

Research

Assessing the needs of healthcare information for assisting family caregivers in cancer fear management: a mindsponge-based approach

Ni Putu-Wulan Purnama Sari¹ · Adrino Mazenda² · Minh-Phuong Thi Duong³ · Made Mahaguna Putra⁴ · Pande Made Arbi Yudamukti⁵ · Minh-Hoang Nguyen⁶ · Quan-Hoang Vuong^{6,7}

Received: 9 January 2025 / Accepted: 9 May 2025

Published online: 31 May 2025

© The Author(s) 2025 **OPEN**

Abstract

This study aimed to examine how types of demanded healthcare information are associated with the need for support in cancer fear management among family caregivers (FCGs) of female cancer patients. The mindsponge theory was used in conceptual development and interpretation. Bayesian Mindsponge Framework (BMF) analytics were used for statistical analysis on a dataset of 48 spouses (husbands) and 12 other family members in five congested communities of Surabaya, Indonesia. Among the six types of healthcare information, FCGs with higher demand for cancer-specific information ($M_{Information_Cancer_FearManagement} = 0.41$; $S_{Information_Cancer_FearManagement} = 0.25$) and information on cancer physical needs ($M_{Information_PhysicalNeed_FearManagement} = 0.32$; $S_{Information_PhysicalNeed_FearManagement} = 0.21$) were more likely to need support in reducing the fear of female cancer patients. Meanwhile, FCGs with a higher demand for information on support services ($M_{Information_SupportServices_FearManagement} = -0.33$; $S_{Information_SupportServices_FearManagement} = 0.22$) were less likely to need support to reduce cancer patients' fear. Other types of healthcare information have ambiguous effects on the need for support in reducing cancer-induced fear. This study underscores that the demanded cancer-specific information, such as information on cancer prognosis and therapeutic outcomes, and the demanded cancer physical needs information are priorities in information disclosure to FCGs to assist their role in cancer fear management.

Keywords Cancer · Fear · Family caregiver · Healthcare information · Mindsponge theory · Bayesian Mindsponge Framework

"[...] under good care and continuing using the panacea, Kingfisher's appetite for fish had returned. the birds brought tasty fat carp, And so he recovered quickly."

In: "Kingfisher's No-Fish Dietary"; *Wild Wise Weird* (2024).

✉ Adrino Mazenda, adrino.mazenda@up.ac.za | ¹Faculty of Nursing, Widya Mandala Surabaya Catholic University, Surabaya, Indonesia. ²Faculty of Economic and Management Sciences, School of Public Management and Administration, University of Pretoria, Hatfield, South Africa. ³Faculty of Social Sciences and Humanities, Ton Duc Thang University, Ho Chi Minh City, Vietnam. ⁴Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia. ⁵Installation of Central Surgery and Anesthesia, Regional Public Hospital of Bali Mandara, Denpasar, Bali, Indonesia. ⁶Centre for Interdisciplinary Social Research, Phenikaa University, Hanoi, Vietnam. ⁷University College, Korea University, Seoul, South Korea.



1 Introduction

Cancer, a disease in the cell regeneration process that damages and grows abnormally, has been feared for its legacy as a lethal disease [12]. Cancer recurrence, metastasis, additional cancer, and diagnostic tests are some possible etiology of cancer-induced fear besides fearful death [44]. Cancer incidence rates are highest in Asia among all continents (48% of all cases worldwide), twice as high as in Europe (24.4%) and the Americas (20.5%). Specifically in Indonesia, breast cancer and cervical cancer have led the Indonesian cancer statistics in the last decade. In 2014, breast cancer occupied the first position as the leading cause of death, followed by cervical cancer in second place [66]. Later on, breast cancer still became the first position as the highest number of new cases and deaths in Indonesian cancer statistics [1]. This situation puts Indonesian females at high risk of cancer fear as a result of psychological threats.

Cancer impacts patients with the disease and their families caring for them psychologically. In Asia, caring for a sick family member is a part of its culture. Similarly, in low-income countries, family caregivers (FCGs) are expected to be actively involved in the cancer care process, even during hospitalization [27]. A study on female cancer patients in congested communities of Surabaya, Indonesia, found that fear was not significantly different between breast and cervical cancer and between survivorship stages in both cases [44]. Another study on cancer caregivers found that their perception of cancer as a fatal disease can affect the intimacy between them and the patients, thereby causing distress [24]. Cancer-induced fear raises cancer stigma, a negative meaning attached to the word cancer, among patients, their caregivers, and mostly in common people [21]. Organizationally, the negative impact of fear-induced cancer stigma is its role in becoming a major barrier to quality palliative care, especially in home-based care settings [21], not only in the cancer treatment process but also in far-reaching public health consequences (Lebel & Devins, 2008; in [12]).

As the life expectancy of patients with advanced cancer increases, the role of healthcare professionals who provide comprehensive support becomes more critical. One of which is the role of providing healthcare information related to cancer care to the FCG. These roles may be executed by community nurses, general physicians, and pharmacists who provide healthcare information on cancer care, cancer cures, and cancer medicines, respectively. Caring for cancer patients for nurses, for instance, is associated with a substantial physical, mental, and financial burden for their FCG. It is essential to understand the impact of caregivers' awareness of cancer prognostic on their quality of life and emotional state [24]. Numerous studies have consistently underlined the essential supportive care needed by cancer caregivers from healthcare professionals [3, 28]. FCG of cancer patients reported the primary unmet needs of healthcare and illness-related needs, which mostly include healthcare information needs [45]. These needs are significant due to the prospective support of FCG's psychosocial care competencies, especially in managing emotional and psychological issues among cancer patients, e.g., cancer-induced fear.

There are challenges in addressing the unmet healthcare information needs among FCG of cancer patients and recognizing the importance of addressing their supportive care needs. However, there is a noticeable gap in understanding the association between the types of demanded healthcare information and the role of FCG in reducing the fear among cancer patients, particularly in the context of breast and cervical cancers. A current study found that cancer recurrence is one of the causes of fear among FCG [40], but they are still expected to assist cancer patients in managing cancer-induced fear at home on a day-to-day basis. Fear of cancer recurrence is a significant concern for cancer FCGs, and managing worries about cancer returning is a commonly reported unmet need in this population [40].

FCG of cancer patients mostly utilize healthcare information to assist them in providing cancer care [45], and there is no specific study assessing the utilization of healthcare information to assist FCG in managing cancer-induced fear among patients. Limited insight exists into how specific types of healthcare information needs may either alleviate or contribute to the fear experienced by female cancer patients through the roles of FCG in cancer caregiving.

Understanding the impact of different types of demanded healthcare information on the role of FCGs in reducing fear among female cancer patients is crucial. In this study, we examined how various types of healthcare information demanded by family caregivers (FCGs) are associated with the need for support in cancer fear management among female cancer patients (i.e., cancer-specific information, caregiver-specific information, therapy-specific information, information on cancer physical needs, information on alternative therapies, and information on support services). Through this assessment, we aimed to analyze how providing the right information or the specific information types can assist FCG's role in reducing cancer-induced fear, especially among female cancer patients. Findings may provide valuable insights to improve the supportive care of healthcare information for FCG of cancer patients from healthcare professionals.

2 Method

2.1 Theoretical foundation

Mindsponge theory (MT) was used in conceptual development and result interpretation [62, 65]. MT views the human mind as an information collection-cum-processor that filters, processes, and accepts or rejects new information or values into or out of the mindset or core values, respectively. MT uses the human mind's information-processing approach to explain not only various mental products, e.g., fear, but also complex human behavior, e.g., adaptation. MT considers the human mind's filtering system to be the key factor of the whole information-processing mechanism [36]. In filtering new information or values, subjective cost–benefit judgments play an important role, and these may be influenced and be meaningful only if considering the sociocultural context of the individuals [58]. As the information filtering process can be energy- and time-consuming, the human mind may employ trust in information sources as the gatekeeper of prioritized information channels to catalyze new information reception and interpretation [63]. The new trusted information may be used as a reference in subsequent information-filtering processes toward other new healthcare information available in the social environment.

