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Psychometric properties of the Fear of Cancer Recurrence Inventory: an item response theory approach

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Abstract

***Objective*: Classical psychometric methods have been used to demonstrate the validity and reliability of the 42-item Fear of Cancer Recurrence Inventory (FCRI). Our aim was to expand on this evidence with information on the discriminative value of the individual items when administered to people with a personal history of melanoma, using an item response theory (IRT) approach.**

***Methods*: We used a two-parameter IRT model to examine all items of the FCRI, primarily regarding whether people with a personal history of melanoma use the response scale as expected (as indicated by item characteristic curves), and whether the items can discriminate between those low and high on the constructs assessed by the instrument.**

***Results*: The sample was comprised of 286 adults with a personal history of melanoma (58% male, mean age: 59.1 years). The established factor structure of the FCRI was generally confirmed. IRT highlighted several items with problematic item characteristic curves, including most items in the *Reassurance* and *Coping Strategies* domains. Several other items exhibited poor discrimination.**

***Conclusions*: Based on this IRT analysis, we outline suggestions for refinement of the FCRI and potential development of a short-form, that could reduce respondent burden. Generalisability of these findings beyond melanoma warrants further examination.**

Background

Fear of cancer recurrence (FCR) is common amongst people affected by cancer [1], with 42–70% of cancer survivors reporting clinically significant levels of FCR [2]. Patients' fears about the future are often not adequately identified in research or addressed in clinical practice [3,4]. A recent review found that few instruments commonly used with cancer populations include items assessing FCR [5], and that measures developed to assess FCR are generally tailored to a specific cancer type (e.g. the Concerns About Recurrence Scale [6]), or have not undergone rigorous psychometric evaluation. FCR assessment requires a broadly targeted instrument with good psychometric properties.

Simard and Savard [7] developed the Fear of Cancer Recurrence Inventory (FCRI), a 42-item self-report instrument inspired by a cognitive-behavioural conceptualisation of FCR [8] and intended for use with adults affected by cancer. The FCRI was designed to provide a standardised method of assessing people's fears about the return of cancer and their perceived capacity to cope with these fears along seven domains: triggers, severity, psychological distress, functional impairment, reassurance, insight and coping strategies. Items were developed in consultation with psycho-oncologists and people with a history of cancer, and final item selection and domain allocation were based on exploratory factor analysis. When used with Canadian adults with different cancer types, the FCRI has high internal consistency and temporal stability, and good construct and criterion validity [7] when compared with other self-report FCR scales [9].

There is, however, growing acknowledgement that classical test theory approaches to instrument validation provide an incomplete representation of the psychometric properties of an instrument. Factor analysis, for example, only provides information about the quality of individual items on a scale inasmuch as how responses to different items are correlated. Evidence of the factor structure and internal consistency of an instrument can be supplemented by analysis based on item response theory (IRT), which provides additional information about how well each item discriminates between respondents who score low and those who score high on each item, and whether respondents use the response scale consistently.

Although the FCRI displays good psychometric properties when assessed using the classical test theory approach [7], closer examination of the properties of the FCRI using IRT may inform development of a short-form of the instrument by identifying items with poor discrimination. Thus, the primary aim of this study was to examine the fit of the FCRI to the two-parameter graded response model (GRM)[10]. A further aim was to extend previous research by examining the performance of the instrument when used by people with

a personal history of melanoma who are at moderate to high risk of developing new primary disease. There is limited research on FCR amongst people with melanoma, and recent studies show that many people diagnosed with melanoma develop significant worries about the possibility of developing new or metastatic disease in the future, and that this fear may persist for years after treatment completion [11,12].

Methods

Participants

This study, conducted in Sydney, Australia, comprised two groups: (a) melanoma survivors at *high risk* of new primary disease due to multiple previous melanomas, or a previous melanoma and dysplastic naevus syndrome (DNS; >100 moles or > four atypical or dysplastic moles) and (b) people at *moderate risk* due to one previous melanoma and no DNS. Participants were identified through the High Risk Clinic at the Sydney Melanoma Diagnostic Centre (Group 1) or Melanoma Institute Australia (Group 2), the world's largest clinical service dedicated to the treatment of melanoma. Patients with metastatic cancer were not approached. Additional eligibility criteria included age ≥18 years, sufficient language skills to complete the questionnaire in English and absence of a strong family history of melanoma (≥3 first-degree or second-degree relatives with melanoma) due to our previous extensive research into the experiences of this group [13–15].

