Revisiting the Reproductive Concerns After Cancer (RCAC) scale

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Abstract

Objective—The aims of this study were to examine the factor structure and reliability of the multidimensional Reproductive Concerns After Cancer (RCAC) scale in a sample of female cancer survivors during their reproductive years, younger than age 45.

Methods—Female reproductive-aged survivors (N = 238, current age 18 to 44 years) with a variety of cancer diagnoses completed a web-based survey that included the RCAC scale. Three structural models were examined via confirmatory factor analysis: 1) one-factor, 2) higher-order with one second-order factor and six first-order factors, and 3) oblique six-factor. Reliability was examined using omega total and Revelle's omega total.

Results—Only the oblique six-factor model of the RCAC scale fit well. Omega total and Revelle's omega total estimates for all of the six three-item subscales were in the nearly satisfactory to good range (.66 to .87).

Conclusions—The RCAC scale was found to have satisfactory factor structure and reliability when measuring a range of reproductive concerns experienced by female reproductive-aged survivors. The RCAC scale is a multidimensional measure of varying aspects of reproductive concerns, and results suggest that the scale may be best represented as a profile of subscale scores. The subscale scores would be useful for tailoring recommendations and interventions to more effectively address the diverse reproductive concerns of female reproductive-aged survivors.

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BACKGROUND

Reproductive health is an important aspect of quality of life (QOL) for reproductive-aged female cancer survivors (RAFCS).[1–5] Reproductive concerns, such as fear of infertility, negative impact of infertility on romantic relationships, fear of poor health affecting their ability to raise their children, and worries about children's risks of birth defects or cancer are common.[6–9] While as many as two thirds of RAFCS experience reproductive concerns, their needs for services and information related to their reproductive health and family planning are often unmet.[10–12] Related reproductive distress, including perceived signs of fertility problems (e.g., irregular menstrual function) after cancer, is associated with increased psychological distress and poorer quality of life.[2, 5, 13–15] While specialized counseling by a fertility specialist can be helpful,[16, 17] many RAFCS could benefit from clinical and supportive care to manage their reproductive concerns across the course of survivorship.[5, 13, 18–23]

A valid measure of cancer-related reproductive concerns has high potential to help healthcare providers offer tailored medical and supportive care to their patients. The Reproductive Concerns After Cancer (RCAC) scale was developed to allow researchers and clinicians to identify the range of fertility and childbearing concerns and unmet needs that RAFCS experience.[7] The RCAC scale is an 18-item self-report scale with six three-item subscales assessing the following areas of concern: fertility potential, partner disclosure of fertility status, child's health, personal health, acceptance of possible infertility, and becoming pregnant. It was developed based on qualitative analysis of focus groups and individual interviews with young adult female cancer survivors who were 18 to 34 years of age. Principal components analysis (PCA) identified a six-factor solution for this scale. Internal consistencies (coefficient alphas) for the total RCAC scale score (alpha = 0.82) and each of its six three-item subscale scores (alphas = 0.78 to 0.88) were good, and evidence for convergent and divergent validity was established using the known-groups approach. This is the first multidimensional scale developed to measure the variety of reproductive concerns that RAFCS experience.

Qiao and colleagues translated and culturally adapted the RCAC scale for use in Chinese populations using the standard Functional Assessment of Chronic Illness Therapy (FACIT) translation methodology and assessed the psychometric properties of the translated scale.[24] The total scale and the six subscales demonstrated good or acceptable internal consistency (Cronbach's alphas ranged from 0.71 to 0.81) and good test-retest reliability at a three-week interval (intra-class correlation coefficients ranged from 0.82 to 0.89) in a sample of 800 young Chinese female cancer survivors, 18 to 40 years of age. Confirmatory factor analysis (CFA) indicated that the six-factor model fit the sample data satisfactorily. Multi-group CFA demonstrated strong factorial invariance across samples of patients with breast, thyroid, and gynecological cancers, supporting the use of the six subscales across patients with different

cancer diagnoses. Content validity was assessed using a panel of experts. Experts were asked to rate the translation equivalence and cultural relevance of each item on a scale from 1 (not relevant) to 4 (very relevant). The content validity index (CVI), was calculated by the percentage of items rated 3 or 4, with a CVI above 0.80 indicating good content validity. The CVI for the overall scale was 0.89, and individual item scores ranged from 0.81 to 1.00.[24] The scale was also recently culturally adapted and translated for use among Swedish breast cancer survivors, where Cronbach's alphas for the subscales ranged from .54 to .92.[9]

