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RESEARCH

Quality of life and appraisal factors of patients with advanced cancer and their family caregivers

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Abstract

Purpose Few existing interventions have effectively improved the quality of life (QOL) for patients with advanced cancer and their caregivers, partly due to limited research on the factors associated with QOL. Guided by an adapted stress-coping model, this study aimed to examine the associations between the QOL of cancer patients and their caregivers and their primary and secondary appraisals. Primary appraisals involve perceptions and evaluations of advanced cancer and related caregiving, while secondary appraisals relate to their available resources and coping capabilities.

Methods Using multi-level modeling, we conducted a secondary analysis of the baseline data collected from a randomized clinical trial that examined the effects of a family-based, psychoeducational support program for patients with advanced cancer and their caregivers ($N = 362$ dyads).

Results The appraisal variables hypothesized in the adapted stress-coping model explained 74.14% of the variance in the QOL of patients with advanced cancer and their caregivers when controlling for demographics and other disease-related variables. Better QOL in patients and caregivers was associated with less negative appraisals of illness/caregiving, less uncertainty and hopelessness, less avoidant coping strategies, more family support, more health behaviors, higher self-efficacy, and more active coping strategies.

Conclusion Our study highlights the significant impact that advanced cancer has on patients and their caregivers' perceptions, responses to the illness, and QOL. Future interventions may benefit from addressing illness/caregiving appraisals, uncertainty, hopelessness, family support, health behaviors, self-efficacy, and coping strategies. However, further research is needed to determine the effectiveness of interventions specifically targeting these factors.

Keywords Advanced cancer · Caregiver · Quality of life · Appraisal · Multi-level model

Background

Quality of life (QOL) in patients with advanced cancer is an essential outcome in cancer care [1]. These patients experience various physical, functional, psychological, emotional, and social challenges triggered by symptoms such as pain, chronic fatigue, cachexia, and breathlessness, as well as distress and dire prognoses; this combination of factors significantly compromises their QOL [2]. Similarly, caregivers who provide intensive care and support to patients with deteriorating health face significant physical, emotional, social, and financial burdens. The thought of losing a loved one due to a poor prognosis further reduces caregivers' QOL. Family caregivers often experience QOL levels similar to, or even worse than, those reported by cancer patients [1, 3], impairing their caregiving capacity and ultimately further decreasing patients' QOL [4].

To manage symptom burden and distress and to improve their QOL, patients with advanced cancer and caregivers engage in complex and evolving appraisal processes. These processes involve perceiving and interpreting stressful situations and assessing their ability to cope with those

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stressors [5]. However, despite these efforts, managing the multifaceted challenges of advanced cancer remains difficult for patients and caregivers. As a result, the effectiveness of interventions to improve their QOL is crucial.

Most interventions aimed at improving the QOL for patients and caregivers have focused primarily on strategies for delivering supportive care related to activities of daily living [2, 6, 7], symptom management [2, 6–8], changing behaviors and thoughts [2, 7], managing burden and improving coping [2, 6–8], enhancing their sense of meaning [2], and promoting cancer communication with family and physicians about care planning [2, 6–8]. However, systematic reviews have shown that only a minor proportion of these existing interventions have effectively improved the QOL for patients and caregivers [2, 6, 8]. Furthermore, these studies used mixed study designs and modalities [2, 6].

Other interventions have been less effective due to a lack of theoretical underpinnings and a limited understanding of the care needed to improve QOL among patients and caregivers managing advanced cancer [2, 6, 8]. To date, limited research has thoroughly investigated the factors associated with QOL for patients with advanced cancer and their caregivers, which is critical for developing effective interventions that best meet their needs [9].

Theoretical framework

This study was guided by Dr. Northouse's adapted stress-coping model, originally based on Lazarus and Folkman's Transactional Theory of Stress and Coping [10]. The original model conceptualizes stress as a dynamic process where individuals evaluate a stressor (primary appraisal) and assess their coping resources (secondary appraisal) to determine its impact on well-being.

Dr. Northouse adapted this model to cancer caregiving by incorporating dyadic processes, which recognized that patients and caregivers experience interconnected stress-coping mechanisms [11]. This version includes moderators (e.g., demographics), dyadic appraisals and coping resources, and QOL outcomes.

For this study, we further adapted Northouse's model to examine specific appraisal variables (e.g., benefit of illness) and dyadic illness-related communication as a coping resource (see Fig. 1).

- Primary appraisals assess the seriousness of cancer and caregiving, including benefit of illness, uncertainties, and feelings of hopelessness [11].
- Secondary appraisals evaluate coping capabilities and resources such as health behaviors, self-efficacy, coping strategies, family support, and dyadic illness-related communication [11].
- Confounding factors (e.g., age, income, symptom burden) were included, as they may influence appraisals and QOL [12, 13].

This study aimed to examine associations between primary/secondary appraisals and QOL, controlling for confounding factors. We hypothesized that the QOL of patients and their family caregivers is significantly associated with individual appraisals, which can provide further validation of stress-coping theory to guide family-focused supportive oncologic care.

Methods

Study design

This study conducted a secondary analysis of the baseline (Time 1) data collected from a randomized controlled trial (RCT) (R01 CA107383, ClinicalTrial.gov: NCT00708968 [PI: Northouse]) that examined the effects of a home-based, dyadic-focused intervention (the FOCUS Program) designed to improve QOL of patients with advanced cancer and their family caregivers [11]. University of Michigan IRB approval was obtained from participating sites (IRBMED No. 2004–0129) in accordance with the Declaration of Helsinki.

