

RESEARCH

Open Access



Associations of temperament, family functioning with loneliness trajectories in patients with breast cancer: a longitudinal observational study

Chunyan He¹, Yang He², Yawei Lin³, Yixuan Hou³, Shaoyi Wang^{4*} and Wei Chang^{5*}

Abstract

Purpose Loneliness is a prevalent affective issue among patients with breast cancer, with its developmental trajectory being a contentious subject. Therefore, the aim of this study was to explore trends in loneliness in patients with breast cancer and identify predictors of different trajectory categories.

Methods Using convenience sampling, 176 patients planning to undergo breast cancer surgery in a university hospital in Shaanxi Province, China, were followed up six times over 12 months following surgery, and data from 144 patients were analyzed. The data were analyzed using a mixed growth model (GMM) and logistic regression.

Results Two latent classes of loneliness trajectory were identified among patients with breast cancer, namely “persistent high loneliness” and “persistent low loneliness.” Patients who with education level of junior secondary and less ($OR = 13.59, P = 0.002$), had a melancholic temperament ($OR = 12.07, P = 0.002$) were more likely to be categorized in the “persistent high loneliness group”, whereas the better family functioning ($OR = 0.60, P < 0.001$) and choleric temperament ($OR = 0.16, P = 0.025$) of the patients were more likely to be categorized in the “persistent low loneliness group”.

Conclusion Patients with breast cancer exhibit diverse trajectories of loneliness, with educational level, temperament type, and family functioning being predictive of these trajectories. Therefore, it is crucial to promptly identify populations at risk in a clinical setting and devise intervention strategies, grounded in identified trajectory characteristics and influencing factors, to enhance patient outcomes.

Keywords Breast cancer, Loneliness, Family functioning, Temperament, Longitudinal study

*Correspondence:

Shaoyi Wang
wsy18292889370@163.com
Wei Chang
15202295126@163.com

¹School of Nursing, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei 430000, China

²Psychology Section, Secondary Sanatorium of Air Force Healthcare Center for Special Services, Hangzhou, Zhejiang 310007, China

³Department of Nursing, Air Force Medical University, Xi'an, Shaanxi 710032, China

⁴Department of General Surgery, Tangdu Hospital Fourth Military Medical University, Shaanxi Xi'an 710038, China

⁵Department of Neurosurgery, Tangdu Hospital Fourth Military Medical University, Xi'an, Shaanxi 710038, China



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

Introduction

Breast cancer has become the most commonly diagnosed cancer worldwide, according to the latest data from the World Health Organization's International Agency for Research on Cancer (IARC) [1]. The disease, which affects mostly women, can have significant physical and emotional effects, including feelings of loneliness and isolation [2]. Patients may have to undergo prolonged treatment, including surgery, chemotherapy, and radiation therapy, making it difficult for them to maintain regular contact with their social circle. Moreover, the changes in physical appearance related to treatment can further exacerbate feelings of loneliness and make it difficult to maintain their sense of identity [3]. Loneliness is highly prevalent among patients with breast cancer, with reported rates varying from 16 to 41% across studies [4]. Persistent loneliness not only increases the likelihood of recurrence, but also exacerbates cancer-specific mortality in breast cancer patients. Specifically, lonely breast cancer survivors exhibit a 43% higher risk of recurrence and a 64% higher risk of cancer-specific mortality compared to those who are socially integrated and do not report loneliness [4]. Furthermore, breast cancer survivors have a relatively high cancer-specific mortality rate compared with other types of cancer [5].

Loneliness is a subjective feeling of social isolation that occurs when people perceive that their social relationships are inadequate [6]. Cancer patients often confront both physical and psychological stressors, with feelings of loneliness impacting their recuperation and well-being. Prolonged loneliness may trigger heightened inflammatory responses through its influence on the neuroendocrine and immune systems, thus influencing the efficacy of treatments [7]. Psychologically, the sense of loneliness adds to their mental burdens, escalating risks of depression and anxiety, which in turn affect their relationships with loved ones, as well as their compliance with treatment regimens [8, 9]. Social withdrawal precipitated by loneliness can deepen feelings of isolation due to a lack of support, subsequently impacting their quality of life and recovery progress [10]. The alleviation of loneliness plays a pivotal role in the patients' physical and mental health, overall quality of life, and treatment outcomes [11]. Identifying the influencing factors of loneliness and providing targeted interventions can assist them cope with the challenges posed by their illness, thereby fostering a sense of confidence and resilience in the face of their condition [12].

Temperament refers to the intrinsic and relatively stable aspects of an individual's personality that emerge early in life, significantly impacting a person's mental state [13]. The influence of temperament on psychology encompasses various dimensions, such as emotional reactions, emotional regulation, and overall psychological

well-being [14, 15]. Research has shown that personality traits can influence the subjective well-being of breast cancer patients. A study among older survivors of breast cancer revealed that personality is a substantial predictor of quality of life changes [16]. Additionally, research has demonstrated that distinct temperament and personality traits exert varying influences on the health-related quality of life among patients with breast cancer, with high optimism being robustly linked to superior adaptation to their cancer status [17]. In addition, patients with introverted personalities may be more likely to experience high levels of loneliness [18], while breast cancer patients with Type D personalities may require more supportive care [19]. According to the diathesis-stress model, individuals possessing vulnerability or susceptibility traits (such as specific personality traits) are more susceptible to psychological issues like anxiety, depression, and loneliness when confronted with stressful events [20]. Consequently, precisely identifying the temperament of breast cancer patients is crucial for the early detection of potential psychological problems, including loneliness.

The family environment serves as the primary setting for emotional development, social learning, and mental well-being. Family functioning, including the dynamics of familial relationships, roles, communication patterns, and holistic health status, profoundly shapes an individual's psychological state [21]. Robust family functioning establishes a dependable support network that is vital for emotional well-being, especially during times of crises or high stress [22]. Families that inadequately provide social support may engender feelings of isolation and lack of support in individuals, thereby heightening the risk of psychological problems [23]. In China, due to traditional family concepts, breast cancer patients are often highly dependent on family support and care during treatment [24]. Therefore, the state of family functioning may have a direct impact on the quality of social support received by patient [25]. Optimal family functioning not only bolsters patients' confidence in combating their illness but also augments their social self-assurance, mitigates feelings of stigma, and alleviates social anxiety and loneliness [24]. Consequently, a comprehensive assessment of the family functioning is crucial for the effective prevention and intervention of potential loneliness among patients.