In cancer patients, subjective judgments influenced by educational attainment, values, norms, culture, and religion are the core of formed perceptions among individuals, including fear perception. Fear of cancer may happen due to the core view of cancer as an unpredictable and indestructible enemy. Cancer may raise four types of fear: its proximity, the (lack of) strategies to keep it at a distance, the personal and social implications of succumbing, and dying from the disease [61]. For women living with cancer, whatever the type of cancer is (breast or cervical cancer), cancer-related fear is similar, even if there is no significant improvement in the long run of cancer survivorship or cancer trajectories [44]. These indicate a very slow improvement in fear tolerance in female patients. Cancer patients who had fear, especially towards cancer recurrence, frequently used emotion-focused coping [44]. A higher fear of cancer recurrence has made the patients use fewer coping skills, being passive, implementing distraction or avoidant coping styles [10, 56]. It is clear that female cancer patients need assistance in overcoming cancer-induced fear, making FCG's role in providing psychosocial care significantly important in home-based cancer care settings.

Dealing with the fear experienced by female cancer patients in a home-based cancer care setting is not an easy task. Due to the limited resources available, FCG needs to be independent at some point. There are various barriers to integrating psychosocial care into routine cancer care identified, one of which is the fear-induced cancer stigma [21]. FCG of cancer patients need to have a correct mindset related to cancer caregiving to avoid cancer stigma. In cancer caregivers, sufficient and trusted healthcare information may be a solution for assisting the patients in reducing cancer-induced fear, as one of the FCG's roles is providing healthcare information to the patients.

This study considers the FCG's mind and social environment in the community setting as the main spectrums. MT views the caregiving mindset as a set of core values that contain cancer care-related values in the human mind. New healthcare information related to cancer caregiving can be absorbed and internalized into the mindset if the results of subjective cost–benefit judgments are positive, subsequently updating the FCG's mindset. FCG may employ trust in healthcare professionals, especially nurses [13], as information sources to foster information processing. Trust is the key to enhancing effective communication with stakeholders [53]. Trust among stakeholders must be ensured, especially in risk communication, such that the message from public agencies, e.g., the Public Health Centre (PHC), is accepted by the public [26]. FCG is inherently responsible for risk management in cancer, including the adverse events arising from cancer-induced fear, e.g., symptoms worsening. FCGs can protect themselves by avoiding unexpected events during cancer caregiving by using preventive measures that utilize healthcare information. Therefore, sufficient information will be beneficial for effective decision-making in life-crisis situations. In this study, FCG's role in cancer fear management may be assisted by meeting their needs regarding the demanded healthcare information.

2.2 Study design and samples

This was a cross-sectional study. Five communities in Surabaya, Indonesia, were involved as study sites among 63 communities under the health management of respectable Public Health Centre (PHC) across the city. Firstly, cluster random sampling was implemented to select the five communities. Secondly, simple random sampling was implemented to select the respondents. 60 FCGs of female cancer patients, consisting of 48 spouses (husbands) and 12 other family members, participated in this study. Inclusion criteria consisted of (1) caring for female cancer patients, (2) the in-site

PHC confirmed the cancer diagnosis of care recipients, and (3) the patients confirmed that the respondents were the primary FCG at home. Exclusion criteria were objections to informed consent.

2.2.1 Consent to participate

All respondents who participated in this study provided their consent to participate. Their decisions were based on prior explanations of study objectives, benefit-risk potencies, data collection procedures, and incentives. All respondents signed an informed consent form to strengthen their willingness to participate in this study.

2.2.2 Human ethics

Before conducting this study, the protocol was reviewed by the Ethical Committee of the Faculty of Medicine, Widya Mandala Surabaya Catholic University, to support the implementation of the Helsinki Declaration. Other implemented ethical aspects were anonymity, confidentiality, beneficence, non-maleficence, veracity, and justice.

2.2.3 Consent to publish

Not applicable.

2.3 Data collection procedure

All respondents were well-informed about this study's purposes, benefit-risk potencies, data collection procedure, and incentives prior to study participation. Exclusion criteria were rejection on filling out the consent form. This study protocol was reviewed by the Ethical Committee of the Faculty of Medicine, Widya Mandala Surabaya Catholic University, in accordance with the Declaration of Helsinki, with an ethical clearance registered certificate of 082/WM12/KEPK/DOSEN/T/2020. Data were collected in February–March 2020. Enumerators collected the data by door-to-door approach. Respondents were asked to read and answer the question/statement in the instrument themselves, but assistance was provided for those in need. No conflict of interest between authors and study funder was declared regarding this study and publication.

2.4 Study instrument

The demography questionnaire was used to collect data on demography characteristics. It consisted of seven items identifying personal information of age, gender, marital status, education level, occupation, Gross Domestic Product (GDP) in Indonesian Rupiah (IDR), and house-mate. The instrument SCNS-P&C45 (Supportive Care Needs Survey—Partners and Caregivers 45) was used to collect data on FCG's supportive care needs. This is a specific instrument for assessing the unmet needs of partners and caregivers of people diagnosed with cancer [5]. It could comprehensively assess the range of caregivers' supportive needs across the cancer trajectory. Researchers and clinicians can use the instrument to determine caregivers' unmet needs, prioritize healthcare resources, and tailor supportive cancer care services accordingly.

SCNS-P&C45 comprises four domains in 45 items. Factor analysis revealed four domains of supportive care needs, such as (1) health care and illness-related needs (11 items), (2) emotional and relational needs (16 items), (3) work and social needs (11 items), and (4) practical needs (7 items). For each item of SCNS-P&C45, respondents were asked to indicate their level of supportive care needs over the last month as a result of caring for people with cancer by using the following response options:

1. No need: consists of "not applicable" (score 1) and "satisfied" (score 2).
2. Some need: consist of "low need" (score 3), "moderate need" (score 4), and "high need" (score 5).

Based on the Likert scale above, the unmet needs of FCG were divided into four categories such as no need (total score: 45–90), low need (total score: 91–135), moderate need (total score: 136–180), and high need (total score: 181–225). Based on the results of instrument testing on 30 FCG of female cancer patients in different communities, SCNS-P&C45 was proved to be a valid and reliable instrument for this study ($r = 0.277$ – 0.761 ; Chronbach Alpha = 0.965).

2.5 Model construction and analysis

2.5.1 Variable selection and rationale

Among all aspects, the unmet needs of healthcare information from the domain of healthcare and illness-related needs may affect FCG's role in addressing fears about the person with cancer's physical or mental deterioration from the domain of emotional and relational needs. In the current study, seven variables were employed for statistical analysis, namely: *FearManagement*, *Information_Caregiver*, *Information_Cancer*, *Information_SupportServices*, *Information_AlternativeThe*, *Information_PhysicalNeed*, and *Information_SideEffects* (see Table 1). To measure the FCG's needs in cancer fear management, we employed the *FearManagement* variable, which reflects the FCG's unmet needs of emotional and relational needs in addressing fears about the person with cancer's physical or mental deterioration. The six types of demanded healthcare information that may affect the FCG's role in addressing the fear of female cancer patients (i.e., cancer-specific information, caregiver-specific information, therapy-specific information, information on cancer physical needs, information on alternative therapies, and information on support services) were represented by variables of *Information_Caregiver*, *Information_Cancer*, *Information_SupportServices*, *Information_AlternativeThe*, *Information_PhysicalNeed*, and *Information_SideEffects*.

2.5.2 Statistical model

In this study, we positioned the types of demanded healthcare information as predictors of the FCG's needs in addressing the fear of female cancer patients. We constructed the analytical model based on the theoretical foundation of MT as presented below:

$$FearManagement \sim normal(\mu, \sigma) \quad (1)$$

$$\begin{aligned} \mu_i = & \beta_0 + \beta_{Information_Caregiver_FearManagement} \\ & * Information_Caregiver_i + \beta_{Information_Cancer_FearManagement} \\ & * Information_Cancer_i + \beta_{Information_SupportServices_FearManagement} \\ & * Information_SupportServices_i + \beta_{Information_AlternativeThe_FearManagement} \\ & * Information_AlternativeThe_i + \beta_{Information_PhysicalNeed_FearManagement} \\ & * Information_PhysicalNeed_i + \beta_{Information_SideEffects_FearManagement} \\ & * Information_SideEffects_i \end{aligned} \quad (2)$$

$$\beta \sim normal(M, S) \quad (3)$$

The probability around μ is determined by the form of normal distribution, with the standard deviation σ . The degree of unmet needs in reducing the stress of female cancer patients of FCG i is indicated by μ_i . *Information_Caregiver_i*, *Information_Cancer_i*, *Information_SupportServices_i*, *Information_AlternativeThe_i*, *Information_PhysicalNeed_i*, and *Information_SideEffects_i* are the types of demanded healthcare information of FCG i . The model has an intercept β_0 and six coefficients of $\beta_{Information_Caregiver_FearManagement}$, $\beta_{Information_Cancer_FearManagement}$, $\beta_{Information_SupportServices_FearManagement}$, $\beta_{Information_AlternativeThe_FearManagement}$, $\beta_{Information_PhysicalNeed_FearManagement}$, and $\beta_{Information_SideEffects_FearManagement}$. The probability around β is also in the form of normal distribution (Fig. 1).

