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Original Article

Network analysis of quality of life among young and middle-aged Korean cancer survivors

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ABSTRACT

Objective: This study aimed to identify and compare the network structure of quality of life factors among cancer survivors to inform tailored interventions.
Methods: A cross-sectional study was conducted using data from 330 cancer survivors aged 18–64 years, drawn from the 2019–2021 Korea National Health and Nutrition Examination Survey (KNHANES). Participants were categorized into two groups: cancer survivors with current cancer and those without. Network analysis using the EBICglasso algorithm was performed to assess eight quality of life (QoL) components measured by the Health-related Quality of Life Instrument with 8 Items (HINT-8) scale: climbing stairs, pain, vitality, work ability, depression, memory, sleep quality, and happiness.
Results: The network analysis revealed distinct patterns between the two groups. Among survivors with current cancer, depression, work ability, and vitality were the most central QoL components, suggesting a need for targeted psychological and occupational support. In contrast, survivors without current cancer exhibited a network where work ability, pain, and climbing stairs (physical function) played a dominant role, emphasizing the importance of pain management and functional rehabilitation. Work ability emerged as a critical determinant in both groups, indicating its sustained impact throughout the survivorship continuum. Additionally, the network structure in survivors without current cancer showed greater interconnectedness, reflecting the complex interplay of long-term survivorship challenges.
Conclusions: The study highlights the need for personalized, stage-specific interventions in cancer survivorship. Work remained central in both groups, emphasizing its ongoing impact on quality of life throughout the survivorship journey. While psychological support is crucial to cancer survivors with current cancer due to the centrality of depression, long-term pain management becomes increasingly important post-treatment. These findings provide valuable insights for nursing practice, suggesting that tailored interventions addressing work-related challenges, psychological distress, and chronic symptom management could improve quality of life and facilitate survivors' reintegration into daily life.

Introduction

Cancer has emerged as a major global health concern, with increasing incidence rates and significant mortality risks.[1–3] Demographics-based predictions indicate new cancer cases will reach 35 million by 2050, with one in five individuals being diagnosed during their lifetime.[1] At the same time, advances in early detection and treatment have significantly improved survival rates. The global five-year survival rate has shown consistent improvement, as evidenced in Korea where it increased by 6.6% over the past decade to 72.1%.[2] Similarly, in the United States, 70% of cancer survivors live beyond five years post-diagnosis, and 11% survive more than 25 years.[3] These improved outcomes have led to a substantial increase in the global cancer survivor population, emphasizing the importance of long-term survivorship care.

As survival rates continue to increase, quality of life (QoL) among cancer survivors has gained sustained attention, necessitating comprehensive strategies that address physical, psychological, and social challenges.[4] Consequently, the role of nursing care in supporting the QoL of

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cancer survivors has become increasingly critical, necessitating approaches that extend beyond immediate physical recovery to encompass the long-term aspects of survivorship. Throughout the survivorship continuum, from diagnosis and treatment to rehabilitation, follow-up care, and reintegration into daily life, nursing care plays a vital role in ensuring holistic support.

The rise in cancer survival rates and post-treatment survivorship is particularly significant among individuals under 65. This study specifically examines cancer survivors aged 18 to 64, a demographic that has experienced notable increases in survival rates due to advancements in cancer treatment and survivorship care.[5] Young and middle adulthood, aged 18 to 64, involves considerable personal and social responsibilities as individuals balance work, family, and health. This age group is also more vulnerable to psychological distress, which has been shown to be higher in individuals under 65 compared to the older adults[6] This heightened distress, combined with the demands of work and family life, presents distinct challenges that further complicate QoL concerns among cancer survivors. Therefore, targeted and individualized nursing interventions are essential to support working-age cancer survivors in managing their daily responsibilities while addressing their holistic health.