Loneliness in breast cancer patients may exhibit varying intensities and manifestations across different stages of the disease. However, the majority of existing studies on loneliness adopt a cross-sectional design, neglecting the dynamic aspects of loneliness, and there are differences in the results of longitudinal studies. A study on older individuals with early-stage breast cancer found no significant changes in loneliness related to the time since diagnosis [26]. However, a study indicated a direct correlation between the intensity of loneliness and the time

since the initial diagnosis [27]. Different research methods, samples and time spans may account for these differences, and we observed that the majority of previous longitudinal studies have assumed group homoscedasticity, implying that all individuals within a group exhibit the same or similar average growth trajectories, thereby neglecting individual heterogeneity [26, 27]. In light of the substantial individual variations observed in breast cancer patients' disease progression, treatment responsiveness, and psychological well-being, as well as the recognized variability in changes to the external environment and life experiences across individuals [28, 29], it is plausible to hypothesize that there may exist differences in the loneliness trajectories among breast cancer patients. GMM (Growth Mixture Modeling) is a statistical model that integrates the characteristics of growth curve modeling and latent class analysis, enabling it to simultaneously process time series data for multiple individuals and effectively discern potential heterogeneity and latent classes within the data [30]. By estimating the parameters associated with each latent class, GMM can uncover distinct growth trajectories and their corresponding features, thereby providing a more precise depiction of the temporal variation in individuals' trends [31]. In this study, the GMM was used to define the trajectory of loneliness in breast cancer patients within the first year after surgery, and to compare the characteristics and differences between different trajectory groups. This method not only helps to deeply explore the heterogeneity of loneliness and target high-risk groups, but also clarifies the diverse growth patterns of loneliness and accurately portrays the dynamic evolution of loneliness in patients [31]. Consequently, it provides a scientific basis for the development of individualized interventions that target the needs of specific subgroups, and also provides theoretical support for the timing of clinical interventions and care, or the design of timely-matched intervention strategies.

In summary, this study followed patients with breast cancer who were about to undergo surgery for one year, used the GMM to identify the trajectory model of change in loneliness, and explored the predictive effects of temperament type and family functioning on the trajectory of loneliness, with the aim of providing a guiding direction for psychological interventions for breast cancer patients.

Methods

Participants

Convenient sampling method was used to recruit patients who will undergo breast cancer surgery in a Grade III Grade A hospital in Xi'an, Shaanxi Province from June 2021 to October 2022. All subjects knew the purpose of the study and signed the informed consent

before the start of the study. The inclusion criteria were (a) female inpatients, (b) aged 18–60 years; (c) had a diagnosis of breast cancer by pathological puncture biopsy and scheduled for surgery, and (d) had good communication and expression skills. Exclusion criteria: (a) breast cancer recurrence or metastasis, (b) other serious diseases (such as serious cardiovascular disease, a history of psychiatric treatment, or cognitive or intellectual disabilities), (c) voluntary withdrawal during follow-up, (d) more than three consecutive lost visits, and (e) death.

The sample size of this study was estimated with reference to a single-group repeated measures design for quantitative data [32]. Every patient was evaluated six times, and the relevant parameters were determined as follows: $r=0.5$, $f=0.14$, $\alpha=0.05$, $\beta=0.2$ [32]. Specifically, $r=0.5$ represents the correlation between repeated measurements, which is considered conservative and closely approximates the actual recommended value. The value of $f=0.14$ signifies the magnitude of change in measurement results over time. Based on Cohen's 1977 analysis of variance (ANOVA), which delineated small, medium, and large effect sizes [33], and Barcikowski's report indicating effect sizes of 0.14, 0.35, and 0.57 for a correlation coefficient of 0.5 [32], the smallest effect value of 0.14 was conservatively selected for this study. So, the minimum sample size was 114 cases, and taking into account the 10% missed visits, we finally determined the minimum sample size as $N=126$.

Data collection

This study investigated eligible patients with breast cancer at six time points: before surgery (T1), 1 month after surgery (T2), 3 months after surgery (T3), 6 months after surgery (T4), 9 months after surgery (T5), and 12 months after surgery (T6). Before the initiation of data collection, data collectors underwent a standardized training program to ensure uniformity in their approach. Subsequently, eligible patients were identified and subjected to individual interviews, during which they were apprised of the study's objectives and the subsequent follow-up procedures. After providing informed consent through the signing of a consent form, patients added the micro-signal (a term commonly used in China for a contact on social media platforms like WeChat) of the investigator responsible for follow-up to maintain communication. Subsequently, researchers collected baseline data on participants' demographics, clinical information, family functioning, temperament type, and loneliness using a paper-based questionnaire. Post-discharge, patients were followed up as planned through regular WeChat voice calls. During each follow-up session, the purpose of the visit and precautions for completing the questionnaire were explained to them in detail. Subsequently, the loneliness questionnaire was administered using Question

Star software to gather data. To ensure the timeliness of data collection, patients were contacted via fixed-line telephone calls within one week during specified follow-up periods, namely between 9:00–11:00 AM or 16:00–18:00 PM.

Instruments

Demographic and clinical questionnaire

The researchers designed a two-part questionnaire. The questionnaire comprised items on sociodemographic (age, educational level, occupation, marital status, and monthly family income per capita) and clinical (radiotherapy and chemotherapy data, surgical method, and temperament type) characteristics.

The Chinese version of the Eysenck personality questionnaire short form

This questionnaire was developed by Eysenck and introduced in China in 2000 by Mingyi et al. [34, 35]. It comprises four subscales that evaluate personality dimensions—extraversion (E), neuroticism (N), psychoticism (P), and lie detection (L)—with each dimension consisting of 12 items. Each item is scored 0 (“Yes”) or 1 (“No”), and total scores range from 0 to 12. Personality characteristics were analyzed using the extraversion and neuroticism subscales, and temperament types were determined according to their scores: high extraversion and low neuroticism (sanguineous), high extraversion and high neuroticism (choleric), low extraversion and low neuroticism (lymphatic), and low extraversion and high neuroticism (melancholic) [36]. The scale is widely used in China and abroad [35, 37]. The Cronbach’s α coefficients of the extraversion and neuroticism subscales used in this study were 0.75 and 0.77, respectively.

The family APGAR Scale

The Family APGAR Scale, developed by Smilkstein and translated into Chinese by Lv, comprises five items: adaptation, participation, growth, affection, and resolution [38, 39]. Each item represents a single dimension of family functioning and is rated on a 3-point Likert scale, with 0 indicating “rarely” and 2 indicating “often.” The maximum score is 10. Scores 0–3 and 4–6 indicate severe and moderate family dysfunction, respectively, and scores 7–10 indicate good family function. The scale is widely used in some Western countries and China, and has good psychometric properties [22, 40]. The Cronbach’s α coefficient of the scale was 0.809.

The Chinese version of the UCLA loneliness scale

The Chinese Version of the UCLA Loneliness Scale, developed by Russell in 1988 and translated into Chinese by Wang, comprises 20 items. All items are rated on a 4-point Likert scale (1 = “never,” 2 = “few,” 3 =

“sometimes,” 4 = “always”) [41, 42]. The scores range from 20 to 80, with scores ≤ 38 indicating a mild level of loneliness and > 38 indicating severe loneliness. The scale is widely used both at home and abroad [24, 43], and in this study the internal consistency coefficient of the scale was 0.834.

