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Confirmatory Factor Analysis of the Fear of Cancer Recurrence Scale-7 in Patients Following Completion of Lung Cancer Treatment with Curative Intent

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Abstract

Purpose: Fear of cancer recurrence (FCR) is highly prevalent among cancer survivors, highlighting the need for brief screening tools. Patients with lung cancer are particularly vulnerable to FCR because the disease carries a high risk of recurrence. The Fear of Cancer Recurrence Scale-7 (FCR-7) has been validated in several cancer populations, but its psychometric properties have been minimally evaluated in lung cancer survivors. The present study validated the FCR-7 in U.S. patients with lung cancer.

Methods: We conducted a secondary analysis of baseline data from a randomized controlled trial of a coping skills intervention for patients with lung cancer. Participants completed the FCR-7 and measures of psychological distress, quality of life (QoL), physical symptoms, social support, and loneliness within 3 weeks of completing treatment with curative intent. Confirmatory factor analysis and structural equation modeling were used to evaluate the unidimensional structure of the FCR-7 and associations between latent FCR and psychosocial variables.

Results: Among participants (N =109; M age=68.9 years, 96% non-Hispanic White; 55% female), a single-factor model with a correlated residual between two items demonstrated acceptable fit ($\Delta\chi^2(1) = 26.16$, $p < .001$; CFI = .960; RMSEA = .126) and high composite reliability ($\omega = .905$). Greater FCR was associated with greater psychological distress, loneliness, and physical symptoms, and lower social support and QoL (*p*'s < .05).

Discussion:The FCR-7 demonstrated a unidimensional structure and strong internal reliability and construct validity in U.S. patients with lung cancer, supporting the use of FCR-7 as a brief screening tool during early survivorship.

Introduction

Fear of cancer recurrence (FCR) is defined as the "fear, worry, or concern relating to the possibility that cancer will come back or get worse" and has been identified as one of the most prevalent and distressing psychological challenges faced by cancer survivors [1, 2]. A consensus study by Mutsaers et al. (2020) identified four features of clinical FCR, including (1) intense preoccupation, (2) excessive worry, (3) persistent fear, and (4) heightened vigilance to bodily sensations. Recent literature estimates that approximately 59% of survivors report at least moderate FCR, and nearly 19% report clinical FCR [3]. While mild to moderate levels of FCR may serve as adaptive motivators for medical follow-up and health-promoting behaviors, elevated FCR has been associated with a diminished quality of life (QoL) [4, 5], adverse health behaviors [6], and reduced engagement in medical follow-up [7]. Thus, screening for FCR is essential as FCR has been associated with elevated psychological distress, loneliness, and physical symptoms, and reduced quality of life and social support [2–12].

Early identification of FCR has become a priority in survivorship care [13]; however, routine screening is limited by the small number of brief FCR measures. Although tools, such as the single-item Fear of Cancer Reccurece-1 revised, have been developed, it is psychometrically limited as they may not

adequately capture nuances of FCR severity [14, 15]. To address this need, Humphris and colleagues (2018) developed the Fear of Cancer Recurrence Scale-7 (FCR-7), a seven-item, unidimensional screening measure that assesses fear, worry, cognitive intrusions, and behavioral checking. In the original validation study of breast and colorectal cancer survivors, the FCR-7 demonstrated strong internal consistency (α = 0.92) and adequate factor loadings (items 1–5, 7 > 0.7, item 6 = 0.45), exhibiting a unidimensional factor structure [16]. Subsequent validations, including Chinese, Tamil, Japanese, Spanish, Malayalam, and Korean adaptations, have repeatedly supported a single-factor structure, high internal consistency (range: 0.83–0.96), and expected convergent relationships with anxiety, depression, physical symptoms, intrusive cognitions, and perceived recurrence risk [17–23].