Population

In the original RCT, eligible patients met the following criteria: 1) diagnosed with stage III or IV breast, colorectal, lung, or prostate cancer within the past 6 months, 2) a life

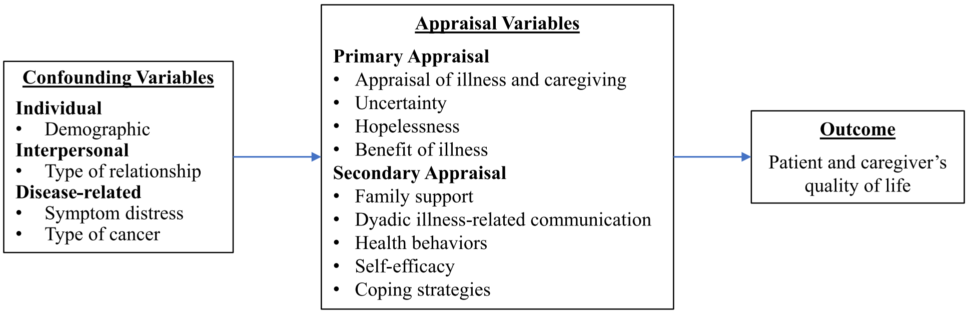


Fig. 1 Adapted stress-coping theoretical model

expectancy of at least 6 months, 3) aged 21 or older, 4) living within 75 miles of a participating cancer center, and 5) having a family caregiver willing to participate. Caregivers were eligible if they were 18 or older, identified as the patient's primary caregiver, and had not been diagnosed with cancer or undergoing treatment in the past year.

Setting and procedures

The setting and procedures of the FOCUS trial were previously published [11]. After clinic staff referred eligible patients and caregivers from four cancer centers who expressed interest in participating, research nurses obtained informed consent and collected the baseline data during a home visit. Data collection occurred at 3 months and 6 months post-randomization. We used the baseline data of all study participants to achieve the research aims.

Measurement

Outcome variable. The 27-item general Functional Assessment of Cancer Therapy (FACT-G) (version 4) measured *QOL*. This instrument assessed the social, emotional, functional, and physical domains of cancer-related QOL [14]. Caregivers completed a modified version of the FACT-G Caregiver instrument to assess their QOL [15, 16].

Primary appraisal variables. Patients completed the 32-item Appraisal of Illness Scale [17] to measure *appraisal of illness*. Caregivers completed the 27-item Appraisal of Caregiving Scale to measure *appraisal of caregiving* [18]. A 9-item brief version of the Mishel Uncertainty in Illness Scale for Adults assessed patient and caregiver *uncertainty* about the disease and their ability to manage it [19]. The 20-item Beck Hopelessness Scale measured *hopelessness*, encompassing feelings about the future, loss of motivation, and expectations [20]. The 11-item Benefit Finding Scale measured the *benefit of illness,* assessing how attitudes and behaviors changed resulting from illness or caregiving [21].

Secondary Appraisal Variables. The 7-item modified subscale of the Social Support Questionnaire measured *family support* [22]. The 23-item Lewis Mutuality and Sensitivity Scale [23] evaluated *dyadic illness-related communication* by assessing verbal communication about cancer between patients and caregivers. A researcher-developed scale analyzed *health behaviors* by measuring the frequency of exercise, balanced nutrition, and adequate sleep [11]. The 17-item Lewis Cancer Self-Efficacy Scale assessed *self-efficacy*, characterized by patient and caregiver confidence in managing cancer-related challenges [23]. The 38-item Brief Cope evaluated *coping strategies*, which measured how frequently participants used different coping strategies [24], with two subscales: active coping (e.g., use of emotional support) and avoidant coping (e.g., denial).

Confounding variables. The original study included various individual, interpersonal, and disease-related variables that affect QOL. Patients and caregivers self-reported their age, gender, race, income, and their relationship to each other. The primary RCT obtained the cancer type from the patient's medical records. The self-administered Risk for Distress Scale (RFD), adapted from the original Omega Clinical Screening Interview, assessed patient and caregiver symptoms separately [25].

Data analysis

We conducted a preliminary descriptive analysis to summarize participant sociodemographic characteristics, medical information, QOL, and appraisal factors. Categorical variables were reported as frequencies and percentages, while continuous variables were summarized using means and standard deviations (SD).

To address collinearity, we calculated Pearson's correlation coefficients between covariates. Since none of the correlation coefficients had an absolute value greater than 0.8, all covariates were retained.

To examine relationships between patients' and caregivers' QOL and appraisal factors while controlling for confounding variables, we conducted multi-level models (MLM) to account for the nesting of patients and their caregivers within dyads. The full model included primary and secondary appraisal variables, confounders, and interaction terms between role (patient vs. caregiver) and appraisal variables to assess differential effects. The dyad effect was treated as a random effect, while all other variables were fixed effects. We used a multi-level linear mixed-effects model with restricted maximum likelihood (REML) [26]. For the fixed effects, t-tests were used to test significance, with Satterthwaite's method computing denominator degrees of freedom and t-value [26].

To improve interpretability, we used a stepwise backward elimination approach, sequentially removing non-significant variables while maintaining the hierarchy of the model. Interaction terms between role (patient vs. caregiver) and appraisal variables were tested first. If an interaction term was significant, its corresponding main effect was not separately tested [26]. Non-significant variables were then eliminated sequentially, starting with confounding variables with the smallest effect on QOL, followed by interaction terms and main effects with minimal impact. This process continued until the likelihood-ratio test indicated a significant difference between models ($p < 0.05$). The final model was the last selected model that did not differ significantly from the full model in terms of model fit.

We performed a post hoc power analysis for the final model using Monte Carlo simulations with 500 iterations. The *R* function *powerSim* (*simr* package) estimated test power and its 95% confidence interval, based on the estimated parameters of the final model. Power was determined by the proportion of iterations rejecting the null hypothesis, using observed effect sizes (coefficient estimates).

All statistical analyses were conducted using *R* software, with statistical significance set at 0.05.