Data analysis

SPSS 25.0 and Mplus 8.3 software were used to analyze the data. Full information maximum likelihood estimation was used to handle data that completed four or more follow-ups, and data that did not complete four follow-ups were treated as missing values. First, descriptive statistics (expressed as means, standard deviations, and percentages) and comparisons of baseline data between the lost-visit and non-lost-visit groups were analyzed by SPSS 25.0. Second, to account for group heterogeneity, the GMM were applied to loneliness data at six time points, to explore the trajectory characteristics of loneliness over time in the sample. The fit metrics were Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), adjusted BIC (aBIC), Entropy, likelihood ratio test (LRT), Bootstrapped Likelihood Ratio Test (BLRT) and category probability. Smaller values of AIC, aBIC and BIC mean better model fit; entropy value closer to 1 means more accurate classification; and LRT and BLRT < 0.05 means that classifying the model into n categories is significantly better than $n-1$ categories, K refers to the number of categories identified by the GMM [31]. Third, comprehensive evaluation of the above indicators and selection of the best-fitting model. Fourth, one-way logistic regression analysis was utilized to screen for variables of significance. Subsequently, multifactorial logistic regression model was employed to analyze the factors influencing the distinct loneliness trajectory categories among patients with breast cancer. Statistical significance was considered at a $P < 0.05$.

Results

Sample characteristics

A total of 176 patients were included in this study, 138 (response rate: 78.4%) patients completed all follow-ups. 144 (81.8%) patients completed four or more visits and their follow-up data were included in this data analysis, finally. Seven (4.0%) patients had a postoperative recurrence, 13 (7.4%) patients withdrew, and 18 (10.2%) patients were lost to follow up. The number of participants assessed for loneliness from T1 through T6 is summarized in a flow chart (Fig. 1). Comparing the baseline information of the follow-up group with that of the lost to follow-up group, there was no significant difference. The Comparative baseline information between the two groups is listed in Table 1.

Table 1 Baseline sociodemographic data and clinical characteristics of patients ($n = 176$)

Variables	follow-up group($n = 144$)	lost to follow-up group($n = 32$)	χ^2/F	P
Age (year) [mean (SD)] ^b	46.63(8.42)	47.16(8.76)	0.075	0.749
Marital status ^c				
Married	135(93.8%)	31(96.9%)	0.692	0.692
Unmarried/divorced/widowed	9(6.2%)	1(3.1%)		
Educational level ^a				
Junior secondary and less	52(36.1%)	9(28.1%)	1.232	0.540
High school/junior college	57(39.6%)	16(50.0%)		
Bachelor and more	35(24.3%)	7(21.9%)		
Family monthly income per capita (RMB) ^a				
< 3000	64(44.4%)	11(34.4%)	1.686	0.430
3000 ~ 5000	49(34.0%)	11(34.4%)		
> 5000	31(21.6%)	10(31.2%)		
Occupation ^a				
Enterprises/institutions	41(28.5%)	9(28.1%)	1.203	0.752
Laborer	26(18.1%)	4(12.5%)		
Retired	27(18.8%)	5(15.6%)		
Unemployed	50(34.6%)	14(43.8%)		
place of residence ^a				
Urban area	98(68.1%)	26(81.2%)	2.190	0.139
Rural area	46(31.9%)	6(18.8%)		
Surgical method ^a				
Radical mastectomy	86(59.7%)	19(59.4%)	0.326	0.850
Breast-conserving	40(27.8%)	10(31.3%)		
Breast reconstruction	18(12.5%)	3(9.3%)		
Chemotherapy ^a				
Yes	119(82.6%)	28(87.5%)	0.450	0.503
No	25(17.4%)	4(12.5%)		
Radiotherapy ^a				
Yes	86(59.7%)	20(62.5%)	0.084	0.772
No	58(40.3%)	12(37.5%)		
Temperament type ^a				
Sanguineous	30(20.8%)	6(18.8%)	1.096	0.778
Choleric	69(47.9%)	13(40.6%)		
Melancholic	29(20.1%)	8(25.0%)		
Lymphatic	16(11.2%)	5(15.6%)		
Family functioning [mean (SD)] ^b	7.26(2.33)	7.78(2.39)	0.022	0.259
Loneliness [mean (SD)] ^b	41.21(9.14)	40.53(8.78)	0.703	0.703

^a Chi-square Pearson test; ^b one-way ANOVA; ^c Fisher exact probability method

Identifying loneliness trajectories

Figure 2 summarizes the results of the model fit metrics. The AIC, BIC and aBIC values exhibited a decreasing trend as the number of model categories increased, nonetheless, the difference in the BLRT was not statistically significant with the addition of the three class. To ensure the model's stability, we selected categories with

relatively low AIC, BIC, and aBIC values, and two categories of the GMM were retained. The results of model fitting are presented in Table 2.

A total of 47 (32.64%) patients in Class 1 had consistently higher scores; however, the mean change was not significant throughout the follow-up period ($F = 1.815$, $P = 0.131$). Therefore, Class 1 was named the “persistent high loneliness group.” In classes 2 of 97 (67.36%) patients with low starting values, loneliness levels decreased during follow-up ($F = 17.935$, $P < 0.001$), and all scores were about below 38. Hence, this group was named the “persistent low loneliness group.” The two trajectories of loneliness based on the model fit are shown in Fig. 2.

Factors influencing loneliness trajectories

General patient information was used as the independent variable, the category of loneliness as the dependent variable for one-way logistic regression analysis. Original values of the age of the patients and baseline family functioning scores were entered, and the remaining independent variables were assigned, as shown in Table 3. The results of the univariate analysis showed statistically significant differences between the two categories of patients, family functioning, family monthly income per capita (RMB), educational level, and temperament type ($P < 0.05$); however, the differences between the other variables were not significant ($P > 0.05$).

Variables with significant differences in the univariate analysis were used as independent variables, the loneliness trajectory category was used as the dependent variable. A multivariate logistic regression analysis was performed. The results showed that junior secondary and less ($OR = 13.59$, $P = 0.002$), and temperament type of melancholic ($OR = 12.07$, $P = 0.002$) were more likely to be categorized in the persistently high loneliness group, whereas patients with better family functioning ($OR = 0.60$, $P < 0.001$) and temperament type of choleric ($OR = 0.16$, $P = 0.025$) more likely to be categorized in the persistent low loneliness group. Table 4 presents the results of the influencing factor analysis.

Discussion

Characterization of loneliness trajectory categories and intervention recommendations for patients with breast cancer

This study aimed to gain insights into loneliness among patients with breast cancer via a one-year longitudinal study. Two trajectory types of loneliness were identified, namely, Class 1 (persistent high loneliness) and Class 2 (persistent low loneliness), accounting for 32.64% and 67.36% of the total sample, respectively. This finding reveals significant group variability in psychological changes in loneliness among patients with breast cancer.