The original English-language RCAC scale has been used in several studies to assess the presence and severity of a variety of reproductive concerns for RAFCS.[2, 14, 20, 25, 26] However, the psychometric properties have only been evaluated in the original development sample of female survivors who were 18 to 35 years of age.[7] The first aim of the present study was to examine the structural validity of the six-factor model of the RCAC scale using confirmatory factor analysis (CFA) in a separate sample of reproductive-aged female survivors, defined as younger than age 45. We examined three models: 1) a one-factor model representing the total score; 2) a higher order model with one second-order factor, representing the total score, and six first-order factors, representing the six subscales; and 3) an oblique six-factor model, representing six intercorrelated subscales. The second aim of the study was to examine reliability of the RCAC scores in the sample.

METHODS

Participants and Procedure

Participants were RAFCS recruited into the Fertility Information Research Study (FIRST; NCT01843140), a prospective cohort study of reproductive health outcomes for cancer survivors. The purpose of FIRST was to examine how different cancers and treatments affect the reproductive health of young survivors. Participants were recruited via social media outreach (60%), university-based fertility preservation programs (26%), FERTLINE-the Oncofertility Consortium's telephone hotline (6%), and community outreach or word of mouth (8%). Participants were enrolled between 2001 and 2015, at age 18 to 44 years. The present study includes 238 participants who completed the follow-up survey, where reproductive concerns were assessed, when they were younger than age 45 (72% of 332 enrolled at baseline). Surveys assessed demographics, cancer history, reproductive history, and psychosocial health outcomes. Reproductive concerns were assessed using the RCAC during follow-up surveys only. The study was approved by the Institutional Review Board at the University of California, San Diego (Protocol 110343).

Measure

The RCAC scale[7] is a multidimensional measure of possible reproductive concerns of women following cancer diagnosis and treatment, yielding six subscale scores: fertility potential, partner disclosure of fertility status, child's health, personal health, acceptance of possible infertility, and becoming pregnant. Each of the subscales is calculated by averaging scale responses to its three respective items. Responses are provided on a five-point Likert scale ranging from 1= "Strongly disagree" to 5= "Strongly agree." Items 5, 10, and 15 (i.e., the items on the acceptance subscale) are reverse scored. Subscale mean scores range from

1 to 5, with higher scores indicating greater concerns in each respective area (e.g., more concerns about fertility potential) or less acceptance of possible infertility.

Data Analysis

Participant characteristics were evaluated descriptively using frequencies for categorical data and means and standard deviations for continuous data. Confirmatory factor analysis (CFA) was used to examine standardized factor loadings, interfactor correlations, and the goodness of fit of three structural models of the RCAC scale: 1) one-factor, 2) higher-order with one second-order factor and six first-order factors, and 3) oblique six-factor. For the one-factor model, all 18 observed items were indicated to one latent variable (RCAC). For the higher-order model, one second-order factor (RCAC) was indicated by six first-order factors (i.e., fertility potential, partner disclosure, child's health, personal health, acceptance, and becoming pregnant) that were indicated by three observed items per factor. For the oblique six-factor model, each of the six latent variables was indicated by three observed variables and interfactor correlations were specified among all six of the latent variables.