Although FCR-7 has been validated across several international samples, no study to date has examined its psychometric properties specifically in patients with cancer in the U.S. Lung cancer is the second most diagnosed cancer in both men and women in the U.S. and is the leading cause of cancer-related mortality [24, 25]. Early-stage disease is often asymptomatic; therefore, many patients are diagnosed with advanced disease [26]. As a result, lung cancer survivors have been underrepresented in survivorship studies, with research in lung cancer focusing primarily on improving early detection and survival rather than post-treatment quality of life (QoL) [27].

Among patients with lung cancer who are diagnosed with locally advanced disease, the standard of care for treatment with curative intent typically involves chemotherapy with or without surgery and/or radiation [28]. Although curative-intent treatment has improved survival outcomes, the risk of recurrence remains at 50–75% [29]. Elevated recurrence risk is associated with heightened FCR, highlighting the need for accurate and efficient FCR assessment in this population [30–32].

We aimed to validate the FCR-7 as a unidimensional screening measure for patients with lung cancer who have recently completed curative-intent treatment. Confirmatory factor analysis (CFA) was used to test whether the theorized single-factor structure replicates in this population. We also investigated the construct validity of the FCR-7, examining associations between FCR and known predictors, including psychological distress, physical symptoms, QoL, social support, and loneliness [2–4, 8–11].

Methods

Study Design. This project involved a secondary analysis of data from a randomized controlled trial evaluating a brief coping skills intervention for patients with lung cancer who had completed treatment with curative intent within the past three weeks. The present analyses utilized pre-randomization baseline data to examine the measurement structure of the FCR-7 and to evaluate associations between FCR and psychosocial variables (psychological distress, physical symptoms, QoL, social support, and loneliness). Although the sample size of 109 is modest for CFA, prior literature indicates that models with low complexity and strong factor loadings can yield reliable results with samples as small as N = 100 [33]. All study procedures were approved by the Dana-Farber/Harvard Cancer Center Institutional Review Board.

Participants & Procedures. Participants at Massachusetts General Hospital and Dana-Farber Cancer Institute, both located in Boston, Massachusetts, were screened from thoracic oncology clinic schedules, referred by their thoracic oncology clinicians, or self-referred. Individuals were eligible if they (a) were 21 years of age or older, (b) were able to speak and read English, (c) had a confirmed diagnosis of Non-Small Cell Lung Cancer or Small Cell Lung Cancer, and (d) had completed treatment with curative intent within the past three weeks. As determined by the electronic health record or treating oncology clinician, patients were ineligible if they had comorbid medical or psychiatric conditions expected to interfere with study participation or were currently receiving cognitive-behavioral therapy.

Study staff screened 2,355 patients, identified 374 as potentially eligible, and approached 254 for enrollment. Of these, 124 participants consented and 109 completed the full baseline assessment. After confirming eligibility and obtaining informed consent in person or via phone, study staff administered the baseline questionnaire to participants either on paper (in clinic or by mail), online via REDCap, or verbally by phone. A trained research assistant conducted an electronic health record review to collect clinical information, including age, lung cancer type, stage, and treatments received. Patients self-reported demographic information, including gender, race, ethnicity, relationship status, education level, and income.

Measures. FCR was assessed using the seven-item FCR-7 scale, which measures current worry, cognitive intrusions, and hypervigilance about the possibility of cancer returning. Items 1–6 are rated from 0 (“not at all”) to 4 (“all the time”), and item 7 is rated from 0 (“not at all) to 10 (“a great deal”). Total scores are created by summing item scores together. Scores ≥ 17 and ≥ 27 indicate moderate and severe FCR, respectively. All items were modeled as continuous indicators of FCR, with higher scores reflecting greater FCR [16].

Psychological distress was measured using the Hospital Anxiety and Depression Scale (HADS), which includes 14 items assessing anxiety and depressive symptoms over the previous week, with higher scores representing greater psychological distress (range: 0–42) [34].

General cancer-related QoL was assessed using the Functional Assessment of Cancer Therapy-General (FACT-G), which comprises four subscales (emotional, functional, physical, and social wellbeing) that are summed to create a total QoL composite score (range 0-108) [35]. Lung-cancer specific physical symptoms were assessed with the Functional Assessment of Cancer Therapy-Lung Cancer Subscale (FACT-LCS; total score range: 0–36) [36]. Both the FACT-G and FACT-LCS ask patients to recall symptoms over the past 7 days, with higher total scores indicating better functioning.