2.5.3 Analysis and validation

Bayesian Mindsponge Framework (BMF) analytics was employed in the current study for several reasons [39, 64]. MT and Bayesian analysis are highly compatible [39]. Bayesian analysis enables similar treatment to all types of properties, including the known and unknown ones, probabilistically [9, 16]. This supports a reliable prediction of parsimonious models. In addition, utilizing the Markov chain Monte Carlo (MCMC) technique still enables Bayesian inference to analyze various intricate models effectively [11]. One great advantage of Bayesian analysis is the ability to use

Table 1 Variable description

Variable's Name	Description	Data type	Value
<i>FearManagement</i>	The need for addressing fears about the person with cancer's physical or mental deterioration	Numerical	1 = not applicable
<i>Information_Caregiver</i>	The need for accessing information relevant to your needs as a carer/partner	Numerical	2 = satisfied
<i>Information_Cancer</i>	The need for accessing information about the person with cancer's prognosis, or likely outcome	Numerical	3 = low need
<i>Information_SupportServices</i>	The need for accessing information about support services for carers/partners of people with cancer	Numerical	4 = moderate need
<i>Information_AlternativeThe</i>	The need for accessing information about alternative therapies	Numerical	5 = high need
<i>Information_PhysicalNeed</i>	The need for accessing information on what the person with cancer's physical needs are likely to be	Numerical	
<i>Information_SideEffects</i>	The need for accessing information about the benefits and side effects of treatments	Numerical	

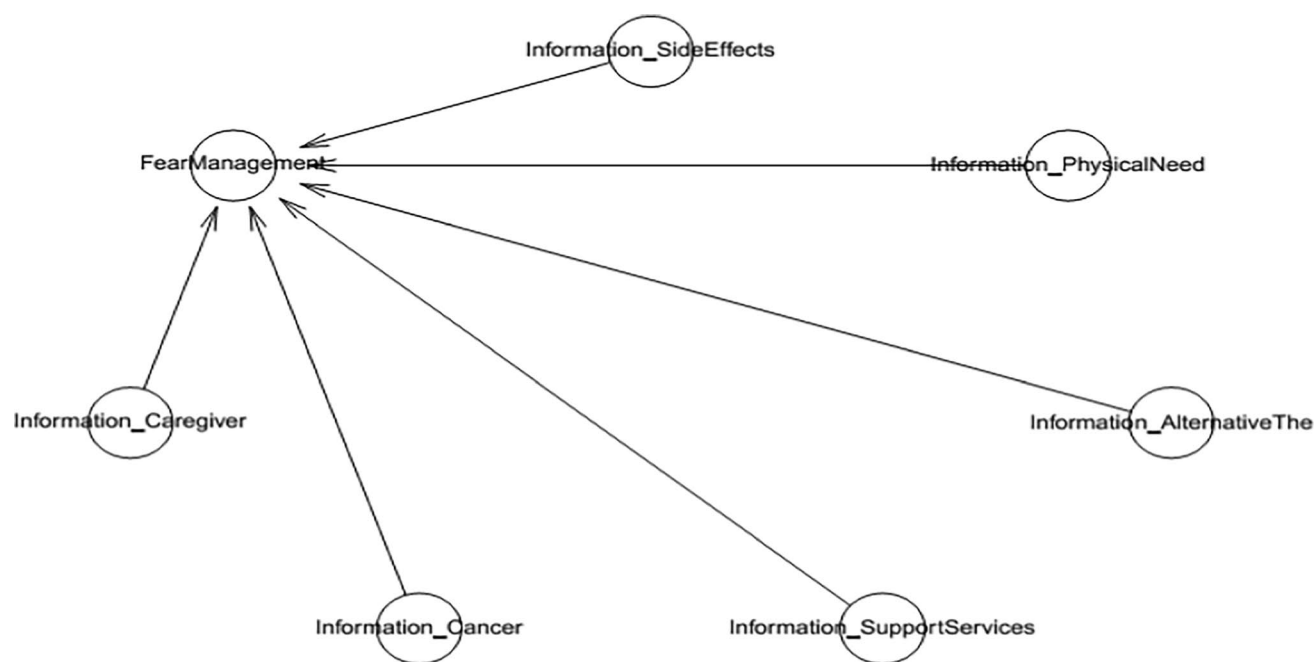


Fig. 1 Model 1's logical network

credible intervals in interpreting results, better than using the dichotomous p -values only in making decisions [19, 66]. The **bayesvl** open-access package built on the R platform was used to run Bayesian analysis in this study [30].

Before conducting Bayesian analysis we must select the appropriate prior. We chose to apply uninformative priors to provide as little prior information as possible for model estimation [10]. To check the model's goodness-of-fit, we employed the Pareto-smoothed importance sampling leave-one-out (PSIS-LOO) diagnostic test [59, 60]. When a model's k values are less than 0.5, it is typically regarded as being fit. When the value is greater than 0.7, it is often considered influential and problematic for accurately estimating LOO cross-validation. This value is utilized in the PSIS method for computing the LOO cross-validation in the R **loo** package. In addition, $p_{post(-i)}(\theta)$ is the posterior distribution calculated through the data minus data point i . LOO is computed as follows:

$$LOO = -2LPPD_{loo} = -2 \sum_{i=1}^n \log \int p(y_i|\theta) p_{post(-i)}(\theta) d\theta$$

When the model fits well with the data based on the above diagnostic test, we proceeded with the convergence diagnoses and result interpretation. We employed two methods for conducting convergence diagnoses. First, we used the effective sample size (n_{eff}) and the Gelman–Rubin shrink factor ($Rhat$) to diagnose the convergence statistically. If n_{eff} value is larger than 1000, it is generally considered that the Markov chains are convergent, and the effective samples are sufficient for reliable inference [38]. As for the $Rhat$ value, if the value equals 1, it is generally considered that the model does converge [4]. Second, we used trace plots to validate the Markov chains' convergence visually. When all the chains are located in the central equilibrium, it is generally considered that the Markov chains are well-converged.

3 Results

Most respondents were middle-aged (41–50 years old: 36.67%), male (80%), married (78.33%), high school graduated (63.33%), private employee (60%), living with a spouse (cancer patients) and children (80%) with maximum GDP of IDR 5 million per month (68.34%) [see Table 2 for detail].

The majority cared for female patients in their advanced stage of cancer (stage III and IV are equal to 65%). Breast cancer is the majority of cases in this study (68.3%). Most of the patients were aged 51–60 years old (41.7%). They were

Table 2 Demography characteristic

No	Characteristic	Frequency	Percentage
1	Age [years old]:		
	a. <21	2	3.33
	b. 21–30	7	11.67
	c. 31–40	15	25.00
	d. 41–50	22	36.67
	e. 51–60	10	16.67
	f. 61–70	4	6.67
2	Gender:		
	a. Male	48	80.00
	b. Female	12	20.00
3	Marital status:		
	a. Single	4	6.67
	b. Married	47	78.33
	c. Separated	2	3.33
	d. Divorced	1	1.67
	e. Widowed	6	10.00
4	Education level:		
	a. Primary school	6	10.00
	b. Secondary school	8	13.33
	c. High school	38	63.33
	d. University graduates	8	13.33
5	Occupation:		
	a. Housewife	12	20.00
	b. Entrepreneur	2	3.33
	c. Civil servant	6	10.00
	d. Private employee	36	60.00
	e. Jobless/retire	4	6.67
6	Gross Domestic Product (GDP) [IDR]:		
	a. Less than minimum wage	16	26.67
	b. Minimum wage – 5 million	25	41.67
	c. More than 5 million	15	25.00
	d. No income	4	6.67
7	House mate:*		
	a. Spouse	48	80.00
	b. Child	48	80.00
	c. Sibling	8	13.33
	d. Parents	9	15

*Respondents may choose more than one answer

short-term cancer survivors (61.7%) who had undergone only surgery as the primary modality of cancer management (33.3%) [see Table 3 for detail].

