instead of a second order model) or an alternative FCRI following exploratory factor analysis (EFA; Costa, Dieng, et al., 2016; Eyrenci & Sertel-Berk, 2018).

Given the inconsistencies in the body of research concerning the FCRI, this study aimed to (a) comprehensively compare all published research investigating the FCRI factor structure. Since the body of research on the FCRI shows there may be room for improvement concerning its factor structure, additional aims are to (b) further explore the factor structure of the FCRI-NL with EFA, in order to improve the FCRI-NL, and (c) to test the newly identified factor structure with CFAs in two new (predominantly breast cancer) patient samples (and to compare these samples).

2 | METHODS

2.1 | Procedure and participants

To compare CFA results of all FCRI translations (first aim), all available articles reporting FCRI CFA results were collected using the electronic bibliographic database PubMed (search terms: ("fear of cancer recurrence inventory" [Title]) AND ("confirmatory factor analys*" [Title/Abstract])). Furthermore, we did an additional search on Google Scholar (search terms: "fear of cancer recurrence inventory" AND "confirmatory factor analysis"). Articles were eligible when they reported CFA results of (a translation of) the original 7-factor FCRI (not an adapted version).

To further explore the factor structure of the FCRI (second aim), we did a secondary analysis (by means of an EFA) on the data from *sample 1*. *Sample 1* is a mixed cancer patient sample (not selected on FCR level) recruited between 2011 and 2013 through

patient organizations with an online opt-in recruitment method (van Helmondt et al., 2017). This sample was also used for the initial FCRI-NL validation (van Helmondt et al., 2017). Participants could fill out the online questionnaire (including demographic information and the FCRI-NL) through a link in an e-mail newsletter from their patient organizations in the Netherlands. Informed consent was obtained from all individual participants. For more details about the data collection for *sample 1*, see van Helmondt et al. (2017). In total, 290 participants completed the FCRI-NL. Thirty-five participants were excluded because they reported disease recurrence, leaving 255 (87.9%) participants for analysis (van Helmondt et al., 2017). The final sample included 255 mixed cancer patients (88.6% women, cancer types not assessed) with mean age 51.0 (±9.8) years.

To test the new factor structure (third aim), we did secondary analyses (by means of CFAs) on the data from *samples 2* and *3*. Both data samples are from large randomized controlled trials and intervention studies (Compen et al., 2015; van Helmondt et al., 2016). *Sample 2* consists of the baseline FCRI-NL scores of the CAREST study (van Helmondt et al., 2016). Oncology nurses in outpatient clinics consecutively recruited women with breast cancer in eight hospitals, both face-to-face and by sending comprehensive information letters. We obtained written informed consent on paper, and participants completed the FCRI and other self-report questionnaires on paper or online. For more details about the data collection for *sample 2*, see van Helmondt et al. (2016). In total, 516 participants returned informed consent. Sixty-two participants were excluded (36 did not complete any item of the FCRI-NL, 25 had missing values, and one had adopted a '0' response pattern for all items of the FCRI), leaving 454 (88.0%) participants for analysis. The final sample included 454 women with breast cancer with mean age 57.9 (±10.5) years.

Sample 3 consists of the baseline FCRI-NL scores of distressed cancer patients from the BeMind study (Compen et al., 2015). The researchers recruited participants in participating outpatient clinics, and via offline and online media. Patients who were interested enrolled themselves on the study's website (www.bemind.info) and filled out the Hospital Anxiety and Depression Scale (HADS). To assess eligibility, researchers phoned all survivors with ≥11 on the HADS. Written informed consent was obtained on paper, and participants completed the FCRI and other self-report questionnaires online prior to randomization. For more details about the data collection, see Compen et al. (2015). In total, 245 participants were eligible for the study and completed the FCRI-NL. Forty participants were excluded (39 had chronic or incurable cancer and one did not complete the FCRI), leaving 205 (83.7%) participants for analysis. The final sample included 205 mixed cancer patients (86.6% women) with mean age 50.9 (±10.4) years, including 67.5% women with breast cancer, 7.3% women with gynaecological cancer, 4.9% patients with colon cancer, 2.4% patients with non-Hodgkin, 5.4% patients with colon cancer and 12.2% patients with other cancers.

Patient characteristics of all samples are presented in Table 1. On average, participants in *sample 2* were older than participants in *samples 1 and 3* (57.9 years vs 51.0 and 50.9 years). Also, participants in *sample 2* had lower FCR levels than *samples 1 and 3* (mean FCR level on the FCRI-S 13.9 vs 19.5 and 20.7). *Sample 2* consists of only female breast cancer patients, while *samples 1 and 3* are mixed samples including a majority of women (88.6% and 86.6%). Education differed between the samples: *samples 1 and 3* primarily consisted of highly educated patients (47.1% and 67.3%), while patients in *sample 2* most often had a medium level of education (50.0%).