Current perceptions of loneliness were assessed using the three-item Campaign to End Loneliness Measure (CELM; total score range: 0–12), with higher scores indicating greater loneliness [37]. Current perceptions of social support were measured using the 12-item Multidimensional Scale of Perceived Social Support (MSPSS; total score range 12–84), with higher scores indicating greater social support [38].

Analytic Plan. All analyses were conducted in R version 4.5.2 [39]. Analyses included all enrolled participants (n = 109). Missing data were negligible, consisting of a single missing item (Item 3 of the CELM) from one participant. This missing value was addressed using full-information maximum likelihood (FIML) estimation, which yields unbiased parameter estimates under the assumption of missing-at-random [40].

Descriptive statistics and normality were evaluated for all psychosocial variables psychological distress, QoL, social support, physical symptoms, and loneliness) and the FCR-7 items. Across exogenous variables and FCR-7 items, skewness (< 2.0) and kurtosis (< 7.0) values remained within acceptable ranges for robust FIML estimation [41]. Outliers were screened using Mahalanobis distance and chi-square (χ^2) cutoff corresponding to p = .001 [42]. One participant exceeded this criterion, with inspection of standardized scores revealing high loneliness and low social support values. The values reflected true clinical variability rather than measurement error; therefore, the case was retained.

CFA analyses were conducted using lavaan 0.6.20 with the maximum likelihood robust (MLR) estimator. The model specified a single latent FCR factor indicated by the seven FCR-7 items. Model fit was evaluated using goodness of fit indices, including χ^2, Comparative Fit Index (CFI > .95), Tucker-Lewis Index (TLI > .95), Root Mean Square Error of Approximation (RMSEA < .05) (with 90% CI), and Standardized Root Mean Square Residual (SRMR < .08) [43]. Standardized loadings (reliable $\geq$ 0.6 [44, 45]), residual correlations, R^2 values, and composite reliability (ω > 0.70; [46] were examined to determine model adequacy. Modification indices and residual correlations were used to evaluate local fit [47]. Standardized residuals (0.17) between these items also exceeded typical cutoffs (i.e., > |.10|) [47], supporting the presence of shared variance not accounted for by the latent factor. Structural equation modeling was used to regress FCR on the exogenous predictors (psychological distress, physical symptoms, QoL, social support, and loneliness). Standardized regression coefficients (B), 95% confidence intervals, and p-values (< .05) were used to evaluate the strength and significance based on unstandardized coefficients. Multicollinearity was examined using variance inflation factors (VIF) and tolerance values. All VIF values fell below 5, and all tolerance values fell above 0.2 [48], indicating acceptable multicollinearity.

Results

On average, participants were 68.9 years old (*SD* = 7.2). The majority of participants were female (n = 59, 55%), and most self-identified as White (n = 105, 96%) and non-Hispanic (n = 109, 100%). Participants were diagnosed with NSCLC (n = 88, 80%) or SCLC (n = 21, 20%). Additional sociodemographic and treatment characteristics are in Table 1.

Table 1. Demographic and Clinical Characteristics

Variable	n (%)
Age, years (M±SD)	68.9 ± 7.2
Range	35.2 – 88.2
Female	59 (55)
Race identification	
White	105 (96)
Black/African American	1 (1)
Multiple races	1 (1)
Unknown	1 (1)
Declined to respond	1 (1)
Non-Hispanic	109 (100)
Relationship status	
Married or living with partner	70 (66)
Widowed/loss of partner	14 (13)
Single	12 (10)
Separated/Divorced	10 (8)
In a relationship, not living together	3 (3)
Education	
< Bachelor's degree	61 (56)
Bachelor's degree	24 (22)
Advanced degree	24 (22)
Income	
< $25,000	17 (16)
$25,000-$49,999	12 (11)
$50,000-$99,999	30 (28)
$100,000-$149,999	19 (17)
$150,000 or greater	19 (17)
Declined to respond	12 (11)
Lung cancer type	
Non-small cell lung cancer	88 (80)