The definition of “cancer survivor” vary, including individuals from the moment of diagnosis or only after completing active treatments.[7–10] Despite these variations, a common characteristic is that individuals undergo the survivorship process after receiving a cancer diagnosis.[10] According to this comprehensive definition, the QoL of cancer survivors encompasses various stages of survivorship. Survivors, including those currently with cancer and those without, experience differing QoL goals as they transition from treatment to post-treatment care. While it is recognized that differences in QoL necessitate tailored interventions for various groups, a gap in the literature exists regarding the specific differences in QoL domains among these groups.[11] In this study, we define cancer survivors as individuals diagnosed with cancer, regardless of their current cancer status. This broad definition enables an examination of QoL across different phases of the cancer journey. The QoL of cancer survivors varies significantly based on their current cancer status, treatment phase, and individual circumstances. Addressing these knowledge gaps is essential for nursing professionals to implement evidence-based care strategies tailored to the needs of each subgroup, enhancing overall care quality and QoL outcomes.

Despite the recognized importance of understanding QoL in cancer survivors, several critical gaps exist in the current literature. First, while various QoL measurement tools are available worldwide,[12–14] traditional approaches often rely on overall scores, potentially masking important nuances in how different QoL aspects interact.[15] Second, while it is acknowledged that QoL differs between cancer survivors with and without current cancer, the specific patterns and relationships between QoL domains in these groups remain poorly understood.[11] Finally, there is limited understanding of how these QoL domains might manifest differently in working-age cancer survivors, who face unique challenges in balancing health management with work and family responsibilities.

Network analysis allows for examining relationships between variables in cancer survivorship research.[16,17] This approach analyses the complex interrelationships among patient-reported outcomes through associative networks,[16–18] enabling researchers to identify key QoL domains that could serve as potential intervention targets.[18,19] By applying this methodology, we examine the structure of QoL networks in cancer survivors with and without current cancer, identifying central components and key domains that warrant targeted interventions.[19] This study is based on nationally collected data,[20] allowing for a broad examination of QoL patterns among cancer survivors.

The nursing implications of this study include identifying and addressing key QoL domains as potential intervention targets for cancer survivors at different stages, thereby contributing to the development of stage-specific, personalized nursing care approaches. The primary objective of this study is to compare the network structure and relationships between various QoL components in two distinct groups of cancer survivors: those with current cancer and those without. By analyzing these networks, we aim to identify the most influential components affecting QoL in each group and understand how these components interact within their respective contexts. This investigation will provide valuable insights into how QoL experiences and needs vary between these two groups, potentially revealing distinct patterns of symptom clusters and domain interactions. Insights gained from this comparative analysis can contribute to developing more tailored and effective intervention strategies that address the unique needs and challenges of each group based on their treatment status. Furthermore, this study seeks to enhance our understanding of the complex nature of cancer survivorship, potentially informing more personalized care approaches throughout the cancer journey. Ultimately, these insights could inform more effective, targeted nursing interventions that meet the unique needs and challenges of each group based on their treatment status, paving the way for comprehensive care strategies that support cancer survivors' long-term well-being and QoL.

Methods

Study design

This cross-sectional descriptive correlation study employs secondary analysis of data from the eighth (2019–2021) Korea National Health and Nutrition Examination Survey (KNHANES). The KNHANES is a nationwide survey conducted by the Korea Disease Control and Prevention Agency to collect data on the health and nutrition status of Koreans.[20] KNHANES is a nationally representative survey conducted annually to assess Koreans' health status, health behaviours, and nutritional intake. The survey employs a stratified, multi-stage cluster sampling design, with stratification based on geographic region, housing type, and demographic variables to ensure representativeness and minimize selection bias. This database was selected for our network analysis due to its robust sampling methodology and standardized assessment of QoL measures.

Study participants

We analysed raw data from the 8th KNHANES. The inclusion criteria for participants in this study were: (1) adults aged 18–64 years, (2) individuals diagnosed with cancer, and (3) individuals with complete responses to the Health-related Quality of Life Instrument with 8 Items (HINT-8) questionnaire. Out of 659 adults with a cancer diagnosis in the dataset, 330 met the age criterion. Notably, all 330 eligible participants provided complete data for all variables of interest, including the QoL questionnaire.

