Nutritional status and quality of life of patients with breast cancer receiving chemotherapy

TIEN THI HONG NGUYEN[1], PHUONG THI THU PHAM[2], BACH VIET HOANG[1], THUY THI TRAN[1] and HUONG THI LE[1,3]

[1]Department of Clinical Nutrition, Vietnam National Cancer Hospital, Hanoi 100000, Vietnam; [2]Ho Chi Minh Orthopedics and Rehabilitation Hospital, Ho Chi Minh City 700000, Vietnam; [3]School of Preventive Medicine and Public Health, Hanoi Medical University, Hanoi 100000, Vietnam

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Abstract. Nutritional status is a critical factor influencing the treatment outcomes and quality of life of patients with breast cancer. Likewise, quality of life can also affect the nutritional status and treatment efficacy, creating a dynamic, interdependent association. The present study investigated the nutritional status and quality of life of patients with breast cancer undergoing chemotherapy. The present cross-sectional study enrolled 195 patients aged ≥18 years and the analysis were performed using the patient-generated subjective global assessment tool alongside anthropometric measurements. Quality of life was evaluated using the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ)-C30 and EORTC QLQ-BR23. According to body mass index classification, malnutrition accounts for a small proportion (5.6% of participants), whereas overweight and obesity account for a higher proportion (15.9% of participants). According to the patient-generated subjective global assessment, the incidence of malnutrition proportion was higher, accounting for 25.6%. The quality of life according to EORTC QLQ C30 indicated that the global health status was 63.2±13.6 points, while physical functioning had the highest value (79.4±20.0 points); social functioning exhibited an opposite trend. The average points of the symptom scales were 18.9±18.8 points; insomnia and fatigue were the most negative symptoms of patients with breast cancer. For the quality of life according to EORTC QLQ-BR23, the average point of functional scales was 30.1±16.1 points, whereas the figure for symptom scales was 12.6±10.0 points. On the whole, the present study demonstrates that obesity is a key issue that warrants attention among patients. Moreover, quality of life is markedly impacted by the side-effects of chemotherapy, with sleep disturbances being the most common symptom.

Correspondence to: Miss Phuong Thi Thu Pham, Ho Chi Minh Orthopedics and Rehabilitation Hospital, 1A Ly Thuong Kiet Street, Ho Chi Minh City 700000, Vietnam
E-mail: phamphuongahihi@gmail.com

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Introduction

Globally, it is estimated that there were ~19.9 million new cancer cases and almost 10.0 million cancer-related deaths in 2022, including 2.3 million women diagnosed with breast cancer and 665.684 related deaths worldwide (1). In Vietnam, according to GLOBOCAN 2022, ~24.563 women were diagnosed with breast cancer, rendering it the leading type of cancer among women (2). There is evidence to indicate that malnutrition is prevalent among patients with cancer and it adversely affects their tolerance to treatment, response to therapy and quality of life (3). A previous study in Iran on the association between the nutritional status and quality of life of patients with breast cancer found that the average body mass index (BMI) values before and after breast cancer diagnosis were 26.8±3.4 and 27.4±2.3 kg/m^2, respectively (4). Notably, ~94.0% of the participants were not at risk of malnutrition according to the patient-generated subjective global assessment (PG-SGA), and 6.0% were at a moderate risk of malnutrition (PG-SGA B) (4). In Vietnam, a previous cross-sectional descriptive study conducted at Hanoi Oncology Hospital in 2016 involving 325 patients with cancer revealed that patients with breast and gynecological cancers had the highest rates of overweight and obesity (32.9%), while the prevalence of undernutrition remained significant at 35.8% according to BMI classification (5). As regards quality of life, a cross-sectional study in Saudi Arabia using the QLQ-C30 and QLQ-BR23 quality of life scales demonstrated that, in general, the quality of life of patients with breast cancer was relatively good; however, insomnia and fatigue were the symptoms that most common symptoms experienced by the patients (6). In another study conducted at Thu Duc District General Hospital in Vietnam, the quality of life of patients with breast cancer was assessed and was found to be at a moderate level (66.6±16.2 points) (7).

Investigating the nutritional status of patients with breast cancer will provide useful information and evidence to help doctors and dietitians make timely interventions for patients, thereby improving their quality of life. However, in Vietnam, there remains a lack of comprehensive

research addressing both the nutritional status and quality of life of breast patients with cancer, particularly during chemotherapy. The Vietnam National Cancer Hospital is the largest medical facility in the country specializing in cancer diagnosis and treatment in general and breast cancer in particular. Therefore, the present study was conducted in an aim to fill the identified research gap. The present study aimed to assess the nutritional status and quality of life of breast cancer patients undergoing chemotherapy at Vietnam National Cancer Hospital.