Small cell lung cancer	21 (20)
Lung cancer stage	
IB	3 (3)
IIA	5 (5)
IIB	21 (19)
IIIA	37 (33)
IIIB	17 (16)
IIIC	3 (3)
IV	1 (1)
Limited Stage	20 (18)
Unknown	2 (2)
Chemotherapy received*	
Pemetrexed	54
Carboplatin	52
Cisplatin	49
Etoposide	28
Paclitaxel (Taxol)	26
Gemcitabine	4
Taxotere	1
Other therapies received*	
Concurrent or sequential radiation	65
Surgery	57
Concurrent or sequential immunotherapy	45
Sequential oral/targeted chemotherapy	37

*multiple responses possible

Model 1. Model 1 specified a single latent FCR factor indicated by the seven FCR-7 items. Fit indices revealed poor model fit, $\chi^2(14) = 72.42$, $p < .001$; CFI = .897; TLI = .846; RMSEA = .196, 90% CI [.152, .241]; SRMR = .049. Standardized factor loadings ranged from .43 (Item 6: “I examine myself to see if I have physical signs of cancer”) to .89 (Item 4: “I get waves of strong feelings about the cancer coming back”). Composite reliability was excellent (ω = .915). Item R^2 values ranged from .185 to .789, indicating that the latent factor explained a substantial proportion of variance for most items. Local fit diagnostics

revealed a substantial residual correlation between Items 1 (“I am afraid my cancer may return”) and 2 (“I am worried or anxious about the possibility of cancer recurrence”), with the largest modification index (MI = 34.93). Given that both items capture core worry and fear content, adding a correlated residual was justified both theoretically [49, 50] and empirically.

Model 2. Model 2 included a correlated residual between Items 1 and 2. This theoretically justified modification improved model fit relative to Model 1: $\chi^2(13) = 35.67$, p = .001; CFI = .960; TLI = .936; RMSEA = .126 (90% CI [.078, .177]); SRMR = .037. A Satorra-Bentler χ^2 difference test showed a significant improvement compared with Model 1, $\Delta\chi^2(1) = 26.16$, $p < .001$. Standardized loadings remained strong overall (λ = .44-.91), and composite reliability remained high (ω = .905). Item R^2 values ranged from .194 to .828, reflecting generally strong measurement quality. Although Item 6 continued to show the weakest loading (λ = .44), it demonstrated acceptable reliability (R^2 = .19), indicating that the FCR factor still accounted for a meaningful proportion of its variance. No other modification indices or standardized residuals exceeded recommended thresholds or reflected theoretically justified sources. Given the improvement in model fit and theoretical justification, Model 2 was retained as the final measurement model.

Model 3. Model 3 examined correlations between latent FCR and psychological distress, general QoL, physical symptoms, loneliness, and social support to evaluate construct validity (Figure 1). Model fit was excellent: $\chi^2(49) = 67.79$, $p = .039$; CFI = .980; TLI = .968; RMSEA = .059 (90% CI [.014, .091]); SRMR = .035 (see Table 2 for comparison across all models). Correlations aligned with hypothesized relationships (see Figure 1). Specifically, higher FCR was strongly associated with greater psychological distress ($r = .75$, $p < .001$), greater physical symptoms ($r = -.34$, $p = .003$), and poorer QoL ($r = -.81$, $p < .001$). Moderate correlations were observed between higher FCR and both greater loneliness ($r = .28$, $p = .010$) and lower social support ($r = -.23$, $p = .021$). Full unstandardized and standardized parameter estimates for the final model, including standard errors, appear in Supplemental Materials. Variance inflation factors (1.16-4.44) and tolerance values (0.23-0.87) indicated acceptable multicollinearity among predictor variables (Table 3). Bivariate correlations among the predictors are shown in Table 3.

