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Original Article

Symptoms associated with concurrent chemoradiotherapy in patients with cervical cancer: Application of latent profile analysis and network analysis

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ABSTRACT

Objective: This study aims to explore symptom subgroups and influencing factors among patients undergoing concurrent chemoradiotherapy (CCRT) for cervical cancer, to construct a symptom network, and to identify core symptoms within the overall sample and its various subgroups.

Methods: A cross-sectional survey was conducted with 378 patients undergoing CCRT for cervical cancer from June 2023 to May 2024 at a tertiary hospital in Anhui Province. Participants completed the General Information Questionnaire, the Symptom Assessment Scale for Patients Undergoing CCRT for Intermediate and Advanced Cervical Cancer, and the Dyadic Coping Inventory. Latent profile analysis (LPA) identified symptom subgroups, while multivariate logistic regression examined influences on these subgroups. Symptom networks were developed using R language to analyze centrality indices and identify core symptoms.

Results: Patients were classified into three subgroups: low symptom burden (n = 200, 52.91%), moderate symptom burden with prominent intestinal response (n = 75, 19.84%), and high symptom burden (n = 103, 27.25%). Multivariate logistic regression indicated that age, tumor stage, chemotherapy frequency, and dyadic coping (DC) were predictive of subgroup membership ($P < 0.05$). Network analysis revealed sadness ($r_s = 1.320$) as the core symptom for the overall sample, nausea ($r_s = 0.801$) for the low symptom burden group, and vomiting ($r_s = 0.705$, 0.796) for both the moderate symptom burden with intestinal response prominence group and the high symptom burden group.

Conclusions: Three symptom subgroups exist among patients undergoing CCRT for cervical cancer, with sadness, nausea, and vomiting identified as core symptoms. Health care professionals should provide individualized symptom management tailored to these subgroups.

Introduction

Cervical cancer is among the most prevalent malignant tumors in females. According to the most recent global cancer statistics, there were 660,000 new cases of cervical cancer and 350,000 deaths worldwide in 2022, placing it fourth in terms of morbidity and mortality among malignant tumors in women.[1] In 2022, China reported approximately 150,000 new cases of cervical cancer and nearly 60,000 deaths, representing approximately one-fifth of the global cervical cancer burden.[2] Concurrent chemoradiotherapy (CCRT) is the standard treatment for patients with locally advanced cervical cancer in the relevant region.[3] However, CCRT requires a prolonged treatment duration and is associated with significant symptomatic responses, frequently resulting in fatigue, nausea, vomiting, abdominal pain, diarrhea, and other symptoms that often manifest in clusters.[4,5] These symptoms severely impact patients' physical and mental health, as well as their quality of life.

The symptomatic responses of patients undergoing CCRT for cervical cancer constitute subjective experiences that vary among individual patients within diverse contexts, including familial and societal environments. These responses are closely associated with various influences, including physiological factors (such as age and variables related to the disease and treatment), psychological factors (such as coping styles), and social factors (such as occupation and income).[6] Spouses frequently serve as the most significant source of support for patients with cervical cancer, acting as their primary caregivers and coping resources throughout the treatment process.[7] Dyadic coping (DC) denotes the shared responses and coping strategies that both spouses employ when confronted with stressful events.[8] Research indicates that a supportive partner can

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mitigate the stress of illness for patients, thus allowing them to actively manage the symptom-related distress associated with the disease and its treatment.[9,10]

Numerous studies have been conducted to investigate symptom clusters in patients undergoing CCRT for cervical cancer. Zhou et al.[11] conducted a study of 250 patients with cervical cancer within six months after CCRT, identifying nine distinct symptom clusters based on symptom incidence and severity. Tie et al.[12] identified four symptom clusters through exploratory factor analysis involving 234 patients with cervical cancer receiving CCRT, with the fatigue-related cluster being the most severe. Prior research has primarily examined the composition of symptom clusters within the general cervical cancer patient population undergoing CCRT, often neglecting the variability among different patient subgroups and individuals. Additionally, there is a scarcity of research on the interactions among symptoms within clusters and a dearth of specific intervention targets. Accurately identifying the heterogeneity in patients' symptom profiles and pinpointing their core symptoms is crucial for effective symptom management.[13] Latent profile analysis (LPA) is a person-centered analytic technique that utilizes categorical variables to elucidate the underlying structure of continuous outcomes, thereby classifying the cohort into distinct subgroups.[14] Li et al.[15] conducted a subgroup analysis involving 677 gastric cancer patients and found that patients with varying symptom profiles were influenced by factors such as literacy level, combined treatment regimen, psychological resilience, and social support. This approach facilitates the rapid identification of patients with varying symptom profiles by health care professionals, aiding in the swift recognition of at-risk populations. In this study, a symptom network analysis was conducted based on the results of the LPA. Network analysis delineates intervention targets for effective symptom management by establishing a model that represents the relationships among symptoms, highlighting the salience and interconnections of each symptom within the network, and pinpointing core symptoms using network centrality metrics.[16] Studies have indicated[17] that core symptoms within symptom clusters can be stabilized and that interventions targeting these symptoms may lead to the alleviation of other related symptoms. The application of symptom network analysis can further differentiate symptom profiles and provide additional insights not captured by patient-centered analytical methods. By combining these two approaches, it is possible to personalize and accurately identify the symptoms experienced by patients with cervical cancer during CCRT, thereby providing more precise intervention targets for symptom management and optimizing the intervention process.