Materials and methods

Ethics approval. The present study was approved by the Hanoi Medical University (Hanoi, Vietnam) under Decision no. 2026/QD-DHYHN dated May 27, 2024, concerning the establishment of Bachelor of Nutrition Thesis Evaluation Committee for the 2020-2024 cohort. All participants voluntarily consented to take part in the study after receiving information about the objectives, procedures and potential implications of the study.

Study design and setting. The present cross-sectional study was carried out at The Departments of Breast and Gynecologic Medical Oncology of Vietnam National Cancer Hospital (Hanoi, Vietnam) from August, 2023 to March, 2024.

Study population. There were 195 patients with breast cancer aged >18 years, who had a mastectomy, and were receiving the same type of chemotherapy. The inclusion criteria included patients who agreed to participate in the interview and research. The exclusion criteria included patients who required intensive treatment, had limited communications and could not answer the questions or who had non-communicable diseases, such as diabetes or high blood pressure.

Study procedures. Participants were recruited through convenience sampling. Following medical record verification and eligibility confirmation, patients were invited to participate. Data collection encompassed general information, nutritional status through BMI, the scored (PG-SGA), quality of life according to the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ)-C30 and EORTC QLQ-BR23.

Nutritional status assessments. Nutritional status was assessed through BMI as follows: BMI=weight/(height)^2. BMI was classified into three levels as follows: Chronic energy deficiency, BMI ≤18.5 kg/m^2; normal, BMI >18.5 and <25 kg/m^2; and overweight and obesity, BMI ≥25 kg/m^2.

The nutritional status was evaluated using the nutritional assessment. The scored PG-SGA was classified as follows: PG-SGA A, well nourished; PG-SGA B, moderately malnourished or suspected of being malnourished; and PG-SGA C, severely malnourished.

Quality of life questionnaires. Quality of life was evaluated according to the EORTC QLQ-C30 questionnaire: A total of 30 questions were measured on four levels from 1 (not at all) to 4 (very much). This was then converted to a 100-point scale and scores were calculated and evaluated using the methods of the EORTC research team (8).

For overall function and health scores, a higher score indicated improved function and health. The higher the symptom score, the more severe and worsening the symptoms become. Quality of life was evaluated according to the EORTC QLQ-BR23 questionnaire: This was converted to a 100-point scale and the method of calculating and evaluating scores was similar to the QLQ-C30. The present study used the Vietnamese version of the questionnaire developed by the EORTC (9). The present study obtained permission and received the Vietnamese questionnaire, the data analysis manual, and the reference dataset via email from EORTC.

Statistical analysis. Data processing was performed using EpiData 3.1 software for entry and cleaning. Statistical analyses were conducted using STATA 14.0. For variables that did not follow a normal distribution, data were analyzed using the Kruskal-Wallis test followed by the Dwass-Steel-Crichtlow-Fligner test with a 95% confidence level. Fisher's exact test was used to examine the association between variables. A P-value <0.05 was considered to indicate a statistically significant difference.

Results

General characteristics and nutritional status of the patients. The present study was carried out on 195 patients with breast cancer with an average age of 49.3±9.1 years; the age group of 40-59 years accounted for the highest proportion of patients (70.3%). The general characteristics of the study participants (n=195) are presented in Table I.

As demonstrated in Table I, 5.6% of the study subjects were in chronic energy deficiency. Overweight and obesity accounted for 15.9% of the patients. Nutritional risk assessment using the PG-SGA tool identified that 74.4% of the study subjects had a good nutritional status (PG-SGA A); 21.1% were at risk of moderate malnutrition (PG-SGA B) and 4.5% were at risk of severe malnutrition (PG-SGA C). The rate of severe malnutrition risk (PG-SGA C) was only found in the age group of ≥60 years, accounting for 9% of the patients. Moreover, in this age group, the rate of moderate malnutrition risk (PG-SGA B) was 36.4%, and those with no malnutrition risk accounted for 54.6%. In the age group of 40-59 years, 76.6% of the patients had no malnutrition risk (PG-SGA A), 23.4% were at moderate malnutrition risk (PG-SGA B), and no patients were in the PG-SGA C group. Similarly, in the 18-39 age group, 88% of the patients had no malnutrition risk (PG-SGA A), and 12% were at a moderate malnutrition risk (PG-SGA B). The difference was statistically significant (P<0.05). As regards the assessment of the nutritional status according to the hemoglobin index, the anemia rate was 26.2%.