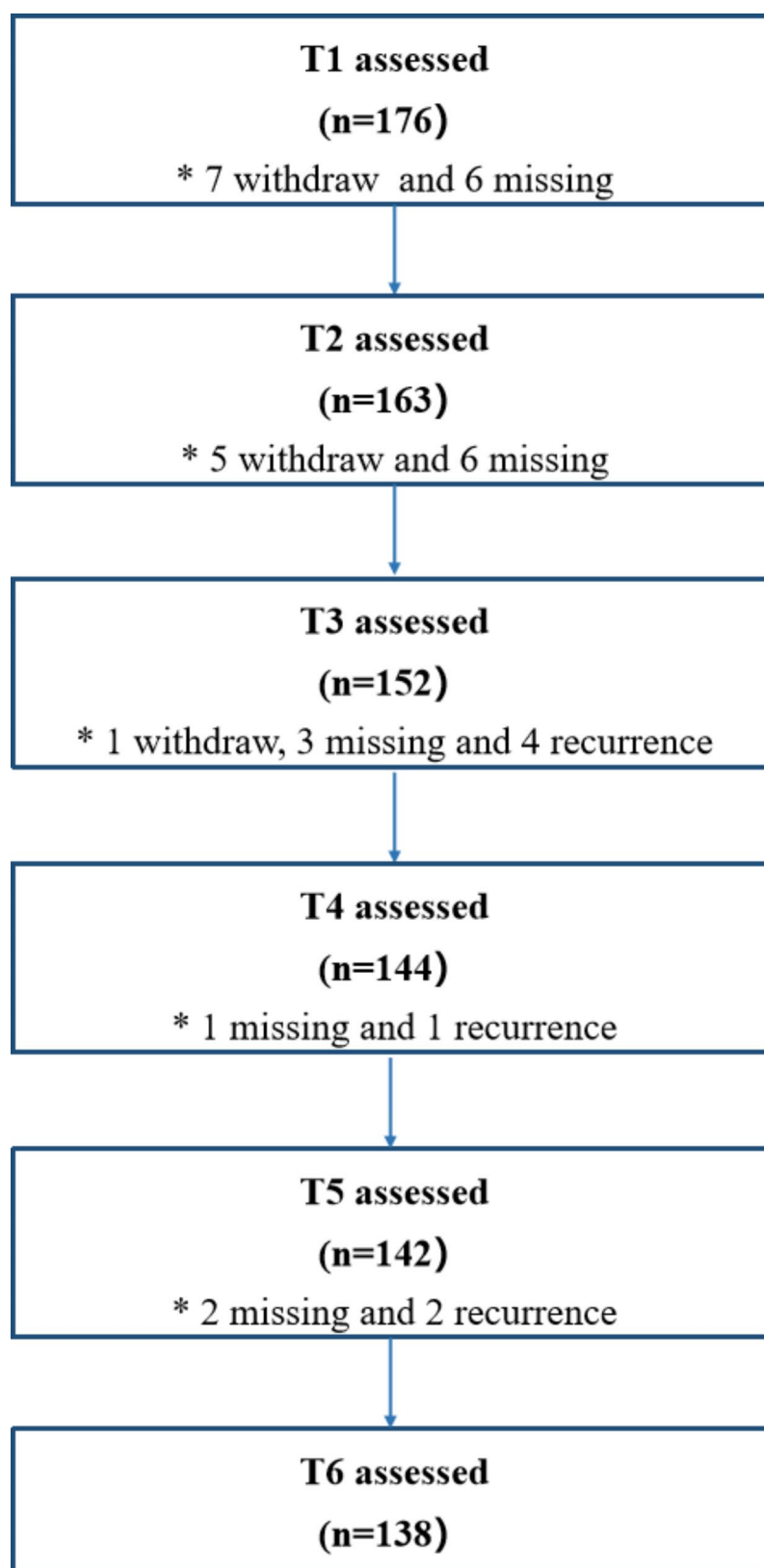


Fig. 1 Flow chart indicating the number of patients who completed each assessment

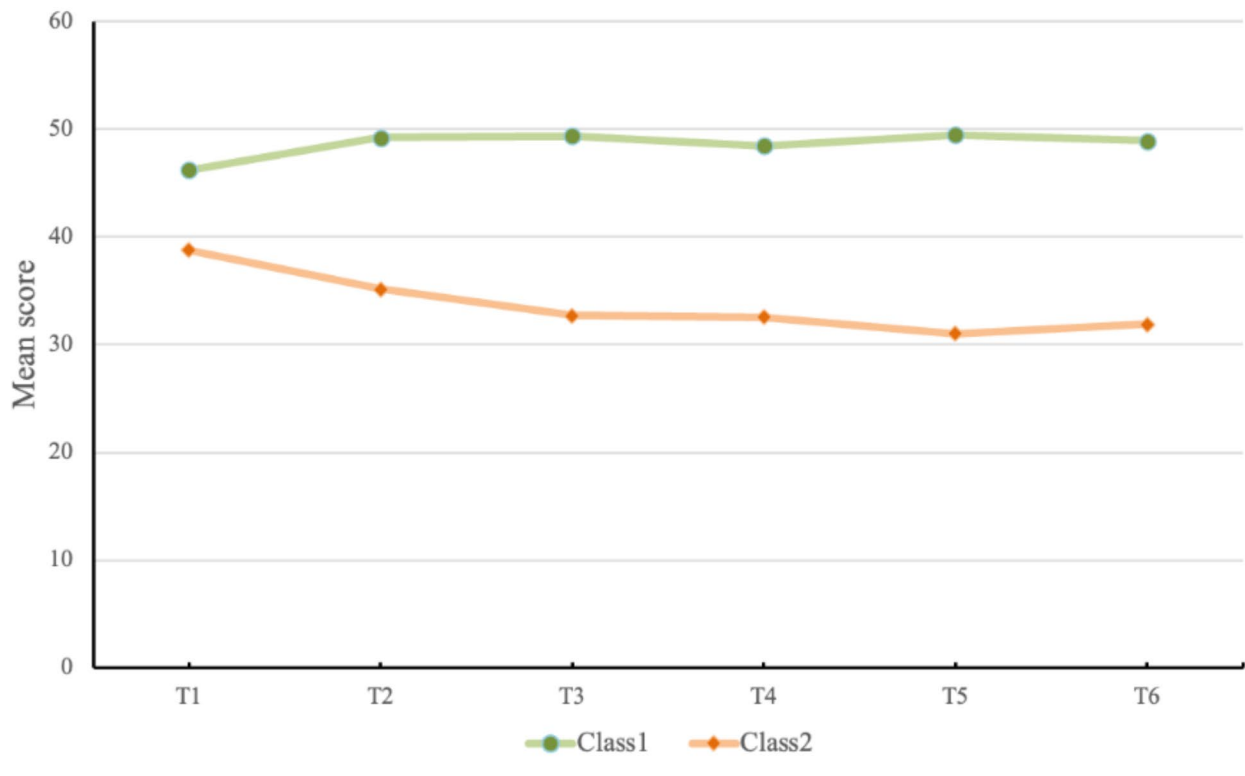


Fig. 2 Loneliness score at each time point based on latent class membership
Note: Class 1: persistent high loneliness group, Class 2: persistent low loneliness group

Table 3 The variable assignment table (n = 144)

Variables	Assigned
Marital status	Married = 1; Unmarried/divorced/widowed = 2
Educational level	Junior secondary and less = 1; High school/junior college = 2; Bachelor and more = 3
Family monthly income per capita (RMB)	< 3000 = 1; 3000 ~ 5000 = 2; > 5000 = 3
Occupation	Unemployed = 1; Retired = 2; Laborer = 3; Enterprises/institutions = 4
Place of residence	Rural area = 1; Urban area = 2
Surgical method	Radical mastectomy = 1; Breast-conserving = 2; Breast reconstruction = 3
Chemotherapy	Yes = 1; No = 2
Radiotherapy	Yes = 1; No = 2
Temperament type	Sanguineous = 1; Choleric = 2; Melancholic = 3; Lymphatic = 4