Results

Participants characteristics

This analysis used baseline data from 362 dyads ($N =$ 724 individuals) with complete data for all variables (See Table 1). Most caregivers were spouses (73.76%). Most patients (80.4%) and caregivers (80.9%) were non-Hispanic White. The mean age was 60.27 years (SD = 11.60; range 26–95) and 56.45 years (SD = 13.21; range 18–88) for patients and caregivers, respectively. On average, the mean age of patients was more than that of the caregivers ($p < 0.0001$). Regarding income, 53.3% of the patients and 61.3% of the caregivers earned more than $50,000 yearly. Patients had advanced breast (30.94%), colorectal (24.3%), lung (30.7%), and prostate cancer (14.1%). Patients also reported higher symptom distress than caregivers ($p <$ 0.0001). Table 2 illustrates the descriptive analysis results of the QOL and appraisal variables for patients and caregivers.

Table 1 Descriptive statistics for participants, their quality of life, and appr ($N =$ 724 subjects, 362 dyads)

Characteristics	Patient (***N*** = 362)		Caregiver (***N*** = 362)		***p*-value**
	Mean	SD	Mean	SD	
Age (Year)	60.27	11.60	56.45	13.21	**<.0001***
Education (Year)	14.64	2.82	14.73	2.86	.4917
Mean symptom distress	11.22	5.14	6.82	6.90	**<.0001***
	N	%	**N**	%	***p*-value**
Gender					.5463
Male	146	40.3	155	42.8	–
Female	216	59.7	207	57.2	–
Race					.9250
White	291	80.4	293	80.9	–
Non-White	71	19.6	69	19.1	–
Ethnicity					1
Hispanic	6	1.7	7	1.9	–
Non-Hispanic	356	98.3	355	98.1	–
Income					**.0354***
< = $50,000	169	46.7	140	38.7	–
> $50,000	193	53.3	222	61.3	–
Type of relationship					–
Spouse	267	73.8	–	–	–
Non-Spouse	95	26.2	–	–	–
Type of cancer					–
Breast Cancer	112	30.9	–	–	–
Colorectal Cancer	88	24.3	–	–	–
Lung Cancer	111	30.7	–	–	–
Prostate Cancer	51	14.1	–	–	–

1. Percentages have been rounded and may not total 100

2. The *p*-values of categorical variables were calculated based on the chi-squared test. The p-values of continuous variables were obtained from the paired t-test.

*indicates the *p*-value smaller than 0.05, which is considered significant

Associated factors of QOL among patients and caregivers

The full model included primary and secondary appraisals, role (patient vs. caregivers), interaction terms between role and each appraisal variable, and all confounding variables (see Table 3). We found an association between an improvement in QOL and primary appraisals (less negative appraisals of illness/caregiving [$p < 0.0001$] and fewer feelings of hopelessness [$p = 0.0115$]) and secondary appraisals (having more family support [$p < 0.0001$], more frequent engagement in health behaviors [$p = 0.0002$], more use of active coping strategies [$p = 0.0005$], and less reliance on avoidant coping strategies [$p < 0.0001$]). The only significant interaction terms were role*benefit of illness and role*active coping strategies, indicating that the effects of the benefit of illness ($p = 0.0456$) and active coping strategies on QOL varied between patients and caregivers ($p = 0.0188$).

Additionally, for patients and caregivers, better QOL had a significant correlation with older age ($p < 0.0001$), being White ($p = 0.0477$), having an income above $50,000 ($p = 0.0289$), and experiencing less symptom distress ($p <$ 0.0001). The role effect demonstrated statistical significance ($p = 0.0292$), indicating that patients had significantly lower QOL than their caregivers when considering appraisals and confounders. We found no significant difference in the association between QOL and type of cancer.

In this full model, the coefficient of determination (R^2) value was 0.7478, indicating that the primary and secondary appraisals can explain about 74.78% of the variance in QOL after controlling for the confounders.

To obtain the final model, we conducted a stepwise elimination process, guided by the adapted stress-coping model, removing variables with the largest *p*-values (See Table 4). Initially, we focused on confounding variables, starting with the type of cancer. Removing it did not result in a significant difference between the full model and the reduced model ($p = 0.1198$), allowing us to proceed with removing the type of relationship, education, and race (ps = 0.1178, 0.0978, 0.0555, respectively), as their removal did not significantly affect model fit. However, gender yielded a significant

Table 2 Descriptive statistics of QOL and appraisal variables for patients and caregivers

Construct Variables	Cronbach's Alpha		Mean (SD)		*p*-value
	Patients	Caregivers	Patients	Caregivers	
Quality of life†	0.72[§]	0.74[§]	76.04 (16.69)	76.50 (15.17)	.6226
Appraisal of illness/caregiving‡	0.94	0.87	3.25 (0.72)	2.87 (0.53)	**<.0001***
Uncertainty‡	0.75	0.71	20.27 (4.81)	20.17 (4.51)	.7321
Hopelessness‡	0.86	0.83	4.77 (4.09)	4.54 (3.68)	.3511
Benefit of illness†	0.90	0.91	3.10 (0.63)	2.84 (0.69)	**<.0001***
Family support†	0.84	0.85	4.26 (0.68)	3.97 (0.75)	**<.0001***
Dyadic illness-related communication†	0.93	0.93	82.74 (15.80)	81.44 (15.71)	.1731
Health behaviors†	0.57	0.68	27.89 (6.92)	26.21 (7.87)	**.0006***
Self-efficacy†	0.97	0.97	132.15 (29.43)	132.05 (27.90)	.9568
Coping strategies					
Active coping strategies†	0.87	0.87	2.85 (0.55)	2.66 (0.54)	**<.0001***
Avoidant coping strategies‡	0.79	0.74	1.56 (0.52)	1.52 (0.46)	.2632