In Table 4, almost all respondents reported unmet needs at various levels (low need + moderate need + high need = 98.33%), but the majority reported low levels of unmet needs (46.67%).

Before interpreting the results of BMF analytics, it is necessary to evaluate how well Model 1 fits the data. As can be seen in Fig. 2, almost all estimated k -values are below 0.5. There is one k -value that is higher than 0.5, but it is still lower than the 0.7 threshold, indicating a good fit signal between the model and the data.

Table 5 shows the posterior distribution statistics of Model 1. Model 1's Markov chains are considered well-convergent because all n_{eff} values are greater than 1000, and $Rhat$ values are equal to 1 statistically. Visually, the trace plots of Fig. 3 show that all Markov chains fluctuate around the central equilibrium after the 2000th iteration.

Table 3 Patient's characteristic

Characteristic	Frequency	Percentage
Age (years old)		
< 21	0	0
21–30	4	6.7
31–40	5	8.3
41–50	12	20.0
51–60	25	41.7
61–70	10	16.7
> 70	4	6.7
Cases		
Breast cancer	41	68.3
Cervical cancer	19	31.7
Stage		
I	4	6.7
II	13	21.7
III	31	51.7
IV	8	13.3
Unknown	4	6.7
Duration of illness		
Less than 1 year (acute survivor)	11	18.3
1–5 years (short-term survivor)	37	61.7
> 5 years (long-term survivor)	12	20.0
Therapy		
Surgery	20	33.3
Chemotherapy	12	20.0
Surgery + chemotherapy	8	13.3
Surgery + radiotherapy	1	1.7
Chemotherapy + radiotherapy	6	10.0
Surgery + chemo-radiotherapy	8	13.3
Alternative therapy	5	8.3

Table 4 The level of unmet needs among FCG

No	Categories	Frequency	Percentage
1	No need (45–90)	1	1.67
2	Low need (91–135)	28	46.67
3	Moderate need (136–180)	21	35.00
4	High need (181–225)	10	16.67

After making sure about the convergence of Markov chains, we interpreted the results of Bayesian analysis. Results showed that FCGs with higher demand for cancer-specific information, such as cancer prognosis and care outcomes, and information about physical needs are more likely to need support from healthcare professionals to reduce the fear of female cancer patients. On the other hand, FCGs with a higher demand for information on support services are less likely to need support in cancer fear management. Other types of information have ambiguous effects on the need for support in reducing cancer patients' fear. Figure 4 shows that the posterior distributions of *Information_Cancer*, *Information_PhysicalNeed*, and *Information_SupportServices* lie entirely on the positive or negative side of the x-axis, indicating the results' high reliability.

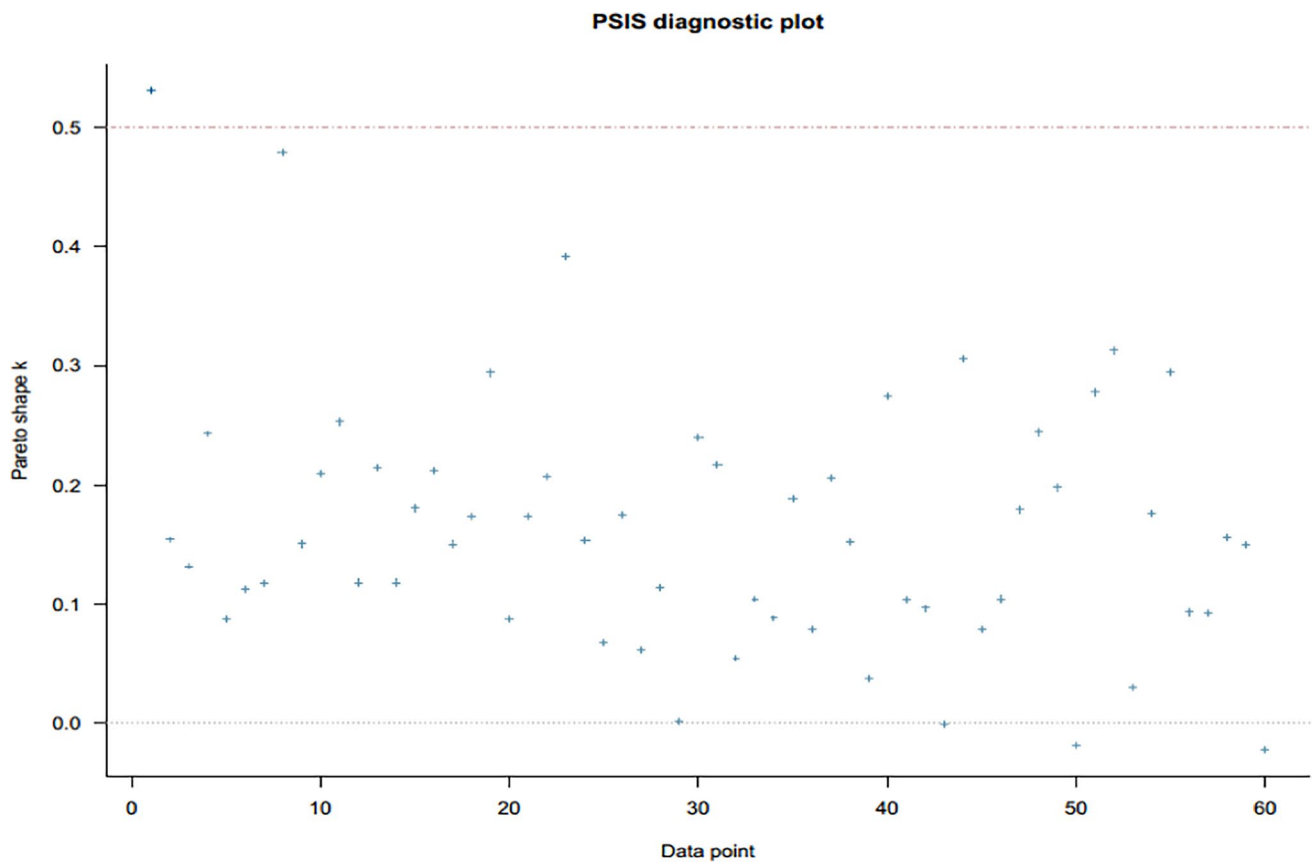


Fig. 2 Model 1's PSIS-LOO diagnosis

Table 5 Estimated results of model 1

Parameters	Mean	SD	n_eff	Rhat
<i>a_FearManagement</i>	2.43	0.56	11,073	1
<i>b_Information_Caregiver_FearManagement</i>	− 0.06	0.24	10,064	1
<i>b_Information_Cancer_FearManagement</i>	0.41	0.25	10,498	1
<i>b_Information_SupportServices_FearManagement</i>	− 0.33	0.22	11,809	1
<i>b_Information_AlternativeThe_FearManagement</i>	− 0.17	0.21	10,969	1
<i>b_Information_PhysicalNeed_FearManagement</i>	0.32	0.21	11,623	1
<i>b_Information_SideEffects_FearManagement</i>	− 0.04	0.19	11,343	1

4 Discussion

In employing BMF analytics, this study delves into the relationship between demanded healthcare information and the role of FCGs in alleviating fear among female cancer patients. The examination of six types of information, spanning from cancer-specific details to support services, reveals insights for supporting FCGs through information provision.

The positive impact coefficient associated with the demand for cancer-specific information signifies a profound correlation between caregivers' desire for comprehensive knowledge and their ability to manage fear effectively. This aligns with the intuitive understanding that a deeper understanding of cancer empowers caregivers, fostering confidence and competence [17]. The effective integration of caregivers into cancer care is crucial, promoting empowerment and self-management [56]. Studies underscore the close link between caregiver burden, distress, and quality of life, emphasizing the imperative to address these issues as cancer evolves into a chronic disease [8, 41].

