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The mediating role of loneliness between psychological resilience and health-related quality of life among patients with nasopharyngeal carcinoma: a cross-sectional study using structural equation modeling

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Abstract

Background Cancer patients' health-related quality of life (HRQoL) has always been a hot discussion spot. Loneliness and psychological resilience are considered to be significant psychosocial factors impacting the HRQoL of the cancer population. However, there is a lack of studies on the interrelationship among loneliness, resilience, and HRQoL in patients with nasopharyngeal carcinoma (NPC). This study aims to explore the relationship between resilience and HRQoL among NPC patients and to recognize the potential mediating role of loneliness in this relationship.

Methods A cross-sectional study was performed in this study. A convenience sampling method was conducted to recruit participants. A total of 155 patients with nasopharyngeal carcinoma were required to complete the socio-demographic questionnaire, the Cancer Loneliness Scale (CLS), the 10-item Connor-Davidson Resilience Scale (CD-RISC-10), and the European Organization for Research and Treatment of Quality of Life Questionnaire C-30 (EORTC QLQ-C30) from April 2022 to August 2022 in a tertiary grade A hospital in Guangzhou, China. The multiple linear regression analysis was used to identify influencing factors, and structural equation modeling with the bootstrap method was performed to test the mediating role of loneliness. This study complied with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Results HRQoL was at a median level among NPC patients, with a mean score of 64.19 (24.38) on the Global health status/quality of life (GHS/QoL) scale. Monthly household income ($B = 4.973$, $P < 0.001$), cancer stage ($B = -4.342$, $P = 0.004$), psychological resilience ($B = 0.914$, $P < 0.001$), and loneliness ($B = -1.083$, $P < 0.001$) were independent factors related to HRQoL, explaining 36.7% of the variance of HRQoL. Psychological resilience exerted its direct negative

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impact on loneliness ($\beta = -0.199$, BC95%CI = -0.318/-0.089), and it also had a both direct and indirect positive impact on HRQoL ($\beta = 0.653$, BC95%CI = 0.423/0.912; $\beta = 0.142$, BC95%CI = 0.046/0.296). Loneliness exerted a partially mediating impact on the relationship between psychological resilience and HRQoL.

Conclusions NPC patients with higher monthly household, early stages of cancer, higher resilience, and lower loneliness show a better HRQoL. Resilience has an indirect positive impact on HRQoL by influencing loneliness in NPC patients. It is suggested that healthcare staff should strive to enhancing resilience and reducing loneliness as new strategies to promote NPC patients' HRQoL further.

Keywords Nasopharyngeal carcinoma, Health-related quality of life, Psychological resilience, Loneliness, Structural equation model

Introduction

Nasopharyngeal carcinoma (NPC), a head and neck malignancy that occurs in the nasopharyngeal mucosal epithelia, is common in Southeast Asia, especially in Southern China, with an extremely high incidence [1]. As chemoradiotherapy is the primary treatment for NPC patients, developing the chemoradiotherapy technique has significantly improved the prognosis and reduced the mortality rate in NPC patients. However, NPC patients still suffer from various physical and psychosocial distress due to cancer diagnosis and therapy-related side effects, such as radiation-related xerostomia, dysphagia, hearing impairment, depression and anxiety, and the dread of cancer recurrence [2], thereby seriously impacting their health-related quality of life (HRQoL).

As an important indicator to assess the prognostic outcome of cancer survivors, HRQoL is considered a multidimensional term consisting of an individual's psychological, physical, social/interpersonal, and financial/material functioning [3]. Literature assessing HRQoL of NPC patients reported that various physical symptoms occur and HRQoL subsequently decreases during their cancer trajectories [2, 4, 5]. Li et al. [6] found that patients with nasopharyngeal carcinoma who have received chemoradiation therapy may experience various chronic clusters of adverse symptoms after discharge, including painful eating and swallowing, social anxiety, psychological disorder, symptoms of shame, teeth/throat symptoms, and sensory abnormalities, which contributed to their damaged HRQoL and challenges to return to their family. As such, managing symptom clusters to enhance the HRQoL should be attached great importance to by the healthcare staff in the post-therapeutic follow-up period of NPC patients.

From the perspective of strengthening the HRQoL of NPC patients, significant psychosocial factors associated with HRQoL need to be highly considered. The first factor is loneliness, defined as individuals' subjective unpleasant experience of deficient social relationships [7], which can have detrimental impacts on human health. Existing studies have demonstrated that loneliness is highly negatively correlated with HRQoL among

the cancer populations, which can increase anxious and depressive symptoms, malnutrition, and precedes sleep difficulties, thereby resulting in all aspects of functional inactivity and impaired HRQoL [8–10]. Despite evidence suggesting that cancer patients may be prone to loneliness [9, 11], limited studies have examined the relationship between loneliness and HRQoL in patients with nasopharyngeal carcinoma. The second factor is psychological resilience, a dynamic process of positive adaptation to stress and adversity when an individual experiences stressful events [12]. Resilience is an important protective factor to strengthen the coping ability to deal with stressors and help against psychological disorders [13]. Previous studies evaluating the resilience of cancer patients have emphasized the importance of resilience in enhancing HRQoL, which plays a significant role in reducing the consequences of cancer-related symptom distress on HRQoL [14, 15]. However, there is far less understanding of the relationship between psychological resilience and HRQoL in NPC patients [16].