3 | MATERIAL

The FCRI-NL consists of 42 items with a 5-point Likert scale ranging from 0 (*not at all* or *never*) to 4 (*a great deal* or *all the time*) (van Helmondt et al., 2017; Simard & Savard, 2009). See Appendix S1 for the FCRI-NL. The FCRI comprises seven subscales: Triggers, Severity, Psychological Distress, Coping Strategies, Functioning Impairments, Insight, and Reassurance. Subscale scores can be calculated by summing the subscale item scores. When summing all items, a total FCRI score can be calculated. The Severity subscale (FCRI-SF) can be used to screen for clinical levels of FCR. The score of item 13 ''I believe that I am cured and the cancer will not come back'' must be reversed before summation (Simard & Savard, 2009, 2015). The reliability and validity of the original French, English, Dutch, Mandarin, Korean and Danish versions of the FCRI total scale and most subscales are sufficient to good.

4 | STATISTICAL ANALYSIS

Analyses were conducted using IBM SPSS 23 for Windows. Data were explored in the same way as the initial FCRI-NL validation study (van Helmondt et al., 2017). First, we checked normality of the FCRI item scores: *Z*-scores (skewness and kurtosis values divided by standard error) larger than 2 or smaller than −2 were considered a violation of normality. Then, we examined Quantile–quantile (Q–Q) plots and probability–probability (P–P) plots to screen for multivariate normality. In addition, we screened the data for floor and ceiling effects. Significance level was 0.05. We excluded participants when they had missing values on the FCRI-NL, because the scale-free least squares estimation method in IBM SPSS AMOS 22 (see below) could not handle missing values. We also excluded participants when they had adopted the same response pattern (only 0, 1, 2, 3 or 4) for all items of the FCRI, including the reversed phrased item (item 13), because this indicates that they likely adopted an automatic response set (Monette et al., 2013).

For comparing the FCRI translations (first aim), we used the following fit indices and cut-off criteria for evaluating good model fit: the root mean square error of approximation (RMSEA ≤0.10); comparative fit index (CFI ≥0.90); normed fit index (NFI ≥0.95); standardised root mean square residual (SRMR ≤0.10); adjusted goodness-of-fit statistic (AGFI ≥0.90); Tucker Lewis index (TLI ≥0.95); non-normed fit index (NNFI ≥0.95); and the parsimonious normed fit index (PNFI) (Hooper et al., 2008; Hu & Bentler, 1999; Weston & Gore Jr, 2006).

TABLE 1 Demographic and medical characteristics of three samples

	Sample 1 (*n* = 255)		Sample 2: CAREST (*n* = 454)		Sample 3: BeMind (*n* = 205)	
	n	**%**	***n***	**%**	***n***	**%**
Demographic characteristics						
Age[a]	*n* = 255		*n* = 450		*n* = 205	
M (SD)	51.0	9.8	57.9	10.5	50.9	10.4
Range	26–77		26–85		26–77	
Gender	*n* = 255		*n* = 450		*n* = 205	
Male	29	11.4	0	0.0	27	13.2
Female	226	88.6	454	100.0	178	86.6
Having a partner			*n* = 380		*n* = 205	
Yes	[c]		315	82.9	171	83.4
No	[c]		65	17.1	34	16.6
Education[b]	*n* = 255		*n* = 380		*n* = 205	
Low (ISCED 0–1–2)	38	14.9	51	13.4	2	1.0
Medium (ISCED 3–4–5)	96	37.6	190	50.0	65	31.7
High (ISCED 6–7–8)	120	47.1	138	30.4	138	67.3
Unknown	1	0.4	1	0.3	0	0.0
Medical characteristics						
Time since diagnosis[a]	[c]		*n* = 450		*n* = 205	
Median (IQR)	[c]		2.4	1.8	1.6	3.1
Cancer diagnosis			*n* = 454		*n* = 205	
Breast cancer	[c]		454	100.0	139	67.8
Gynaecological cancer	[c]		0	0.0	15	7.3
Colon cancer	[c]		0	0.0	10	4.9
Non-Hodgkin	[c]		0	0.0	5	2.4
Prostate	[c]		0	0.0	11	5.4
Other	[c]		0	0.0	25	12.2
FCR Severity[a]	*n* = 255		*n* = 454		*n* = 205	
M (SD)	**19.5**	**6.3**	13.9	6.9	20.7	6.4
Median (IQR)	20.0	9.0	**14.0**	**9.0**	**21.0**	**10.0**

Abbreviations: FCR, fear of cancer recurrence; IQR, interquartile ranges; ISCED, International Standard Classification of Education; M, mean; SD, standard deviation.

[a]Means and standard deviations (SD) were reported for normally distributed variables, medians and interquartile ranges (IQR) were reported for not-normally distributed variables (where both are reported, the bold numbers need to be looked at).

[b]UNESCO Institute for Statistics (UIS). International Standard Classification of Education: ISCED 2011. Montreal, Quebec: UIS; 2012.

[c]These variables were not assessed in sample 1.