Quality of life of the patients. According to the 100-point scale of the QLQ-C30 scale, the global health status score was 63.2±13.6 points, the functional scales exhibited an average score of 57.9±23.1 points and the symptom scale scores were 18.9±18.8 points. The results of the quality of life of the patients according to EORTC QLQ-C30 are presented in Table II.

Table I. General characteristics of the study participants (n=195).

Characteristics	Age groups, years n (%)			Total	Percentage
	18-39	40-59	>60		
BMI classification (kg/m^2)					
Chronic energy deficiency (<18.5)				11	5.6
Normal (18.5-24.9)				153	78.5
Overweight/obese (≥25)				31	15.9
PG-SGA classification (P=0.002[a])					
PG-SGA A	22 (88.0%)	105 (76.6%)	18 (54.6%)	145	74.4
PG-SGA B	3 (12.0%)	32 (23.4%)	12 (36.4%)	47	21.1
PG-SGA C	0 (0%)	0 (0%)	3 (9%)	3	4.5
Anemia status					
Anemia (hemoglobin <120 g/l)				51	26.2
Non-anemia (hemoglobin(≥120 g/l))				144	73.8

[a]Data were analyzed using Fisher's exact test (P=0.002). BMI, body mass index; PG-SGA, patient-generated subjective global assessment.

Table II. Quality of life according to EORTC QLQ-C30 (n=195).

Characteristics	Items	Mean ± SD
	Global health status	63.2±13.6
Functional scales	Physical functioning	79.4±20.0
	Role functioning	53.9±25.5
	Cognitive functioning	57.0±23.3
	Emotional functioning	54.9±20.9
	Social functioning	44.6±25.6
	Average score	57.9±23.1
Symptom scales	Fatigue	36.2±25.9
	Nausea and vomiting	6.7±15.7
	Pain	26.9±27.7
	Dyspnoea	9.1±17.7
	Insomnia	42.6±31.1
	Appetite loss	22.2±30.4
	Constipation	5.8±17.9
	Diarrhoea	2.2±9.6
	Average score	18.9±18.8
Financial scale	Financial difficulties	57.4±25.0

EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire - Core 30.

Table III. Association between certain symptoms according to the EORTC QLQ-C30 scoring system and the nutritional status of patients based on PG-SGA.

Parameter	PG-SGA			P-value[a]
	A	B	C	
Insomnia	38.6±30.6	54.0±31.0	55.6±19.2	0.01
Fatigue	31.2±24.0	49.9±25.3	66.7±33.3	0.0001
Pain	22.6±26.1	40.1±29.4	27.8±9.6	0.001
Appetite loss	14.9±26.3	41.8±31.4	66.7±33.3	0.0001

[a]Data were analyzed using the Kruskal-Wallis test. PG-SGA, patient-generated subjective global assessment; European Organization for Research and Treatment of Cancer Quality of Life Questionnaire - Core 30.

Association between symptoms and nutritional status of the patients. As regards the association between symptoms and nutritional status of the patients, the scores for symptoms according to the QLQ-C30 scale gradually increased with each PG-SGA stage. Specifically, the insomnia score for patients with no malnutrition risk (PG-SGA A) was 38.6±30.6 points, while for those at a moderate and severe risk of malnutrition (PG-SGA B and PG-SGA C), the scores are 54.0±31 points and 55.6±19.2 points, respectively. A similar trend was observed for the symptoms of fatigue and loss of appetite. However, for the symptom of pain, the patients with breast cancer in the PG-SGA B category had the highest score (40.1±29.4 points), followed by those in the PG-SGA C category (27.8±9.6 points). Lastly, the group with no malnutrition risk (PG-SGA A) had the lowest score (22.6±26.1 points). These differences were statistically significant (P<0.05) (Table III).

Quality of life according to QLQ-BR23. The functional score according to QLQ-BR23 was 30.1±16.1 points and the symptoms score was 12.6±10.0 points (Table IV).

Association between certain functional scales according to the QLQ-BR23 scoring system and the patient age groups. The age group >60 years had higher scores for body image and future perspectives compared to the other two age groups. However, their sexual functioning and sexual enjoyment scores were the lowest. The opposite trend was

Table IV. Quality of life according to EORTC QLQ-BR23.