The focus on adults aged 18–64 years was intentional, as this age group faces distinct challenges in cancer survivorship compared to older adults. While individuals aged 65 and older represent a significant portion of cancer survivors, they were excluded due to marked differences in survival rates and life circumstances compared to younger patients.[5]

The 330 participants were classified into two groups based on their current cancer status: Group A (cancer survivors with current cancer) and Group B (cancer survivors without current cancer). Group A comprises individuals currently diagnosed with cancer, regardless of their treatment status, while Group B includes those who have been diagnosed with cancer in the past but currently show no evidence of disease.

Measurement

Demographic and clinical characteristics

Demographic characteristics included the participant's age, sex at birth (male or female), education (elementary school, middle school, high school, college, and more), and household income (low, middle–low, middle–high, high). and clinical characteristics included cancer

site and time since diagnosis. Cancer site categories included stomach, liver, lung, colon, breast, cervix, thyroid, and others. Other cancer sites included ovarian, kidney, prostate, and endometrial cancers.

Health-related QoL

The health-related QoL was measured using the Korean Health-related QoL Instrument with 8 items (HINT-8).[21] The HINT-8 is a generic health-related QoL instrument consisting of 8 dimensions: *climbing stairs, pain, vitality, working, depression, memory, sleep,* and *happiness*. Each dimension is assessed on a four-level scale. While specific phrasing may vary, responses are consistently categorized into four levels: Level 1 indicates no issues, while Level 4 indicates very severe issues. The HINT-8 addresses the limitations of the EuroQol-5 Dimension, including a high ceiling effect observed in Korean populations.[21] Reflecting Korean cultural contexts, the HINT-8 was incorporated into the KNHANES in 2019.

Construct validity has been supported by a single-factor structure confirmed through exploratory graph analysis and confirmatory factor analysis, demonstrating good model fit indices.[22] Test-retest reliability of the HINT-8 is well-established, with Cohen's kappa coefficients for individual items ranging from moderate to good (0.565–0.799) and an excellent intraclass correlation coefficient of 0.853 for the total score, indicating strong consistency.[23] Internal consistency was also confirmed, with an omega coefficient exceeding 0.70.[22] This instrument has demonstrated validated reliability and validity, including structural validity, internal consistency, and measurement invariance across various populations, particularly cancer survivors.[22,24]

Data analysis

Data analysis was conducted using R software. Descriptive statistics were computed for demographic and clinical characteristics, as well as HINT-8 subscales, which comprise components of QoL. Homogeneity tests, including independent t-tests for continuous variables and chi-square tests for categorical variables, were performed to assess differences between Group A and Group B in demographic characteristics. Network analyses were conducted using the qgraph and bootnet packages within R.[18,19,25,26] These analyses enabled the identification of central QoL components and the visualization of their interrelationships, which are important for understanding complex interactions and prioritizing key factors in cancer survivorship. The regularized partial Pearson's correlation network, employing the EBICglasso algorithm, was applied to identify the most influential or central outcome measures (nodes) and the associations between these measures (edges).

In the network diagrams, nodes are represented by labelled ovals corresponding to the variables in the model. Edges, depicted as lines connecting the nodes, represent partial correlations between variables. The strength of relationships is indicated by the width of the connecting edges, with thicker lines signifying stronger partial correlations. The color of the edges indicates the direction of the association, with blue lines representing a positive correlation. Network density quantifies the extent of inter-node connections relative to all possible associations, with higher density suggesting greater interconnectedness among nodes.[26]

To explore the importance of individual components within the network, three centrality indices were computed with z-scores: strength, closeness, and betweenness.[27,28] Using z-scores standardized the centrality scores, allowing clearer comparisons across nodes to identify those with exceptional influence. The strength index highlighted nodes crucial for maintaining network interactions and identifying potential intervention targets.[28,29] Closeness centrality represented the influence of a node within the network, while betweenness centrality revealed the node's role as a connector between otherwise unrelated nodes.[28] The centrality indices were visualized using centrality plots to facilitate interpretation.