Although the RSMEA, CFI and SRMR cut-off criteria are less strict than sometimes recommended, they are considered adequate because the FCRI 7-factor model is a complex model (stricter cut-off values are preferred for simpler models) (Weston & Gore Jr, 2006). Using a parsimony-corrected fit index next to other goodness-of-fit measures is strongly recommended, but it is difficult to interpret because there are no threshold levels recommended yet. However, it is possible to have acceptable models with parsimony-corrected fit index values in the 50s, and higher values indicate a better fit to the data (Hooper et al., 2008).

To further explore the factor structure of the FCRI (second aim), we performed an EFA on *sample 1*. First, we assessed suitability of the data for conducting an EFA, details are presented in Appendix S2. When the data met the criteria, factors were extracted with the principal components analysis (PCA) method. When the assumption of multivariate normality was violated, the principal axis

factor (PAF) method was used. We used oblique (direct oblimin) factor rotation because we expected strong correlations between the factors (Yong & Pearce, 2013). We used multiple decision rules to determine the number of significant factors: (a) Kaiser's criterion (eigenvalue >1 rule); (b) the Cattell's Scree test (eigenvalues above the elbow of the plot are retained as number of factors); and (c) Horn's parallel analysis (Field, 2009; Williams et al., 2012). For Horn's parallel analysis, Monte Carlo PCA for Parallel Analysis (version 2.5) was used (Watkins, 2010). When the average communality was lower than.60, given sample size >250, little value was attached to Kaiser's criterion and more value was attached to Cattell's Scree test and the more accurate parallel analysis (Field, 2009). Subsequently, we examined the pattern matrix according to the 0.40–0.30–0.20 rule. This rule implies that satisfactory items (a) load onto their primary factor above 0.40, (b) load onto alternative factors below 0.30 and (c) demonstrate a difference of 0.20 between their primary and alternative factor loading (Howard, 2016). After removing the item that least met these criteria (first based on the factor loadings, then on the crossloadings), we repeated the PCA/PAF analysis in an iterative fashion until every remaining item met the criteria. After three experienced clinicians/researchers made a careful judgement on which solution was the best-fit and which of the factors extracted made the most conceptual sense, the best-fit solution was presented. Thereafter, they operationalised and labelled the factors.

To test the new factor structure (third aim), we tested the factor structure (identified with EFA) in CFAs on *samples 2 and 3*. We used the scale-free least squares estimation method in IBM SPSS AMOS 22, to handle any non-normal item score distributions. We evaluated goodness of fit with AGFI, NFI, PNFI and SRMR and the earlier described cut-off criteria.

5 | RESULTS

5.1 | Comparison of the different FCRI translations (first aim)

We conducted a PubMed search on 23 April 2020, which resulted in six articles. All articles were reporting CFA results for FCRI translations and, therefore, eligible for comparison (Galica et al., 2018; van Helmondt et al., 2017; Lebel, Simard, et al., 2016; Lin et al., 2018; Liu et al., 2017; Shin et al., 2017). An additional search on Google Scholar resulted in 55 articles, of which two articles included CFA results for FCRI translations and were eligible for comparison (Costa, Dieng, et al., 2016; Simard et al., 2010). Table 2 shows the results of the comparison between the eight different studies. Since Simard et al. (2010) reported the CFA results very concise in their Methods section, extra information received from the first author was added to Table 2 (S. Simard, personal communication, 8 July 2010). It turned out that the psychometric properties were comparable across translations. For the total FCRI and most FCRI subscales, internal consistency was good (Cronbach's alpha ≥0.80). The reassurance and coping strategies subscales showed acceptable internal consistency (estimated Cronbach's alpha 0.70–0.80) for 66.7% and 33.3% of the translations, respectively. Regarding test–retest reliability, the Insight, Reassurance, and Coping Strategies subscales showed suboptimal results. Internal consistency and test–retest reliability of these subscales differed between the translations.

There were differences between the included studies in for example the CFA software, the types and numbers of reported fit indices and the cut-off criteria (see Table 2). Also, most studies reported both the original 7-factor CFA and an adjusted version in which residual covariance parameters were added to improve the model (7 studies). Yet, one study reported only the original 7-factor model, because the robust CFA method in IBM Amos did not allow adding residual covariance parameters (van Helmondt et al., 2017). When applying the same cut-off criteria to the reported fit indices of all studies, conclusions regarding model fit occasionally differed from those originally reported. For example, the original French CFA results were interpreted as a reasonably good fit with the original 7-factor structure, while based on the current criteria only one out of three fit indices was sufficient (Simard et al., 2010; S. Simard, personal communication, 8 July 2010). Moreover, for the Dutch CFA, the results had been interpreted as a reasonable, yet suboptimal fit, while based on the current criteria three out of four fit indices were sufficient (van Helmondt et al., 2017). Also, there was some variation in the model fit between translations and within the CFAs conducted on the same translation. For example, both a good model fit and a more doubtful model fit were found for the English translation, with five out of five and one out of three acceptable fit criteria, respectively (Galica et al., 2018; Lebel, Simard, et al., 2016). These results illustrate that CFA results and interpretation are dependent on the used fit criteria. Comparing the different FCRI translations and applying the same cut-off criteria to all translations, results in acceptable factor analyses results. Results are fairly consistent across translations and do not seem to be dependent on the translations or cultural differences. However, there may be some room for improvement concerning the FCRI factor structure and items. For more details, see Table 2.