Therefore, this study aimed to utilize LPA to identify symptom subgroups among patients undergoing CCRT for cervical cancer, assess differences in demographic information and levels of DC among these subgroups, and employ network analysis to pinpoint core symptoms within the overall sample and its subgroups, thereby informing personalized symptom management approaches.

Methods

Study design and participants

This is a cross-sectional survey study. The study population consists of patients with CCRT for cervical cancer attending an oncology center of a tertiary-level hospital in Anhui Province from June 2023 to May 2024, selected by convenience sampling method. The inclusion criteria were as follows: (1) pathologically confirmed diagnosis of cervical cancer, (2) married with spouse as primary caregiver, (3) the primary treatment modality must be CCRT, and (4) patients agreed to participate in this study. The exclusion criteria were as follows: (1) presence of other malignant tumors, and (2) mental illness or cognitive impairment.

Sample size estimation[18] was performed using G*power software with the following parameters: effect size = 0.3, significance level α = 0.05, Power = 95%, and degree of freedom = 6. The sample size was calculated as 232. Accounting for a 10% invalid response rate, a sample size of 258 cases was deemed necessary. A total of 385 questionnaires were distributed, of which 378 were deemed valid, resulting in an effective recovery rate of 98.2%. Fig. 1 illustrates the patient flow of the original data collection process.

Instruments

General information questionnaire

The survey instrument was self-designed and included the following variables: age, educational attainment, occupation, monthly per capita household income, methods of payment of medical expenses, tumor type, cancer stage, months since cancer diagnosis, comorbidity with other chronic illnesses, frequency of chemotherapy, and radiotherapy dose.

Symptom assessment scale for patients undergoing CCRT for intermediate to advanced cervical cancer

Developed by Zhang, this scale was employed to assess the symptom experience and perceptions of patients undergoing simultaneous radiotherapy for cervical cancer.[19] The scale comprises six dimensions: psychological symptoms, nutritional symptoms, intestinal symptoms, urinary symptoms, sexual symptoms, and physical symptoms, encompassing a total of 23 symptom entries. A 5-point Likert scale was utilized, ranging from 1 (“none”) to 5 (“severe”), with higher scores reflecting increasing severity of symptoms. In this study, the Cronbach's α coefficient for this scale was found to be 0.907.

Dyadic coping inventory

This scale, developed by Bodenmann and translated into Chinese by Xu, was utilized to evaluate the level of support in stress coping for both patients and their spouses.[8,20] The scale comprises six dimensions: stress communication, supportive coping, empowering coping, joint coping, negative coping, and coping quality evaluation, totaling 37 items. A 5-point Likert scale was utilized, scoring from 1 (“rarely”) to 5 (“very often”), to measure the frequency of occurrences. Higher scores represent more supportive coping among couples, categorized as follows: scores below 111 indicate low levels of adaptive coping, scores between 111 and 145 represent moderate levels, and scores exceeding 145 denote high levels of adaptive coping. In this study, the Cronbach's α coefficient for the scale was found to be 0.931.

Study procedures

Questionnaires were distributed and collected by investigators who received uniform training. The investigator explained the purpose of the study to the patients, and after obtaining informed consent, a paper questionnaire was provided and collected on the spot. The investigator conducted verification, and if the questionnaire contained omissions or multiple selections, the patient was promptly asked to make additions or

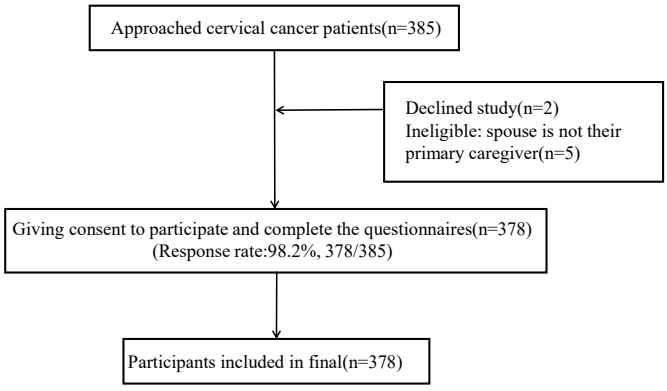

Fig. 1. Patients flow illustrating the original process of data collection and filtering.

corrections. Questionnaires with logical errors or patterns of responses that were clearly regular were discarded. The investigator completed disease-related information with reference to the e-case, while other survey instruments were filled out by the study participants. For patients unable to provide information independently, the investigator assisted through a question-and-answer session.

Data analysis

LPA was performed using Mplus 8.3 to identify potential classifications of patient symptom characteristics. The model fitting effectiveness was assessed using the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and adjusted BIC (aBIC). Smaller values for these metrics correspond to a better model fit. The closer the entropy value approaches 1, the more accurate the model classification becomes. The *P*-values for both the Lo-Mendell-Rubin likelihood ratio test (LMR) and the bootstrap likelihood ratio test (BLRT) are less than 0.05, indicating that models with k categories fit better than those with k-1 categories.