To assess the network's accuracy and stability, bootstrap analysis was performed (10,000 iterations). Edge-weight accuracy was evaluated using non-parametric bootstrapping, which provided confidence intervals for the edge weights. The stability of centrality indices was assessed using the correlation stability coefficient (CS-coefficient), which represents the maximum proportion of participants that can be dropped while maintaining a 95% probability that the correlation between centrality metrics from the full dataset and the subset is at least 0.7,[30] with a recommended threshold of no lower than 0.25.[18] This comprehensive approach provided insights into the reliability of the network structure, enhancing our understanding of key relationships within the model and potentially informing targeted intervention strategies.

Results

Characteristics of study participants

A total of 330 cancer survivors aged 18 to 64 participated in the study (Table 1). The participants were categorized into Group A ($n = 145$) and Group B ($n = 185$). The average age of the participants was 53.06 ± 9.13 years, with Group A having a mean age of 51.99 ± 9.80 years and Group B having a mean age of 53.88 ± 8.51 years. The sex distribution was consistent across both groups, comprising 29.7% male and 70.3% female participants. Regarding educational attainment, 43.0% of participants held a college degree or higher, with 40.7% in Group A and 44.9% in Group B. Household income levels varied, with 9.7% reporting low income, 24.5% middle-low, 31.5% middle–high, and 33.6% high economic status. Participants reported a variety of cancer sites, with thyroid cancer being the most frequently reported (32.7%), followed by breast cancer (16.7%). HINT-8 scores for the entire participant group ($n = 330$) indicated the highest mean score for *happiness* (2.25 ± 0.78) and the lowest for *climbing stairs* (1.47 ± 0.65). Additional details regarding the demographic characteristics are provided in Table 1.

The homogeneity test between Group A and Group B showed no significant differences in age ($t = 3.59$, $P = 0.59$), sex distribution ($\chi^2 = 0.00$, $P = 0.988$), education level ($\chi^2 = 4.54$, $P = 0.103$) and household income ($\chi^2 = 1.42$, $P = 0.701$). Time since diagnosis differed between the two groups, with Group B having a longer duration since diagnosis than Group A ($t = 148.8$, $P < 0.001$).

Network estimation

Network analysis demonstrated distinct structures and relationships among components in the two networks examined. In Group A (cancer survivors with current cancer), Fig. 1A illustrates the network structure of correlations between the eight components. The network density was relatively low (density = 0.643, 18/28), indicating that some measures within this group were interrelated. The centrality plot (Fig. 2) reveals that the nodes for *depression, work*, and *climbing stairs* exhibited the highest strength, betweenness, and closeness. Specifically, *depression* showed the highest betweenness (1.933) and closeness (1.518) centrality, while *work* demonstrated the highest strength (1.575). The strongest edges within the network were observed between *work* and *vitality* (0.450), *depression* and *happiness* (0.327), and *work* and *climbing stairs* (0.330).

In Group B (cancer survivors without current cancer), Fig. 1B illustrates the network structure of correlations between the eight components. The network density was higher compared to Group A (density = 0.821, 23/28). The centrality plot (Fig. 2) indicates that *work, pain,* and *climbing stairs* were the most central nodes in this group. *Work* emerged as the most central node, with the highest betweenness (2.210), closeness (1.469), and strength (1.478). *Pain* demonstrated high strength (0.917) while *climbing stairs* exhibited high closeness centrality (0.949). The strongest edges within the network for Group B were similar to those in Group A but with variations in strength: *depression* and *happiness* (0.318), *pain* and *climbing stairs* (0.313), and *work* and *vitality* (0.297).

When comparing the centrality plots of the two groups, *work* had the highest strength in both Group A and Group B. However, while *work* also

Table 1
Demographic, clinical, and QoL characteristics ($N = 330$).