5.2 | Exploring the FCRI factor structure (second aim)

All criteria confirmed that the data are suitable for EFA (details are presented in Appendix S2). Because of the non-normally distributed item scores (see Appendix S3), we used the PAF method with oblique (direct oblimin) factor rotation to conduct an EFA on the 42 items of the FCRI. An initial PAF analysis showed nine components had eigenvalues larger than 1. The scree plot was slightly ambiguous and showed inflexions that would justify retaining nine or four components. Parallel analysis suggested four components. Since the average communality was lower than 0.60 (0.47) and the sample size larger than 250 (255), Kaiser's criterion was not accurate, and we

TABLE 2 Comparison of the psychometric properties and factor structure (confirmatory factor analysis results) of the different FCRI translations

	French (Simard et al., 2010)	English (Lebel, Simard, et al., 2016)	English (Costa, Dieng, et al., 2016)	Dutch (van Helmondt et al., 2017)	English/Mandarin (Liu et al., 2017)	Korean (Shin et al., 2017)	English (Galica et al., 2018)	Chinese (Lin et al., 2018)
Sample	Mixed sample: • Breast 49% • Prostate 37% • Colorectal 9% • Lung 5%	Mixed sample: • Breast 40% • Prostate 42% • Colorectal 12% • Lung 6%	Melanoma sample (not metastatic)	Mixed sample (included cancer sites unknown)	Mixed sample: • Breast 38% • Gynaecological 27% • Gastro-intestinal 14% • Other 21%	Mixed sample: • Stomach 39% • Breast 25% • Lung 9% • Thyroid 8% • Other 19%	Mixed sample: • Breast 66% • Other 34%	Head and neck cancer sample: • Nasopharyngeal 45% • Pharyngeal larynx 21% • Oral cavity 29% • Other 5%
Internal consistency								
	Cronbach's α (n = 600)	Cronbach's α (n = 350)	–	Cronbach's α (n = 255)	Cronbach's α (n = 222)	Cronbach's α (n = 444)	Cronbach's α (n = 984)	–
Triggers	0.90	0.93	–	0.88	0.90	0.80	0.92	–
Severity	0.89	0.88	–	0.85	0.84	0.77	0.88	–
Psychological Distress	0.86	0.88	–	0.84	0.94	0.83	0.89	–
Functioning Impairments	0.91	0.94	–	0.92	0.95	0.82	0.94	–
Insight	0.80	0.85	–	0.84	0.89	0.87	0.89	–
Reassurance	0.75	0.71	–	0.76	0.82	0.84	0.77	–
Coping Strategies	0.89	0.91	–	0.75	0.91	0.77	0.89	–
Total FCRI	0.95	0.96	–	0.93	0.95	0.84	–	–
Test–retest reliability								
	Pearson's correlation (1 month)	Pearson's correlation (1 month)	–	ICC (16 days)	ICC (unknown)	ICC (206 days)	–	–
	n = 287	n = 135	–	n = 95	n = 177	n = 62	–	–
Triggers	0.83	0.78	–	0.81	0.80	0.76	–	–
Severity	0.80	0.87	–	0.87	0.89	0.84	–	–
Psychological distress	0.76	0.79	–	0.74	0.87	0.73	–	–
Functioning impairments	0.70	0.71	–	0.78	0.83	0.67	–	–
Insight	0.58	0.85	–	0.74	0.87	0.80	–	–
Reassurance	0.73	0.56	–	0.56	0.84	0.80	–	–
Coping strategies	0.75	0.75	–	0.59	0.89	0.54	–	–
Total FCRI	0.89	0.88	–	0.84	0.91	0.90	–	–
Confirmatory factor analysis[a]								
	n = 1984	n = 350	n = 228	n = 255	n = 222	n = 444	n = 984	n = 300

(Continues)

TABLE 2 (Continued)