Characteristics of breast cancer patients with persistent high loneliness scores

In the persistently high loneliness group, our analysis revealed no statistically significant variations in patients' loneliness scores across the six investigated time points, aligning with previous research findings [44, 45]. Specifically, approximately 30% of breast cancer patients with negative emotions will remain relatively stable. The underlying reason for this stability is that during the treatment period, breast cancer patients may encounter difficulties in engaging in social activities as they previously did, owing to the decline in their physical condition and immunity. This physical constraint diminishes their

interaction with the external world, thereby augmenting their sense of isolation [46]. Furthermore, surgical interventions, chemotherapy, and other treatments may lead to image-related issues such as breast amputation, alopecia, and skin discoloration, which can evoke disturbances in the patients' self-image [47]. Consequently, this may result in psychological distress and social anxiety. Additionally, patients undergo role transitions during their prolonged battle with the disease, which may contribute to a loss of self-worth and foster feelings of loneliness and helplessness [48]. This, combined with persistent apprehension and uncertainty regarding the disease prognosis, inclines them towards social withdrawal, which is a

Table 4 Factors influencing loneliness trajectories ($n = 144$)

Variables	Univariate analysis			Multivariate analysis		
	β	OR (95%CI)	P	β	OR (95%CI)	P
Age	-0.01	0.99 (0.91, 1.07)	0.890			
Family functioning	-0.50	0.61 (0.46, 0.80)	< 0.001	-0.52	0.60 (0.46, 0.76)	< 0.001
Marital status						
Married	1.00	2.73 (0.16, 45.45)	0.485			
Educational level						
Junior secondary and less	2.35	10.43 (1.04, 105.08)	0.047	2.61	13.59 (2.63, 70.30)	0.002
High school/junior college	1.31	3.70 (0.63, 21.85)	0.149	1.25	3.50 (0.85, 14.41)	0.083
Family monthly income per capita (RMB)						
< 3000	-2.34	0.10 (0.01, 0.68)	0.019	-1.44	0.24 (0.04, 1.28)	0.094
3000 ~ 5000	-0.68	0.51 (0.09, 2.88)	0.505	-0.06	0.94 (0.21, 4.29)	0.940
Occupation						
Unemployed	0.90	2.46 (0.33, 18.50)	0.382			
Retired	0.41	1.50 (0.22, 10.15)	0.676			
Laborer	0.49	1.64 (0.12, 22.93)	0.715			
Place of residence						
Rural area	0.87	2.39 (0.46, 12.36)	0.300			
Surgical method						
Radical mastectomy	0.40	1.49 (0.23, 9.58)	0.675			
Breast-conserving	1.35	3.85 (0.55, 27.03)	0.176			
Chemotherapy						
Yes	0.89	2.43 (0.42, 14.17)	0.323			
Radiotherapy						
Yes	0.15	1.16 (0.31, 4.28)	0.824			
Temperament type						
Sanguineous	1.09	2.97 (0.54, 16.46)	0.212	0.89	2.44 (0.55, 10.91)	0.244
Choleric	-1.95	0.14 (0.03, 0.79)	0.025	-1.82	0.16 (0.03, 0.80)	0.025
Melancholic	2.73	15.37 (2.66, 88.93)	0.002	2.49	12.07 (2.46, 59.31)	0.002

Note: Reference group: Class 2 (persistent low loneliness group)

Abbreviations: CI, confidence interval; OR, odds ratio

Table 2 Results of the model fitting ($n = 144$)

Model	K	AIC	BIC	aBIC	Entropy	LRT P	BLRT P	Class percentage
GMM	1	5674.139	5709.776	5671.805	-	-	-	1
	2	5659.121	5703.668	5656.204	0.788	0.002	0.000	67.36/32.64
	3	5661.154	5714.610	5657.654	0.674	0.793	0.635	32.64/51.39/15.97
	4	5654.657	5717.023	5650.573	0.806	0.083	0.040	27.08/40.97/28.47/3.47
	5	5654.264	5725.539	5649.597	0.861	0.307	0.300	3.47/24.31/2.78/43.75/26.31

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size adjusted BIC; LRT, likelihood ratio test; BLRT, bootstrapped likelihood ratio test

pivotal factor in precipitating and perpetuating feelings of isolation [48].

Characteristics of breast cancer patients with persistent low loneliness scores

In the group of patients exhibiting consistently low loneliness, their loneliness scores exhibited fluctuations yet remained consistently below 38. This outcome indicates that the majority of these patients maintained a favorable emotional status. This finding is akin to a study conducted by Li et al., which reported that 60.7% of the

participants exhibited stable low levels of anxiety [49]. Several factors may account for this observation, including earlier detection of breast cancer within this cohort, more favorable surgical outcomes, a reduced necessity for subsequent treatments or less severe treatment-related adverse effects, and relatively minimal distress associated with body image alterations. Collectively, these factors contributed to the patients' capacity to sustain a positive psychological state, which, in turn, facilitated the maintenance of good social interactions and effectively mitigated feelings of loneliness.

Recommendations for loneliness interventions for patients with breast cancer

Previous foundational studies have revealed that sustained feelings of loneliness may trigger tumor cell proliferation via physiological pathways, consequently elevating the mortality risk among patients [50]. In addition, behavioral research has suggested that loneliness can erode patients' cognitive functions, work productivity, and social competencies, adversely affecting their overall quality of life [48]. Hence, to mitigate patients' feelings of loneliness, it is imperative to conduct early identification of vulnerable groups and implement targeted intervention strategies. The research has demonstrated that moderate-intensity resistance training or a combination of aerobic and resistance training yields substantial benefits for breast cancer patients. These benefits include the reduction of fatigue, enhancement of immune function and muscle strength, ultimately leading to an improvement in their quality of life [51]. Furthermore, dance movement therapy has proven to be pivotal in alleviating stress, augmenting physical activity levels, bolstering confidence, mitigating image anxiety, and fostering socialization among patients [52]. Additionally, cognitive behavioral therapy can assist patients in adjusting misconceptions and alleviating their disease-related fears [53]. Concurrently, social cognitive training has exhibited considerable value in enhancing patients' social skills and self-confidence [54]. Consequently, healthcare professionals ought to proactively employ suitable interventions tailored to the individual characteristics of patients, with the aim of diminishing their sense of isolation and further elevating their quality of life.

Predictors of loneliness trajectories in patients with breast cancer

Family functioning as a predictor of loneliness trajectory categories in patients with breast cancer

Compared to patients in Class 1, this study found that patients with poorer baseline family functioning were more likely to experience persistently high loneliness. Family support is one of the main sources of social support [55], which not only provides economic security for patients undergoing treatment but also provides emotional support. Hence, good family functioning can enhance the emotional regulation ability and social adaptability of patients and reduce the burden of disease [55]. Good family functioning is an important coping resource that can help patients achieve posttraumatic relief and transcendence [40]. The implementation of an Internet-based family resilience promotion program has been demonstrated to be efficacious in enhancing family resilience and optimizing family functioning among cancer patients [56]. In parallel, Wang et al. reported that their intervention, employing family participatory dignity

therapy, notably improved the psychological well-being of patients with hematologic malignancies and their family caregivers, alongside bolstering family resilience and cohesion [57]. Therefore, a precise assessment of patients' family functioning and the judicious application of family-centered interventions may hold pivotal significance in mitigating loneliness among patients with breast cancer.