Variable		Mean ± SD or *n* (%)			
		Total ($N = 330$)	Group A ($n = 145$)	Group B ($n = 185$)	F/χ^2 (P)
Age (years)		53.06 ± 9.13	51.99 ± 9.80	53.88 ± 8.51	3.59 (0.059)
Sex	Male	98 (29.7)	43 (29.7)	55 (29.7)	0.00 (0.988)
	Female	232 (70.3)	102 (70.3)	130 (70.3)	
Education	Middle school or lower	55 (16.7)	19 (13.1)	336 (19.5)	4.54 (0.103)
	High school	133 (40.3)	67 (46.2)	66 (35.7)	
	College or higher	142 (43.0)	59 (40.7)	83 (44.9)	
Household income	Low	32 (9.7)	13 (9.0)	19 (10.3)	1.42 (0.701)
	Middle–low	81 (242.5)	37 (25.5)	44 (23.8)	
	Middle–high	104 (31.5)	42 (29.0)	62 (33.5)	
	High	111 (33.6)	53 (36.6)	58 (31.4)	
	Missing data	2 (0.6)	0 (0.0)	2 (1.1)	
Time since diagnosis (years)		7.33 ± 5.63	3.78 ± 3.82	10.11 ± 5.25	148.80 (< 0.001)
	Less than 1	37 (11.2)	33 (22.8)	4 (2.2)	
	1 to 3	62 (18.8)	57 (39.3)	5 (2.7)	
	3 to 10	160 (48.5)	47 (32.4)	113 (61.1)	
	More than 10	71 (21.5)	8 (5.5)	63 (34.1)	
Cancer sites[a]	Stomach	39 (11.8)	13 (9.0)	26 (14.1)	
	Liver	4 (1.2)	4 (2.8)	0	
	Lung	8 (2.4)	4 (2.8)	4 (2.8)	
	Colon	34 (10.3)	18 (12.4)	16 (8.6)	
	Breast	55 (16.7)	32 (22.1)	23 (12.4)	
	Cervix	19 (5.8)	5 (3.4)	14 (7.6)	
	Thyroid	108 (32.7)	38 (26.2)	70 (37.8)	
	Other	73 (22.1)	36 (24.8)	37 (20.0)	
HINT-8	Climbing stairs	1.47 ± 0.65	1.46 ± 0.62	1.48 ± 0.67	
	Pain	1.77 ± 0.72	1.79 ± 0.73	1.76 ± 0.72	
	Vitality	2.10 ± 0.85	2.19 ± 0.88	2.03 ± 0.82	
	Work	1.63 ± 0.75	1.66 ± 0.85	1.61 ± 0.66	
	Depression	1.62 ± 0.64	1.60 ± 0.68	1.64 ± 0.60	
	Memory	1.70 ± 0.58	1.69 ± 0.57	1.71 ± 0.59	
	Sleep	1.72 ± 0.74	1.71 ± 0.73	1.73 ± 0.76	
	Happiness	2.25 ± 0.78	2.23 ± 0.78	2.27 ± 0.78	
	Total	1.78 ± 0.46	1.79 ± 0.44	1.78 ± 0.47	

Group A: cancer survivors with current cancer; Group B: cancer survivors without current cancer. HINT-8, Health-related Quality of Life Instrument with 8 Items; Some participants had more than one type of cancer.

showed the highest betweenness and closeness centrality in Group B, *depression* ranked highest in these measures in Group A. Additionally, *pain* demonstrated higher strength in Group B compared to Group A.

Network accuracy and stability

The bootstrap analysis revealed good accuracy in network estimation, as indicated by the confidence intervals for edge weights (Figs. 3 and 4). Smaller confidence intervals suggested a more accurate estimation of these weights. The stability of centrality indices was deemed acceptable, with correlation stability coefficients meeting the recommended threshold of 0.25 for both networks. These results indicate robust and reliable network structures, providing confidence in the identified key relationships and central nodes within the components of QoL.

Discussion

As the number of cancer survivors continues to grow, providing effective care during and after treatment has become an essential aspect of nursing practice. Effective nursing care for cancer survivors requires understanding the network of QoL components, facilitating a holistic comprehension of their needs. Rather than merely focusing on individual components, it is crucial to understand the entire network to determine which components should be prioritized in interventions. This study aimed to analyse and compare the network of QoL components between cancer survivors with current cancer (Group A) and those without current cancer (Group B).