SPSS 25.0 was utilized for the statistical description of the patients' general demographic characteristics, disease- and treatment-related variables, and DC. Categorical variables were depicted using frequencies and percentages, while continuous variables were expressed as means and standard deviations. Differences in demographic information, disease- and treatment-related information, and DC across symptomatic subgroups were analyzed using the χ^2 test or Fisher's exact probability method. Significant factors were included in a multivariate logistic regression model to explore the influence of various categories of symptom characteristics in patients undergoing CCRT for cervical cancer. All statistical tests used a significance criterion of $P < 0.05$.

Symptom network models for the overall sample and each potential category were constructed using the EBICglasso function and Spearman correlation analysis in R version 4.4.0. Supplementary material provided code for analyzing symptom network models. Studies have demonstrated that the strength centrality index is the most stable, with larger values indicating that a symptom can influence other symptoms.[21] Consequently, strength was selected as the primary determinant of core symptoms in this study. The bootnet package and Bootstrap algorithm are used to estimate the accuracy of the network edge weights and to calculate the stability coefficient of the centrality metric, which is usually considered to be at least 0.25 and preferably greater than 0.5.[22]

Ethical considerations

This study received approval from the Ethics Committee of the First Affiliated Hospital of Anhui Medical University (IRB No. PJ2023-08-47). The study adhered to the provisions of the Declaration of Helsinki, and all participants provided written informed consent.

Results

Classification of latent profile

In this study, a total of four models were fitted, as presented in Table 1. The values of AIC, BIC, and aBIC showed a progressive decrease with the increase in categories. Furthermore, the LMR test did not reach statistical significance at the four-category level. Between categories 2 and 3, category 2 showed the highest entropy value (0.968). However, category 2 had high AIC, BIC, and aBIC values and represented a simplistic categorization. Conversely, category 3 showed the second highest entropy value (0.958), and the results of the LMR and BLRT tests corroborated its superiority over category 2. Therefore, the model with three categories was selected as the optimal potential profile model.

Utilizing model 3, the mean symptom scores for each category were presented in Fig. 2. Supplementary Table S1 showed the specific values of the symptom scores for the three subgroups. Patients in the Class 1 (C1) group had lower scores for each symptom, reflecting the lower symptom burden in patients undergoing CCRT for cervical cancer, hence it was named the "low symptom burden group." In contrast, patients in the Class 3 (C3) group had higher symptom scores, indicating a higher symptom burden, hence it was named the "high symptom burden group." The overall symptom scores of patients in the Class 2 (C2) group were between the C1 and C3 groups. However, the scores of intestinal symptoms such as urgency with a feeling of heaviness after defecation, anal pain, and diarrhea were significantly higher, which may indicate the special challenges related to intestinal toxicity during CCRT in patients with cervical cancer; hence it was named the "medium symptom burden-intestinal reaction prominent group."

Participant characteristics

This study enrolled a total of 378 patients with cervical cancer who were undergoing CCRT, ranging in age from 27 to 84 years (mean age: 56.41 ± 10.52 years). The majority of patients had an educational level of junior high school or below (85.2%) and were not employed (80.4%). A large proportion of patients (64.3%) had a per capita monthly household income of less than 2000 yuan, and 84.7% had their medical expenses covered by residents' health insurance. The majority of patients in this study were diagnosed with squamous carcinoma (89.9%), with 46.6% classified at Stage III. The duration of illness for 39.4% of patients ranged from 3 to 6 months, while 73.5% had no comorbidities with other chronic diseases. Furthermore, 53.4% of patients underwent 1–2 times of chemotherapy, and 33.3% received a radiotherapy dose exceeding 60 Gy. Additionally, 63.2% exhibited an intermediate level of DC.

Factors associated with symptom subgroups

The univariate analysis results indicated statistically significant differences ($P < 0.05$) among the three subgroups regarding age, cancer stage, frequency of chemotherapy, and DC, as presented in Table 2.

Multiple logistic regression analysis were conducted, employing the category of potential symptoms among patients with cervical cancer undergoing CCRT as the dependent variable. The independent variables included indicators that were statistically significant in one-way analyses, with the low symptom burden group serving as the reference category, and the results were shown in Table 3. The results indicated that patients in the medium symptom burden-intestinal reaction prominent group were significantly less likely to be aged 51–60 years (OR = 0.517, $P = 0.047$). Patients in high symptom burden were less likely to be 40–50 years old (OR = 0.182, $P < 0.001$) and 51–60 years old (OR =

Table 1
Potential profile model fit metrics for patients undergoing CCRT for cervical cancer.