Functional scales	Mean Mean ± SD	Symptom scales	Mean Mean ± SD
Body image	60.1±37.1	Systemic therapy side-effects	21.4±15.0
Sexual functioning	12.6±16.3	Breast symptoms	8.1±13.0
Sexual enjoyment	9.4±16.5	Arm symptoms	12.4±13.4
Future perspectives	38.5±30.4	Upset by hair loss	8.5±24.5
Functional score	30.1±16.1	Symptom score	12.6±10.0

European Organization for Research and Treatment of Cancer Quality of Life Questionnaire - BR23.

Table V. Association between certain functional scales according to the EORTC QLQ-BR23 scoring system and the patient age groups.

	Age			
Functional scales	18-39 years	40-59 years	>60 years	P-value[a]
Body image	34.3±38.0	57.9±35.7	89.1±21.1	0.0001
Sexual functioning	22.0±18.5	13.3±16.2	2.5±8.5	0.0001
Sexual enjoyment	17.3±21.8	9.7±16.3	2.0±8.1	0.0029
Future perspectives	28.0±30.0	37.9±30.0	48.5±30.2	0.0215

[a]Data were analyzed using the Kruskal-Wallis test. European Organization for Research and Treatment of Cancer Quality of Life Questionnaire - BR230.

observed for the age group of 18-39 years, which had the lowest scores for body image and future perspectives among the three groups, but had higher scores for sexual function and sexual enjoyment. These differences were statistically significant (P<0.05; Table V).

Discussion

The nutritional status of the study subjects based on BMI indicated that 15.9% of the patients were overweight or obese. A previous cross-sectional descriptive study conducted on 325 patients with cancer treated at Hanoi Cancer Hospital in 2016 by Hai (10) found that patients with breast and gynecological cancer had the highest rates of overweight and obesity (32.9%) among all cancer patients, with a malnutrition rate of 35.8%. Another study in Brazil found that 77% of the patients were overweight or obese, and 2% were underweight (11). The issue of overweight and obesity in patients with breast cancer is receiving increasing attention, with potential causes attributed to chemotherapy-induced ovarian failure, hormonal changes and early menopause, leading to a reduction in metabolism in these patients. Additionally, other factors such as decreased physical activity and increased calorie intake have also been mentioned (12,13).

Therefore, the prevalence of overweight and obesity in patients with breast cancer in the present study was lower than that observed in the aforementioned studies, although it remained relatively high. This discrepancy may be attributed to variations in ethnicity, as well as differences in the sample size and population characteristics across the studies.

The present study revealed that 25.6% of the patients were at a risk of moderate to severe malnutrition (PG-SGA B and C), with 4.5% of the patients classified as suffering from severe malnutrition. The study by Trang *et al* (14) at Gia Định People's Hospital reported that 32.4% of the patients were classified as PG-SGA B and 2.9% as PG-SGA C. The results of the present study are also consistent with those of a study conducted in Brazil using SGA, which found that 80.8% of the patients were well-nourished (SGA A) and 19.2% were moderately malnourished (SGA B) (15). Although patients with breast cancer have a higher possibility of being overweight or obese, some patients remain at a high risk for malnutrition due to the prolonged treatments and side-effects of therapeutic interventions. Therefore, it is essential to assess the nutritional status of patients with breast cancer to ensure that those at risk of malnutrition are not overlooked and receive appropriate interventions, as well as nutritional counseling and care during treatment and after discharge.

In terms of the risk of malnutrition according to age group and PG-SGA, the present study revealed that the proportion of patients classified as PG-SGA A decreased with age, while the proportion of patients classified as PG-SGA B and C increased with age. Specifically, the rate of patients with PG-SGA B in the 18-39 age group was 12.0%, which increased to 23.4% in the 40-59 age group, and 36.4% in the age group >60 years. Additionally, the risk of severe malnutrition (PG-SGA C) was only observed in patients >60 years of age. This difference was statistically significant (P<0.05). The Lieu *et al* (5) on patients with gynecological cancer also found a similar trend. This is entirely consistent, as older patients typically have a

poorer physical condition, reduced endurance and less efficient nutrient absorption. This population is more vulnerable both physically and psychologically, with additional factors such as cognitive decline, loss of appetite, immobility, and oral health problems further exacerbating their nutritional status. Therefore, regular and thorough monitoring, care and nutritional assessment of elderly patients with cancer is essential.