Examining the difference in network density, Group B exhibited a higher network density than Group A. This suggests that interactions among QoL components may become more complex in cancer survivors without current cancer, indicating that various aspects of QoL may be more closely interconnected for those who no longer have cancer. Therefore, nurses should provide comprehensive care that addresses diverse aspects for both cancer survivors with and without current cancer. This aligns with the definition of "cancer survivor," which encompasses the period from diagnosis through post-treatment.[7,8,10,31] By addressing both physical and psychological aspects holistically, nurses can support patients' reintegration into daily life and enhance overall QoL.

The network analysis revealed that work maintained significant importance across both groups despite variations in centrality measures. *Work*, representing the challenges cancer survivors face in fulfilling job duties, demonstrated the highest strength centrality in Group A and high values across all centrality measures in Group B. This highlights the profound impact that work difficulties have on QoL for cancer survivors, regardless of their current cancer status. With advancements in medical care, the number of cancer survivors in the workforce is increasing. Despite the high prevalence of functional needs among cancer patients, significant gaps exist in addressing these needs, with only a small percentage of individuals receiving necessary rehabilitation services.[32] These findings emphasize the critical importance of comprehensive occupational support and rehabilitation services for all cancer survivors, both with and without current cancer, to improve QoL, maintain and enhance their ability to work successfully and encourage their return to work.

The centrality of the *work* node suggests that the ability to maintain regular work functions or the struggles associated with doing so plays an important role in the overall QoL of all cancer survivors. *Work* emerged as the most influential node in both groups when examining strength centrality, indicating its critical role as an intervention target. This aligns

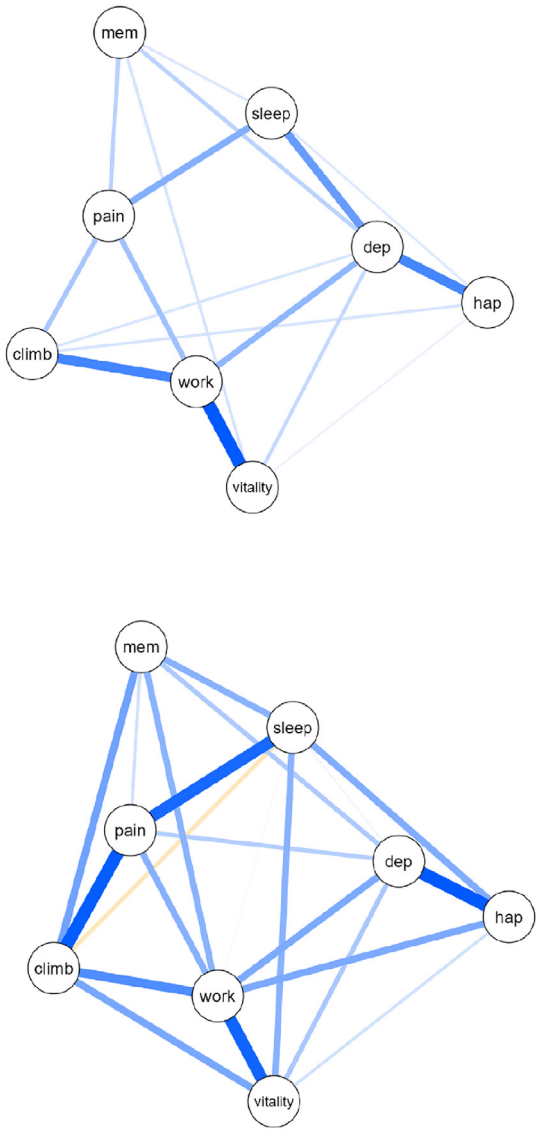


Fig. 1. Network structure. A: cancer survivors with current cancer; B: cancer survivors without current cancer. Hap, happiness; climb, climbing stairs; dep, depression; mem, memory; vit, vitality. Blue lines represent positive associations and red line represent negative associations. Thicker lines (edges) between symptoms or indicators (nodes) in the network indicate stronger partial correlations between the nodes.

with studies emphasizing the importance of returning to daily life and work for cancer survivors.[33] Therefore, it is essential to provide nursing care that addresses work-related issues for all cancer survivors.