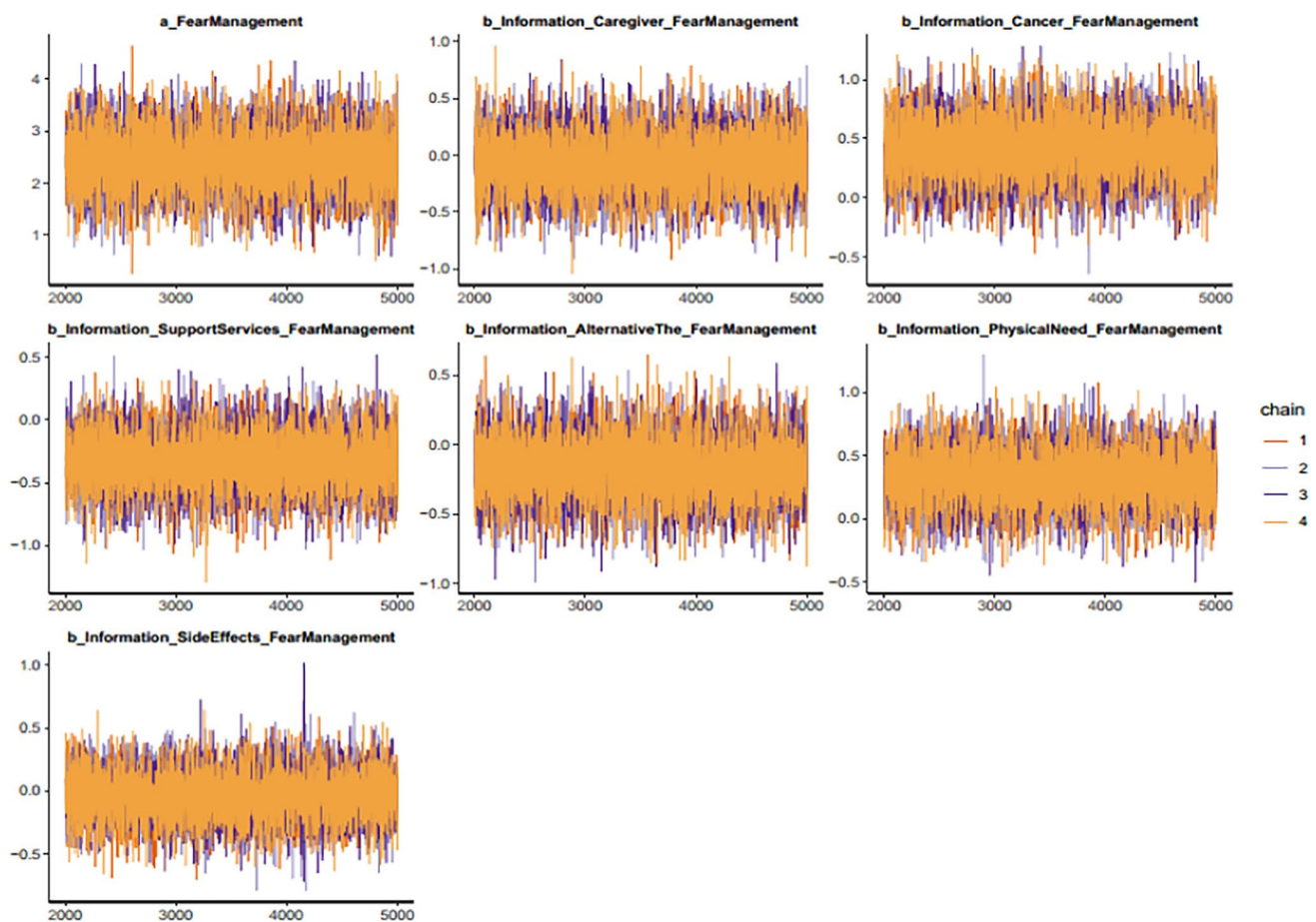


Fig. 3 Model 1's trace plots

A deep understanding emerges as a crucial foundation in the caregiver's journey, facilitating informed decisions across diverse facets of patient care [42]. This comprehension empowers caregivers to make well-informed choices regarding the patient's care, treatment, and overall well-being. Additionally, it assists caregivers in anticipating potential challenges and proactively addressing them [46]. The empowerment derived from staying informed becomes more than just a tool; it transforms into a source of resilience and confidence—essential elements for enhancing the quality of care provided to loved ones [20].

The positive relationship between a profound understanding of cancer and heightened confidence and competence suggests a notable impact on caregivers' experiences. Equipped with knowledge, caregivers assume a role with increased self-assurance, effectively mitigating uncertainties and anxieties inherent in caregiving within the context of a serious illness. This correlation is substantiated by research linking greater perceived self-competency and a sense of meaning to improved psychological outcomes for caregivers [55]. Grounded in factors like self-efficacy and healthcare decision-making capabilities, this perspective seamlessly aligns with the principles of patient-centered care [6, 29].

The observed positive coefficient suggests a connection between caregivers actively seeking information and their ability to address the physical needs of cancer patients [33]. Caregivers frequently express specific information needs related to providing direct care for cancer patients, underscoring the crucial role of knowledge in fulfilling caregiving responsibilities [35]. Further studies highlight the intimate link between caregiver burden, distress, and the quality of life with the physical health of cancer patients, underscoring the importance of addressing these needs [41]. As cancer increasingly transitions into a chronic disease, understanding and meeting long-term palliative care requirements become vital for sustaining the quality of life for both patients and caregivers. The positive impact also extends to the psychological well-being of both cancer patients and their caregivers [32].

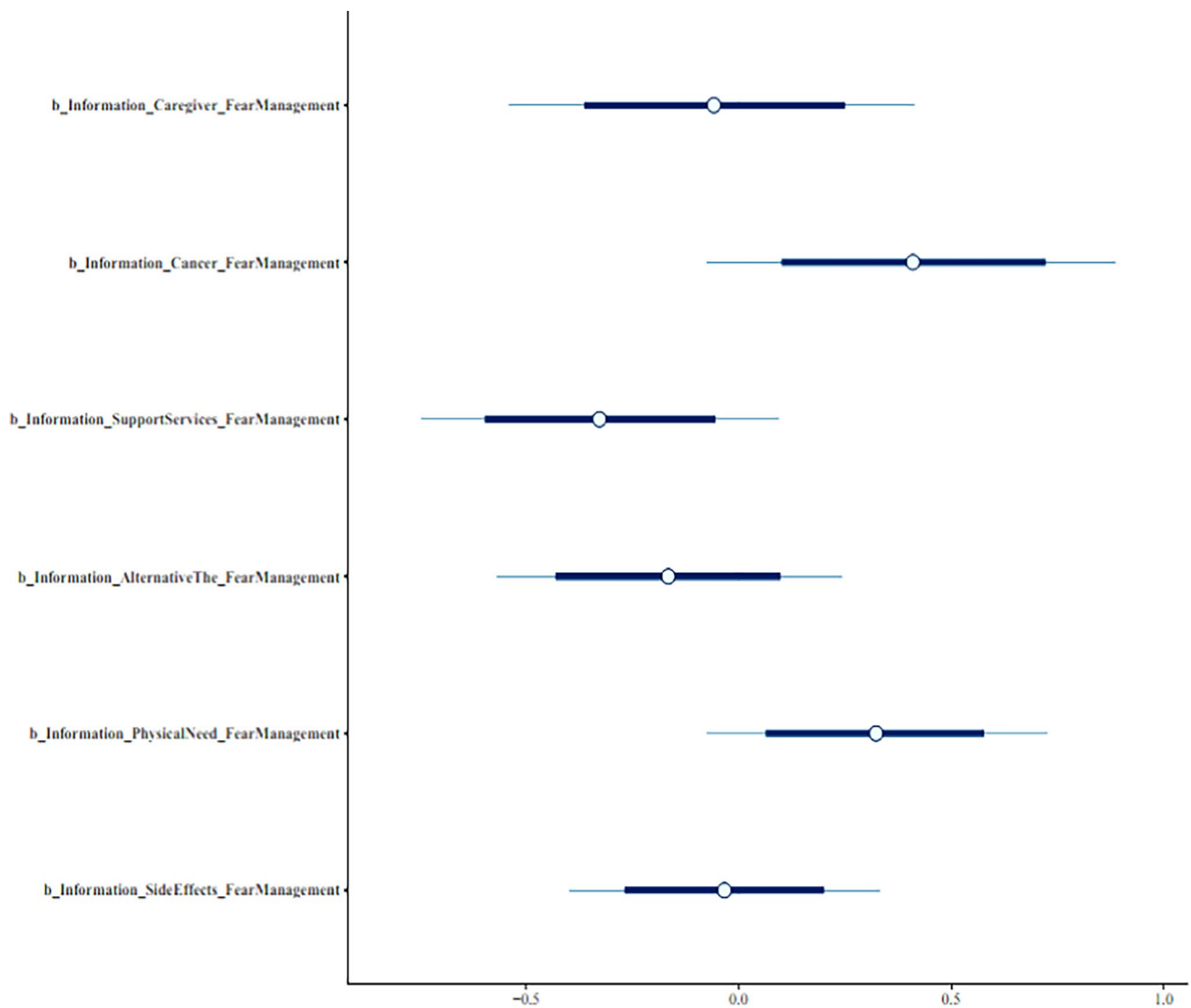


Fig. 4 Model 1's posterior distributions

The relationship between caregivers actively seeking comprehensive information about the cancer diagnosis and its physical implications and grappling with challenges in managing the emotional aspects of patients' fear is complex. Initially, delving into the specifics of cancer and its physical effects enhances caregivers' awareness of associated challenges, contributing to an increased emotional burden as they grasp the potential impact on the patient's well-being [22]. Furthermore, caregivers dedicated to understanding the intricacies of cancer may cultivate a deeper sense of empathy and concern for the patient's struggles, heightening their emotional connection and response to the patient's fear [25].