	French (Simard et al., 2010)	English (Lebel, Simard, et al., 2016)	English (Costa, Dieng, et al., 2016)	Dutch (van Helmondt et al., 2017)	English/Mandarin (Liu et al., 2017)	Korean (Shin et al., 2017)	English (Galica et al., 2018)	Chinese (Lin et al., 2018)
Software	Not reported	LISREL (v 90.1)	Mplus (v 6)	IBM Amos (v 22)	Mplus (v 60.12)	Mplus (v 60.1)	Mplus (v8)	Not reported
Initial 7-factor model								
χ^2	7798	2602	1346	1597	2399	2710	4359	—
df	812	812	798	812	812	812	812	—
p	<0.001	<0.001	<0.001	<0.001	<0.001	—	<0.001	—
RMSEA	0.066[a]	0.079[a]	0.055[a]	—	0.077[a]	0.073[a]	0.067[a]	—
RMSEA (90% CI)	—	—	0.050–0.060[a]	—	—	0.070 —0.076[a]	0.065 —0.069[a]	—
CFI	0.870	0.964[a]	0.949[a]	—	0.853	0.853	0.858	—
NFI	0.860	0.949	—	0.927	—	—	—	—
SRMR	—	0.088[a]	—	0.083[a]	0.085[a]	—	—	—
PNFI	—	0.895[a]	—	0.874[a]	—	—	—	—
TLI	—	—	0.946	—	—	—	0.849	—
AGFI	—	—	—	0.935[a]	—	—	—	—
NNFI	—	—	—	—	—	0.844	—	—
Final 7-factor model (model fit improved by freeing parameters in the residual covariance matrix)								
χ^2	5816	1963	1269	—	1804	2094	3460	—
df	807	803	796	—	801	803	807	—
p	<0.001	<0.001	<0.001	—	<0.001	—	<0.001	—
RMSEA	0.056[a]	0.064[a]	0.051[a]	—	0.062[a]	0.060[a]	0.058[a]	0.075[a]
RMSEA (90% CI)	—	—	0.046–0.056[a]	—	—	0.057–0.063[a]	0.056–0.060[a]	—
CFI	0.910	0.977[a]	0.956[a]	—	0.907	0.900	0.893	0.948[a]
NFI	0.900	0.962[a]	—	—	—	—	—	0.919
SRMR	—	0.075[a]	—	—	0.085[a]	—	—	0.093[a]
PNFI	—	0.897[a]	—	—	—	—	—	0.867[a]
TLI	—	—	0.953[a]	—	—	—	0.886	—
AGFI	—	—	—	—	—	—	—	—
NNFI	—	—	—	—	—	0.893	—	—

Values that were not reported in the articles, were indicated with '—'.

Abbreviations: AGFI, adjusted goodness-of-fit statistic; CFI, comparative fit index, CI, confidence interval; Cronbach's α, Cronbach's alpha; df, degrees of freedom, ICC, intraclass correlation; *n*, sample size; NFI, normed fit index; NNFI, non-normed fit index; *p*, *p*-value; PNFI, parsimonious normed fit index; RSMEA, root mean square error of approximation; SRMR, standardised root mean square residual; TLI, Tucker Lewis index; χ^2, chi square.

[a]Cut-off criteria for fit indices: RMSEA ≤0.10; CFI ≥0.90; NFI ≥0.95; SRMR ≤0.10; for PNFI no thresholds have been recommended, although values between 0.50 and 0.90 are possible; TLI ≥0.95 acceptable and ≥0.97 good; AGFI ≥0.90; and NNFI ≥0.95.

[b]Acceptable model fit.

attached more value to the results of Cattell's Scree test and parallel analysis. We retained four factors for the final analysis.

Following oblique (direct oblimin) rotation for a four-factor solution, factors 1 and 3 showed a moderate negative intercorrelation (r = −0.50), the other factors showed small intercorrelations (r = −0.05 −0.18). Several items had factor loadings smaller than 0.40 or crossloadings. Following the PAF analysis, we discarded 8 items in the following order: 36–38–17–21–20 (items that loaded below 0.40 on their primary factor), and 16–19–15 (items that loaded above 0.30 on their alternative factor and demonstrated a difference of <0.20 between their primary and alternative factor loadings) (see Table 3). The remaining 34 items showed a clear four-factor solution (see Table 3), which explained 56.0% of the variance in the FCRI-NL item scores. Since we used an oblique rotation method, we interpreted the meaning of each factor using the pattern matrix, as these factor-item correlations are not confounded by the association of items with other factors. We labelled the factors FCR severity (factor 1; 14 items), cognitive coping (factor 2; 7 items), impact of FCR on functioning (factor 3; 10 items) and behavioural coping (factor 4; 3 items).

5.3 | Test the new factor structure (third aim)

CFA did not show good model fit of the 4-factor model for both *samples 2 and 3*. In *sample 2* (χ^2 (595) = 10,750; p <0.001; χ^2/df = 18.068), the AGFI (0.750) and NFI (0.695) were smaller than the recommended criterium, and the SRMR index (0.147) was larger than the recommended criterion, all suggesting misfit (see Table 4). The PNFI of *sample 2* was 0.738. In *sample 3* (χ^2 (595) = 1195; p <0.001; χ^2/df = 2.008), the AGFI (0.920) and SRMR index (0.109) met the criteria for adequate model fit and the NFI (0.895) was smaller than the recommended criterion, indicating some misfit of the 4-factor model to the data of *sample 3* (see Table 4).The PNFI of *sample 3* was 0.949. At first sight, the 4-factor model seems to fit the data of *sample 3* better than the data of *sample 2*. However, these differences should be interpreted with care, as to the best of our knowledge there exists no statistical tests to assess whether the difference between fit indices of models fitted on different samples is statistically significant.