Temperament type as predictors of loneliness trajectory categories in patients with breast cancer

Furthermore, the current study has found that individuals with melancholic temperament types are more inclined to be categorized within the persistent high loneliness group, whereas choleric temperament tends to serve as a predictor of persistent low loneliness, which is similar to previous findings [58]. According to personality theory, choleric individuals typically demonstrate high levels of neuroticism coupled with extraversion, whereas individuals exhibiting melancholic temperament display high neuroticism accompanied by low extraversion traits [59]. Studies have indicated that patients with high neuroticism tend to exhibit excessive concern for their own feelings and are susceptible to depression and avoidance behaviors when confronted with difficulties, serving as a notable predictor of loneliness [60]. However, in the current study, patients with choleric temperament were more prone to being categorized in the consistently low loneliness group. This may be attributed to the fact that extraverts are generally warm, lively, more communicative, and sociable, tending to share their experiences with family and friends and managing their emotions more effectively by seeking social support. In contrast, introverts may become overly preoccupied with their own feelings and are more inclined to handle their emotions in isolation, thereby being more susceptible to falling into a state of loneliness and helplessness [18]. As a result, individuals exhibiting melancholic traits, characterized by high neuroticism and low extraversion, may exhibit excessive concern for the opinions of others and utilize psychological defense mechanisms to mitigate stress and anxiety [61]. However, such heightened harm avoidance behaviors can exacerbate the development and perpetuation of negative emotional states, including sensitivity, detachment, and loneliness, thereby fostering a vicious cycle [62]. Although temperament type constitutes a relatively stable individual trait, it is influenced by a complex interplay of genetic and social environmental factors. Existing research indicates that personality traits can indeed be altered through specific interventions. For instance, Cheng et al. observed a decrease in scores on the P (Psychoticism) and E (Extraversion) scales of their personality questionnaire following a psychological care intervention among 45 esophageal cancer patients [63].

Furthermore, another study has demonstrated the efficacy of digital personality interventions in modifying personality traits [64]. Therefore, early identification and the implementation of appropriate intervention strategies are crucial in preventing or alleviating loneliness among patients.

Education level as a predictor of loneliness trajectory categories in patients with breast cancer

An interesting finding of this study was that patients with an education level of junior secondary and less were more likely to report persistently high levels of loneliness. We tentatively hypothesized that the mechanisms behind this phenomenon are rooted in the following: firstly, patients with lower levels of education may face limited access to information and insufficient information processing skills, which limits their ability to grasp key information about breast cancer treatment and prognosis in a comprehensive and in-depth manner, and thus exacerbates the uncertainty and fear associated with the disease [65]. Secondly, lower levels of education are often associated with smaller social networks and weaker communication and understanding skills, which may weaken the patient's social support system and impede their ability to effectively express their feelings and needs, thus exacerbating the experience of loneliness [66]. Furthermore, low levels of education are often associated with poor economic status, which has been shown to be strongly associated with psychological distress, treatment adherence, and prognosis [67]. However, when we considered the average monthly income of families as the only variable for the statistical analysis, we found that income did not significantly affect loneliness in patients with breast cancer. This finding prompts us to hypothesize that educational level may serve as an independent and significant moderator of the onset and progression of loneliness. A higher level of education not only suggests a more stable source of income relative to the family's economic status but, more crucially, it equips the patient with a greater capacity to acquire knowledge about the disease, the opportunity to engage in treatment decisions, and the potential to enhance the disease's prognosis [68]. These factors may collectively contribute to mitigating the patient's feelings of loneliness. However, to test this hypothesis, we need to conduct a large-scale investigation.

Limitations

Firstly, the utilization of convenience sampling in this study may introduce bias in the sample concerning age, socio-economic status, education, and cultural aspects, thereby limiting the representativeness of the findings to the broader target population. To enhance the generalizability and applicability of the findings, future studies ought to employ more stringent sampling methods, such

as random or stratified sampling. Additionally, endeavors should be directed towards validating and replicating the results across diverse populations to bolster the universal applicability of the conclusions. Secondly, the selection of follow-up time points in this study did not encompass treatment phases like chemotherapy and radiotherapy, impeding a thorough understanding of loneliness fluctuations during treatment and rehabilitation. Future research endeavors could be designed in accordance with the treatment stages to meticulously dissect the evolving characteristics of loneliness. Thirdly, owing to resource limitations, the current study was unable to comprehensively evaluate the impact of confounding factors, including physical activity and physical symptoms (e.g., pain and fatigue), as well as time-varying covariates such as temperament type, depression, and anxiety, on the trajectory of loneliness, resulting in a less in-depth analysis of the factors influencing the trajectory of loneliness. Fourthly, the single-center nature and the relatively small sample size of this study constrained the generalization of the findings, potentially obscuring categories with low prevalence or underestimating the relationships between potential categorical variables and covariates. Future studies should collect multicenter data and expand the sample size to validate the findings. Last but not least, this study refrained from implementing interventions to tackle the identified issues. Future research endeavors should devise pertinent intervention programs and undertake controlled trials grounded in the study findings.

Conclusions

First, this study identified two distinct trajectories of loneliness in patients with breast cancer and elucidated the presence of individual differences among patients. Second, we found that loneliness levels among patients with breast cancer were relatively stable, with little change over time. Furthermore, early detection and intervention may be important for alleviating loneliness among such patients. Third, patients with an education level of junior secondary and less, and those with melancholic temperament types, were more likely to report persistently high levels of loneliness. However, those with choleric temperament types, and those with better family functioning were more likely to report persistently low levels of loneliness. Early identification of these risk factors and effective interventions may prevent or reduce loneliness among these patients. Finally, although this study has some limitations, it provides novel insights into the management of loneliness and the development of personalized care for patients with breast cancer.

Acknowledgements

The authors would like to thank all patients for completing the surveys.

Author contributions

HCY written the first draft of the manuscript. HY and LYW collected data. HXY prepared Figs. 1 and 2. WSY and CW gave useful comments to the experiment and helped to revise the manuscript for several times. All authors read and approved the final manuscript.

Data availability

The datasets utilized and analyses conducted in the current study are available upon reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate

This study adheres to the principles of the Declaration of Helsinki and has been approved by the Ethics Committee of the First Affiliated Hospital of the Fourth Military Medical University (KY20192117-F-1). All participants provided written informed consent to confirm their voluntary participation. The informed consent also ensured that the participants could withdraw at any time, which did not affect their normal treatment.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Clinical trial number

Not applicable.