Model	AIC	BIC	aBIC	Entropy	LMR(*P*)	BLRT(*P*)	Category probability
1	25,922.677	26,103.682	25,957.735	–	–	–	–
2	23,809.908	24,085.351	23,863.257	0.968	< 0.0001	< 0.0001	0.5582/0.4418
3	23,338.712	23,708.592	23,410.351	0.958	0.0046	< 0.0001	0.5291/0.1984/0.2725
4	22,989.117	23,453.434	23,079.046	0.945	0.0649	< 0.0001	0.3995/0.1905/0.2275/0.1825

AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, adjusted Bayesian information criterion; LMR, Lo-Mendell-Rubin likelihood ratio test; BLRT, bootstrap likelihood ratio test; CCRT, concurrent chemoradiotherapy.

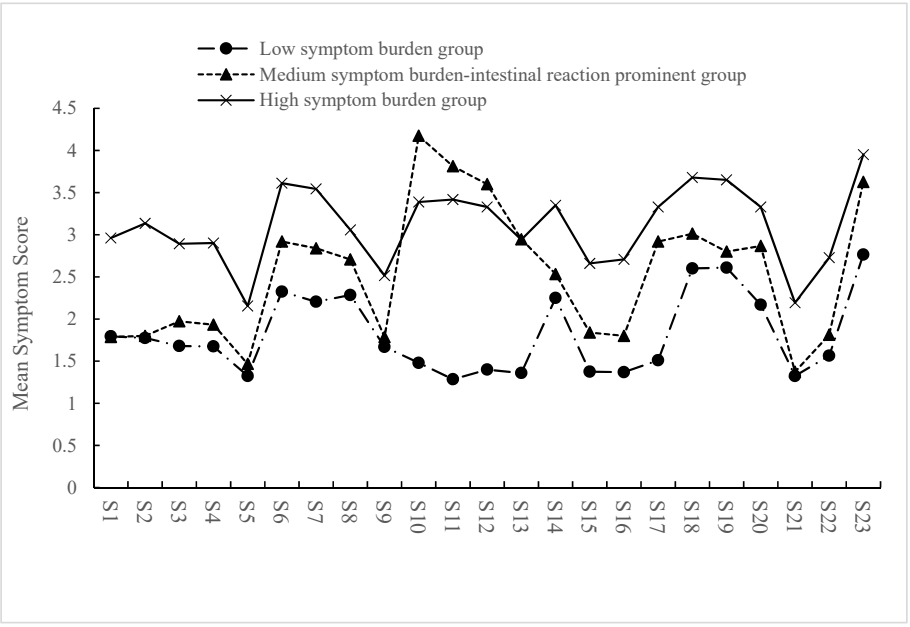

Fig. 2. Distribution of potential categories of symptom characteristics in patients undergoing CCRT for cervical cancer. S1: anxiety; S2: sadness; S3: nervousness; S4: low mood; S5: irritable; S6: nauseating; S7: vomiting; S8: loss of appetite; S9: weight loss; S10: urgency with a feeling of heaviness after defecation; S11: anal pain; S12: diarrhea; S13: abdominal pain; S14: constipation; S15: urinary urgency; S16: urinary frequency; S17: burning pain when urinating; S18: loss of interest in sex; S19: fear of having sex; S20: poor sleep; S21: numbness in the hands and feet; S22: generalized or localized pain; S23: fatigue (weakness). CCRT, concurrent chemoradiotherapy.

0.462, $P = 0.011$), and were less likely to have stage I (OR = 0.188, $P = 0.027$) OR stage II (OR = 0.245, $P = 0.003$). Furthermore, patients in high symptom burden were less likely to have undergone one or two chemotherapy times (OR = 0.474, $P = 0.026$) and more likely to exhibit a low DC level (OR = 3.462, $P = 0.006$).

Symptom network analysis plot and centrality indices

The structure of the symptom network for the overall sample and its three potential categories was depicted in Fig. 3, with red lines indicating positive correlations and blue lines indicating negative correlations. The strength indicators (r_s) were shown in Fig. 4, and the specific strength values were presented in Supplementary Tables S2-5. Supplementary Tables S6-9 showed the weights of each connecting line of the symptom network for the overall sample and its three potential categories. The top two pairs of symptoms exhibiting strong correlations across the overall sample and its three potential symptom categories were D1 (urinary urgency) with D2 (urinary frequency), and B1 (nausea) with B2 (vomiting). According to the strength centrality index, in the symptom network of the overall sample, the centrality index for A2 (sadness) was the highest ($r_s = 1.320$). In the low symptom burden group, the symptom network exhibited the highest centrality index for B1 (nausea), with a strength value of $r_s = 0.801$. B2 (vomiting) exhibited the highest strength centrality index in both the medium symptom burden-intestinal response prominent group ($r_s = 0.705$) and the high symptom burden group ($r_s = 0.796$). In the symptom network analysis, the edge weights for the overall sample and its three potential categories exhibited narrower 95% confidence intervals, suggesting greater precision. The stability coefficients for the strength centrality index were 0.751 for the overall sample and 0.750, 0.520, and 0.515 for the three subgroups, respectively.