Relevant studies have confirmed that loneliness and resilience both are influencing factors for cancer patients' HRQoL [17, 18], and loneliness can play a significant mediating role between psychological predictors (e.g., perceived social support) and HRQoL [19]. Resilience, known as “a dynamic process for individuals to maintain psychological well-being in response to stress and adversity” [20], is also a significant protector of individuals' psychological health [21]. Unfortunately, there is still far less understanding on whether loneliness mediates resilience and HRQoL in NPC patients in China. As such, gaining more insights into the interrelationship among loneliness, resilience, and HRQoL is necessary. This research aims to explore [1] whether loneliness and resilience play independent predicting roles in the HRQoL of NPC patients; [2] whether loneliness plays a mediator role in the relationship between resilience and HRQoL in NPC patients. The findings of this research seek to provide a new theoretical basis for determining loneliness as a mediating factor of the relationship between resilience and HRQoL of NPC patients and formulating targeted

intervention strategies for further strengthening the HRQoL of NPC patients in China.

Methods

Study design and participants

A cross-sectional study was conducted from April 2022 to August 2022 in Sun Yat-sen University Cancer Center (SYSUCC). SYSUCC is a 2247-beds specialized cancer hospital in Guangzhou, one of the best and largest integrated cancer centers in China for cancer diagnosis,

Table 1 Sample characteristics of the patients with nasopharyngeal carcinoma (n = 155)

Variables	n	Percentage (%)
Age (year)		
18 ~ 44	93	60.00
45 ~ 59	56	36.13
≥ 60	6	3.87
Gender		
Male	105	67.74
Female	50	32.26
Education Level		
Primary school and below	14	9.03
Middle and high school	79	50.97
College and beyond	62	40.00
Residence		
City	58	37.42
Town	45	29.03
Rural	52	33.55
Marital status		
Not married	15	9.68
Married	134	86.45
Divorced/widowed	6	3.87
Children status		
None	19	12.26
One child	45	29.03
Two children	63	40.65
Three children or more	28	18.06
Employment status		
Employed	122	78.71
Underemployed	25	16.13
Retired	8	5.16
Monthly household income (¥)		
≤ 3000	34	21.94
3001 ~ 5000	48	30.97
5001 ~ 10,000	51	32.90
> 10,000	22	14.19
Cancer stage		
I	25	16.13
II	48	30.97
III	51	32.90
IV	31	20.00
Payment for medication		
Public medical care or medical insurance	150	96.77
Out of pocket	5	3.23

treatment, and care. In 2023, more than 1.84 million outpatients visited, 185,408 inpatients stayed, and 45,492 surgeries were performed in SYSUCC (<https://english.sysucc.org.cn/>). Total 155 NPC patients were included using convenience sampling. Participants were enrolled if they met the inclusion criteria: [1] diagnosed with NPC; [2] ages ≥ 18 years; [3] adequate literacy skills to complete the questionnaires independently or with the assistance of investigators; [4] fluent in communication; [5] informed and voluntary participation in this study. The exclusion criteria were as follows: [1] diagnosed with psychological disorders; [2] occurrence of metastatic cancer; [3] a combination of other types of cancer or other serious physical diseases. This study was represented in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [22] (Supplementary Files Table 1) (<https://www.equator-network.org/>).

The sample size was calculated based on the recommendations from previous studies on the structural equation model [23]. To explore the predictors of HRQoL in NPC patients, this study set the effect size to be 0.25, the significance level (α) to be 0.05, the statistical power ($1-\beta$) to be 0.8, one latent variable, and four measured variables. Thus, the minimum sample size was counted to be 100.

Measurements

Socio-demographic questionnaire

This custom-designed questionnaire consisted of participants' socio-demographic data, including age, gender, education level, residence, marital status, children status, employment status, monthly household income, cancer stage, and payment for medication.

Cancer loneliness scale (CLS)

The loneliness in cancer patients was assessed by using the Chinese version of CLS, first developed by Adams et al. [24] and then translated by Cui [25]. The one-single-dimension scale has seven items with five response options (1 = never, 5 = always). The total score on the scale ranges from 7 to 35, with higher scores representing a higher level of loneliness. The Chinese version of CLS had an excellent internal consistency of 0.912 [25], and Cronbach's α was 0.823 in this study.

10-item connor-davidson resilience scale (CD-RISC-10)

The Chinese version of CD-RISC-10, developed by Campbell-sills et al. [26] after simplifying the 25-item Connor-Davidson Resilience Scale [27] and revised by Ye et al. [28], was adopted to evaluate the level of psychological resilience. The 10-item and single-dimension scale was rated on a 5-point Likert scale ranging from 0 (never) to 4 (almost always). The total score ranges from 0 to 40,

with the higher score representing the better resilience capacity. The scale showed good psychometric properties with Cronbach's α of 0.877 [28]. In this study, Cronbach's α of the entire scale was 0.914.