Table 2. Fit Indices for CFA Models of the FCR-7

Fit Indices	Model 1	Model 2	Model 3
χ^2 (df)	72.42 (14)	35.67 (13)	67.79 (49)
p	< .001	0.001	0.04
CFI	0.90	0.96	0.98
TLI	0.85	0.94	0.97
RMSEA	0.20	0.13	0.06
RMSEA 90% CI	0.15-0.24	0.08-0.18	0.01-0.09
SRMR	0.05	0.04	0.04
Unstandardized Loadings (B)	0.59-3.37	0.66-3.66	0.66-3.66
Standardized Loadings (λ)	0.43-0.89	0.44-0.91	0.44-0.91
Item Reliability (R^2)	0.19-0.79	0.19-0.83	0.19-0.79
Composite Reliability (ω)	0.92	0.91	0.91

Note. Model 1 = unidimensional FCR-7; Model 2 = model with correlated residuals between Items 1 and 2; Model 3 = model including correlations between latent FCR and observed covariates. All models were estimated using MLR with FIML for missing data.

Table 3. Correlation Matrix for Psychosocial Variables

	1	2	3	4	5
1. Quality of Life (QoL)	–	0.63	-0.81	-0.64	0.47
2. Physical Symptoms	0.63	–	-0.57	-0.29	0.22
3. Psychological Distress	-0.81	-0.57	–	0.51	-0.39
4. Loneliness	-0.64	-0.29	0.51	–	-0.63
5. Social Support	0.47	0.22	-0.39	-0.63	–
VIF	4.44	1.87	2.94	2.32	1.73

Note. Values are Pearson correlations. Variance inflation factors (VIFs) for observed covariates ranged from 1.16 to 4.44, and tolerance values ranged from 0.23 to 0.87, indicating no problematic multicollinearity. Major diagonal is shown with *em* dashes.

Discussion

In the present study, we evaluated the psychometric properties of the FCR-7 in a U.S.-based sample of patients with lung cancer who recently completed treatment with curative intent. Consistent with prior

validation studies [16–23], the FCR-7 demonstrated strong internal consistency and a predominantly unidimensional factor structure. Notably, the present study is the first to assess the validity of the FCR-7 among U.S. patients with lung cancer in the immediate post-treatment phase, providing a narrowly defined and clinically salient window. Because all participants were assessed within this time window, this study minimizes timing variability that often complicates FCR research and enables more precise screening of FCR at the transition from patient to survivor, a period marked by heightened uncertainty [51].

Overall, findings supported a unidimensional factor structure of the FCR-7, indicating that fear of cancer recurrence is best conceptualized as a single construct. Although the initial base model (Model 1) demonstrated poor fit, this was largely attributable to shared residual variance between Items 1 (“I am afraid that my cancer may recur”) and 2 (“I am worried or anxious about the possibility of cancer recurrence), which assess highly overlapping emotional expressions of fear and worry about recurrence that may be interpreted interchangeably by respondents [23, 49, 50]. Allowing the residuals of these items to correlate substantially improved model fit, consistent with prior research in patients with hematological cancers [23], and suggests overlap in item wording and content rather than distinct components of fear of cancer recurrence. Additionally, the low factor loading of Item 6, which focuses on behavioral checking for cancer recurrence, is consistent with prior FCR-7 research (see Supplemental Materials [16]). The revised model demonstrated strong factor loadings, high composite reliability, and excellent item-level R^2 values, further supporting the robustness of the single-factor structure.

Construct validity analyses demonstrated strong and theoretically coherent relationships between FCR and key psychosocial variables. Consistent with hypotheses and prior literature in breast cancer survivors [8], individuals reporting greater FCR also endorsed elevated psychological distress, increased physical symptoms, and reduced overall QoL. These findings suggest that FCR extends beyond cancer-specific worry and reflects broader emotional and functional difficulties in cancer survivorship. This pattern aligns with conceptual models of FCR, such as the Lee-Jones framework, which proposes that internal (e.g., physical symptoms) and external cues (e.g., medical appointments, surveillance scans) activate cognitive-emotional processes related to recurrence, which, in turn, contribute to heightened psychological distress [4, 52]. Importantly, interventions that target FCR through these cognitive-emotional pathways have demonstrated reductions in psychological distress and improvements in overall QoL, highlighting FCR as a clinically meaningful and modifiable treatment target [52]. Given that FCR is one of the most prevalent and persistent unmet psychological needs post-treatment [3], routine screening may facilitate timely intervention, thereby attenuating associated psychological distress and impacts on QoL.