Procedure

Eligible melanoma survivors were sent an invitation letter from their treating dermatologist, accompanied by a participant information sheet, consent form, questionnaire and reply paid envelope. A free-call telephone line was established to enable easy access to the research team. Individuals who did not decline participation were telephoned 14 days after letters were mailed to determine interest in participating. Appropriate Human Research Ethics Committee approvals were obtained.

Measures

The survey instrument comprised the following:

(1) *Demographic characteristics:* age, sex, marital status, educational level, country of birth and number of biological children.
(2) Number of previous melanomas, assessed via self-report.
(3) *Fear of Cancer Recurrence Inventory*: a multidimensional, 42-item, self-report measure developed in French [7], and later translated into English [16]. The FCRI comprises seven sub-scales (Table 2). The sum of the 42-item scores is typically interpreted as representing FCR (score range: 0–168), with higher scores indicative of greater FCR (Item 13 is reverse coded). *Triggers* (8 items) assesses the presence of stimuli that can activate FCR. *Severity* (9 items) evaluates the presence and severity of thoughts or images associated with FCR. *Psychological Distress* (4 items) and *Functional Impairment* (6 items) measure potential consequences of FCR. *Insight* (3 items) assesses the level of self-criticism towards FCR intensity. *Reassurance* (3 items) and *Coping Strategies* (9 items) measure coping responses that may influence FCR severity (e.g. denial, wishful thinking). Items are rated on a 5-point scale, where 0 = *never/not at all*, 1 = *rarely/a little*, 2 = *sometimes/somewhat*, 3 = *most of the time/a lot* and 4 = *all the time/a great deal*. A score of ≥13 on severity (possible range: 0–36) is considered indicative of a fear response warranting clinical assessment [17]. High internal consistency ($\alpha = 0.95$) and temporal stability ($r = 0.89$) have been demonstrated [7].

Statistical methods

Confirmatory factor analysis

A measurement model based on the established FCRI factor structure [7] was tested using confirmatory factor analysis (CFA) in MPlus v6 [18]. Each sub-scale was modelled as a latent variable, with constituent items used as indicators. Item loadings and factor covariances were estimated. Neither a single factor ('FCR'), nor a higher-order factor for the seven sub-scales, were assumed. Rather, the sub-scales were modelled as seven logically independent but empirically related variables.

Because the FCRI response options are ordinal, the mean-adjusted and variance-adjusted weighted least squares estimation procedure was used. We reported standardised factor loadings and the following model fit indices (criteria indicating good model fit in parentheses): χ^2 test ($p > 0.05$), χ^2/df (<2), the root mean square error of approximation (RMSEA, <0.06 with its 90% confidence interval [CI] including 0.05), comparative fit index (CFI, >0.95) and Tucker-Lewis index (TLI, >0.95). The modification index (MI) for a parameter not estimated in the model is the expected reduction in the model χ^2 statistic if that parameter was estimated, indicating which added parameters improve model fit. MIs were examined to determine whether model modifications were required. No absolute criterion was used, but any pair of items with an MI substantially larger than the others was examined for content with a view to making theoretically defensible model adjustments.

Item response theory analysis

Item response theory describes the relation between an unobserved (latent) trait and item responses (see [19,20] for an introduction to IRT). The probability of an individual's

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response on an item is determined by: (a) their value on the latent trait and (b) properties of the item. We used Samejima's two-parameter GRM [10], in which observed responses to polytomous items (i.e. items with > two response options) are assumed to be a logistic function of the latent trait (e.g. each FCRI factor); the probability of responding with a higher response option increases as the level of the latent trait increases. The two parameters estimated for each item in this model were: (a) location along the continuum of latent trait values and (b) discrimination, or ability to differentiate between those scoring high and low on each domain.

Item response theory analysis was conducted using the GRM function of the ltm (latent trait models) package [21] in R and was performed separately for factors identified using CFA. The aim of the analysis was to examine the discrimination parameters of each item and to use item characteristic curves (ICCs) to determine whether any of the items exhibited problems with the ordering of response category thresholds (i.e. the value of the latent trait for which adjacent response categories are equally likely). Problems with threshold ordering suggest that respondents are not using the response scale in the manner expected. Two-parameter model fit was assessed in comparison with the one-parameter model (where the discrimination parameter is held constant between items) using the likelihood ratio test, where $p < 0.01$ indicates significantly better fit of the two-parameter model.