European organization for research and treatment of cancer quality of life questionnaire-C30 (EORTC QLQ-C30)

The EORTC QLQ-C30, developed by the European Organization for Research and Treatment of Cancer (EORTC), is a cancer-specific measurement tool to assess the HRQoL [29]. The 30-item questionnaire contains a scale of the Global Health Status/Quality of Life (GHS/QoL), five Functioning Scales (FS) (including Physical functioning, role functioning, cognitive functioning, emotional functioning, and social functioning), three Symptoms Scales (SS) (including fatigue, nausea, and vomiting, pain) and six single-items (including dyspnea, sleep disturbance, appetite loss, constipation, diarrhea, financial impact). The items ranging from 1 to 28 were rated on a 4-point Likert scale (1=not at all, 4=very much), and items 29 and 30 were rated on a 7-point Likert scale (1=very poor, 7=excellent).

The calculation method of the EORTC-QLQ-C30 score is shown below: firstly, the Raw Score (RS) for each scale was calculated ($RS = \text{Sum of each item in each scale} / \text{Number of items}$). Secondly, the standard score (SS') for each scale was calculated, where the SS' of FS was calculated as $[1 - (RS - 1) / R] \times 100$, and the SS' of GHS/QoL and SS was calculated as $[(RS - 1) / R] \times 100$. "R" indicated the difference between the maximum and minimum scores of items. The items range from 0 to 100, with the higher scores for FS indicating a healthier level of functioning and the higher scores for GHS/QoL representing a higher level of HRQoL. In contrast, the higher scores for SS represent more symptomatology/problems. In this study, the GHS/QoL and FS scores were considered the evaluation criteria for the overall HRQoL of NPC patients. In our study, Cronbach's α of the GHS/QoL and FS scale was 0.857 and 0.851, respectively.

Data collection procedure

A structured self-reported questionnaire was used to collect data. After obtaining the consent of the hospital administrators, the researchers entered the wards to investigate. The researchers used unified instructions to explain the purpose of the survey and the method of filling out the questionnaire to the participants. They conducted the questionnaire survey after obtaining the informed consent of all participants. The questionnaires were completed by participants independently, and the researchers were on site to answer the participants' questions about filling out the questionnaires at any time. All questionnaires were distributed and collected on the spot. When the questionnaires were finished, the

researchers would check whether the questionnaires were complete.

Data analysis

$P < 0.05$ (two-sided) was set to the significance level. Descriptive statistics for all variables were represented by the mean and standard deviation (SD) for numerical variables and frequencies for categorical variables. *T*-test, one-way ANOVA, and multiple linear regression analysis were performed to investigate the influencing factors of HRQoL among NPC patients. Pearson's correlation analysis was conducted to explore correlations between loneliness, psychological resilience, and HRQoL.

The structural equation model (SEM) conducted by Analysis of Moment Structure (AMOS 21.0) was used to identify the mediating role of loneliness on the relationship between psychological resilience and HRQoL. The Maximum Likelihood (ML) was set as parameter estimation, and the bias-corrected bootstrap method (2000 samples) was carried out to identify direct and indirect effects by computing a 95% confidence interval (CI). The fitting index (χ^2/df) < 3.0 , comparative fit index (CFI) > 0.90 , the goodness of fit index (GFI) > 0.90 , non-normed fit index (NNFI) > 0.90 , and root mean square error of approximation (RMSEA) < 0.08 were considered as indicators of satisfactory goodness of model fit.

Ethical aspect of the study

Ethical approval for this study was obtained from the Ethics Review Committee of the Sun Yat-sen University Cancer Center (Ethics Review Approval Number: B2020-078-01). This study strictly followed the Declaration of Helsinki's principles to protect the rights of participants. We obtained informed consent from all participants before the research. Participants were informed of all research rights, including permission to withdraw from the study at any time and the confidentiality of the collected data.

Results

Participants characteristics

Table 1 describes the socio-demographic characteristics of the participants. A total of 155 participants were included in this study, and the male-to-female ratio of NPC patients was 2.1:1 (male=105; female=50). The participants' mean age was 42.47 years (SD, 9.69), ranging from 22 to 71. Of the total sample, half of the participants showed a middle and high school level of education ($n=79$, 50.97%), 40% ($n=62$) had a college and beyond level of education, while less than one in ten received primary school and below level education ($n=14$, 9.03%). Most of the participants were married ($n=134$, 86.45%), while the rest were not married ($n=15$, 9.68%) and divorced/widowed ($n=6$, 3.87%). The participants

Table 2 The HRQoL, loneliness, and psychological resilience scores ($n = 155$)

Scales	Mean	SD	Minimum	Maximum
Global health status/Quality of life	64.19	24.38	0.00	100.00
Functioning scale	76.77	13.42	26.67	100.00
Physical functioning	81.59	14.42	40.00	100.00
Role functioning	73.98	23.19	0.00	100.00
Emotional functioning	81.72	18.78	0.00	100.00
Cognitive functioning	76.08	18.48	0.00	100.00
Social functioning	63.98	24.14	0.00	100.00
Symptom Scale	29.34	18.13	0.00	100.00
Fatigue	37.92	20.21	0.00	100.00
Pain	22.26	18.64	0.00	100.00
Nausea and vomiting	23.55	25.47	0.00	100.00
CLS	20.24	5.36	7.00	34.00
CD-RISC-10	27.39	7.98	3.00	40.00

Abbreviations: HRQoL, Health Related Quality of Life; CLS, Cancer loneliness scale; CD-RISC-10, 10-item Connor-Davidson Resilience Scale