Moderate FCR associations with loneliness and social support were also consistent with prior literature [9, 10, 53], indicating that FCR may be associated with perceived social isolation. Assessing these interpersonal constructs is particularly important in lung cancer, given that survivors often face unique stigma related to smoking history and may experience greater social withdrawal, lower perceived support, and heightened self-blame compared to other cancer populations [53]. Because FCR can

intersect with these interpersonal and stigma-related experiences, including loneliness and social support in the model, allowed us to capture psychosocial dimensions of FCR that are often overlooked in prior studies.

In addition to the strengths of this study, several limitations are worth noting. First, the cross-sectional study design precludes causal inferences regarding the directionality of associations between FCR and psychosocial variables, as well as conclusions about temporal stability. Longitudinal assessments are needed to better characterize the natural course of FCR over time, including identifying who may have FCR that remits, persists, or worsens following treatment completion. The sample consisted predominantly of White, non-Hispanic patients receiving care in a single region (northeast U.S.) who were assessed immediately post-treatment. Prior research indicates that Latina breast cancer survivors report higher levels of FCR compared to their non-Hispanic White counterparts [54], and more broadly, Hispanic/Latino cancer survivors report greater unmet needs associated with increased symptom burden [55]. Thus, our results may not generalize across racially and ethnically diverse populations. Finally, FCR-7 items showed expected positive skew, which potentially may have underestimated factor loadings and standard errors. MLR estimation was used to minimize the influence of slightly skewed data.

Overall, the results provide promising evidence that the FCR-7 is a psychometrically valid screening tool for FCR in U.S. patients with lung cancer during the transition from treatment to survivorship. In future studies, researchers should evaluate longitudinal measurement invariance to assess the stability of the FCR-7 structure across other clinically meaningful timepoints in survivorship and examine longitudinal relationships between FCR and psychosocial outcomes, including identifying predictors of distinct FCR trajectories. Additional research is also needed to compare the FCR-7 to other FCR instruments (e.g., Fear of Cancer Recurrence Inventory - Short Form; FCR-1r) to further evaluate convergence and test whether subgroups (e.g., age group, treatment type, symptom burden) moderate associations between FCR and psychosocial outcomes [14, 15, 56].

Statements & Declarations

Author Contributions: Elisabeth C. Henley and Maia A. Chester were responsible for model design, data analysis, and manuscript writing. Sierra Bainter assisted with model design and data analysis. Daniel L. Hall and Frank J. Penedo assisted with manuscript reviewing and writing. Jessica Whitman assisted with manuscript reviewing and writing. Lara Traeger, Areej El-Jawahri, Jennifer S. Temel, and Joseph A. Greer led study conceptualization, methodology, and contributed to manuscript writing. The first draft of the manuscript was written by Elisabeth C. Henley and Maia A. Chester and all authors read and approved of the final manuscript.

Trial Registration: NCT05087251 (10/01/2021)

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Competing Interests. No competing interests were reported by any of the authors.

Data Availability. The dataset used/analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval. This study was performed in accordance with the principles of the 1964 Declaration of Helsinki. The protocol was approved by the DF/HCC Institutional Review Board prior to patient recruitment and consent. The clinical trial is registered at ct.gov as NCT05087251 on 10/1/2021.

Consent to Participate. All participants provided written or verbal informed consent according to the DF/HCC IRB-approved protocol.