Received: 7 October 2024 / Accepted: 3 February 2025

Published online: 10 February 2025

References

- Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer statistics 2020: GLOBOCAN estimates of incidence and Mortality Worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2021;71:209–49.
- Marroquin B, Czamanski-Cohen J, Weihs KL, Stanton AL. Implicit loneliness, emotion regulation, and depressive symptoms in breast cancer survivors. *J Behav Med*. 2016;39:832–44.
- Wagner JF, Lüdders D, Hoellen F, Rody A, Banz-Jansen C. Treatment anxiety in breast cancer patients. *Arch Gynecol Obstet*. 2019;299:1365–71.
- Kroenke CH, Michael YL, Poole EM, Kwan ML, Nechuta S, Leas E, et al. Postdiagnosis social networks and breast cancer mortality in the after breast Cancer Pooling Project. *Cancer*. 2017;123:1228–37.
- Wang F, Gao Y, Han Z, Yu Y, Long Z, Jiang X, et al. A systematic review and meta-analysis of 90 cohort studies of social isolation, loneliness and mortality. *Nat Hum Behav*. 2023;7:1307–19.
- Hutten E, Jongen EMM, Vos AECC, van den Hout AJHC, van Lankveld JJDM. Loneliness and Mental Health: the Mediating Effect of Perceived Social Support. *Int J Environ Res Public Health*. 2021;18:11963.
- Hawkey LC, Cacioppo JT. Loneliness matters: a theoretical and empirical review of consequences and mechanisms. *Ann Behav Med*. 2010;40:218–27.
- Riba MB, Donovan KA, Andersen B, Braun I, Breitbart WS, Brewer BW, et al. Distress management, Version 3.2019, NCCN Clinical Practice guidelines in Oncology. *J Natl Compr Canc Netw*. 2019;17:1229–49.
- Laing EM, Heinen JM, Acebo de Arriba R, Schäffeler N, Zipfel S, Stengel A, et al. Adaptations of interpersonal psychotherapy in psycho-oncology and its effects on distress, depression, and anxiety in patients with cancer: a systematic review. *Front Psychol*. 2024;15:1367807.
- Kuczynski AM, Piccirillo ML, Dora J, Kuehn KS, Halvorson MA, King KM, et al. Characterizing the momentary association between loneliness, depression, and social interactions: insights from an ecological momentary assessment study. *J Affect Disord*. 2024;360:376–86.
- McElfresh JJ, Skiba MB, Segrin CG, Badger TA, Crane TE, Crist JD, et al. Interventions for loneliness among Adult Cancer survivors: a systematic review and Meta-analysis. *J Psychosoc Oncol*. 2021;39:509–33.
- Poudel PG, Horan MR, Brinkman TM, Wang Z, Robison LL, Hudson MM, et al. Interventions with Social Integration Components addressing Psychosocial outcomes of Young- and middle-aged Adult Cancer individuals: a systematic review. *Cancers (Basel)*. 2023;15:4710.
- Tang A, Fox NA, Slopen N. Examination of early childhood temperament of shyness and Social Avoidance and Associations with Cardiometabolic Health in Young Adulthood. *JAMA Netw Open*. 2022;5:e2144727.
- Spittlehouse JK, Vierck E, Pearson JF, Joyce PR. Temperament and character as determinants of well-being. *Compr Psychiatry*. 2014;55:1679–87.
- Stroustrup A, Hsu H-H, Svensson K, Schnaas L, Cantoral A, Solano González M, et al. Toddler temperament and prenatal exposure to lead and maternal depression. *Environ Health*. 2016;15:71.
- Durá-Ferrandis E, Mandelblatt JS, Clapp J, Luta G, Faul L, Kimmick G, et al. Personality, coping, and social support as predictors of long-term quality-of-life trajectories in older breast cancer survivors: CALGB protocol 369901 (Alliance). *Psychooncology*. 2017;26:1914–21.
- Aho T, Harno H, Lipsanen J, Kalso E, Sipilä R. Pain-related and psychological factors mediate the effect of personality on health-related quality of life. A study in breast cancer survivors with persistent pain. *Front Psychol*. 2023;14:1063920.
- von Soest T, Luhmann M, Hansen T, Gerstorf D. Development of loneliness in midlife and old age: its nature and correlates. *J Pers Soc Psychol*. 2020;118:388–406.
- Wang S, Li Y, Li S, Zhang E, Dai Z, Cui J, et al. Association between type D personality and supportive care needs in elderly patients with breast cancer: a prospective longitudinal observational study. *BMC Geriatr*. 2023;23:721.
- Monroe SM, Simons AD. Diathesis-stress theories in the context of life stress research: implications for the depressive disorders. *Psychol Bull*. 1991;110:406–25.
- Howard Sharp KM, Tillery Webster R, Cook J, Okado Y, Long A, Phipps S. Profiles of resilience, distress, and Posttraumatic Growth in parents of children with Cancer and the relation to subsequent parenting and family functioning. *J Pediatr Psychol*. 2023;48:375–85.
- Maru M, Paris R, Simhi M. The protective effects of social support and family functioning on parenting stress among Hispanic/Latino/a American immigrant parents with traumatic life experiences: a mediation analysis. *Infant Ment Health J*. 2023;44:348–61.
- Taylor HO, Taylor RJ, Nguyen AW, Chatters L. Social isolation, Depression, and psychological distress among older adults. *J Aging Health*. 2018;30:229–46.
- He C, Wu C, He Y, Yan J, Lin Y, Wan Y, et al. Characteristics and influencing factors of social isolation in patients with breast cancer: a latent profile analysis. *Support Care Cancer*. 2023;31:363.
- YY H S, T L J, H W W L. Factors associated with fear of progression in Chinese cancer patients: sociodemographic, clinical and psychological variables. *J Psychosom Res*. 2018;114.
- Lemij AA, de Glas NA, Derks MGM, Linthorst-Niers EMH, Guicherit OR, van der Pol CC, et al. Mental health outcomes in older breast cancer survivors: five-year follow-up from the CLIMB study. *Eur J Cancer*. 2023;187:87–95.
- Deckx L, van den Akker M, van Driel M, Bulens P, van Abbema D, Tjan-Heijnen V, et al. Loneliness in patients with cancer: the first year after cancer diagnosis. *Psychooncology*. 2015;24:1521–8.
- Li Y, Fang C, Xiong M, Hou H, Zhang Y, Zhang C. Exploring fear of cancer recurrence and related factors among breast cancer patients: a cross-sectional study. *J Adv Nurs*. 2024;80:2403–14.
- Lay JC, Pauly T, Graf P, Biesanz JC, Hoppmann CA. By myself and liking it? Predictors of distinct types of solitude experiences in daily life. *J Pers*. 2019;87:633–47.
- Muthén B, Muthén LK. Integrating person-centered and variable-centered analyses: growth mixture modeling with latent trajectory classes. *Alcohol Clin Exp Res*. 2000;24:882–91.
- Nguefack HLN, Pagé MG, Katz J, Choinière M, Vanasse A, Dorais M, et al. Trajectory modelling techniques useful to Epidemiological Research: a comparative narrative review of approaches. *CLEP*. 2020;12:1205–22.
- Barcikowski RS, Robey RR. Sample Size Selection in Single Group Repeated Measures Analysis. *Anal Var*. 1985: 31.
- Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Statistical power analysis for the behavioral sciences; 1988.
- Eysenck HJ, Eysenck MW. Personality and individual differences: a Natural Science Approach. *Pers Indiv Differ*. 1985;9:343–63.
- Li L, Li X, Han D, Li J, Zhao W, Zhang M. A longitudinal study of psychological distress trajectories and influencing factors in breast cancer patients. *Chin J Nurs*. 2020;55:1140–6.
- Franks CM, Holden EA, Phillips M. Eysenck's stratification theory and the questionnaire method of measuring personality. *J Clin Psychol*. 1961;17:248–53.