Based on these results, we additionally performed two nonprespecified CFAs to investigate the original 7-factor model in *samples 2 and 3*. In *sample 2* (χ^2 (812) = 2326; p < 0.001; χ^2/df = 2.865), the AGFI (0.958), NFI (0.956) and SRMR index (0.075) met the criteria for adequate model fit, indicating a good model fit of the 7-factor model to the data of *sample 2* (see Table 4). The PNFI of *sample 2* was 0.901. In *sample 3* (χ^2 (812) = 1369; p <0.001; χ^2/df = 1.685), the AGFI (0.926) and the SRMR index (0.086) met the criteria for adequate model fit and the NFI (0.917) was smaller than the recommended criterion, indicating some misfit of the 7-factor model to the data of *sample 3* (see Table 4). The PNFI of *sample 3* was 0.864. These results suggest an acceptable fit of the 7-factor model to the data of *samples 2 and 3*. At first sight, the 7-factor model seems to fit the data of *sample 2* better than the data of *sample 3* (which is reversed compared to the 4-factor model). However, as mentioned before, these differences should be interpreted with care. Additionally, internal consistency values for both the 4-factor and the 7-factor model in all samples are available in Appendix S4.

6 | DISCUSSION

This is the first study that has compared and evaluated all available information about the FCRI factor structure (first aim) and has tried to improve the factor structure of the FCRI-NL by testing a new factor structure (second and third aim).

The factor structure results of the different FCRI translations were comparable after applying the same cut-off criteria to all translations (first aim). The comparison of all published papers including FCRI factor structure results was hampered by the use of different fit indices. Results show that interpretation of the FCRI factor structure results for the different translations was dependent on the used fit criteria. Although we have interpreted the results of the 7-factor FCRI-NL as weaker than the results of other translations of the FCRI earlier, the results of the current comparison showed that they are in line with other translations (van Helmondt et al., 2017). Although the body of research shows a reasonable model fit, psychometric properties and the factor structure results show there still may be room for improvement.

Exploratory analysis resulted in a four-factor solution in which 34 items of the original FCRI-NL were retained (second aim). We labelled the factors FCR severity, cognitive coping, impact of FCR on functioning, and behavioural coping. However, this new multidimensional 4-factor structure of the FCRI-NL was not replicated in two new (predominantly breast cancer) patient samples (third aim). Nonprespecified CFAs of the original 7-factor structure of the FCRI-NL showed a reasonable fit of this model to the data of both samples. Because of these results, we suggest retaining the original 7-factor FCRI-NL, instead of the new 4-factor FCRI-NL. However, the comparison showed that psychometric properties of the Reassurance and Coping Strategies subscales of the FCRI were weaker. This confirms that caution is needed for using and interpreting the FCRI-NL total score (van Helmondt et al., 2017). Van Helmondt et al. (2017) recommended to use the FCRI-SF-NL for research and screening purposes. The remaining subscales seem most valuable in clinical practice, to discuss at item level and for tailoring interventions to the patients' needs.

Although the factor structure of the FCRI may be suboptimal, there is increasing evidence for the multidimensional approach that underlies this questionnaire (Custers et al., 2017; Fardell et al., 2016; Lebel et al., 2018; Lee-Jones et al., 1997; Maheu et al., 2019; Simard & Savard, 2009; Simonelli et al., 2017). FCR is an intense, difficult and multidimensional experience according to patients (Almeida et al., 2019). Therefore, multidimensional measures for FCR should be preferred above unidimensional measures. Since multidimensional measures for FCR are scarce, and often only available in one language, cancer site specific, or have limited availability of research

TABLE 3 Pattern matrix for final results of Principal Axis Factoring extraction with oblique (direct oblimin) rotation of a 4-factor solution for FCRI-NL items

4-factor FCRI-NL items:		Factor 1: FCR severity	Factor 2: Cognitive coping	Factor 3: Impact of FCR on functioning	Factor 4: Behavioural coping
3.	The following situations make me think about the possibility of cancer recurrence: Medical examinations (e.g. annual check-up, blood tests, X-rays)	0.800			
2.	The following situations make me think about the possibility of cancer recurrence: An appointment with my doctor or other health professional	0.797			
4.	The following situations make me think about the possibility of cancer recurrence: Conversations about cancer or illness in general	0.779			
5.	The following situations make me think about the possibility of cancer recurrence: Seeing or hearing about someone who is ill	0.732			
1.	The following situations make me think about the possibility of cancer recurrence: Television shows or newspaper articles about cancer or illness	0.692			
9.	I am worried or anxious about the possibility of cancer recurrence	0.669			
10.	I am afraid of cancer recurrence	0.668			
6.	The following situations make me think about the possibility of cancer recurrence: Going to a funeral or reading the obituary section of the paper	0.648			
18.	When I think about the possibility of cancer recurrence, I feel: Worry, fear or anxiety	0.593			
11.	I believe it is normal to be worried or anxious about the possibility of cancer recurrence	0.572			
12.	When I think about the possibility of cancer recurrence, this triggers other unpleasant thoughts or images (such as death, suffering, the consequences for my family)	0.558			
7.	The following situations make me think about the possibility of cancer recurrence: When I feel unwell physically or when I am sick	0.516			
13.	I believe that I am cured and that the cancer will not come back	0.482			
14.	In your opinion, are you at risk of having a cancer recurrence?	0.448			
41.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try to replace this thought with a more pleasant one		0.746		
35.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try not to think about it. To get the idea out of my mind		0.669		
42.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I tell myself 'stop it'		0.605		
40.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try to find a solution		0.541		
34.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try to distract myself (e.g. do various activities, watch television, read, work)		0.509		
37.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try to convince myself that everything will be fine or I think positively		0.470		
39.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I try to understand what is happening and deal with it		0.434		