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Figures

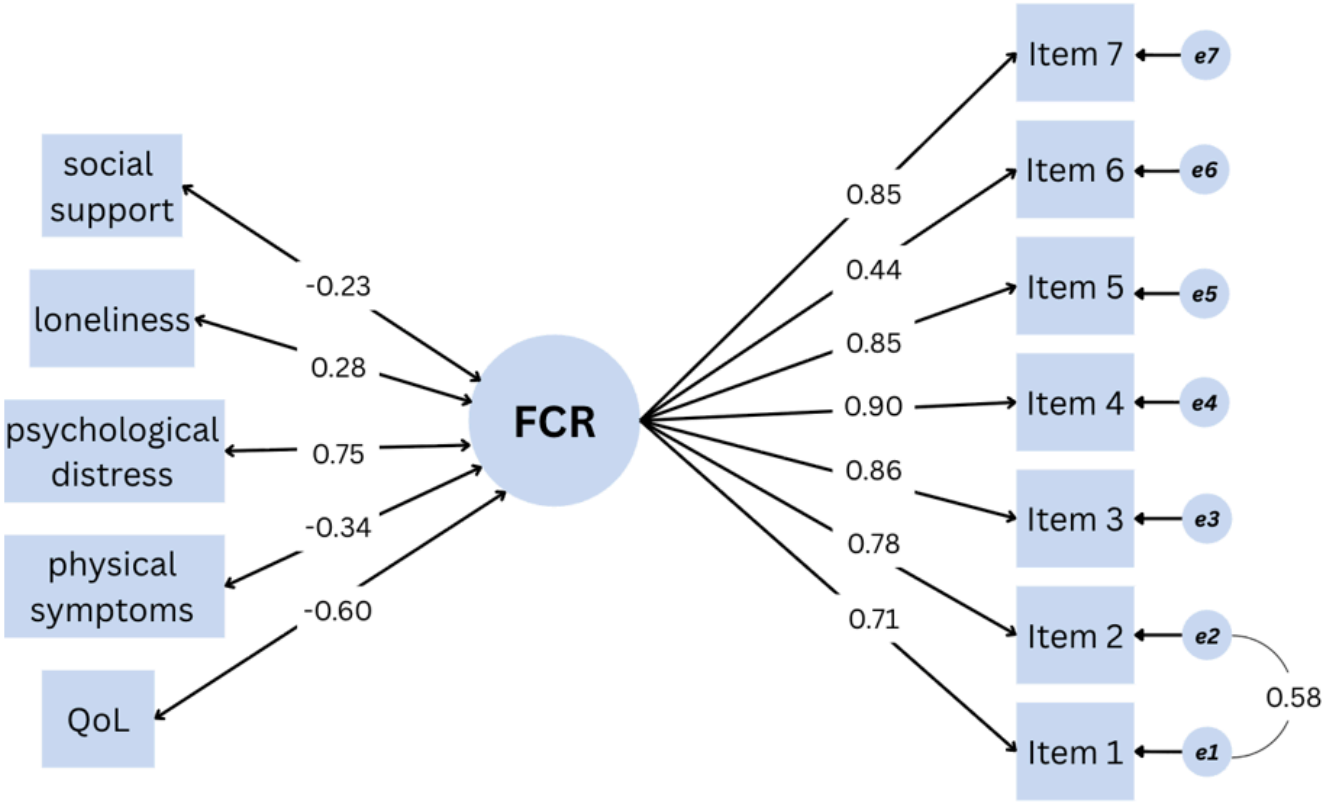


Figure 1

Final Confirmatory Factor Analysis Model with Correlations Between Fear of Cancer Recurrence and Covariates (Model 3).

Note. FCR = Fear of cancer recurrence; Psychological distress = HADS total score; Global QoL = FACT-G; Lung cancer-specific Physical Symptoms = FACT-LCS; Loneliness = Campaign to End Loneliness Measure; Social support = MSPSS. The figure displays standardized loadings on the single-headed arrows, indicating the strength of the relationship between FCR and observed items. Double-headed arrows represent Pearson Correlations between FCR and psychosocial variables. All loadings and correlations are statistically significant ($p < 0.001$). Positive correlations reflect higher levels of FCR associated with higher levels of the predictor. For the FACT-LCS, higher scores reflect lower lung-cancer–specific symptom burden. Correlations ≥ |.30| generally indicate moderate associations.

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