Model fit was assessed using the recommendations of Bentler.[27] Three indicators of model fit were examined: (1) Root Mean Square Error of Approximation (RMSEA),[28] an absolute index of overall model fit; (2) the Standardized Root Mean Residual (SRMR),[29] also an absolute index of overall model fit; and (3) Comparative Fit Index (CFI),[30] a relative index of model fit compared to the null model. For the CFI descriptive index, values > 0.93 are indicative of acceptable model fit and values > 0.95 are indicative of good fit. For the SRMR and RMSEA fit indices, values < .08 are indicative of acceptable model fit and values < .05 are indicative of good model fit. The χ^2 value was reported for completeness, but not used to assess model fit due to its lack of robustness to sample size.[31] Acceptable model fit was determined if at least two of the three descriptive fit indices met acceptable model fit criteria. This is consistent with Bentler and others' suggestions for use of these indicators as the most stable fit indices, despite the recognition that they do not perform optimally in all instances.[27, 32, 33]

Reliability was examined using omega total and Revelle's omega total.[34] Cronbach's coefficient alpha was not used to assess reliability because the tau equivalence assumption was violated for several of the subscales but was reported for completeness. Omega total and Revelle's omega total rely on fewer assumptions and, therefore, provide more valid estimates of reliability.[34] Data were analyzed using MPlus version 8,[35] SPSS version 24,[36] and R[37] in conjunction with RStudio version 1.[38]

RESULTS

Sample Characteristics

A comparison between the present sample (N=238) and the 332 enrolled at baseline revealed only one significant difference; the present sample was more likely to have biological children (28% vs. 20%, p < .05). Participants were RAFCS with a mean age of 32.7 years (*SD* = 5.7 years) and had an average time since diagnosis of 5.5 years (*SD* = 4.7 years). Most participants were diagnosed between ages 15 and 39 years old (94%). The

most common cancer types reported were breast cancer (28%), lymphoma (26%), and gynecologic (i.e. cervical, uterine, and ovarian) cancers (8%). Most participants were white (79%), non-Hispanic (92%), college graduates (84%), and partnered at the time of the survey (57%). The majority of participants had received chemotherapy (79%) or surgery (61%) as part of cancer treatment. See Table 1. The present sample is older ($M = 32.7$ years vs. 28.3 years), a higher proportion were diagnosed with breast cancer (27.9% vs. 11.5%), and were more likely to have biological children (28.2% vs. 17.2%) than those in the original development sample.

Mean scores for each subscale were: fertility potential, $M = 3.62$, $SD = 1.14$; partner disclosure of fertility status, $M = 2.49$, $SD = 1.17$; child's health, $M = 3.32$, $SD = 1.18$; personal health, $M = 2.93$, $SD = 1.03$; lack of acceptance of possible infertility, $M = 2.77$, $SD = 1.05$; and becoming pregnant, $M = 2.83$, $SD = 0.94$.

Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was used to examine three structural models of the RCAC scale: 1) one-factor, 2) higher-order model with one second-order factor and six first-order factors (i.e., bi-factor model), and 3) oblique six-factor. The one-factor and the higher-order model with one second-order factor and six first-order factors did not fit the data well statistically nor descriptively (χ^2 [135, $N = 238$] = 1212.59, $p < .001$, CFI = .331, RMSEA = .183, SRMR = .176; χ^2 [129, $N = 238$] = 360.54, $p < .001$, CFI = .856, RMSEA = .087, SRMR = .127, respectively). The oblique six-factor model did not fit well statistically (χ^2 [120, $N = 238$] = 269.30, $p < .001$), but it did fit well descriptively (CFI = .907, RMSEA = .072, SRMR = .074). All standardized factor loadings were generally large and statistically significant for all six of the factors (Table 2). All but six of the 15 interfactor correlations were statistically significant (Table 3).

Reliability

Composite reliability for each of the six three-item subscales were: fertility potential, α = .86, Ω = .87, $R\Omega$ = .87; partner disclosure of fertility status, α = .85, Ω = .85, $R\Omega$ = .86; child's health, α = .87, Ω = .87, $R\Omega$ = .87; personal health, α = .68, Ω = .74, $R\Omega$ = .75; acceptance of possible infertility, α = .84, Ω = .84, $R\Omega$ = .85; and becoming pregnant, α = .62, Ω = .65, $R\Omega$ = .66.