The prevalence of anemia in patients with breast cancer in the present study was relatively high, accounting for 26.2%. A previous study involving 247 Austrian patients with breast cancer with non-metastatic disease treated with four cycles of non-platinum adjuvant chemotherapy reported an anemia rate of 37.9% among patients who underwent mastectomy, compared to 22.8% among those who had lumpectomy (16). The findings of the present study are lower than those observed in the study by Lieu *et al* (5) on patients with gynecological cancer at the Central Obstetrics and Gynecology Hospital, where the anemia rate was 32.0%, and those in the study by Nguyen *et al* (17) on patients with cancer in general, where the anemia rate was 59.2%. These differences may be due to variations in the study populations. However, it is evident that, despite differences in anemia rates across studies, the prevalence of anemia among patients with cancer is generally high. Therefore, when providing nutritional counseling for patients with cancer, attention should be paid to foods rich in iron that can stimulate red blood cell production and support the generation of other blood cells.

As regards the quality of life in patients with breast cancer, the overall quality of life score, measured using the QLQ-C30 scale, was 63.2±13.6 points, which is consistent with the findings of the studies by Nguyen (18) (61.8±13.9 points), Nghi *et al* (19) (60.1±15.8 points), and a study in Ethiopia (61.3±20.8 points) (20). The average functional score was 58.0±23.1 points, indicating a marked decline in the overall quality of life and functionality of the patients. Physical function had the highest score (79.4±20.0 points), while scores in other items indicated notable impairments, particularly in social function (44.6±25.6 points). For women, body image and appearance play a crucial role in their mindset and daily lives. Patients with breast cancer, after undergoing surgery and chemotherapy, may experience mental health issues such as anxiety, low self-esteem, depression, or frustration (21). Moreover, these patients often temporarily suspend social relations and community activities to focus on treatment and personal recovery. These factors may explain why emotional and social functions in breast cancer patients have lower scores.

The present study also revealed that the most bothersome symptoms for patients were sleep disturbances and fatigue. Insomnia is a common issue among middle-aged women, particularly those following menopause, due to physiological and emotional changes. The majority of the study participants fall into this age group, and the aforementioned physical, psychological and other symptoms contribute to insomnia being the most common symptom. Modern medicine has not yet found a strategy to avoid this, and patients have to accept it as a 'price to pay' for having their lives saved (7). Statistical analysis reveals significant differences ($P<0.05$) in insomnia scores and nutritional status based on PG-SGA. Patients with moderate and severe malnutrition risk (PG-SGA B and C) experience more severe insomnia compared to those without malnutrition risk (PG-SGA A). Furthermore, sleep disturbance scores were higher among patients with chronic energy deficiency (BMI ≤18.5 kg/m^2) compared to those with a normal BMI (18.5-24.9 kg/m^2). Poor nutritional status impairs immune function and the ability to tolerate treatment side-effects, further affecting sleep. These findings are consistent with those of the study by Shooka Mohammadi's on 100 patients with breast cancer in Iran, which found that a poorer nutritional status was associated with more severe symptoms (4). Besides sleep disturbances, symptoms such as fatigue, pain, and loss of appetite also showed significant differences ($P<0.05$) across PG-SGA-based nutritional status groups. Patients at moderate and severe risk of malnutrition (PG-SGA B and C) had higher symptom scores compared to those without malnutrition risk (PG-SGA A). A cross-sectional study on patients with gynecological cancer, including 68.7% patients with breast cancer, indicated that loss of appetite and fatigue are closely linked to malnutrition, particularly among patients undergoing chemotherapy, as the drugs used significantly alter taste perception, increasing the risk of weight loss and various nutritional deficiencies (22). However, quality of life domains depend largely on individual perceptions, meaning that each individual and demographic group may experience symptoms differently. Furthermore, treatment regimens and medication usage vary across countries, leading to differences in the severity of symptoms experienced by patients. Dietary patterns rich in fruits, vegetables, whole grains and anti-inflammatory fatty acids could improve cancer-related fatigue in patients with cancer and cancer survivors. Some research suggests that nutritional supplements could improve cancer-related fatigue outcomes (3). However, there is very limited research available on this topic, and few resources are available for cancer survivors with fatigue currently. Further studies, particularly clinical trials, examining dietary interventions for cancer-related fatigue are required, to establish cancer-related fatigue and determine specific dietary recommendations for patients with cancer and survivors (3).