Discussion

Subgroups of symptoms

Three distinct symptom subgroups were identified among patients undergoing CCRT for cervical cancer. The low symptom burden group comprised the largest proportion of patients, accounting for 52.91% of the overall sample. The medium symptom burden-intestinal reaction prominent group accounted for 19.84% of the patients and was characterized by radiotherapy doses greater than 40 Gy. This group of patients may be in a phase where radiotherapy overlaps with chemotherapy, during which chemotherapeutic agents may increase the sensitivity of intestinal tissues to radiation therapy.[23] Currently, clinical practice focuses on advanced prevention and intervention for uncomfortable symptoms such as nausea and vomiting, while the management of other intestinal symptoms, such as diarrhea, is often overlooked. Health care professionals can enhance the management of patients' intestinal discomfort by utilizing retention enemas that incorporate both traditional Chinese and Western medications.[24] Patients in the high symptom burden group accounted for 27.25%, and this group was characterized by a larger proportion of elderly patients, more patients with intermediate to advanced tumors, and a disease duration of more than 6 months. Patients in this group also exhibited poorer body functions. Simultaneously, DC within this group predominantly fell within a low to moderate range, accompanied by limited spousal support for caregiving. It is recommended that health care professionals integrate symptom assessments into their routines to facilitate the early identification of patients in the high symptom burden group. Additionally, they should enhance health education and provide guidance on symptom care for caregivers, while assisting patients in accessing other effective external resources when necessary.

Influencing factors of symptom subgroups in patients with cervical cancer undergoing CCRT

Patients older than 60 years were more likely to be classified in the medium symptom burden-intestinal reaction prominent group and the high symptom burden group, consistent with the findings of the study by Lei et al.[25] Elderly patients often exhibit diminished physiological functions and may have multiple chronic diseases, leading to increased complications during treatment. Furthermore, their tolerance to radiotherapy and chemotherapy is generally lower, and their recovery capacity is poorer.[26] Health care professionals are encouraged to prioritize elderly patients with cervical cancer by conducting timely assessments and providing appropriate symptom management. Additionally, it is essential to enhance emotional support and deliver more compassionate care to these patients.

Patients with tumor stage IV had a higher probability of belonging to the high symptom burden group, similar to the findings of Tie et al.[12] Tumor staging serves as a critical indicator for assessing patient prognosis.[27] Patients diagnosed with stage IV cervical cancer frequently

Table 2
Univariate analysis of symptom categories in patients with cervical cancer undergoing CCRT.

Variables	Low symptom burden group ($n = 200$)	Medium symptom burden-intestinal reaction prominent group ($n = 75$)	High symptom burden group ($n = 103$)	Test statistic	*P*-value
Age (years)				28.519[a]	< 0.001
< 40	17 (8.5)	3 (4.0)	5 (4.9)		
40-50	49 (24.5)	15 (20.0)	7 (6.8)		
51-60	95 (47.5)	32 (42.7)	46 (44.7)		
> 60	39 (19.5)	25 (33.3)	45 (43.7)		
Educational attainment				1.033[b]	0.930
Junior high school and below	170 (85.0)	64 (85.3)	88 (85.4)		
High school or junior college	25 (12.5)	8 (10.7)	13 (12.6)		
College and above	5 (2.5)	3 (4.0)	2 (1.9)		
Occupation				5.438[a]	0.066
Be employed	48 (24.0)	12 (16.0)	14 (13.6)		
Non-working	152 (76.0)	63 (84.0)	89 (86.4)		
Monthly per capita household income (RMB)				7.816[b]	0.092
< 2000	117 (58.5)	49 (65.3)	77 (74.8)		
2000-5000	73 (36.5)	23 (30.7)	23 (22.3)		
> 5000	10 (5.0)	3 (4.0)	3 (2.9)		
Methods of payment of medical expenses				2.781[b]	0.566
Employee medical insurance	27 (13.5)	14 (18.7)	14 (13.6)		
Residents' medical insurance	170 (85.0)	61 (81.3)	89 (86.4)		
Other	3 (1.5)	0	0		
Tumor type				4.888[b]	0.260
Squamous cancer	181 (90.5)	65 (86.7)	94 (91.3)		
Adenocarcinoma	16 (8.0)	10 (13.3)	6 (5.8)		
Other	3 (1.5)	0	3 (2.9)		
Cancer stage				31.607[a]	< 0.001
I	27 (13.5)	11 (14.7)	3 (2.9)		
II	80 (40.0)	23 (30.7)	22 (21.4)		
III	81 (40.5)	36 (48.0)	59 (57.3)		
IV	12 (6.0)	5 (6.7)	19 (18.4)		
Months since cancer diagnosis				6.117[a]	0.191
< 3	52 (26.0)	16 (21.3)	23 (22.3)		
3-6	82 (41.0)	34 (45.3)	33 (32.0)		
> 6	66 (33.0)	25 (33.3)	47 (45.6)		
Comorbidity with other chronic illnesses				1.481[a]	0.477
No	150 (75.0)	51 (68.0)	77 (74.8)		
Yes	50 (25.0)	24 (32.0)	26 (25.2)		
Frequency of chemotherapy (times)				16.111[a]	0.003
1-2	121 (60.5)	40 (53.3)	41 (39.8)		
3-4	44 (22.0)	22 (29.3)	27 (26.2)		
> 4	35 (17.5)	13 (17.3)	35 (34.0)		
Radiotherapy dose (Gy)				9.683[a]	0.139
1-20	45 (22.5)	17 (22.7)	19 (18.4)		
21-40	26 (13.0)	8 (10.7)	13 (12.6)		
41-60	70 (35.0)	29 (38.7)	25 (24.3)		
> 60	59 (29.5)	21 (28.0)	46 (44.7)		
DC				25.135[a]	< 0.001
Low	16 (8.0)	9 (12.0)	29 (28.2)		
Medium	131 (65.5)	53 (70.7)	55 (53.4)		
High	53 (26.5)	13 (17.3)	19 (18.4)		