Table 3 Predictors of the GHS/QoL as dependent variable (regression analyses, $n = 155$)

Variable	Unstandardized Coefficients B	P	95% CI for B	
			Lower Bound	Upper Bound
(Constant)	60.290	< 0.001	36.810	83.770
Gender	-4.684	0.138	-10.883	1.515
Educational level	-0.446	0.850	-5.106	4.215
Cancer stage	-4.342	0.004	-7.310	-1.374
Monthly household income	4.973	< 0.001	2.098	7.848
CLS	-1.083	< 0.001	-1.641	-0.524
CD-RISC-10	0.914	< 0.001	0.518	1.310

Abbreviations: GHS/QoL, Global health status/quality of life; CLS, Cancer Loneliness Scale; CD-RISC-10, 10-item Connor-Davidson Resilience Scale

$F = 15.865$, $P < 0.001$, $R^2 = 0.391$, Adjusted $R^2 = 0.367$

represented 78.71% of the employed ($n = 122$), while 33 patients were underemployed ($n = 25$, 16.13%) and retired ($n = 8$, 5.16%). Only 22 participants (14.19%) reported a monthly household income of over 10,000 yuan, over 50% had an income of less than 5000 yuan ($n = 82$, 52.91%). Most participants reported public medical care or medical insurance for medication payment ($n = 150$, 96.77%). The participants' cancer stage was as follows: stage I ($n = 25$, 16.13%), II ($n = 48$, 30.97%), III ($n = 51$, 32.90%), IV ($n = 31$, 20%).

The univariate association analysis was conducted to test the impact of socio-demographic characteristics on HRQoL among NPC patients (Supplementary Files Table 2). Significant differences were found in GHS/QoL and FS among gender, monthly household income, and cancer stage, and education level was also found to affect the scores of GHS/QoL significantly. Male patients scored higher on GHS/QoL and FS than female patients ($t = 2.643$, $P = 0.009$; $t = 2.260$, $P = 0.025$). Patients with lower education levels had significantly less scores of GHS/QoL than those with higher education levels (Middle and high school/College and beyond) ($F = 3.186$, $P = 0.044$). Patients with higher monthly incomes scored higher on GHS/QoL and FS than those with lower incomes ($F = 3.102$, $P = 0.029$; $F = 4.839$, $P = 0.003$). Patients

in stage I/II had significantly higher GHS/QoL and FS levels than those in stage III/IV ($F = 5.806$, $P = 0.001$; $F = 9.360$, $P = 0.000$).

The level of HRQoL, psychological resilience, and loneliness

The means and SD of the GHS/QoL, FS, and SS are represented in Table 2. The mean scores of GHS/QoL, FS, and SS were 64.19 (SD, 24.38), 76.77 (SD, 13.42), and 29.34 (SD, 18.13), respectively. Of the five Functioning Scales, Emotional Functioning (Mean $\pm$ SD, 81.72 ± 18.78) and Physical Functioning (Mean $\pm$ SD, 81.59 ± 14.42) scored higher than other functioning sub-scales, and Social Functioning had the lowest score (Mean $\pm$ SD, 63.98 ± 24.14). Among the three Symptom Scales, the Fatigue sub-scales scored highest (Mean $\pm$ SD, 37.92 ± 20.21), and the Pain sub-scales had the lowest score (Mean $\pm$ SD, 22.26 ± 18.64). In addition, the mean scores of CD-RISC-10 and CLS were 27.39 (SD, 7.98) and 20.24 (SD, 5.36).

Correlations among HRQoL, psychological resilience, and loneliness

The correlation between GHS/QoL, FS, SS, CD-RISC-10, and CLS is shown in Supplementary Files Table 3. The GHS/QoL was significantly positively correlated with

CD-RISC-10 ($r=0.489$, $P<0.01$) and negatively correlated with CLS ($r=-0.393$, $P<0.01$). The FS had a significant positive correlation with CD-RISC-10 ($r=0.463$, $P<0.01$) but a negative correlation with CLS ($r=-0.415$, $P<0.01$). The SS correlated negatively with CD-RISC-10 ($r=-0.250$, $P<0.01$) but positively correlated with CLS ($r=0.307$, $P<0.01$). CD-RISC-10 was also negatively correlated with CLS ($r=-0.296$, $P<0.01$).

Multiple regression analysis with QoL

Using variables with $P<0.05$ in the univariate analysis (including gender, education level, monthly household income, cancer stage, psychological resilience, and loneliness) as independent variables and the score of GHS/QoL as a dependent variable for the multiple regression analysis, the results were described in Table 3. Cancer stage, monthly household income, psychological resilience, and loneliness were all associated with the level of GHS/QoL. Based on the results, NPC patients with higher stages of cancer had lower GHS/QoL scores ($B=-4.342$, $P=0.004$). Those with higher monthly household income levels had higher scores for GHS/QoL ($B=4.973$, $P<0.001$). Also, there were lower GHS/QoL scores among NPC patients with higher scores for loneliness ($B=-1.083$, $P<0.001$), and with a one-point increase in the loneliness scores, their GHS/QoL scores decreased by 1.083. On the contrary, patients with higher scores for psychological resilience had higher GHS/QoL scores ($B=0.914$, $P<0.001$), and their GHS/QoL scores increased by 0.914 with every one-point increase in the psychological resilience levels. These variables were determinants of the GHS/QoL score and explained 36.7% (Adjusted $R^2=0.367$) of the variance of GHS/QoL (Table 3).