Results

A response rate of 74.5% amongst eligible, successfully contacted individuals (286/384) was achieved; with response rates of 74.7% and 74.3% for the high-risk ($n = 162$) and moderate-risk ($n = 124$) groups, respectively (Figure 1). The mean age of participants was 59.1 years ($SD = 12.9$), 58% were men, and all were > 2 years on from their most recent melanoma diagnosis. See Table 1 for demographic data.

Confirmatory factor analysis

Descriptive statistics for the FCRI and CFA results are shown in Table 2. Overall, 72% of participants had an FCRI Severity sub-scale score above the clinical cut-off score of 13 (75% high melanoma risk and 70% moderate risk). The CFA was carried out only with participants who responded to all items ($n = 228$). This subset of

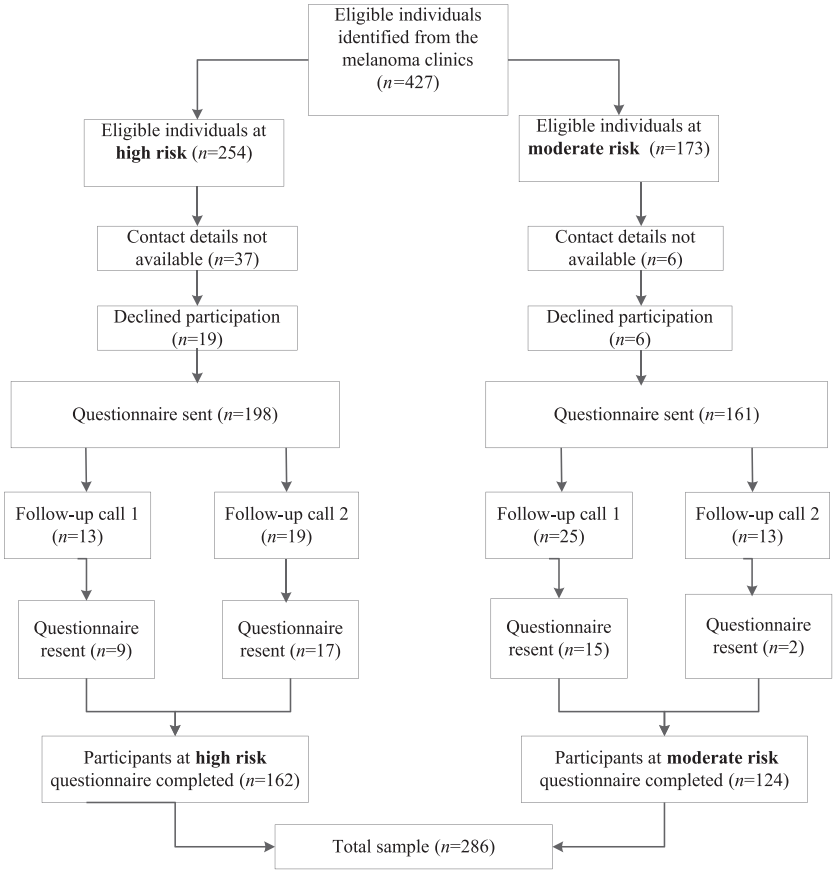

Figure 1. Flowchart outlining the recruitment process and study participation rates, presented separately for the high-risk groups and moderate-risk groups, as well as the total study sample ($n = 286$).

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Table 1. Demographic characteristics presented separately for participants at high risk ($n = 162$), participants at moderate risk ($n = 124$) and the total study sample ($n = 286$)

		High risk participants	Moderate risk participants	Total sample
Variable	**Level**	***n* (%)**	***n* (%)**	***n* (%)**
Sex	Male	102 (63)	63 (51)	165 (58)
	Female	60 (37)	61 (49)	121 (42)
Age (years)	18–29	1 (1)	4 (3)	5 (2)
	30–39	8 (5)	5 (4)	13 (5)
	40–49	28 (18)	18 (15)	46 (16)
	50–59	50 (31)	27 (22)	77 (27)
	>60	73 (46)	69 (56)	142 (50)
	Mean age (SD)	58.1 (11.8)	60.4 (14.1)	59.1 (12.9)
Marital status	Married	132 (82)	93 (75)	225 (79)
	Not married	28 (17)	30 (24)	58 (20)
Biological children	Yes	143 (89)	103 (83)	246 (87)
	No	17 (11)	21 (17)	38 (13)
Education level	University degree	57 (35)	41 (33)	98 (34)
	No university degree	104 (64)	82 (66)	186 (65)
Birthplace	Australia	133 (85)	98 (79)	231 (83)
	Other	22 (14)	22 (18)	44 (16)
Mean number of self-reported melanomas		2.2 (1.2)	1.2 (0.7)	1.8 (1.1)