DC, dyadic coping; CCRT, concurrent chemoradiotherapy.
[a] Chi-square test.
[b] Fisher's exact test.

present with metastatic lesions at the time of initial diagnosis and are likely to experience more profound grief. Additionally, patients with advanced tumor stages experience rapid disease progression, which further exacerbates the symptom burden. Health care professionals should implement targeted nursing intervention programs tailored to patients at various tumor stages, conduct early and comprehensive assessments of symptom burden, and proactively offer emotional support to patients with advanced tumors to assist them in rebuilding their confidence.

Patients who underwent more than four times of chemotherapy exhibited a greater likelihood of being classified within the high symptom burden group. The toxicity of chemotherapeutic agents exhibits a cumulative effect, leading to a progressive increase in the patient's symptom burden as the number of chemotherapy treatments escalates.[28] Health care personnel should prioritize health education both before and after treatment, assisting patients in understanding the prevention and management of discomforting symptoms following radiotherapy. This can be achieved through departmental knowledge lectures, the dissemination of educational videos, and the creation of informative bulletin boards to enhance patients' health literacy.

Patients exhibiting lower levels of DC were more likely to be classified within the high symptom burden group. The coping styles of couples significantly influence the management of physical and mental health among individuals with chronic illnesses.[9] Rottmann et al.[29] demonstrated that the joint perception, active communication, and collaborative decision-making of both spouses in managing illness-related stress

Table 3
Multiple logistic regression analysis of symptom categories in patients with cervical cancer receiving CCRT.

Variables	β	SE	Wald χ^2	P	OR	95% CI
Medium symptom burden-intestinal reaction prominent group versus low symptom burden group						
Age (Compared to > 60 years)						
51-60	−0.659	0.332	3.947	0.047	0.517	0.270–0.991
High symptom burden group versus low symptom burden group						
Age (Compared to > 60 years)						
40-50	−1.706	0.490	12.131	< 0.001	0.182	0.070–0.474
51-60	−0.773	0.303	6.519	0.011	0.462	0.255–0.836
Cancer stage (Compared to IV)						
I	−1.674	0.756	4.903	0.027	0.188	0.043–0.825
II	−1.408	0.479	8.651	0.003	0.245	0.096–0.625
Frequency of chemotherapy (Compared to > 4 times)						
1-2	−0.746	0.336	4.928	0.026	0.474	0.245–0.916
DC (Compared to high DC)						
Low	1.242	0.450	7.612	0.006	3.462	1.433–8.366

DC, dyadic coping; CCRT, concurrent chemoradiotherapy.

are crucial factors in facilitating health recovery. Supportive DC not only alleviates the adverse effects of cancer, but also enhances the physical and psychological well-being of both spouses, thereby improving their overall quality of life.[30,31] Inadequate dyadic coping can result in heightened emotional stress and diminished treatment adherence, ultimately impeding disease recovery.[32] It is suggested that health care professionals should assist patients and their spouses in establishing effective interaction patterns, enhancing self-expression, encouraging both parties to share empathic experiences, and positively facing and overcoming somatic symptoms and emotional fluctuations, in order to improve patients' overall quality of life. Further research is necessary to comprehensively elucidate the mechanisms and wider implications of DC on patients' physical and mental health management.

Symptom network architecture and core symptoms across the entire sample and three subgroups

Sadness was the core symptom of the symptom network in the overall sample and was strongly correlated with low mood, nervousness, and anxiety, consistent with the findings of Cui et al.[33] and Kuang et al.[34] Early detection and alleviation of emotional distress are essential components of effective symptom management.[35] Negative emotions heighten the sensitivity to uncomfortable symptoms and intensify the patient's symptomatic expressions and feelings. Simultaneously, the patient's uncomfortable symptoms can, in turn, influence negative emotions, creating a vicious cycle. Sadness and anxiety, as manifestations of mood swings, are considered significant predictors of depression,[36] which can severely impact both the physical and mental health of patients and may even threaten their lives. The majority of patients in this study were unemployed due to their treatment, had a low per capita monthly family income, and experienced financial pressure from ongoing treatment, which exacerbated their feelings of sadness. Simultaneously, patients may be unable to achieve their anticipated recovery goals after undergoing concurrent radiotherapy, and the “discrepancy in expectations” stemming from the uncertainty of future treatments further compounds their existing psychological burdens.[37] Ye et al.[38] found that sadness was the most pivotal symptom within the symptom network of cancer patients during the treatment interval, and the cluster of psychoemotional symptoms that included it had the most significant impact on patients' quality of life. It is recommended that health care professionals closely monitor patients'