In contrast to traditional notions regarding the connection between information-seeking and the need for emotional support in caregiving, the surprising negative correlation disrupts prevailing assumptions [2]. Typically, one might assume that individuals actively seeking information about available support services would likely have a greater need for additional support, particularly in handling fears or concerns related to their caregiving responsibilities. However, the unexpected finding indicates an opposite correlation: family caregivers with higher demands for information on support services seem less likely to require additional support in fear management.

The noted negative correlation, as evidenced by the negative impact coefficient [54], triggers a thorough examination of the underlying factors that could clarify this unforeseen relationship. The study pinpoints various potential contributing factors, including minority status, shorter durations of caregiving, and a higher stress burden. These elements are crucial in unraveling the intricacy of the correlation between family caregivers' information-seeking behavior regarding support services and their perceived need for additional support in fear management. For example, the

consideration of shorter durations of caregiving acknowledges the substantial influence that the length of caregiving can wield over the caregiver's experience level and coping mechanisms. Shorter durations of caregiving often signify a novice status for caregivers, shaping their approach to information-seeking and emotional management [32], and inexperienced caregivers may face difficulties in coping and may struggle with efficient information processing [57]. The emotional impact of caregiving, influenced by the caregiver's duration, is pivotal as it correlates with caregiver burden and depression [47].

The analysis of an elevated stress burden recognizes stress's crucial role in influencing how caregivers perceive and react to support services [37]. Healthcare professionals, contending with high stress and burnout rates, encounter impediments in patient care, underscoring the influence of stress on professionals and, consequently, on fear management [43].

Exploring an increased stress burden is essential for comprehending how caregivers perceive and react to support services. Stress significantly shapes the efficacy of support services in fear management for caregivers [34]. Caregiver burden, often encountered by long-term caregivers, is linked to stressors and may result in depressive moods [47]. Early life stress in caregivers can notably influence their responsiveness, impacting the dynamics of caregiving [47]. Stress also induces muscle tension as a reflex reaction, illustrating the intricate interplay between stress levels and physical responses [47]. The support offered by families can either alleviate or worsen caregiver stress, underscoring the importance of a holistic understanding of stress in caregiving situations [51].

The results of the study establish a groundwork for crafting precise interventions and support services, especially in the field of cancer care. It emphasizes the significance of understanding the distinct information requirements of family caregivers, including their need for cancer-specific information and details regarding physical needs. This knowledge is essential for healthcare professionals to customize their support adeptly.

The difficulties caregivers encounter in obtaining information from healthcare professionals underscore the pressing necessity for improved communication and support systems. Employing principles from patient-centered care, as elucidated in nursing literature, becomes imperative. This approach highlights the importance of cultivating meaningful relationships with caregivers and thoroughly grasping their concerns and needs [29]. Recognizing that the information needs of family caregivers evolve throughout the cancer journey, it becomes essential to harness diverse information sources to address their changing requirements [7]. This enhanced understanding of the dynamic nature of caregiver dynamics has significant potential to enhance caregiver support and positively influence patient outcomes.

The complexities inherent in the caregiving experience, especially in fear management, highlight the need for customized information provision that considers caregivers' individual needs and preferences [50]. Embracing a multifaceted approach aligns with the acknowledgment that caregiving roles are varied and intricate, necessitating readiness for intellectual, emotional, and physical challenges [49]. Applying the basic psychological need theory, which centers on autonomy, competence, and relatedness, significantly contributes to effective caregiving [50]. This comprehensive perspective underscores the importance of a thorough understanding in shaping the caregiving experience and ensuring the well-being of both caregivers and patients.

Based on the findings, several recommendations could help enhance support for family caregivers (FCGs) of cancer patients. The study highlights the valuable role of both informational and emotional support, suggesting that targeted interventions may contribute to improved caregiver well-being and, in turn, better patient outcomes. Strengthening communication channels with caregivers is essential to ensure they receive timely, relevant information while addressing their evolving needs [48].

In this regard, healthcare professionals can develop and deliver caregiver-focused education programs to reduce uncertainty and support informed decision-making. For instance, educators and counselors could offer these programs through workshops, one-on-one counseling sessions, or digital platforms, providing caregivers with the knowledge and skills they need to manage changing caregiving demands effectively [31]. Additionally, hospital administrators may implement relevant information sessions and digital resources to help caregivers navigate their responsibilities with greater confidence [14].

Furthermore, doctors, nurses, and social workers could conduct regular check-ins—in person, by phone, or via telehealth—to assess caregivers' well-being, address emerging challenges, and offer timely guidance [18]. Mental health professionals, in particular, could integrate psychological support into healthcare services by providing counseling, facilitating peer support groups, and developing stress reduction programs to help caregivers manage emotional burdens. In addition, hospital and community care organizations could assess caregiver stress levels and offer targeted support, such as training, informational resources, and respite care, to alleviate their workload [23].

Moreover, researchers and program developers may design interventions adapted to caregivers' experience levels. For example, those with less experience may particularly benefit from structured guidance, while involving all caregivers

in decision-making can boost their confidence and sense of validation in their role [15]. Policymakers and healthcare administrators need to ensure that support programs acknowledge caregivers' cultural values and address potential barriers to effective caregiving [52].

By implementing these strategies, healthcare providers, policymakers, and community organizations could create a more supportive environment for caregivers, ultimately leading to better outcomes for both patients and their families.

5 Study limitations

Though the study provides valuable insights, it is crucial to recognize certain limitations [61]. One limitation is the study's cross-sectional design, which offers a snapshot of caregivers' experiences at a single point in time. Longitudinal studies would provide deeper insights into the evolving caregiving experience and the changing role of healthcare professionals, particularly nurses, in supporting caregivers throughout different stages of cancer care. Additionally, the regional focus of this study, with a sample of only 60 FCGs from a single geographical area, may limit the generalizability of the findings. Caregiving experiences can vary significantly across different regions, cultures, and healthcare systems. Therefore, the findings may not fully capture the diverse needs of cancer caregivers worldwide. For example, caregiving practices and cultural beliefs about illness differ across regions, and access to healthcare resources may vary. In cultures where caregiving is seen as a communal responsibility, the support systems available to caregivers may differ from those in more individualistic societies. Thus, the study's results may not reflect the experiences of caregivers in different cultural or socio-economic contexts.

To address these limitations, future research could consider including larger, more diverse samples from multiple regions, encompassing both urban and rural settings. This would help enhance the generalizability of the study and provide a broader understanding of caregiving across different healthcare systems and cultural contexts. Additionally, cross-cultural studies would be valuable to explore how caregiving needs and emotional support differ across various cultural and socio-economic environments. Gaining insight into these variations can assist healthcare professionals in designing their support to meet the unique needs of caregivers, particularly in regions with different caregiving dynamics. Another important consideration is the sample selection criteria. In this study, caregivers were selected based on their direct involvement in providing care to female cancer patients. This criterion may have influenced the caregiving experiences represented, as caregivers with a closer emotional connection to the patient may have different information needs and emotional responses compared to those less involved. Future studies could expand the selection criteria to include caregivers with varying levels of involvement, such as long-term versus short-term caregivers or those caring for patients with different types of cancer.

6 Practical implications

For practical implications, this study underscores that the demanded cancer-specific information, such as information on cancer prognosis and therapeutic outcomes, and the demanded cancer physical needs information are priorities in information disclosure to FCGs to assist their role in cancer fear management. Initially, nurses, for instance, need to assess the general unmet supportive care needs among cancer FCGs by using an instrument of SCNS-P&C45 and, later on, identify a specific need for assistance in cancer fear management. Once the need for support in managing cancer-related fear is identified, nurses can provide healthcare information through health education activities or family counseling. They should prioritize disclosing cancer-specific details and addressing physical needs before delivering other related information. This approach helps FCGs feel that healthcare professionals acknowledge their concerns about cancer fear management. In turn, FCGs can share this information with female cancer patients at home, helping to alleviate cancer-induced fear.