participants did not differ significantly from those not included on any key demographic or disease variable (sex, education, number of melanomas and time since diagnosis), nor on any FCRI sub-scales. The initial model approached good fit; $\chi^2(798) = 1346.09$ ($p < .001$), $\chi^2/df = 1.69$, RMSEA = 0.055 (90% CI = 0.05–0.06), CFI = 0.949, TLI = 0.946. MIs suggested associations between Items 39 ('When worried about melanoma I try to understand and deal with it') and 40 ('When worried about melanoma I try to find a solution'; MI = 43.52), and between Items 41 ('When worried about melanoma I try to replace it with a pleasant thought') and 42 ('When worried about melanoma I tell myself "stop it"'; MI = 48.66) beyond those captured by loadings on the same factor. Given the similarity in item content within each pair, we considered estimating covariances between these items' residuals theoretically defensible. This improved model fit; $\chi^2(796) = 1268.62$ ($p < .001$), $\chi^2/df = 1.59$, RMSEA = 0.051 (90% CI = 0.046–0.056), CFI = 0.956, TLI = 0.953. Given the sensitivity of the χ^2 test to sample size and the inconsistency of the test result with the other fit indices examined, model fit was deemed to be good on the basis of the other fit indices. With the exception of Item 13 ('I believe that I am cured and the melanoma will not come back'), all factor loadings were significant and in the range of 0.40 to 0.94.

Item response theory analysis

The IRT results are summarised in Table 2. Several items exhibited problematic item response thresholds, most notably all but one of the Coping Strategies items (Figure 2). All other ICCs are included as online supplementary material.

Table 2. Results of the confirmatory factor analysis and item response theory analysis. For the confirmatory factor analysis, standardised factor loadings are reported

Item	Mean	SD	Factor loading	Threshold problem	Discrimination
Triggers					Fit $p < 0.001$
1	2.13	1.00	0.79		2.10
2	2.05	0.93	0.81		2.25
3[a]	2.04	1.08	0.86		2.61
4[a]	1.89	1.02	0.87		3.37
5[a]	1.70	1.03	0.85		3.51
6	1.41	1.08	0.79		2.39
7	1.47	1.04	0.72		1.88
8	1.19	1.09	0.43		0.76
Severity					Fit $p < 0.001$
9[a]	1.63	0.99	0.91		3.76
10[a]	1.75	1.14	0.89		3.75
11	2.19	1.00	0.71		1.92
12	1.59	1.22	0.82		2.82
13	2.84	1.22	0.14	X	0.28
14	2.43	0.94	0.40		1.04
15	1.06	0.72	0.79		1.93
16	0.74	0.74	0.81		2.15
17	2.14	1.73	0.52	X	0.95
Psychological distress					Fit $p = 0.11$
18[a]	1.01	1.05	0.86		3.46
19[a]	0.6	0.92	0.87		3.68
20	0.81	0.96	0.88		2.54
21			0.82		1.98
Functioning impairments					Fit $p = 0.53$
22	0.45	0.86	0.88		1.44
23	0.35	0.82	0.87		1.77
24[a]	0.36	0.79	0.88		2.71
25[a]	0.33	0.77	0.86		3.04
26	0.54	0.81	0.94		2.53
27[a]	0.46	0.85	0.84		3.35
Insight					Fit $p = 1.00$
28[a]	0.41	0.81	0.93		3.46
29	0.28	0.66	0.79	X	1.78
30[a]	0.25	0.64	0.79		3.19
Reassurance					Fit $p < 0.001$
31	0.89	1.22	0.72	X	2.31
32[a]	1.32	1.43	0.79		4.07
33	2.09	1.16	0.64	X	1.35
Coping strategies					Fit $p < 0.001$
34	1.04	1.26	0.84	X	2.35
35[a]	1.53	1.37	0.68	X	2.58
36	0.67	1.09	0.68	X	1.20
37[a]	2.10	1.42	0.65	X	2.76
38	1.12	1.12	0.72		1.32
39	2.12	1.36	0.68	X	2.05
40	1.87	1.44	0.66	X	1.97
41[a]	1.87	1.4	0.67	X	4.03
42	1.48	1.461	0.58	X	2.68

The X in the 'Threshold problem' column indicates that the thresholds between consecutive item response categories, as indicated by the item characteristic curves, are not in the expected order

See online table for item wording.