†: Higher scores indicated more positive results, i.e., better quality of life, more benefit of illness, more family support, better dyadic illness-related communication, more frequent engagement in health behaviors, and more active coping strategies adopted (e.g., getting advice or help)

‡: Higher scores indicated more negative results, i.e., more negative appraisal of illness/caregiving as a threat, more feelings of uncertainty and hopelessness, and more avoidant coping strategies adopted (e.g., alcohol or drug use)

§: The Cronbach's alpha was calculated based on the 4 subscales of the Functional Assessment of Cancer Therapy (FACT-G) among patients and caregivers

*: Significant findings

impact ($p = 0.0283$) and was retained (fm4). Subsequently, we evaluated interaction terms. We removed six interaction terms until role*active coping strategies cannot be removed (fm11). Lastly, we assessed the main effects of appraisal variables. The removal process was halted when the first variable, dyadic illness-related communication, resulted in a significant difference ($p = 0.0362$), requiring its retention (fm11).

As we closely followed the model selection procedures, we observed that removing a variable affected the effects of the remaining variables on the QOL. For example, although race had a significant effect on QOL in the full model (see Table 3), it was removed in Step 4 due to its conditional independence on QOL, given the other remaining variables (see Table 4). This indicated that race appeared significant only when all variables were considered together but became non-significant in fm4. Similarly, role*active coping strategies was significant in the full model but non-significant in fm11. However, it remained in the final model (fm11) because removing it at Step 12 showed a significant difference between the full model and the resulting reduced model. The step-by-step model selection ensured the model's goodness of fit and simplicity.

The final model revealed an association between QOL improvement and primary appraisals (less negative appraisals of illness/caregiving [$p < 0.0001$] and fewer feelings of uncertainty [$p = 0.0057$] and hopelessness [$p = 0.0047$]) and secondary appraisals (having more family support [$p < 0.0001$], more frequent engagement in health behaviors [$p < 0.0001$], higher level of self-efficacy [$p = 0.0116$], more use of active coping strategies [$p = 0.0037$], and less reliance on avoidant coping strategies [$p < 0.0001$]).

The only significant interaction terms were role*hopelessness and role*benefit of illness (see Fig. 2), indicating that their associations with QOL varied between patients and caregivers. Among patients, a one-unit increase in hopelessness had no significant effect on QOL ($p = 0.9215$). However, for caregivers, higher hopelessness was linked to significantly lower QOL ($p = 0.0047$). A one-unit increase in the benefit of illness was associated with a significant QOL improvement in patients ($p < 0.0001$) but had no significant effect on caregivers. The interactions role*family support and role*active coping strategies had marginally significance (*p*s = 0.0844 and 0.0878, respectively).

Among all confounding variables, better QOL was significantly associated with older age ($p < 0.0001$), having an income above $50,000 ($p = 0.0267$), and experiencing less symptom distress ($p < 0.0001$). Furthermore, the role effect on QOL became non-significant, suggesting the effect of role was masked by the interaction effects between appraisals and roles. The appraisals (how they evaluate their circumstances) interacted with their roles in a way that hid the direct effect of the role on QOL. In simpler terms, how patients and caregivers appraised their situation could overshadow the direct influence that their specific role might have on their QOL.

Table 3 Full multilevel model and final model of QOL with interaction terms of role and appraisal variables

Effect	Full Model			Final Modal			Power (95% CI)
	Estimate	SE	***p*-value**	Estimate	SE	***p*-value**	
Intercept	85.74	7.42	**<.0001**	75.29	5.40	**<.0001**	
Role (referent: caregiver)	−20.20	9.24	**0.0292**	−8.85	5.64	0.1172	35.80% (31.59,40.18)
Primary Appraisals							
Appraisal of illness/caregiving†	−7.63	1.32	**<.0001**	−6.48	0.78	**<.0001**	100.0% (99.26, 100.0)
Uncertainty†	−0.22	0.14	0.1170	−0.28	0.10	**0.0057**	77.80% (73.90, 81.37)
Hopelessness†	−0.42	0.16	**0.0115**	−0.41	0.15	**0.0047**	77.60% (73.69, 81.18)
Benefit of illness‡	0.79	0.81	0.3283	0.66	0.77	0.3912	14.60% (11.62, 18.00)
Secondary Appraisals							
Family support‡	3.68	0.89	**<.0001**	3.48	0.76	**<.0001**	99.60% (98.56, 99.95)
Dyadic illness-related communication‡	−0.07	0.04	0.0918	−0.05	0.03	0.1264	33.20% (29.08, 37.52)
Health behaviors‡	0.24	0.06	**0.0002**	0.32	0.05	**<.0001**	100.0% (99.26, 100.0)
Self-efficacy‡	0.02	0.02	0.3206	0.04	0.02	**0.0116**	70.80% (66.60, 74.75)
Coping strategies							
Active coping strategies‡	3.62	1.04	**0.0005**	2.87	0.99	**0.0037**	83.60% (80.06, 86.74)
Avoidant coping strategies†	−9.67	1.28	**<.0001**	−7.78	0.84	**<.0001**	100.0% (99.26, 100.0)
Confounding Variables							
Age	0.16	0.03	**<.0001**	0.16	0.03	**<.0001**	100.0% (99.26, 100.0)
Gender (referent: female)	−0.96	0.69	0.1646	−1.13	0.68	0.0942	42.00% (37.63, 46.46)
Race (referent: non-White)	1.84	0.92	**0.0477**				
Education	−0.18	0.14	0.1877				
Income (referent: < =$50,000)	1.79	0.82	**0.0289**	1.56	0.70	**0.0267**	60.20% (55.76, 64.52)
Type of relationship (referent: non-spouse)	−1.22	0.88	0.1657				
Symptom distress	−0.51	0.06	**<.0001**	−0.54	0.06	**<.0001**	100.0% (99.26, 100.0)
Type of cancer (referent: breast cancer)							
Colorectal cancer	−1.08	0.92	0.2424				
Lung cancer	−0.88	0.89	0.3261				
Prostate cancer	1.36	1.15	0.2357				
Interaction Terms							
Role * Appraisal of illness/caregiving	1.43	1.59	0.3694				
Role * Uncertainty	−0.11	0.20	0.5831				
Role * Hopelessness	0.40	0.23	0.0772	0.43	0.18	**0.0173**	66.00% (61.66, 70.15)
Role * Benefit of illness	2.34	1.17	**0.0456**	2.75	1.12	**0.0145**	68.80% (64.54, 72.84)
Role * Family support	0.86	1.28	0.5014	1.61	0.93	0.0844	39.00% (34.70, 43.43)
Role * Dyadic illness-related communication	0.05	0.06	0.4179				
Role * Health behaviors	0.15	0.09	0.1020				
Role * Self-efficacy	0.03	0.03	0.3415				
Role * Coping strategies							
Role * Active coping strategies	−3.37	1.43	**0.0188**	−2.28	1.33	0.0878	42.80% (38.42, 47.27)
Role * Avoidant coping strategies	2.96	1.66	0.0749				