(Continues)

TABLE 3 (Continued)

4-factor FCRI-NL items:		Factor 1: FCR severity	Factor 2: Cognitive coping	Factor 3: Impact of FCR on functioning	Factor 4: Behavioural coping
23.	My thoughts or fears about the possibility of cancer recurrence disrupt: My work or everyday activities			0.890	
22.	My thoughts or fears about the possibility of cancer recurrence disrupt: My social or leisure activities (e.g. outings, sports, travel)			0.868	
27.	My thoughts or fears about the possibility of cancer recurrence disrupt: My quality of life in general			0.775	
24.	My thoughts or fears about the possibility of cancer recurrence disrupt: My relationships with my partner. my family. or those close to me.			0.771	
26.	My thoughts or fears about the possibility of cancer recurrence disrupt: My state of mind or my mood			0.763	
28.	I feel that I worry excessively about the possibility of cancer recurrence			0.652	
25.	My thoughts or fears about the possibility of cancer recurrence disrupt: My ability to make future plans or set life goals			0.637	
29.	Other people think that I worry excessively about the possibility of cancer recurrence			0.579	
30.	I think that I worry more about the possibility of cancer recurrence than other people who have been diagnosed with cancer			0.567	
8.	The following situations make me think about the possibility of cancer recurrence: Generally, I avoid situations or things that make me think about the possibility of cancer recurrence			0.432	
31.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I call my doctor or other health professional				0.843
32.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I go to the hospital or clinic for an examination				0.816
33.	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I examine myself to see if I have any physical signs of cancer.				0.476
% of variance explained		32.0	90.1	80.5	60.4
Internal consistency (Cronbach's alpha)		0.92	0.76	0.92	0.76
Discarded items from original 42-item FCRI-NL:		FCR severity	Cognitive coping	Impact of FCR on functioning	Behavioural coping
36[a]	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I pray, meditate or do relaxation.	0.129	0.256	0.023	0.275
38[a]	When I think about the possibility of cancer recurrence, I use the following strategies to reassure myself: I talk to someone about it.	0.131	0.248	−0.014	0.278
17[a]	How long have you been thinking about the possibility of cancer recurrence?	0.372	0.093	0.041	−0.004
21[a]	When I think about the possibility of cancer recurrence, I feel: Helplessness or resignation	0.297	0.022	0.384	0.103
20[a]	When I think about the possibility of cancer recurrence, I feel: Frustration, anger or outrage	0.142	0.092	0.370	0.106
16[b]	How much time per day do you spend thinking about the possibility of cancer recurrence?	0.362	−0.013	0.443	0.089

(Continues)

TABLE 2 (Continued)

4-factor FCRI-NL items:		Factor 1: FCR severity	Factor 2: Cognitive coping	Factor 3: Impact of FCR on functioning	Factor 4: Behavioural coping
19[b]	When I think about the possibility of cancer recurrence, I feel: Sadness, discouragement or disappointment	0.460	0.066	0.319	0.185
15[b]	How often do you think about the possibility of cancer recurrence?	0.465	0.013	0.314	0.040

[a]Items that loaded <0.40 onto their primary factor were discarded, according to the 0.40–0.30–0.20 rule.

[b]Items with crossloadings that loaded >0.30 onto their alternative factor and demonstrated a difference of <0.20 between their primary and alternative factor loadings were discarded, according to the 0.40–0.30–0.20 rule.

TABLE 4 Model fit of the 4-factor and the original 7-factor structure of the FCRI-NL in two patient samples

	4-factor structure		Original 7-factor structure	
	Sample 2: CAREST (*n* = 454)	Sample 3: BeMind (*n* = 205)	Sample 2: CAREST (*n* = 454)	Sample 3: BeMind (*n* = 205)
χ^2	10,750	1195	2326	1369
df	595	595	812	812
χ^2/df	18.068	2.008	2.865	1.685
AGFI[a]	0.750	0.920	0.958	0.926
NFI[a]	0.695	0.895	0.956	0.917
PNFI[a]	0.738	0.949	0.901	0.864
SRMR[a]	0.147	0.109	0.075	0.086

Abbreviations: AGFI, adjusted goodness-of-fit index; df, degrees of freedom; NFI, normed fit index; PNFI, parsimonious normed fit index; SRMR, standardised root mean squared residual; χ^2, chi square.