Acknowledgements We thank Widya Mandala Surabaya Catholic University, Indonesia, for providing a research grant, and the University of Pretoria, South Africa, for sponsoring this publication. We also thank all study respondents for their kind participation in making this study possible.

Author contributions NPWPS: conceptualization, data curation, formal analysis, methodology, supervision, funding acquisition, writing original draft, review-editing; MPTD: methodology, writing original draft, review-editing; MMP: visualization, writing original draft, review-editing,

PMAY: software, writing original draft, review-editing; MHN: conceptualization, methodology, supervision, validation, review-editing; QHV: project administration, resources, validation; AM: supervision, funding acquisition, resources, review-editing.

Funding This study was funded by the Centre for Research and Community Service, Widya Mandala Surabaya Catholic University, East Java, Indonesia, with grant registered number of 4514/WM01/N/2019. The publication was supported by University of Pretoria, South Africa.

Data availability The dataset generated and/or analyzed during the current study are available from the corresponding author, Adrino Mazenda (primary) and Ni Putu Wulan Purnama Sari (secondary), on a reasonable request.

Declarations

Competing interests The authors declare no competing interests.

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/>.

References

1. Arafah ABR, Notobroto HB. Factors associated with housewives behavior in doing breast self-assessment (in Bahasa Indonesia). *Indones J Public Health*. 2017;12(2):143–53.
2. Bangerter LR, Griffin J, Harden K, Rutten LJ. Health information-seeking behaviors of family caregivers: analysis of the health information national trends survey. *JMIR aging*. 2019;2: e11237.
3. Bechthold AC, Azuero A, Puga F, Ejem DB, Kent EE, Ornstein KA, Ladores SL, Wilson CM, Knoepke CE, Miller-Sonet E. What is most important to family caregivers when helping patients make treatment-related decisions: findings from a national survey. *Cancers*. 2023;15:4792.
4. Brooks SP, Gelman A. General methods for monitoring convergence of iterative simulations. *J Comput Graph Stat*. 1998;7(4):434–55.
5. Centre for Health Research and Psycho-oncology (ChERP), The Cancer Council New South Wales, Australia. 2009. The Supportive Care Needs Survey – Partners and Caregivers. Retrieved from: https://www.researchgate.net/publication/312701763_SCNS-PC45-with_revised_new_items-2009_VERSION_FOR_ALL_NEW_STUDIES
6. Chen J, Mullins CD, Novak P, Thomas SB. Personalized strategies to activate and empower patients in health care and reduce health disparities. *Health Educ Behav*. 2016;43:25–34.
7. Chen S-C. Information needs and information sources of family caregivers of cancer patients. *Aslib J Inf Manag*. 2014;66:623–39.
8. Cruz-Oliver DM. Palliative care: an update. *Mo Med*. 2017;114:110.
9. Csilléry K, Blum MGB, Gaggiotti OE, François O. Approximate Bayesian Computation (ABC) in practice. *Trends Ecol Evol*. 2010;25(7):410–8. <https://doi.org/10.1016/j.tree.2010.04.001>.
10. Diaconis P, Ylvisaker D. Quantifying prior opinion. In: Bernardo JM, DeGroot MH, Lindley DV, Smith AFM, editors. *Bayesian Statistics*, vol. 2. Amsterdam: North Holland Press; 1985. p. 133–56.
11. Dunson DB. Commentary: practical advantages of Bayesian analysis of epidemiologic data. *Am J Epidemiol*. 2001;153(12):1222–6. <https://doi.org/10.1093/aje/153.12.1222>.
12. Else-Quest NM, Jackson TL. Cancer stigma. In: Corrigan PW, editor. *The stigma of disease and disability: understanding causes and overcoming injustices*. Washington: American Psychological Association; 2014. p. 165–81. <https://doi.org/10.1037/14297-009>.
13. Emler AC, Bornstein BH. Trust in the medical profession: Reflections from the COVID-19 pandemic. In: Miller MK, editor. *The Social Science of the COVID-19 Pandemic: A Call to Action for Researchers*. Oxford: Oxford University Press; 2023. p. 234.
14. Fernandez-Bueno L, Torres-Enamorado D, Bravo-Vazquez A, Rodriguez-Blanco C, Bernal-Utrera C. Technological innovations to support family caregivers: a scoping review. *Healthcare*. 2024;12(23):2350. <https://doi.org/10.3390/healthcare12232350>.
15. Galletta M, Piazza MF, Meloni SL, Chessa E, Piras I, Arnetz JE, D'Aloja E. Patient involvement in shared decision-making: do patients rate physicians and nurses differently? *Int J Environ Res Public Health*. 2022;19(21):14229. <https://doi.org/10.3390/ijerph192114229>.
16. Gill J. *Bayesian methods: a social and behavioral sciences approach*. 3rd ed. Florida: CRC Press; 2015.
17. Gómez-Zúñiga B, Pulido R, Pousada M, Armayones M. The role of parent/caregiver with children affected by rare diseases: navigating between love and fear. *Int J Environ Res Public Health*. 2021;18:3724.
18. Haleem A, Javaid M, Singh RP, Suman R. Telemedicine for healthcare: capabilities, features, barriers, and applications. *Sens Int*. 2021;2: 100117. <https://doi.org/10.1016/j.sintl.2021.100117>.
19. Halsey LG, Curran-Everett D, Vowler SL, Drummond GB. The fickle P value generates irreproducible results. *Nat Methods*. 2015;12:179–85. <https://doi.org/10.1038/nmeth.3288>.
20. Hazelwood DM, Koeck S, Wallner M, Hoehn Anderson K, Mayer H. Patients with cancer and family caregivers: management of symptoms caused by cancer or cancer therapy at home. *HeilberufeSCIENCE*. 2012;3:149–58.
21. Holland JC, Kelly BJ, Weinberger MI. Why psychosocial care is difficult to integrate into routine cancer care: stigma is the elephant in the room. *J Natl Compr Canc Netw*. 2010;8(4):362–6. <https://doi.org/10.6004/jnccn.2010.0028>.