The mediating role of loneliness in the relationship between psychological resilience and HRQoL

Figure 1 describes the mediation model of the impact of loneliness on the relationship between psychological resilience and HRQoL, and the results of direct and indirect effects of variables in the structural equation model are shown in Table 4. The final model demonstrated a satisfactory overall fit: $\chi^2/df=0.229$, GFI=0.999, AGFI=0.993, RMSEA=0.000, NNFI=0.998, IFI=1.006, RFI=0.990, CFI=1.000. Psychological resilience had a negatively direct effect on loneliness ($\beta=-0.199$, BC 95%CI=-0.318/-0.089), and loneliness exerted a negatively direct effect on HRQoL ($\beta=-0.716$, BC 95%CI=-1.075/-0.386). Psychological resilience also had both direct and indirect adverse impacts on HRQoL ($\beta=0.653$, BC 95%CI=0.423/0.912; $\beta=0.142$, BC 95%CI=0.046/0.296), and the relationship between psychological resilience and HRQoL was partially mediated by loneliness.

Discussion

To our knowledge, this is the first study to investigate the mediating effect of loneliness on the relationship between psychological resilience and HRQoL in NPC patients using mature scales, which may provide a preliminary groundwork for future exploration into how to improve the long-term outcomes of NPC patients. This study signified that psychological resilience had both direct and indirect effects on HRQoL, with loneliness exerting a partially mediating role of psychological resilience on HRQoL.

Levels of HRQoL among patients with nasopharyngeal carcinoma

The findings of this study indicated that the HRQoL among NPC patients was significantly lower than that reported in previous studies [30, 31] ($P<0.05$), with a mean score of 64.19 (SD, 24.38) on the GHS/QoL scale. One possible reason for this discrepancy may be that this cross-sectional survey was conducted during the COVID-19 pandemic. Our research samples may suffer from the detrimental impacts of the pandemic, such as the fear of infection with COVID-19, restrictions of social activities [32], financial concerns about the pandemic, and higher depression [33], thus resulting in poorer HRQoL of NPC patients than that of reported in the pre-pandemic period. In addition, the cancer itself and its treatment may also have adverse consequences on NPC patients' physiological and psychological well-being. From the physiological aspect, the increased symptoms related to the radiation and chemotherapy, such as fatigue, pain, nausea, and vomiting, weakened nutritional status [34], swallowing disorder, social anxiety [6], can impact their social activities, role adaptation, and cognitive function, with the consequent decline in HRQoL.

Additionally, from the psychosocial standpoint, there was a link between psychosocial problems and impaired HRQoL among NPC patients. Various factors, e.g., treatment-related toxicity reactions, economic burden, and deficiency in social support, can create enormous psychological stress and distress among NPC patients during their cancer trajectories [35]. These psychological issues may also harm their social life, role adaptation, and cognitive function, leading to their weakening HRQoL. These assumptions can be supported by our research findings, which indicated the lowest scores on Social Functioning among the five Functioning Scales and lower scores on the Role/Cognitive Functioning subscales (Table 2).

However, it should be noted that the factors mentioned above are only some possible reasons. The decline in the HRQoL among NPC patients may also be affected by other potential factors, such as personal support systems, cancer stage, etc. Thus, it is crucial to recognize