[a]Goodness-of-fit criteria: AGFI ≥0.90; NFI ≥0.95; for PNFI no thresholds have been recommended, although values between 0.50 and 0.90 are possible; SRMR ≤0.10.

and psychometric data, further refinement of the FCRI is recommended. To date, many FCRI translations have been made and the body of research concerning the FCRI is rapidly growing (Thewes et al., 2012). A first step for refinement of the FCRI was the development of the Turkish 5-factor FCRI, which fitted the data better than the original 7-factor model (Eyrenci & Sertel-Berk, 2018). Also, a re-examination of the dimensionality of the FCRI was done by comparing different models of FCR. They found that a multidimensional model with seven first-order factors fitted the data better than the original second order model (Galica et al., 2018). The current article adds to this body of research.

Limitations of this study are that *samples 2 and 3* consist of (mainly) female breast cancer patients and that the participants of *sample 3* registered themselves for an intervention study, which could have influenced the results. FCR is considered a multidimensional construct, and there is a possibility that specific cancer types may involve different aspects of FCR (Fardell et al., 2016; Lee-Jones et al., 1997; Simard & Savard, 2015). Also, the results of the CFA may not be generalisable to all (breast) cancer patients, because patients willing to participate in an intervention study may experience more FCR than the general (breast) cancer population. Future research should study whether the FCRI factor structure and measurement model is invariant across different types of patient populations, using a test for measurement invariance (van de Schoot et al., 2012). A second limitation is the small sample size of *sample 3* for CFA. This may have resulted in unstable parameter estimates, especially because there are factors with few items (Marsh et al., 1998). A third limitation might be the use of an online version of the FCRI-NL for all samples. To the best of our knowledge, other studies have used a pen-and-paper version. However, several meta-analyses have shown that paper and electronic questionnaires can be considered psychometrically equivalent (Campbell et al., 2015; Gwaltney et al., 2008). Also, the current study found comparable factor structure results across all FCRI translations. This illustrates that the use of an online version of the FCRI-NL has most likely not influenced the results. A fourth limitation is that the scale-free least squares estimation method in AMOS (to handle any non-normal item score distributions) applies listwise deletion to handle missing values. Listwise deletion can be problematic as it can reduce the statistical power and may result in biased parameter estimates (Enders, 2010). This approach resulted in exclusion of 25 participants with missing FCRI-NL item scores in *sample 2*. To find out if the use of the scale-free least squares estimation method was problematic for our results, we performed some additional analyses. We made a comparison of the current estimation approach (listwise deletion) and two missing data procedures that maximise the use of available data (pairwise deletion and multiple imputation) in Mplus. All approaches resulted in similar fit indices, indicating that our conclusions would

not have been different when using other approaches to handle missing data. Therefore, we retained our analyses.

A strength of this study is that an accurate estimation method for CFA was used, which handled any non-normal item score distributions (i.e. scale-free least squares). The CFAs of the French and English version of the FCRI, for example, do not mention which estimation method was used. Using the default maximum likelihood estimation on data that is not multivariate normally distributed may lead to underestimated parameters and inflated standard errors (Muthen & Kaplan, 1992). A second strength of this study is the CFA for two different patient samples, with different levels of FCR. The model fit for the 7-factor model was better in *sample 2*, with a lower mean FCR Severity score (13.9). Although these results suggest that the FCRI-NL may be more suitable for a sample with a moderate level of FCR, more research on this topic is needed.

To conclude, although there may be room for improvement, comparing all available FCRI factor structure data showed that all translations had reasonable results. Finding a better fit by proposing a new 4-factor structure of the FCRI-NL did not succeed. Therefore, we recommend retaining the original 7-factor FCRI. Future research should focus on refinement of the weaker FCRI subscales in order to be able to assess the multidimensional nature of FCR.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

ETHICAL APPROVAL

Sample 1: The FCRI validation study was approved by the Ethical Review Board and the Board of Directors of the TweeSteden hospital in Tilburg (2013–362). All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional and/or National Research Committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (World Medical Association, 2013). *Sample 2*: The CAREST study protocol was approved by the ethical review board of the Maasstad hospital in Rotterdam (TWOR; 2013/41), and all participating hospitals provided local ethics approval. The study has been registered under the trial number NL45768.101.13, was registered on www.trialregister.nl (NTR4119) and was reported following CONSORT guidelines, and a protocol paper was published in advance (Schulz et al., 2010; van Helmondt et al., 2016). *Sample 3*: The BeMind study was approved by the ethical review board of the Radboud University Medical Center (CMO Arnhem-Nijmegen; 2013/542) and all centres provided local ethics approval. The study was registered on Clinicaltrials.gov (NCT02138513) shortly after the start of recruitment and was reported following CONSORT guidelines, and a protocol paper was published in advance (Compen et al., 2015; Schulz et al., 2010).

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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