1. The coefficient of determination (R2) values of the full model and final model are 0.7478 and 0.7414, respectively

2. The p-value of the likelihood-ratio test comparing the full model and final model is 0.0748

3. †: Higher scores indicated more negative results, i.e., more negative appraisal of illness/caregiving as a threat, more feelings of uncertainty and hopelessness, and more avoidant coping strategies adopted (e.g., alcohol or drug use)

4. ‡: Higher scores indicated more positive results, i.e., more benefit of illness, more family support, better dyadic illness-related communication, more frequent engagement in health behaviors, and more active coping strategies adopted (e.g., getting advice or help)

5. Power for testing the null hypothesis that all fixed-effect coefficients in the final model are zero is 100.0% (99.26, 100.0)

Table 4 Step-by-step procedures of model selection

Variables	ANOVA Chi-Square	Degree of Freedom	*P*-Value†	R^2	Results	Model Selected
Confounding Variables						
1 Type of cancer	5.84	3	0.1198	0.7472	Type of cancer is removed	Fm1
2 Type of relationship	7.37	4	0.1178	0.7472	Type of relationship is removed	Fm2
3 Education	9.30	5	0.0978	0.7463	Education is removed	Fm3
4 Race	12.31	6	0.0555	0.7448	Race is removed	Fm4
5 Gender	15.67	7	**0.0283***	0.7457	Gender needs to be kept	Fm4
After removing "gender," a significant difference is observed between the full model and model fm4 (ρ <.05); therefore, "gender" and other remaining confounding variables need to be kept in the final model. Confounding variables of type of cancer, type of relationship, education, and race are removed from the model. The selection of confounding variables stops						
Interaction Terms						
6 Role*uncertainty	12.55	7	0.0838	0.7449	Role*uncertainty is removed	Fm6
7 Role* dyadic illness-related communication	13.18	8	0.1058	0.7444	Role*dyadic illness-related communication is removed	Fm7
8 Role*appraisal of illness/caregiving	13.94	9	0.1245	0.7438	Role*appraisal of illness/caregiving is removed	Fm8
9 Role*self-efficacy	14.76	10	0.1409	0.7434	Role*self-efficacy is removed	Fm9
10 Role*avoidant coping strategies	16.98	11	0.1085	0.7414	Role*avoidant coping strategies is removed	Fm10
11 Role*health behaviors	19.61	12	0.0748	0.7414‡	Role*health behaviors is removed	Fm11
12 Role*active coping strategies	22.61	13	**0.0467***	0.7394	Role*active coping strategies needs to be kept	Fm11
After removing "role*active coping strategies", a significant difference is observed between the full model and model fm11 (ρ <.05); therefore, "role*active coping strategies" and other remaining interaction terms need to be kept in the final model. Interaction terms of role*uncertainty, role*dyadic illness-related communication, role*appraisal of illness/caregiving, role*self-efficacy, role*avoidant coping strategies, and role*health behaviors are removed from the model. The selection of interaction terms stops						
Main Effects of the Appraisal Variables						
13 Dyadic illness-related communication	24.84	14	**0.0362**	0.7379	Dyadic illness-related communication needs to be kept	Fm11
After removing "dyadic illness-related communication," a significant difference is observed between the full model and model fm11 (ρ <.05); therefore, "dyadic illness-related communication" and other main effects of the appraisal variables need to be kept in the final model. No main effect of the appraisal variable is removed from the model. The model selection stops. Fm11 is selected as the final model						

1. †: ρ-value is the result of the likelihood-ratio test comparing the full and selected models