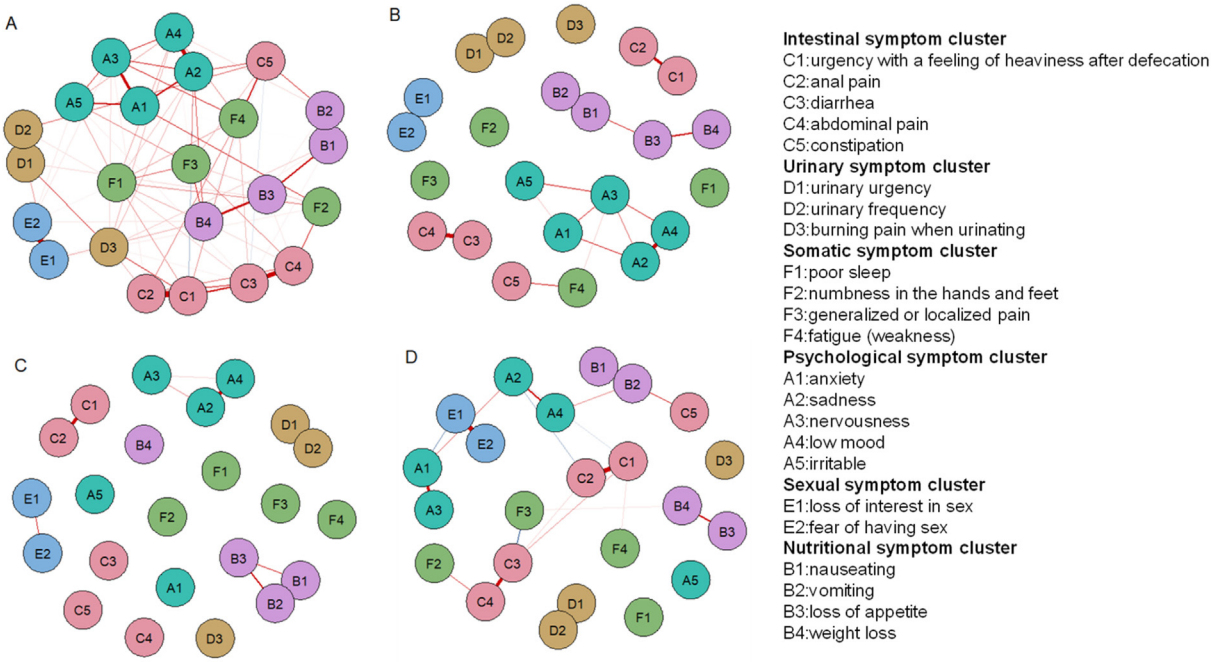

Fig. 3. Symptom network in the overall sample and three subgroups: A full sample, B low symptom burden group, C medium symptom burden-intestinal reaction prominent group, D high symptom burden group.

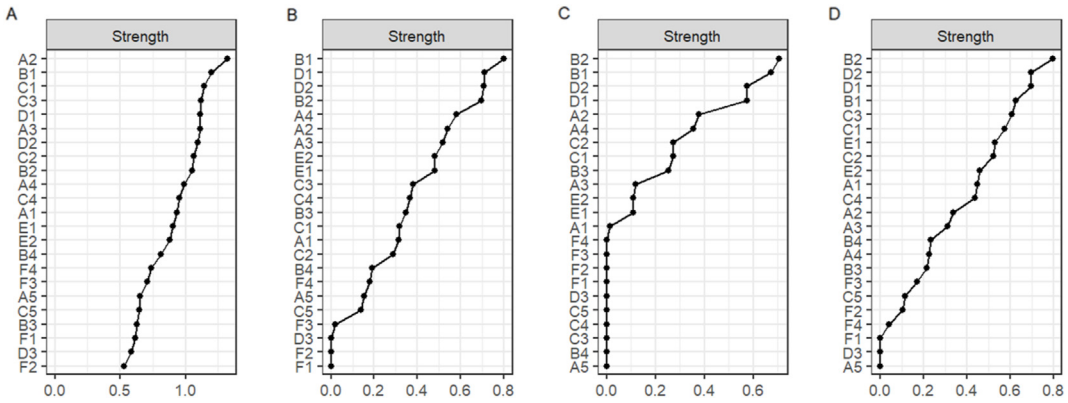

Fig. 4. Strength centrality indices for the overall sample and three subgroups: A full sample, B low symptom burden group, C medium symptom burden-intestinal reaction prominent group, D high symptom burden group.

mood changes and incorporate psychological screening and interventions into the symptom management process. Narrative care[39] and acceptance commitment therapy[40] were implemented to assist patients in reducing their psychological stress. Additionally, patient exchange activities and positive self-expression interventions were conducted to encourage patients to express their feelings openly.