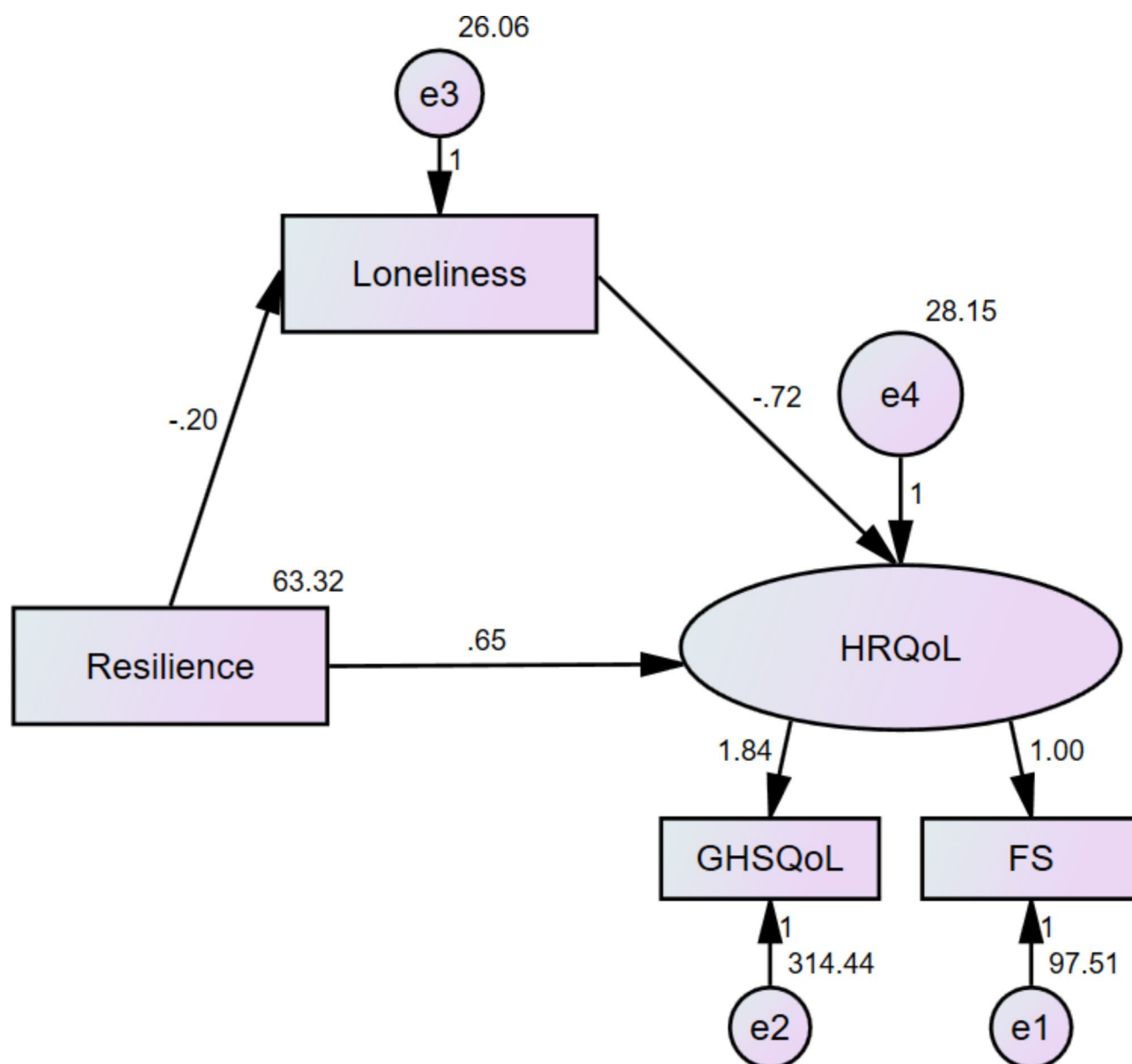


Fig. 1 Effects of variables on HRQoL based on structural equation modeling. Abbreviations: HRQoL, Health-related Quality of life; GHS/QoL, Global Health Status/Quality of life; FS, Functioning Scale.

Table 4 Decomposition of effects of variables for the structural model ($n = 155$)

	Effect	Estimate	P	Percentile 95%CI	BC 95% CI
Resilience → Loneliness	Direct	-0.199	0.001	-0.320, -0.091	-0.318, -0.089
	Indirect	0.000	—	0.000, 0.000	0.000, 0.000
	Total	-0.199	0.001	-0.320, -0.091	-0.318, -0.089
Loneliness → HRQoL	Direct	-0.716	0.001	-1.077, -0.388	-1.075, -0.386
	Indirect	0.000	—	0.000, 0.000	0.000, 0.000
	Total	-0.716	0.001	-1.077, -0.388	-1.075, -0.386
Resilience → HRQoL	Direct	0.653	0.001	0.409, 0.894	0.423, 0.912
	Indirect	0.142	0.001	0.045, 0.294	0.046, 0.296
	Total	0.795	0.001	0.536, 1.066	0.546, 1.073

Abbreviations: BC 95% CI, Bias-corrected 95% Confidence Interval; HRQoL, Health Related Quality of Life; —, no significance

that nursing staff should explicitly identify the potential factors associated with HRQoL and dedicate themselves to exploring individualized solutions to maintain the HRQoL and all functional domains of NPC patients in the future.

Levels of loneliness among patients with nasopharyngeal carcinoma

The present results represented that NPC patients had a high level of loneliness, with a mean score of 20.24 (SD, 5.36), which is similar to the research findings of Cui [25] regarding the cancer population. While substantial evidence demonstrates that cancer patients are at high risk of experiencing loneliness [9, 11], the current loneliness status in NPC patients during therapy has still received little attention. The adverse consequences of cancer and radiation/chemotherapy may be the main reasons leading to a high level of loneliness in NPC patients. According to previous studies, NPC patients may experience severe adverse effects caused by cancer itself and cancer-related therapy, such as hearing loss, articulation disorder, swallowing difficulty, and eating disorder [4, 36], which can significantly affect their social activities, lessen social identity and result in social isolation [36], thereby contributing to higher loneliness among them. Meanwhile, all participants of this research were hospitalized during the COVID-19 pandemic, which may partially account for the high loneliness among NPC patients. The epidemic has prevented cancer patients from spending time with their relatives and friends, which may further restrict their social interactions and increase their social isolation and feelings of loneliness [11]. It is well known that a high level of loneliness can have a detrimental impact on the cancer patient's physical and mental health in the long run. Consequently, further empirical research may be needed to explore and understand the prevalence of loneliness and its associated factors in NPC patients and to screen for and address loneliness in the clinical oncology practice.