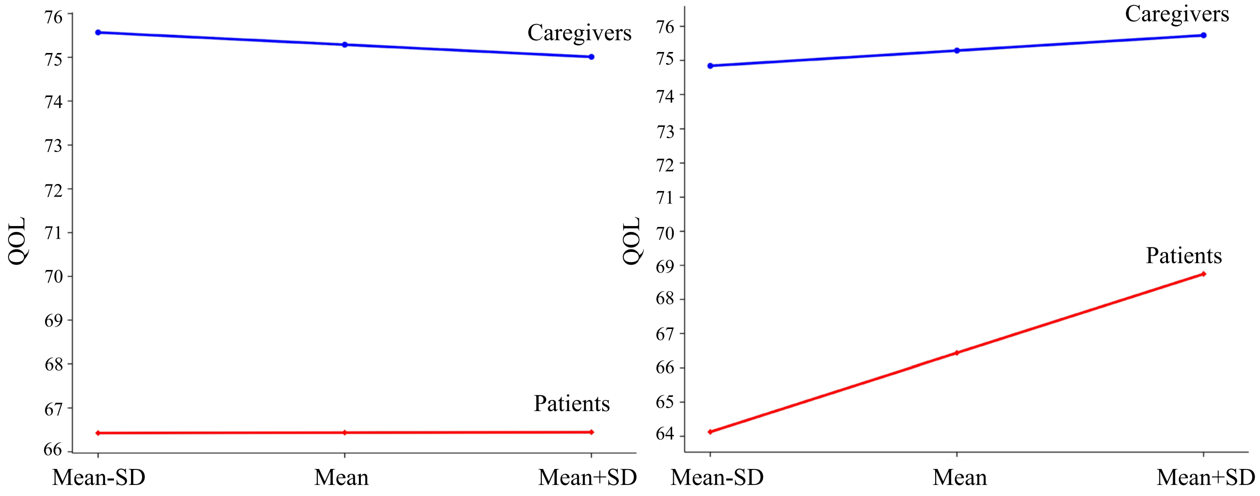
2. ‡: R2 is 0.7414 for the final model, which is fm11, indicating the variables in the final model explained 74.14% of the variance in the QOL of patients with advanced cancer and their caregivers

3. *: The p-values of the likelihood-ratio test comparing the full model and selected models are < 0.05, and the model selection for that group of variables is complete

In the final model, the coefficient of determination (R^2) value was 0.7414, indicating approximately 74.14% of the variance in QOL was explained by the primary appraisals (appraisals of illness/caregiving, uncertainty, hopelessness, benefit of illness, role*hopelessness, and role*benefit of illness) and secondary appraisals (family support, dyadic illness-related communication, health behaviors, self-efficacy, active and avoidance coping strategies, role* family support, and role*active coping strategies) after controlling for the effects of the confounders (age, gender, income, and symptom distress) and role.

Post hoc power analysis

Table 3 presents the post hoc power analysis results for the final model. The null hypothesis assumed that each fixed-effect coefficient was zero. The analysis showed high power for significant coefficients and low power for non-significant ones. When testing whether all fixed-effect coefficients were zero, the power was nearly one, confirming that the final model was robust and well-equipped to detect effects when they were truly present.



(a) Hopelessness

(b) Benefit of Illness

Fig. 2 Estimated trajectories of changes in patients' and caregivers' QOL. **a.** For patients, the effect of hopelessness on QOL is $-0.41 + 0.43 = 0.02$ ($p = .9215$), indicating that as the hopelessness in patients increased, their QOL increased, but this change is not significantly different from zero; while for caregivers, the effect of hopelessness on QOL is -0.41 ($p = .0047$), indicating that as the hopelessness in caregivers increased, the QOL significantly decreased. Note: a higher score on the hopelessness scale indicates more hopelessness is perceived. **b.** For patients, the effect of the benefit of illness on QOL is $0.66 + 2.75 = 3.41$ ($p < .0001$), indicating that as the benefit of illness in patients increases by one unit, their QOL significantly increases by 3.41 units. For caregivers, the effect of the benefit of illness on QOL is 0.66 ($p = .3912$), indicating that as the benefit of illness in caregivers increases by one unit, their QOL increases by 0.66 unit, but this change is not significantly different from zero. Note: a higher score on the benefit of illness scale indicates more benefit of illness is perceived

Discussion

This study is among the few theory-guided studies examining the associations between primary and secondary appraisals and QOL in patients with advanced cancer and their family caregivers using a large sample. Supporting Northouse's adapted stress-coping model, our findings indicated that better QOL was significantly associated with primary appraisals (appraisals of illness/caregiving, uncertainty, hopelessness) and secondary appraisals (family support, health behaviors, self-efficacy, and active and avoidant coping strategies) while controlling for confounding variables (age, income, and symptom distress). Additionally, the associations between QOL and factors like hopelessness and the benefit of illness varied between patients and caregivers. These appraisal factors, along with confounding variables, explained over 74% of the variance in QOL.

The post hoc power analysis further confirmed the robustness of our findings, which demonstrated high power to detect significant effects and confirmed that the model effectively captured meaningful associations. These results strengthen confidence in the reliability of our findings and suggest that appraisal factors are likely to have a real impact on QOL.

This study adds to the evidence that Northouse's adapted stress-coping model is a useful framework for understanding how perceptions and coping mechanisms shape QOL in advanced cancer dyads. By including both patients and caregivers, this research highlights the importance of stress-coping and psychosocial support alongside medical treatment to improve QOL in cancer care.

Associations between primary appraisal variables and QOL

Our study found that primary appraisals were associated with QOL. Primary appraisals evaluate whether a situation that threatens well-being is manageable, or is benign or advantageous [10]. Corroborating previous research [27], we found that less negative appraisals of illness/caregiving were associated with higher QOL. Patients may view physical and psychological symptoms as signs of declining health or increased dependency, negatively impacting their QOL. Similarly, caregivers may see daily responsibilities as burdensome, further diminishing their QOL [5]. These perspectives underscore the importance of supportive care that addresses their perceptions and experiences during advanced cancer.

We found negative associations between QOL and uncertainty and hopelessness, significant sources of psychological distress for cancer patients and their families. Other studies have reported similar findings but without considering caregivers/families as subjects [28]. A recent study demonstrated that hope and uncertainty accounted for 22% of the variance in anxiety and 34% of depressive symptoms among patients with advanced lung cancer, highlighting the clinical relevance of addressing these factors in psychological intervention [29]. Our study expands on prior research by examining the roles of uncertainty and hopelessness on the overall well-being of both patients and caregivers.