Nausea was a core symptom in the low symptom burden group and was closely associated with both vomiting and decreased appetite. Nausea, being a subjective experience, can be challenging for health care professionals to directly detect. Additionally, this group exhibited a higher intensity of urinary symptoms, including urinary urgency and frequency, a pattern observed in the other two subgroups as well. Given the anatomical location of cervical cancer, radiotherapy may impact the tissues and organs in the abdominal and pelvic regions, stimulating the digestive system and triggering nausea. Concurrently, radiotherapy may also cause damage or inflammation to the bladder's mucous membrane, resulting in increased frequency and urgency of urination. Additionally, chemotherapeutic agents may harm the cells of the gastrointestinal tract and stimulate the vagus nerve, further exacerbating the patient's discomfort, such as nausea and vomiting, and negatively affecting appetite.[41] In this study, the majority of patients in this group received 1–2 times of chemotherapy, and nausea was more pronounced during the initial exposure to chemotherapeutic agents, possibly due to their bodies not yet being accustomed to the drugs. Vomiting was identified as a core symptom in both the medium symptom burden-intestinal response prominence group and the high symptom burden group. However, vomiting strength was greater in the high symptom burden group, and symptoms exhibited more interconnections. In addition to its strong correlation with nausea, vomiting is significantly associated with both low mood and constipation. Research indicates[42] that the gastrointestinal tract's health status significantly influences brain emotional regulation and mental well-being, and vomiting can induce dysbiosis, potentially resulting in mood disturbances like depression in patients. Vomiting can also lead to dehydration and electrolyte imbalances, which can disrupt the normal functioning of the intestines and subsequently lead to constipation.[43] Health care professionals should encourage patients to proactively report symptoms such as nausea and vomiting, as well as other discomforts. They should also consider the interrelationships between symptoms and offer health guidance based on a symptom cluster approach. Nutritional dietary patterns should also be developed, dietary intervention missionary content should be refined, and patients can also be relieved of nausea, vomiting, and other discomforts by warm needles with acupoints.[44]

Implications for nursing practice and research

This study identified three potential categories of symptom characteristics in patients undergoing CCRT for cervical cancer. Therefore, it is recommended that health care professionals customize interventions based on individual differences to assist patients in alleviating their discomfort. Based on the centrality results obtained from the network analysis, sadness, nausea, and vomiting emerged as the core symptoms across the entire sample as well as its three subgroups. These symptoms represent potential effective targets for interventions aimed at preventing and alleviating the symptom burden in patients undergoing CCRT for cervical cancer. In addition, our analysis revealed that patients aged over 60 years, at an advanced tumor stage, having received more than four chemotherapy treatments, and exhibiting low levels of DC were more likely to experience a high symptom burden. The results of this study will assist health care professionals in identifying patients with a high symptom burden and in developing individualized and targeted symptom management strategies.

Limitations

Firstly, because of the cross-sectional study design, we were unable to establish causal relationships between the observed symptoms or track the dynamics of the symptom network over time. This limitation underscores the importance of conducting longitudinal studies in the future to gain a deeper understanding of the dynamic nature of symptom experiences. Secondly, the population of this study was restricted to a tertiary care hospital in Anhui Province, China, and included only patients whose spouses served as primary caregivers, which may limit the generalizability of our findings. In future studies, we will validate the findings using a multicenter design and by including more patients from diverse family structures. This approach will provide a deeper understanding of patients' experiences with symptom management in various contexts and further enhance the generalizability of the findings. Despite these limitations, our findings may serve as a reference for symptom management in patients with cervical cancer undergoing CCRT across various clinical contexts. Lastly, the interpretation of the study results is contingent upon the symptom assessment scale utilized. Future studies could be enhanced by validating other symptom assessment scales to confirm the robustness of our findings. Furthermore, objective clinical indicators, such as biomarkers, are imperative for elucidating the underlying mechanisms.

Conclusions

In this study, we employed LPA to categorize patients receiving concurrent radiotherapy for cervical cancer into three subgroups: a low symptom burden group, a moderate symptom burden with predominant bowel response group, and a high symptom burden group. Health care professionals should prioritize patients who are over 60 years of age, have an advanced tumor stage, have undergone more than four times of chemotherapy, and exhibit low levels of DC. Network analyses indicate that sadness is a core symptom for the entire sample, whereas nausea is

identified as a core symptom for the low symptom burden group, and vomiting serves as a core symptom for both the moderate symptom burden group characterized by intestinal response prominence and the high symptom burden group. Health care professionals should conduct precise assessments and deliver targeted interventions based on the core symptoms across different patient categories.

CRediT authorship contribution statement

Xiangyu Lu: Conceptualization, Methodology, Data curation, Formal analysis, Software, Writing. **Lingling Zheng, Xue Jin:** Methodology, Data curation, Writing – Original draft preparation. **Yuejia Wang, Shengwu Wu:** Conceptualization, Data curation, Writing – Original draft preparation. **Hua Du, Yin Lv:** Methodology, Project administration, Supervision, Writing – review & editing. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethics statement

This study received approval from the Ethics Committee of the First Affiliated Hospital of Anhui Medical University (IRB No. PJ2023-08-47). All participants provided written informed consent.

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Declaration of competing interest

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author, Hua Du, upon reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

No AI tools/services were used during the preparation of this work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.apjon.2024.100649.

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