The QLQ-BR23 questionnaire, specifically designed for patients with breast cancer, revealed an average functional score of 30.1±16.1 points in the present study. The highest scores were found in body image (60.1± 37.1 points) and future perspectives (38.5±30.4 points), while sexual function had the lowest score (12.6±16.3 points). The body image score in the present study had the highest functional score (60.1±37.1 points), similar to the findings of the study by Ngoc *et al* (23) (64.2±19.4 points), a study in Kuwait (23) (61.8±23.3 points), but lower than those in the study by Hoang *et al* (7) (76.5±24.9 points). Concerns about body image are common among patients with breast cancer, particularly following surgery, as it is linked to a range of psychological, physical and social issues (24). In the present study, inn terms of symptoms, the QLQ-BR23 symptom score was 12.6±10.0 points, indicating that the participants experienced post-surgery symptoms such as side-effects from systemic therapy (21.4±15.0 points), breast symptoms (8.1±13.0 points) and arm symptoms (12.4±13.4 points). Currently, excessive mastectomy and axillary lymph node dissection have been reduced, thereby minimizing discomfort in the arm and breast areas. The present study also highlights the association between quality of life and age, particularly in the functional scores. As age increases, the body image and future perspective scores

are higher, while sexual function and sexual enjoyment scores are lower. These results should be interpreted with caution. Sociocultural norms and attitudes, particularly in Vietnam, may influence how older patients perceive and report their body image and sexual functioning. Additionally, response bias, including social desirability or reluctance to disclose sensitive information, may have affected the accuracy of self-reported data (21). Future studies using suitable tools may help to further elucidate these findings. In the present study, in the age group >60 years, the body image score was 89.1 points, almost 3-fold higher than that in the age group of 18-39 years. The future perspective score for the 18-39 age group was 28 points, which increased progressively to 38 points for the 40-59 age group and 48.5 points for the >60 years age group. This may be explained by the fact that middle-aged patients tend to have a more positive and gentler outlook on the future and bodily changes than younger patients. Long-term breast cancer survivors appear to be better mentally prepared to cope with treatment methods, despite accompanying comorbidities (25,26). Concerns about body image in younger women are often related to mastectomy, surgical scars, and physical changes due to adjuvant therapy, which can significantly affect quality of life, particularly as regards body image perception in younger women (27). A previous systematic review found that younger patients with breast cancer may experience different issues contributing to reduced quality of life, including psychological problems and depression, weight gain, lack of physical activity during treatment, and concerns about menopause (28). Furthermore, other research has noted that younger patients with breast cancer are more concerned about their appearance (29). Overall, younger women tend to experience more psychological distress than older women (30,31). Younger patients with breast cancer (18-39 years of age) face more psychological barriers, feelings of low self-esteem, and disappointment, especially those who are unmarried or newly married.

The present study has several limitations that should be acknowledged. First, due to its cross-sectional design, nutritional status and quality of life were assessed at a single time point during chemotherapy, which limits the ability to observe changes over the course of treatment or establish causal relationships between variables. Future studies using longitudinal designs are recommended to explore changes in nutritional status and their potential impacts on quality of life throughout the treatment trajectory.

Secondly, although patients with chronic diseases such as diabetes, hypertension, liver, and kidney diseases were excluded, other potential confounding factors, such as cancer stage, chemotherapy cycle and comorbidities were not controlled for in the analysis, which may have influenced the study outcomes. Further studies are thus warranted to incorporate these variables to provide a more comprehensive understanding.

In conclusion, the present study highlights that while the majority of patients with breast cancer have a normal nutritional status, the prevalence of overweight and obesity remains relatively high. The quality of life of patients with breast cancer is significantly affected by the side-effects of adjuvant treatment, with sleep disturbances being the most common symptom. Women with breast cancer require support and counseling on psychological, social and sexual health issues. Expanding health insurance coverage and providing additional financial support for cancer patients in general should be implemented.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

All authors (TTHN, PTTP, BVH, TTT and HTL) conceptualized and designed the study. TTHN and TTPP performed the statistical analysis. TTHN, PTTP and HTL interpreted the data and drafted the original manuscript. All authors contributed substantially to manuscript revision and critically reviewed the content, and all authors have read and approved the final version. TTHN and HTL confirm the authenticity of all the raw data.

Ethics approval and consent to participate

The present study was approved by the Hanoi Medical University (Hanoi, Vietnam) under Decision no. 2026/QD-DHYHN dated May 27, 2024, concerning the establishment of Bachelor of Nutrition Thesis Evaluation Committee for the 2020-2024 cohort. All participants voluntarily consented to take part in the study after receiving information about the study's objectives, procedures and potential implications.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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