We identified differences in the associations between QOL and hopelessness for patients and caregivers. Specifically, patients had worse QOL than caregivers, but their QOL appeared less affected by hopelessness. This could suggest psychological adaptation among patients, though other factors—such as differences in coping mechanisms or unmeasured support systems—may also play a role. In contrast, caregivers may be more emotionally vulnerable due to the patient's disease progression and anticipated loss of their loved one, making their QOL more sensitive to hopelessness [30].

Additionally, we discovered that the associations between QOL and the benefit of illness varied between patients and caregivers. While the increased perceived benefit of illness improved QOL for both, the positive impact was more significant for patients, indicating psychological resilience, which positively affects patients' QOL [31]. Caregivers' perceived benefits had less impact on their QOL due to other responsibilities or stressors. These findings highlight the importance of considering the unique experiences and perceptions of both patients and caregivers in advanced cancer settings.

Associations between secondary appraisal variables and QOL

Our study demonstrated that almost all secondary appraisals were associated with QOL. Secondary appraisals evaluate an individual's resources and capability to cope [10]. Family support was significantly associated with QOL for patients and caregivers. In a previous study, patients with advanced colorectal cancer and their caregivers viewed strengthened relationships with family and friends as a significant benefit of the illness, improving QOL through practical, emotional, and spiritual support [32].

Health behaviors are active coping strategies for advanced cancer patients and their family caregivers. Our study found that better QOL was associated with more frequent engagement in health behaviors. However, patients with advanced cancer might be less inclined to adopt lifestyle changes due to physical limitations. In contrast, caregivers facing fewer physical constraints may be able to engage in these behaviors [33]. Despite multiple demands, such as employment, family responsibilities, and caregiving, caregivers may try to cope with the distress by actively engaging in health behaviors. This discrepancy emphasizes the complexity of applying a one-size-fits-all approach to health behaviors in advanced cancer.

Self-efficacy was also linked to QOL, indicating that believing in one's abilities to accomplish tasks, achieve goals, or handle challenges successfully was beneficial for both patients and caregivers [34]. Our findings align with recent reviews that reported significant associations between lower self-efficacy, greater distress, and poorer QOL [35]. Our study adds evidence of significant associations between secondary appraisals and QOL in caregivers to the literature.

Active coping was positively associated with QOL for patients and caregivers, whereas avoidant coping was negatively associated. Our findings are consistent with recent reviews indicating that avoidant coping and greater distress were associated with poorer QOL [35]. Patients with advanced cancer are more likely to adopt active coping strategies, such as seeking support from family and friends, possibly due to the increased availability of caregivers in this setting compared to curative care, ultimately improving the patients' QOL [36].

Associations between confounding variables and QOL

In addition, we found a significant association between several demographic and illness-related factors and better QOL of patients and their caregivers: older age, better income, and less symptom distress. Previous studies have shown that younger cancer patients experience more significant financial difficulties and challenges with social and role-functioning [37]. Patients with lower income have poorer QOL and survival [38]. The presence and severity of physical symptoms, such as pain, fatigue, nausea, and breathlessness, are likely to negatively impact patient well-being [12].

Study limitations

This study has several limitations. First, its cross-sectional design prevents causal inferences between appraisal factors and QOL. Longitudinal studies are needed to examine how these relationships evolve over time.

Second, the sample lacked racial and ethnic diversity, limiting generalizability. Future research should explore these associations in diverse populations, particularly Hispanic communities facing unique linguistic and healthcare barriers.

Third, the study did not model dyadic interdependence, though stress and coping are likely bidirectional. Future research should use longitudinal dyadic designs to better understand these dynamics.

Additionally, the study focused on overall QOL scores, without analyzing subdomains (physical, emotional, social, functional). A more detailed examination could refine targeted interventions.

Finally, while the adapted stress-coping model was useful, unmeasured factors (e.g., healthcare access, social determinants, mental health) may also influence QOL. Future studies should integrate these contextual variables.

Despite these limitations, this study advances knowledge of the factors shaping QOL among patients with advanced cancer and their caregivers, providing a foundation for future research and intervention development.

Clinical and research implications

Clinical implications

Integrated psychosocial care. Healthcare providers should assess illness appraisals, uncertainty, and hopelessness to identify at-risk patients and caregivers, offering tailored support (e.g., counseling and coping skills training).

Dyadic, behavior-focused interventions. programs should target both patients and caregivers, enhancing family support, self-efficacy, and coping strategies while promoting healthy behaviors (e.g., exercise, nutrition, and sleep).

Research implications

Longitudinal & dyadic studies. future research should track changes in appraisal factors over time and explore how stress and coping responses interact between patients and caregivers.

Diversity and intervention testing. studies should include diverse populations and test whether modifying appraisal factors improves QOL through randomized trials.

Domain-specific QOL analysis. Future research should examine how appraisal factors impact emotional, social, and functional well-being.

Conclusion

To our knowledge, this study is among the few to apply a theory-driven approach to comprehensively analyze the associations between QOL and a broad range of primary and secondary appraisal factors with a notably large sample of patients with advanced cancer and their family caregivers using multi-level analyses. While prior studies have explored similar constructs, this analysis provides additional insights into the interplay between these factors in patients with advanced cancer and their caregivers. Our findings indicate how patients and caregivers perceive and respond to the challenges of advanced cancer and how they influence their QOL. It is crucial to tailor these interventions to meet the specific needs of patients with advanced cancer and caregivers.

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Data availability The original data have been deposited at the University of Michigan. Access of data is upon request.

Declarations

Ethics approval In accordance with the Declaration of Helsinki, this research was exempt from review by the internal review board (IRB) of the University of Texas Health Science Center at San Antonio, as it did not involve human subjects. University of Michigan IRB approval of the original Randomized Controlled Trial (RCT) was obtained from participating sites (IRBMED No. 2004–0129).

Consent to participate Informed consent was obtained from all individual participants included in the original RCT study.

Competing interests The authors declare no competing interests.