[a]Items tentatively selected for inclusion in a potential short form

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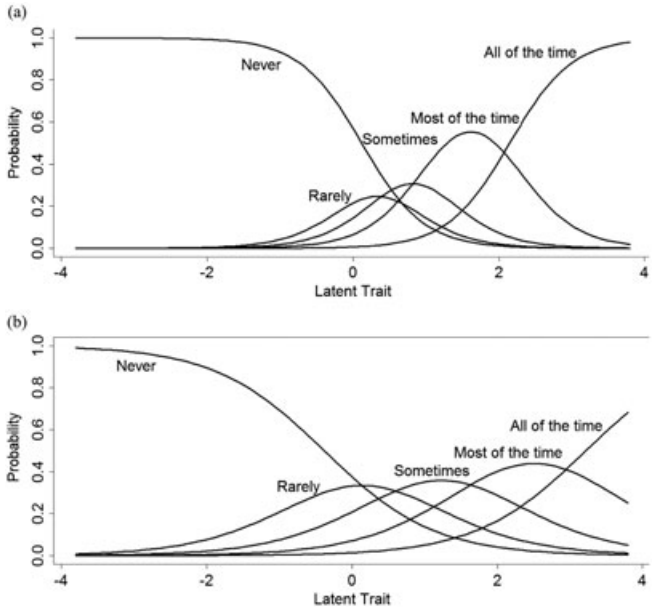

Figure 2. Item characteristic curves for two items from the *Coping Strategies* sub-scale. The latent trait on the horizontal axis is an arbitrarily scaled representation of the domain to which the item belongs. As the value of the latent trait increases, the probability of responding with successively higher response options should increase. A curve for a particular response option that does not have a higher peak than the other response options for any value of the latent variable means that this response option was not the most likely response for any value of the latent trait, and represents a possible problem with the response categories. (a) Item 34: 'I try to distract myself (e.g. do various activities, watch TV, read, work)'. The curves are problematic in that the 'rarely' category was not the most likely response for any value of the latent trait. The relative concentration of the curves reflects the relatively high discriminative ability of this item. (b) Item 38: 'I talk to someone about it'. All response categories were the most likely response for some value of the latent trait. The relative spread of the curves reflects the relatively low discriminative ability of this item.

Items with the highest discrimination parameters were: Items 4 and 5 for Triggers; Items 9 and 10 for Severity; Items 18 and 19 for Psychological Distress; Items 24, 25 and 26 for Functioning Impairments; Items 28 and 30 for Insight (and unlike the other items in this factor, did not exhibit a threshold ordering problem); Item 32 for Reassurance (which was the only item in this factor that did not exhibit a threshold ordering problem); and Item 41 for Coping Strategies (which did exhibit a threshold ordering problem, as did all but Item 38 in this factor).

Conclusions

Few studies have examined the nature and measurement of FCR amongst cancer survivors, particularly those with a history of melanoma, making this a highly relevant yet underserved area in psycho-oncology. To our knowledge, this is the first detailed examination of the item response patterns of the FCRI amongst melanoma survivors at moderate to high risk of new primary disease, and one of the first to show that a high proportion of melanoma survivors (72%) reports levels of FCR warranting clinical assessment.

Using IRT, we have provided information about items in the FCRI that expands on traditional methods used to originally validate the instrument [7]. Our data broadly support the established FCRI factor structure, providing evidence of its stability between cancer populations, although Item 13 ('I believe that I am cured and the melanoma will not come back') loaded relatively weakly on its prescribed factor (Severity). This may be because the item is worded such that a higher score represents a more positive attitude, unlike the other items in the domain, although it is noteworthy that Simard and Savard [7] observed a high factor loading for this item. Alternatively, this finding may be specific to people who have had melanoma and are at risk of developing the disease again. Indeed, scores on this item tended to be higher than for other Severity items (see means in Table 2). More generally, the study findings may not be generalisable to other cancer types, as how well a patient adjusts to the diagnosis of any disease, and the coping responses they utilise can depend on multiple and complex factors, including demographic (e.g. gender, access to resources), clinical (e.g. disease type, disease stage and treatment), psychological (e.g. personality dynamics, patterns of thinking) and sociocultural (e.g. social support, cultural dynamics) factors.