22. Johansen S, Cvancarova M, Ruland C. The effect of cancer patients' and their family caregivers' physical and emotional symptoms on caregiver burden. *Cancer Nurs*. 2018;41:91–9.
23. Joo JH, Bone L, Forte J, Kirley E, Lynch T, Aboumatar H. The benefits and challenges of established peer support programmes for patients, informal caregivers, and healthcare providers. *Fam Pract*. 2022;39(5):903–12. <https://doi.org/10.1093/fampra/cmz004>.
24. Kang EK, Keam B, Lee NR, Kang JH, Kim YJ, Shim HJ, Jung KH, Koh SJ, Ryu H, Lee J, Choo J, Yoo SH, Yun YH. Impact of family caregivers' awareness of the prognosis on their quality of life/depression and those of patients with advanced cancer: a prospective cohort study. *Support Care Cancer*. 2021;29(1):397–407. <https://doi.org/10.1007/S00520-020-05489-8/FIGURES/5>.
25. Kilic ST, Oz F. Family caregivers' involvement in caring with cancer and their quality of life. *Asian Pac J Cancer Prev: APJCP*. 2019;20:1735.
26. Kinoshita T. Risk Communication Thought and Technology Techniques of Contemplation and Trust. Kyoto: Nakanishiya Shuppan; 2016. (in Japanese).
27. Kristanti MS, Vernooij-Dassen M, Utarini A, Effendy C, Engels Y. Measuring the burden on family caregivers of people with cancer: cross-cultural translation and psychometric testing of the caregiver reaction assessment-indonesian version. *Cancer Nurs*. 2021;44(1):37. <https://doi.org/10.1097/NCC.0000000000000733>.
28. Kusi G, Boamah Mensah AB, Boamah Mensah K, Dzomeku VM, Apiribu F, Duodu PA, Adamu B, Agbadi P, Bonsu KO. The experiences of family caregivers living with breast cancer patients in low- and middle-income countries: a systematic review. *Syst Rev*. 2020;9:1–18.
29. Kwame A, Petrucka PM. A literature-based study of patient-centered care and communication in nurse-patient interactions: barriers, facilitators, and the way forward. *BMC Nurs*. 2021;20:1–10.
30. La V-P, Vuong Q-H. Bayesvl visually learning the graphical structure of Bayesian networks and performing MCMC with 'Stan. The comprehensive r archive network location; 2019. <https://doi.org/10.31219/osf.io/wyc6n>.
31. Légaré F, Adekpedjou R, Stacey D, Turcotte S, Kryworuchko J, Graham ID, Lyddiatt A, Politi MC, Thomson R, Elwyn G, Donner-Banzhoff N. Interventions for increasing the use of shared decision making by healthcare professionals. *Cochrane Database Syst Rev*. 2018. <https://doi.org/10.1002/14651858.cd006732.pub4>.
32. LeSeure P, Chongkham-Ang S. The experience of caregivers living with cancer patients: a systematic review and meta-synthesis. *J Personal Med*. 2015;5:406–39.
33. Li J, Luo X, Cao Q, Lin Y, Xu Y, Li Q. Communication needs of cancer patients and/or caregivers: a critical literature review. *J Oncol*. 2020. <https://doi.org/10.1155/2020/7432849>.
34. Liu Z, Heffernan C, Tan J. Caregiver burden: a concept analysis. *Int J Nurs Sci*. 2020;7:438–45.
35. Longacre ML. Cancer caregivers information needs and resource preferences. *J Cancer Educ*. 2013;28:297–305.
36. Mantello P, Ho M-T, Nguyen M-H, Vuong Q-H. Machines that feel: Behavioral determinants of attitude towards affect recognition technology—upgrading technology acceptance theory with the mindsponge model. *Humanit Soc Sci Commun*. 2023. <https://doi.org/10.1057/s41599-023-01837-1>.
37. Mason AE, Adler JM, Puterman E, Lakmazaheri A, Brucker M, Aschbacher K, Epel ES. Stress resilience: Narrative identity may buffer the longitudinal effects of chronic caregiving stress on mental health and telomere shortening. *Brain Behav Immun*. 2019;77:101–9.
38. McElreath R. Statistical rethinking: a Bayesian course with examples in R and Stan. Boca Raton: Chapman and Hall/CRC Press; 2018.
39. Nguyen MH, La VP, Le TT. Introduction to Bayesian mindsponge framework analytics: an innovative method for social and psychological research. *MethodsX*. 2022;9: 101808. <https://doi.org/10.1016/j.mex.2022.101808>.
40. O'Rourke L, Fisher PL, Campbell S, Wright A, Cherry MG. Factors associated with fear of cancer recurrence in family caregivers of cancer survivors: a systematic review. *Front Psychol*. 2021. <https://doi.org/10.3389/fpsyg.2021.625654>.
41. Özönder Ünal I, Ordu C. Decoding caregiver burden in cancer: role of emotional health, rumination, and coping mechanisms. *Healthcare*. 2023;11:2700.
42. Reinhard SC, Given B, Petlick NH, Bemis A. Supporting family caregivers in providing care. Patient safety and quality: An evidence-based handbook for nurses. 2008.
43. Rink LC, Oyesanya TO, Adair KC, Humphreys JC, Silva SG, Sexton JB. Stressors among healthcare workers: a summative content analysis. *Glob Qual Nurs Res*. 2023;10:23333936231161130.
44. Sari NPWP. Stress and fear in women living with cancer: an argumentation towards the adaptation theory. *Int J Public Health Sci (IJPHS)*. 2020;9(3):272–80. <https://doi.org/10.11591/IJPHS.V9I3.20413>.
45. Sari NPWP. Study report: needs analysis of palliative care stakeholders in community setting: the patients, families, professionals, and volunteers. Surabaya: Faculty of Nursing, Widya Mandala Surabaya Catholic University; 2020.
46. Schulz R, Eden J. Family caregivers interactions with health care and long-term services and supports. In: *Families Caring for an Aging America*. Washington: National Academies Press (US); 2016.
47. Schulz R, Sherwood PR. Physical and mental health effects of family caregiving. *AJN Am J Nurs*. 2008;108:23–7.
48. Sheehan J, Laver K, Bhojti A, Rahja M, Usherwood T, Clemson L, Lannin NA. Methods and effectiveness of communication between hospital allied health and primary care practitioners: a systematic narrative review. *J Multidiscip Healthc*. 2021;14:493–511. <https://doi.org/10.2147/jmdh.s295549>.
49. Sherman DW. A review of the complex role of family caregivers as health team members and second-order patients. *Healthcare*. 2019;7:63.
50. Slatyer S, Aoun SM, Hill KD, Walsh D, Whitty D, Toye C. Caregivers' experiences of a home support program after the hospital discharge of an older family member: a qualitative analysis. *BMC Health Serv Res*. 2019;19:1–10.
51. Stevenson C, Wakefield JR, Kellezi B, Stack RJ, Dogra S. Families as support and burden: a mixed methods exploration of the extent to which family identification and support predicts reductions in stress among disadvantaged neighbourhood residents. *J Soc Pers Relat*. 2022;39:886–907.
52. Stubbe DE. Practicing cultural competence and cultural humility in the care of diverse patients. *Focus*. 2020;18(1):49–51. <https://doi.org/10.1176/appi.focus.20190041>.
53. Tanemura N, Kakizaki M, Kusumi T, Onodera R, Chiba T. Levels of trust in risk-only negative health messages issued by public agencies: a quantitative research-based mindsponge framework. *Human Soc Sci Commun*. 2022. <https://doi.org/10.1057/s41599-022-01415-x>.

54. Teixeira MJC, Abreu W, Costa N, Maddocks M. Understanding family caregivers' needs to support relatives with advanced progressive disease at home: an ethnographic study in rural Portugal. *BMC Palliat Care*. 2020;19:1–11.
55. Teo I, Baid D, Ozdemir S, Malhotra C, Singh R, Harding R, Malhotra R, Yang MG, Neo SH-S, Cheung YB. Family caregivers of advanced cancer patients: self-perceived competency and meaning-making. *BMJ Support Palliat Care*. 2019;10:435.
56. Ugalde A, Winter N, Sansom-Daly UM, Rhee J, Jongebloed H, Bergin RJ, Livingston PM. Effective integration of caregivers and families as part of the care team for people with cancer. *Aust J Gen Pract*. 2021;50:527–31.
57. Uren SA, Graham TM. Subjective experiences of coping among caregivers in palliative care. *Online J Issues Nurs*. 2013;18:88.
58. Vaughn L. Psychology and Culture: Thinking, Feeling and Behaving in a Global Context. 2019. Retrieved from: https://books.google.co.id/books?hl=en&lr=&id=AtqMDwAAQBAJ&oi=fnd&pg=PP1&dq=culture+and+human+thinking+or+human+behavior&ots=yK9ooc3eYf&sig=Icy3xvi4kbl3qFOEwSdJ3SjCAQo&redir_esc=y#v=onepage&q=culture%20and%20human%20thinking%20or%20human%20behavior&f=false
59. Vehtari A, Gabry J. Bayesian Stacking and Pseudo-BMA weights using the loo package. (Version loo 2.2.0). 2019. <https://mc-stan.org/loo/articles/loo2-weights.html>
60. Vehtari A, Gelman A, Gabry J. Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. *Stat Comput*. 2017;27(5):1413–32. <https://doi.org/10.1007/s11222-016-9696-4>.
61. Vuong QH. The limitations of retraction notices and the heroic acts of authors who correct the scholarly record: an analysis of retractions of papers published from 1975 to 2019. *Learn Pub*. 2020;33(2):119–30. <https://doi.org/10.1002/leap.1282>.
62. Vuong QH. *Mindsponge Theory*. Berlin: Walter de Gruyter. 2023. <https://books.google.com/books?id=OSiGEAAQBAJ>
63. Vuong QH. *The Kingfisher Story Collection*. 2022. <https://www.amazon.com/dp/B0BG2NNHY6>
64. Vuong QH, Nguyen MH, La VP. *The Mindsponge and BMF Analytics for Innovative Thinking in Social Sciences and Humanities*. Berlin: Walter de Gruyter. 2022. <https://books.google.com/books?id=EGeEEAAQBAJ>
65. Vuong QH, Nguyen MH. Further on informational quanta, interactions, and entropy under the granular view of value formation. *SSRN*. 2024. <https://doi.org/10.2139/ssrn.4922461>.
66. World Health Organization (WHO). *Cancer Country Profiles (2014)*. 2015. Available from: <https://www.who.int/cancer/country-profiles/en/>

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