Related factors on QOL

Monthly household income

The present results showed that a higher monthly household income level was significantly associated with better HRQoL among NPC patients, which is consistent with previous research [37, 38]. The lower household income, identified as a risk factor for increased subjective financial distress, was associated with the cancer patients' worsened financial situation [39]. Those with lower household incomes are more likely to have higher financial toxicity [40]. Patients with poor financial status tend to experience more financial distress by worrying about medical expenses, thereby significantly affecting their living standards and quality of life during their cancer

treatment [38]. Economic pressures may also impede access to the cancer-related rehabilitation services most cancer survivors need [41]. Moreover, the low-income family financial status may lead to psychological distress in cancer patients. A study by Thaduri et al. [41] on oral cancer survivors reported that financial toxicity and depression, anxiety, and stress were significantly interrelated. Financial hardship may contribute to mental health deterioration in low-income cancer patients, with various impacts on the future HRQoL of cancer survivors, such as decreased functional capacities, insomnia, weight loss or malnutrition, increased probability of cancer recurrence, etc. [41, 42]. Therefore, medical staff should pay attention to the financial status of NPC patients with lower household income and increase communication regarding the financial burden with the low household income groups. In addition, medical staff should focus on psychological interventions for NPC patients with lower household levels. Methods such as group psychoeducation and cognitive intervention can be carried out to enhance their psychological status and contribute to their long-term HRQoL.

Cancer stage

This study illustrated that NPC patients with higher stages of cancer had a significant association with a lower level of HRQoL, with cancer patients at stages IV and III reporting lower GHS/QoL scores than those at stages II and I, which is in line with the findings of Pereira et al. [43] on breast cancer patients. It's probable that the cancer stage impacts the symptom burden of cancer patients [44]. Those with higher cancer stages are likely to bear more symptom burden. Symptoms such as pain, weakness, poor mobility, poor appetite, anxiety, and depression are more prevalent among patients with higher cancer stages, which may result in the decline of the cancer patients' HRQoL [45]. Moreover, the cancer stage may affect the cancer patients' supportive care needs, with advanced cancer patients reporting higher unmet supportive care needs than patients with early-stage cancer [46]. A previous study on pancreatic cancer patients reported that those with advanced cancer were at higher risk for unmet needs for supportive care in the future [47], which may lead to deterioration in the quality of life among cancer patients [48]. Accordingly, enhancing the symptoms of management for advanced cancer patients by early identifying the symptom cluster in cancer and implementing patient-centered symptom management interventions, and satisfying the unmet needs of supportive care by nursing staff may significantly influence the long-term HRQoL for NPC patients.

Structural equation model analysis

Resilience exerts a direct negative effect on loneliness

Psychological resilience had a direct negative effect on the loneliness of patients with NPC, with higher resilience significantly associated with lower loneliness. To our knowledge, this relationship between resilience and loneliness among patients with NPC has not been reported. Still, it can be supported by the previous findings of college students indicating that high levels of resilience are protective factors in reducing loneliness [49]. A possible interpretation of this relationship is that resilience plays a crucial psychological resource in enabling individuals to cope with stress and adversity and contributes to managing emotional responses and facilitating positive feelings amidst suddenly changing situations [50]. Higher resilience serves as a positive impact on protecting individuals against psychological health problems related to crisis, such as anxiety, emotional exhaustion, and loneliness. Additionally, higher resilience may promote the adoption of positive coping strategies and utilizing social support from cancer diagnosis to treatment [51]. The increased social connectivity provides cancer patients with emotional support and a sense of belonging from their family, friends, and other important social circles, thereby alleviating the sense of loneliness. To leverage this, healthcare staff should give weight to the role of resilience in regulating the loneliness of NPC patients and implement tailored interventions to enhance resilience. Strategies such as resilience training programs, cognitive-behavioral therapy, and social support initiatives can be employed to help patients build their resilience, which enables to equip NPC patients with the skills needed to navigate the emotional and social challenges posed by their illness, thus reducing the sense of loneliness [52, 53]. By fostering resilience, healthcare providers can create a supportive environment that promotes psychological well-being and reduces the impact of loneliness on patients' lives.

Loneliness exerts a direct negative effect on HRQoL

This study indicated that loneliness plays a direct negative role in the HRQoL of NPC patients, where the lower levels of loneliness are associated with greater HRQoL, which is similar to the results of previous studies on mixed cancer patients, indicating that the increasing loneliness plays a risk factor in HRQoL [8]. This may be attributed to the reason that higher loneliness is correlated with cancer-related negative social expectations and social constraints [8]. Limited social interactions and social dysfunction may occur when individuals with higher loneliness feel incapable of expressing their negative emotions concerning stressors throughout their cancer trajectory, which may further increase the social isolation and perceptions of disconnection [50], consequently reducing support-seeking behaviors and leading

to the deteriorated HRQoL for NPC patients. Moreover, the occurrence of loneliness seems to activate several psychological, neurological, and behavioral processes that deteriorate one's physiological health, for example, increased stress, poor coping mechanisms, and impaired recovery process [17]. This may further damage the already delicate HRQoL for cancer patients. Compared to the general population, cancer patients are more vulnerable to experiencing loneliness, which may stem from the heightened stress and distress they perceive and the unmet intimate relationships during their cancer trajectories, and the loneliness and its negative impacts tend to worsen over time following diagnosis [17]. It is, therefore, crucial that nursing staff should attach great importance to the loneliness status and its predictive role in lower HRQoL for NPC patients. Multidisciplinary and tailored loneliness interventions for NPC patients should be actively developed and employed for long-term enhancement in HRQoL.