References

1. van Roij J et al (2022) Quality of life and quality of care as experienced by patients with advanced cancer and their relatives: a multicentre observational cohort study (eQuiPe). Eur J Cancer 165:125–135
2. Teo I, Krishnan A, Lee GL (2019) Psychosocial interventions for advanced cancer patients: a systematic review. Psychooncology 28(7):1394–1407
3. Northouse L et al (2012) Psychosocial care for family caregivers of patients with cancer. J Clin Oncol 30(11):1227–1234
4. Chen J-J et al (2021) Family resilience, perceived social support, and individual resilience in cancer couples: analysis using the actor-partner interdependence mediation model. Eur J Oncol Nurs 52:101932

5. Cui P et al (2024) The impact of caregiver burden on quality of life in family caregivers of patients with advanced cancer: a moderated mediation analysis of the role of psychological distress and family resilience. BMC Public Health 24(1):817
6. Becqué YN et al (2023) Supportive interventions for family caregivers of patients with advanced cancer: a systematic review. Psychooncology 32(5):663–681
7. Lee JZJ et al (2021) Effects of psychosocial interventions on psychological outcomes among caregivers of advanced cancer patients: a systematic review and meta-analysis. Support Care Cancer 29(12):7237–7248
8. Singer AE et al (2016) Populations and interventions for palliative and end-of-life care: a systematic review. J Palliat Med 19(9):995–1008
9. Fu F et al (2017) A Systematic Review of Psychosocial Interventions to Cancer Caregivers. Front Psychol 8:834
10. Lazarus RS, Folkman S (1984) Stress, appraisal, and coping. Springer Publishing Company
11. Northouse LL et al (2013) Randomized clinical trial of a brief and extensive dyadic intervention for advanced cancer patients and their family caregivers. Psychooncology 22(3):555–563
12. Corli O et al (2020) Impact of palliative care in evaluating and relieving symptoms in patients with advanced cancer. Results from the DEMETRA Study. Int J Environ Res Public Health 17(22)
13. Maxwell CM et al (2024) Socioeconomic factors predict long-term quality of life of cancer survivors: an international survey. J Surg Res 293:389–395
14. Cella DF et al (1993) The functional assessment of cancer therapy scale: development and validation of the general measure. J Clin Oncol 11(3):570–579
15. Northouse LL et al (2002) Quality of life of women with recurrent breast cancer and their family members. J Clin Oncol 20(19):4050–4064
16. Song L et al (2020) Psychometric properties of the FACT-G quality of life scale for family caregivers of cancer patients. Qual Life Res 29(8):2241–2252
17. Oberst M (1991) Appraisal of illness scale: Manual for use. Wayne State University, Detroit, MI
18. Oberst M (1991) Appraisal of caregiving scale: Manual for use. Wayne State University, Detroit, MI
19. Mishel M, Epstein D (1997) Uncertainty in illness scales manual. University of North Carolina, Chapel Hill, NC, pp 4–9
20. Beck AT et al (1974) The measurement of pessimism: the hopelessness scale. J Consult Clin Psychol 42(6):861
21. Carver CS, Antoni MH (2004) Finding benefit in breast cancer during the year after diagnosis predicts better adjustment 5 to 8 years after diagnosis. Health Psychol 23(6):595
22. Northouse LL (1988) Social support in patients' and husbands' adjustment to breast cancer. Nurs Res 37(2):91–95
23. Lewis F (1996) Family home visitation study final report. National Cancer Institute, National Institutes of Health
24. Carver CS (1997) You want to measure coping but your protocol'too long: Consider the brief cope. Int J Behav Med 4(1):92–100
25. Worden JW (1983) Psychosocial screening of cancer patients. J Psychosoc Oncol 1(4):1–10
26. Gelman A, Hill J 92007) Data analysis using regression and multilevel/hierarchical models. Cambridge University Press
27. Ellis KR et al (2024) Symptom burden and quality of life among patient and family caregiver dyads in advanced cancer. Qual Life Res 33(11):3027–3038
28. Verduzco-Aguirre HC et al (2021) Associations of uncertainty with psychological health and quality of life in older adults with advanced cancer. J Pain Symptom Manag 61(2):369–376.e1
29. Cruz-Castellanos P et al (2023) Uncertainty and hope in relation to anxiety and depression in advanced lung cancer. BMJ Support Palliat Care 13(e3):e847–e850
30. Cormican O, Meskell P, Dowling M (2022) Psychosocial vulnerability among carers of persons living with a chronic illness: A scoping review. Int J Nurs Pract 28(6):e13024
31. Sun H, Qin Y, Hengudomsub P (2021) Factors associated with resilience in spousal caregivers of patients with cancer: An integrative review. Nurs Open 8(5):2131–2141
32. Mosher CE et al (2017) Positive changes among patients with advanced colorectal cancer and their family caregivers: a qualitative analysis. Psychol Health 32(1):94–109
33. Cassidy T (2013) Benefit finding through caring: the cancer caregiver experience. Psychol Health 28(3):250–266
34. Bandura A, Freeman WH, Lightsey R (1999) Self-efficacy: the exercise of control. Springer
35. Chirico A et al (2017) A meta-analytic review of the relationship of cancer coping self-efficacy with distress and quality of life. Oncotarget 8(22):36800–36811
36. Gu Y et al (2025) Navigating life after gastric cancer surgery: a qualitative exploration of the dyadic patient-caregiver perspective on quality of life outcomes. BMC Cancer 25:288
37. Dayan D et al (2023) Association of social service counseling in breast cancer patients with financial problems, role functioning and employment—results from the prospective multicenter BRENDA II study. Arch Gynecol Obstet 307(2):541–547
38. Benedict C et al (2022) Greater financial toxicity relates to greater distress and worse quality of life among breast and gynecologic cancer survivors. Psychooncology 31(1):9–20