37. He C, Wu C, Yang T, He Y, Yan J, Lin Y, et al. Trajectories and predictors of social avoidance in female patients with breast cancer. *Front Psychiatry*. 2022;13:1051737.
38. Lv F, Gu Y. Family APGAR questionnaire and its clinical application. *Overseas Med (Hospital Management)*. 1995;56:–9.
39. Smilkstein G. The family APGAR: a proposal for a family function test and its use by physicians. *J Fam Pract*. 1978;6:1231–9.
40. He C, Yang T, He Y, Guo S, Lin Y, Wu C, et al. Relationship between family functioning and self-transcendence in patients with breast cancer: a network analysis. *Front Public Health*. 2022;10:1028860.
41. Wang D. A study of the reliability and validity of the Russell Loneliness Scale. *Chin J Clin Psychol*. 1995;23:5.
42. Russell DW. UCLA Loneliness Scale (Version 3): reliability, validity, and factor structure. *J Pers Assess*. 1996;66:20–40.
43. Hudiñana J, Lincoln TM, Hartanto S, Shadiqi MA, Milla MN, Muluk H, et al. How Universal is a construct of loneliness? Measurement invariance of the UCLA loneliness scale in Indonesia, Germany, and the United States. *Assessment*. 2022;29:1795–805.
44. Schou I, Ekeberg Ø, Ruland CM, Sandvik L, Kåresen R. Pessimism as a predictor of emotional morbidity one year following breast cancer surgery. *Psychooncology*. 2004;13:309–20.
45. Schapira L, Zheng Y, Gelber SI, Poorvu P, Ruddy KJ, Tamimi RM, et al. Trajectories of fear of cancer recurrence in young breast cancer survivors. *Cancer*. 2022;128:335–43.
46. Choi E, Henneghan AM. Comparing fatigue, loneliness, daytime sleepiness, and stress in younger and older breast cancer survivors: a cross-sectional analysis. *Clin J Oncol Nurs*. 2022;26:155–64.
47. Wang S, Hua Y, Zhang Y, Guo D, Tian L. Trajectories and influencing factors of social anxiety in postoperative breast cancer patients. *BMC Psychiatry*. 2024;24:357.
48. Campbell-Enns H, Woodgate R. The psychosocial experiences of women with breast cancer across the lifespan: a systematic review protocol. *JBI Database Syst Rev Implement Rep*. 2015;13:112–21.
49. Li W, Zhang Q, Xu Y, Sun H, Wen Y, Xu W, et al. Group-based trajectory and predictors of anxiety and depression among Chinese breast cancer patients. *Front Public Health*. 2022;10:1002341.
50. Brown EG, Gallagher S, Creaven A-M. Loneliness and acute stress reactivity: a systematic review of psychophysiological studies. *Psychophysiology*. 2018;55:e13031.
51. Ficarra S, Thomas E, Bianco A, Gentile A, Thaller P, Grassadonio F, et al. Impact of exercise interventions on physical fitness in breast cancer patients and survivors: a systematic review. *Breast Cancer*. 2022;29:402–18.
52. Fatkulina N, Hendrixson V, Rauckiene-Michealsson A, Kievisiene J, Razbadauskas A, Agostinis Sobrinho C. Dance/Movement Therapy as an Intervention in Breast Cancer Patients: A Systematic Review. *Evid Based Complement Alternat Med*. 2021; 2021:4989282.
53. Dodds SE, Pace TWW, Bell ML, Fiero M, Negi LT, Raison CL, et al. Feasibility of cognitively-based Compassion Training (CBCT) for breast cancer survivors: a randomized, wait list controlled pilot study. *Support Care Cancer*. 2015;23:3599–608.
54. Cleary EH, Stanton AL. Mediators of an internet-based psychosocial intervention for women with breast cancer. *Health Psychol*. 2015;34:477–85.
55. Pehlivan S, Ovayolu O, Ovayolu N, Sevinc A, Camci C. Relationship between hopelessness, loneliness, and perceived social support from family in Turkish patients with cancer. *Support Care Cancer*. 2012;20:733–9.
56. Park M, Kim S, Lee H, Shin YJ, Lyu CJ, Choi EK. Development and effects of an internet-based family resilience-promoting program for parents of children with cancer: a randomized controlled trial. *Eur J Oncol Nurs*. 2023;64:102332.
57. Wang C, Chen J, Wang Y, Xu W, Xie M, Wu Y, et al. Effects of family participatory dignity therapy on the psychological well-being and family function of patients with haematologic malignancies and their family caregivers: a randomised controlled trial. *Int J Nurs Stud*. 2021;118:103922.
58. Karvat Gracia DF, Lara DR, Ottoni G, de Araújo L. Analysis of association between temperament and psychological symptoms using the affective and emotional composite temperament (AFFECT) model: an internet-based survey. *J Affect Disord*. 2020;264:446–54.
59. Eysenck HJ. Dimensions of personality: 16, 5 or 3?—Criteria for a taxonomic paradigm. *Personality Individual Differences*. 1991;12:773–90.
60. Abdellaoui A, Chen H-Y, Willemsen G, Ehli EA, Davies GE, Verweij KJH, et al. Associations between loneliness and personality are mostly driven by a genetic association with Neuroticism. *J Pers*. 2019;87:386–97.
61. Hoang VM, Pham CP, Vu QM, Ngo TT, Tran DH, Bui D et al. Household Financial Burden and Poverty Impacts of Cancer Treatment in Vietnam. *Biomed Res Int*. 2017; 2017: 9350147.
62. Wan L, Zha R, Ren J, Li Y, Zhao Q, Zuo H, et al. Brain morphology, harm avoidance, and the severity of excessive internet use. *Hum Brain Mapp*. 2022;43:3176–83.
63. Cheng Q, Kong C, Chang S, Wei A. Effects of psychological nursing intervention on personality characteristics and quality of life of patients with esophageal cancer. *Clin Res Hepatol Gastroenterol*. 2013;37:283–8.
64. Stieger M, Flückiger C, Rüggeger D, Kowatsch T, Roberts BW, Allemand M. Changing personality traits with the help of a digital personality change intervention. *Proc Natl Acad Sci U S A*. 2021;118:e2017548118.
65. Coughlin SS. Social determinants of breast cancer risk, stage, and survival. *Breast Cancer Res Treat*. 2019;177:537–48.
66. Calderon C, Gomez D, Carmona-Bayonas A, Hernandez R, Ghanem I, Gil Raga M, et al. Social support, coping strategies and sociodemographic factors in women with breast cancer. *Clin Transl Oncol*. 2021;23:1955–60.
67. Çeli KY, Çeli KSŞ, Sarıköse S, Arslan HN. Evaluation of financial toxicity and associated factors in female patients with breast cancer: a systematic review and meta-analysis. *Support Care Cancer*. 2023;31:691.
68. Liu Y, Zhang J, Huang R, Feng W-L, Kong Y-N, Xu F, et al. Influence of occupation and education level on breast cancer stage at diagnosis, and treatment options in China: a nationwide, multicenter 10-year epidemiological study. *Med (Baltim)*. 2017;96:e6641.

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.