Using IRT, we determined that some items can better discriminate between respondents low on the latent trait and those high. Given the length of the FCRI and the consequent burden it imposes on respondents (with anecdotal reports that completion can take up to 10 minutes), a short-form may be considered that excludes items with weaker discrimination; for example, Item 8 ('Generally, I avoid situations or things that make me think about the possibility of developing cancer') clearly had poorer discrimination than other Triggers items, as did Item 14 ('In your opinion, are you at risk of developing cancer?') in the Severity domain.

The ICCs provided information about respondents' usage of the response categories. Several items exhibited at least one item response category that was not dominant for any value of the latent trait. For example, in Figure 2a, for Item 34 ('I try to distract myself'), as the latent trait *Coping Strategies* increased, the item response with highest probability went from 'never' to 'sometimes', skipping 'rarely'. This was particularly the case for the Coping Strategies factor, where all but one of the items exhibited this phenomenon. Inspection of response category frequencies (not reported) revealed that these problematic items exhibited bimodality, such that the first, third and fourth categories had higher frequencies than the second. This bimodality held for all items in this factor except Item 38 – the only item that exhibited appropriate ordering of response category thresholds in its ICC. In

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short, for items in the Coping Strategies factor, respondents tended to use the 'never', 'sometimes' and 'most of the time' categories with far greater frequency than 'rarely', calling into question the utility of the 'rarely' option. However, the benefits of removing this response option for the sub-scale must be weighed against the resulting inconsistency in response options between sub-scales, which may not be worthwhile given that this would not dramatically reduce burden.

Another issue with Coping Strategies was our observation of residual correlation in CFA between two pairs of items in this sub-scale. Although the IRT software we used did not permit a test of local independence, the CFA results suggest that this assumption of IRT may not have been satisfied. Possible content redundancy in these item pairs is worthy of future consideration, particularly when contemplating a short-form, where our results suggest that both items in a locally dependent pair are not necessary.

Research implications

Item response theory can provide item-level information to supplement the information provided by classical methods such as CFA, that tend to focus on the domain level. The present results demonstrate the limitations of assessing factor structure and internal consistency without any check of the underlying pattern of item responses. Based on IRT analysis, it is possible to create a short-form of the FCRI for use with melanoma survivors, which would serve to reduce respondent burden and increase the likelihood of detection of FCR in medical settings. Based on the present data, we might consider retaining Items 3–5 (Triggers), 9 and 10 (Severity), 18 and 19 (Psychological Distress), 24, 25 and 27 (Functioning Impairments), 28 and 30 (Insight), 32 (Reassurance) and 35, 37 and 41 (Coping Strategies). This would reduce the total number of questions (and instrument completion time) by about 60%.

Notwithstanding these suggestions and the evidence upon which they are based, further data are needed to support the development of an FCRI short-form. Advice regarding adequacy of sample size for IRT analysis is variable, and further research is needed to determine whether the present results can be replicated in a larger sample. Furthermore, estimates of scale validity are dependent upon the population being assessed [22], and across different populations, the underlying factor structure of a given instrument may vary. Although beyond the scope of the present study, testing the invariance of the FCRI factor structure between the high and moderate risk groups would provide evidence of its applicability in different melanoma risk groups. Further validation of the FCRI in different patient groups using traditional psychometric methods, such as construct validation, would also be of value.

Short-form development is further complicated by the fact that some FCRI domains represent causal variables (e.g. Triggers), at least one represents fear and risk (i.e. Severity), and others are consequences (e.g. Functioning Impairments). Because a short-form based on all seven domains is not conceptually equivalent to the Severity sub-scale, such a short-form should not be considered a replacement of the Severity sub-scale as a screening tool. Rather, its purpose would be to capture the same information as the complete FCRI, but with lower respondent burden. For causal variables, analytic methods based on inter-item correlations may not be appropriate [23]. More generally, the nature of the relations between these domains calls into question the practice of interpreting a score that aggregates across domains, whether for the full FCRI or a short-form; the conceptual meaning of such a score is unclear [24], and for a short-form, we recommend separate interpretation of sub-scale scores. Thus, further research (both theoretical and empirical) and analysis amongst different patient groups will help refine this instrument.

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Conflict of interest

The authors have declared no conflicts of interest.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site.

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