CONCLUSIONS

Consistent with the conceptualization of this multi-dimensional scale, confirmatory factor analyses provided support for a six-factor model with intercorrelated factors. For the six-factor model, each item loaded significantly onto its respective factor, suggesting these items measure the six factors effectively. All but six of the interfactor correlations were significant, suggesting that some of the distinct reproductive concerns dimensions are related (e.g., personal health and child's health). This largely replicates findings from the original developmental study.[7] The lack of statistical support in this study for the one-factor and higher order models suggest that the RCAC scale may be best represented as a profile of subscale scores, rather than as a total score. Additional studies are needed to confirm this.

Results generally support the reliability of the subscales, and the mean subscale values for the current sample are similar to those in the developmental sample. The mean score for the fertility potential subscale was most comparable (3.59 vs. 3.62 in the present sample), and the mean score for partner disclosure was the most dissimilar (3.15 vs. 2.49 in the present sample).[7] The omega total and Revelle's omega total coefficients for all but one of the subscales were in the good range (.74 to .87). The remaining subscale, becoming pregnant, was in the nearly adequate range (.65 to .66). Of note, the reliability estimate, based on Cronbach's alpha, for the becoming pregnant subscale in the original development study was higher (.78), yet still the lowest among the subscales. Readers should be aware that lower reliability means that the correlation between the subscale and other measures will be attenuated and the true relationship may be underestimated.[39] Further research is needed to determine how the subscales, particularly 'becoming pregnant,' perform in cohorts with different demographics, life stages at diagnosis, and cancer characteristics.

This study provides further evidence that the RCAC scale is a useful tool for measuring a range of reproductive concerns experienced by RAFCS. While one of the descriptive fit indices, the CFI, was just under the threshold for acceptable model fit[30], there are instances where individual fit indices do not perform optimally.[27, 32, 33] The CFI could have risen to levels that would indicate reasonable model fit. However, this would have required specific correlated residuals (i.e., correlated uniqueness terms) simply to improve model fit, which is not recommended.[40] Importantly, our results indicate that the RCAC scale may be best implemented as a multidimensional measure to assess each of the six reproductive concerns independently, rather than as a total score indicating overall concerns. Scale users will need to determine whether each subscale is appropriate and reliable for their research questions and sample.

Study Limitations

While this study provides novel insight on the validity and use of this scale in a new sample with different characteristics than in the developmental study (e.g., older reproductive age), some limitations should be noted. Participants represented cancer survivors with a wide age range at diagnosis (age 3 to 43 years); however, most were white, non-Hispanic, and college educated, limiting the generalizability of the results. While the original scale was developed using feedback from racially and ethnically diverse participants[6] and the scale has been validated in a cohort of Chinese survivors,[24] additional studies are needed to establish the psychometric properties of the RCAC scale for other racial and ethnic groups. The study's focus on fertility likely yielded a sample that was overly representative of RAFCS interested in having children. Additional studies with other cohorts are needed to solidify recommendations regarding use of the RCAC total score.

Clinical Implications

The established importance of reproductive health in cancer survivorship and the related psychological concerns affecting RAFCS underscore the need for improved reproductive-related medical and supportive care for this population.[5, 13, 18–23] The novel aspect and important contribution of the RCAC scale is its capacity to capture multiple different dimensions of reproductive concerns that are important for RAFCS. The RCAC scale is

a promising tool for assisting clinicians with identifying specific reproductive concerns. This knowledge can then be used to tailor communication, education, and other intervention strategies (e.g., referral to a fertility specialist) to address those concerns.