The mediating role of loneliness on the relationship between resilience and HRQoL

The findings of the mediating model revealed that resilience positively influences HRQoL both directly and indirectly by reducing feelings of loneliness, and loneliness partially mediates the relationship between resilience and HRQoL among NPC patients. This mediating effect of loneliness to HRQoL indicated that as resilience increases, loneliness decreases, which, in turn, enhances HRQoL.

On the one hand, following previous studies on mixed cancer patients, resilience has a significantly positive association with HRQoL, where the higher the levels of resilience, the greater HRQoL for NPC patients [54]. The probable reason for this relationship is that psychological resilience is recognized as a learning process for individuals to maintain psychological well-being in response to stress and adversity [20, 55], which may enable NPC patients with greater resilience to enhance the perception of positive changes and rationally employ their own internal and external resources to cope with the challenges throughout the cancer trajectory, and consequently, to help sustain their HRQoL [14]. Moreover, a previous study has confirmed that psychological resilience plays a facilitating role in alleviating cancer-related symptom distress, such as anxiety and depression, in maintaining the HRQoL among cancer patients [14]. Compared to those with less resilience, more resilient individuals may show stronger optimism, flexibility, and self-efficacy to facilitate better response to cancer-related distressing symptoms and more significant promotion of the recovery of physical function after the cancer treatment, contributing to the enhancement of HRQoL.

On the other hand, loneliness partially mediates the relationship between the NPC patients' resilience and HRQoL. Several mechanisms may explain why loneliness mediates this relationship. Firstly, resilience equips individuals with better coping skills and emotional regulation strategies, which enable patients to manage the emotional distress associated with their illness more effectively, thereby reducing feelings of loneliness [56]. Positive mindset helps patients feel more connected and less isolated, directly impacting their perceived quality of life. Secondly, loneliness is a profound psychological stressor that can exacerbate the physical and emotional burdens of cancer illness [57]. When patients feel lonely, they may experience higher levels of stress, anxiety, and depression, which can negatively impact their overall well-being and HRQoL. By mitigating loneliness, resilience helps to buffer these negative effects, leading to better health outcomes and an improved HRQoL. Furthermore, resilient patients are often more adaptable and capable of maintaining social relationships. This adaptability allows them to find the purpose of life and sustain their social networks, which is crucial for emotional support and subjective well-being [58]. As a result, patients with higher resilience levels are better able to cope with the isolating effects of NPC, thereby reducing loneliness and enhancing their HRQoL. Interventions aimed at enhancing resilience should be complemented with strategies specifically designed to reduce loneliness.

Limitations and recommendations

Despite the significant results, this study still has some limitations. Firstly, a cross-sectional survey was conducted to analyze the relationship between loneliness, psychological resilience, and HRQoL in NPC patients. Still, it could not support the causal relationship between all variables. Therefore, it is necessary to employ randomized controlled trials to confirm further the effects of resilience and loneliness interventions in strengthening NPC patients' HRQoL. Secondly, this research analyzed the impact of loneliness on the relationship between resilience and HRQoL in NPC patients. However, many other factors not included in the analysis may affect the HRQoL of NPC patients. It is recommended that more variables should be considered in further research to examine how to enhance the HRQoL of NPC patients. Thirdly, only one tertiary hospital served as the site for this investigation, indicating that the representativeness and generalization of results need to be interpreted with caution. It is recommended that multi-center and large-sample surveys be carried out to confirm the relationship between variables further.

Conclusions

NPC patients' HRQoL is at a low level. Better HRQoL was displayed by NPC patients with higher monthly household, early stages of cancer, higher resilience, and lower loneliness. Psychological resilience has a negative impact on loneliness, and loneliness plays a direct negative impact on the HRQoL. Additionally, psychological resilience has positive direct and indirect impacts on HRQoL, and loneliness partially mediates the relationship between psychological resilience and HRQoL. As such, nursing staff should attach great importance to the significant psychological factors of resilience and loneliness that affect HRQoL of NPC patients and seek to develop and employ effective interventions as the new means to facilitate the improvement of HRQoL among NPC patients.

Abbreviations

NPC	Nasopharyngeal carcinoma
HRQoL	Health-related quality of life
CLS	Cancer Loneliness Scale
CD-RISC-10	10-item Connor-Davison Resilience Scale
EORTC QLQ-C30	European Organization for Research and Treatment of Quality of Life Questionnaire C-30
SEM	Structural equation model
GHS/QoL	Global health status/quality of life
FS	Functioning Scales
SS	Symptom Scales

Supplementary Information

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Supplementary Material 1

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All authors have read and approved the manuscript.

Author contributions

Yuying Fan designed and directed this research. Mengna Luo, Siting Lin, Zhenxiu Li, Liping Wu, Linmin Chen, and Qiulan Yang recruited the participants and obtained the data. Mengna Luo and Siting Lin conducted the data analysis and drafted the manuscript. All authors revised the paper and approved the final version.

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Data availability

The dataset used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study strictly followed the Declaration of Helsinki and was approved by the Ethics Review Committee of the Sun Yat-sen University Cancer Center (Ethics Review Approval Number: B2020-078-01). Written informed consent was obtained from all participants before the research.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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