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Table 1

Sample characteristics (N = 238)

	N (%)
Age at survey, years[a]	32.7 (5.7)
Race	
White	188 (79.3)
Black	9 (3.8)
Asian	13 (5.5)
Other	27 (11.4)
Ethnicity	
Hispanic/Latino	20 (8.4)
Not Hispanic/Latino	217 (91.6)
Relationship status	
Partnered	135 (57.0)
Not Partnered	102 (43.0)
Education	
College graduate	200 (84.4)
Did not graduate from college	37 (15.6)
Income	
$50,000	74 (31.2)
>$50,000	117 (49.4)
Decline to answer	46 (19.4)
BMI[a]	25.9 (6.9)
Has biological child(ren)	67 (28.2)
Desires child(ren)	171 (71.9)
Cancer characteristics and treatment	
Cancer type	
Breast	66 (27.9)
Lymphoma	62 (26.1)
Gynecologic (cervix/uterus/ovary)	19 (8.0)
Blood/leukemia	19 (8.0)
Thyroid	14 (5.9)
Other	57 (24.1)
Cancer stage	
High Risk	3 (1.3)
Standard Risk	2 (0.8)
Low Risk	1 (0.4)
I	48 (20.3)
II	74 (31.2)
III	40 (16.9)
IV	18 (7.6)
Unknown	51 (21.5)

	N (%)
Age at diagnosis, years[a]	27.1 (7.1)
< 15	12 (5.0)
15–39	223 (93.7)
40–44	3 (1.3)
Time since diagnosis, years[a]	5.5 (4.7)
Surgery	145 (61.2)
Chemotherapy	187 (78.9)
Radiation	117 (49.4)
Endocrine therapy	43 (18.1)
Bone marrow or stem cell transplant	14 (5.9)
Unknown	1 (0.4)

Note. Due to missing data, some variables do not add up to 238.

[a]Mean (Standard Deviation)

Table 2

Standardized factor loadings from the six-factor RCAC model

RCAC Subscale/Item	Factor Loadings
Fertility Potential	
1. I am afraid I won't be able to have any (more) children.	.736[**]
8. I am worried about my ability to get pregnant (again).	.862[**]
17. I am concerned that I may not be able to have (more) children.	.885[**]
Partner Disclosure	
3. I worry about telling my (potential) spouse/partner that I may be unable to have children.	.864[**]
7. I am concerned that my (potential) spouse/partner will be disappointed if I can't get pregnant.	.678[**]
16. The thought of telling my (potential) spouse/partner that I may be unable to have children makes me uncomfortable.	.893[**]
Child's Health	
2. I am worried about passing on a genetic risk for cancer to my children.	.857[**]
9. I am worried about how my family history might affect my children's health.	.793[**]
18. I am afraid my children would have a high chance of getting cancer.	.842[**]
Personal Health	
4. I am scared of not being around to take care of my children someday.	.665[**]
11. Having (more) children will make me more nervous about getting cancer again.	.453[**]
13. I am cautious about having (more) children because I might not be around to raise them.	.899[**]
Acceptance	
5. I can accept it if I'm unable to have (more) children.	.688[**]
10. I will be happy with life whether or not I have (more) children someday.	.808[**]
15. I will feel content if I do not have (more) children.	.894[**]
Becoming Pregnant	
6. I am overwhelmed by thought of trying to get pregnant (again).	.638[**]
12. I worry that getting pregnant (again) would take too much time and effort.	.371[**]
14. It is stressful to think about trying to get pregnant (again).	.819[**]

Note.

[**] $p < .01$.

Table 3.

Standardized interfactor and Pearson product-moment correlations among the six latent factors

	Fertility Potential	Partner Disclosure	Child's Health	Personal Health	Acceptance	Becoming Pregnant
Fertility Potential		.394 **	.115	-.101	-.381 **	.312 **
Partner Disclosure	.389 **		.362 **	.113	-.340 **	.084
Child's Health	.110	.271 **		.479 **	.072	.163 *
Personal Health	-.129	.112	.461 **		.238 **	.212 **
Acceptance	-.503 **	-.351 **	.072	.316 **		-.054
Becoming Pregnant	.452 **	.095	.179 *	.308 **	-.081	

Note. Standardized interfactor correlations are reported below the diagonal. Pearson product-moment correlations are reported above the diagonal.

*
$p < .05$.

**
$p < .01$