However, interesting differences emerged in the secondary influential nodes: Group A exhibited higher strength centrality in *depression* as a secondary factor, while Group B demonstrated higher strength centrality in *pain*, followed by *vitality* and *climbing stairs* related to physical function as tertiary factors. This suggests that the QoL of cancer survivors with current cancer is more closely tied to psychological aspects like *depression*, whereas the QoL of cancer survivors without current cancer is more strongly influenced by physical challenges such as pain, followed by vitality and functional limitations. Therefore, tailored nursing interventions must address work-related issues throughout the cancer journey, focusing on pain and physical function management for those with current cancer and psychological support for those without. The networks of the two groups reveal similarities and subtle differences in the centrality of key outcomes between Group A and Group B. In Group A, *depression* played a particularly central role, with high betweenness and closeness centrality, underscoring its function as a key connector among QoL components for cancer survivors with current cancer. This finding aligns with previous research showing that intervention programs targeting depression in cancer patients not only alleviate depression but also improve overall QoL.[34] Furthermore, it supports existing evidence highlighting the importance of addressing psychological distress during diagnosis and treatment.[35] A meta-analysis of 183 studies (n = 182,521) further reinforces the global burden of depression, reporting that approximately 27% of cancer patients experience depression (95% CI: 24% to 30%).[36] These combined findings from our network analysis and global studies highlight the urgent need for targeted psychological interventions for cancer survivors with current cancer to address depression and enhance their overall quality of life.

In contrast, Group B exhibited lower values in all centrality measures for *depression*, indicating decreased overall influence (lower strength), reduced connectivity with other symptoms (lower betweenness), and less immediate impact on the network (lower closeness). This may be partly attributable to the absence of current cancer, which could alleviate the psychological burden. Additionally, cancer survivors tend to experience heightened depression during the initial phase following diagnosis.[37]

Notably, *pain* demonstrated higher importance in Group B compared to Group A, as evidenced by its higher strength centrality, suggesting stronger direct connections with other QoL components in cancer survivors. While the betweenness and closeness centrality measures of *pain* were similar between groups, its elevated strength centrality in Group B highlights the significance of chronic pain management in cancer survivors without current cancer. Cancer survivors often experience chronic pain during and after treatment, which varies by sex, ethnicity, and type of cancer and can persist for years following the initial diagnosis.[38] Pain is often inadequately controlled and remains one of the unmet needs of cancer survivors, who frequently encounter difficulties accessing support services and care.[39] Furthermore, cancer-related pain is more prevalent among cancer survivors diagnosed at age 65 or younger.[38] Therefore, nurses caring for adult cancer survivors should continue to prioritize pain management after cancer treatment.

Group differences revealed distinct intervention needs. In Group A, while *work* showed highest strength centrality, *depression* dominated betweenness and closeness centralities, indicating psychological support's importance alongside work assistance. Consequently, implementing targeted psychological interventions—such as cognitive-behavioural therapy or stress management programs—could be particularly beneficial for survivors with current cancer.[40,41] Moreover, multidimensional interventions addressing both psychological and physical needs have yielded significant improvements in QoL of people with cancer.[42] For Group B, *work* dominated all centrality measures, with *pain* and *climbing stairs* as key secondary factors. Studies show pain significantly impacts QoL,[38] and integrated programs combining pain management with physical recovery effectively support work reintegration.[43,44] These findings suggest group-specific interventions: psychological support with work assistance for Group A, and occupational rehabilitation with pain management for Group B.

The strongest relationships between components, such as *work-vitality*, *depression-happiness,* and *work-climbing stairs*, were observed in both groups, highlighting the interconnected nature of physical, psychological, and functional domains in cancer survivors. These results align with the growing emphasis on holistic approaches that consider the multidimensional aspects of cancer survivors' QoL.[11,14,15] The patterns revealed distinct characteristics. In Group A, the prominent *work-vitality* and *depression-happiness* connections emphasize the significant role of emotional well-being alongside functional ability. This finding aligns with research on emotional support and psychological care for cancer survivors with current cancer.[45] In Group B, the strong association between *work-vitality* and *work-climbing stairs* reflects an increased focus on

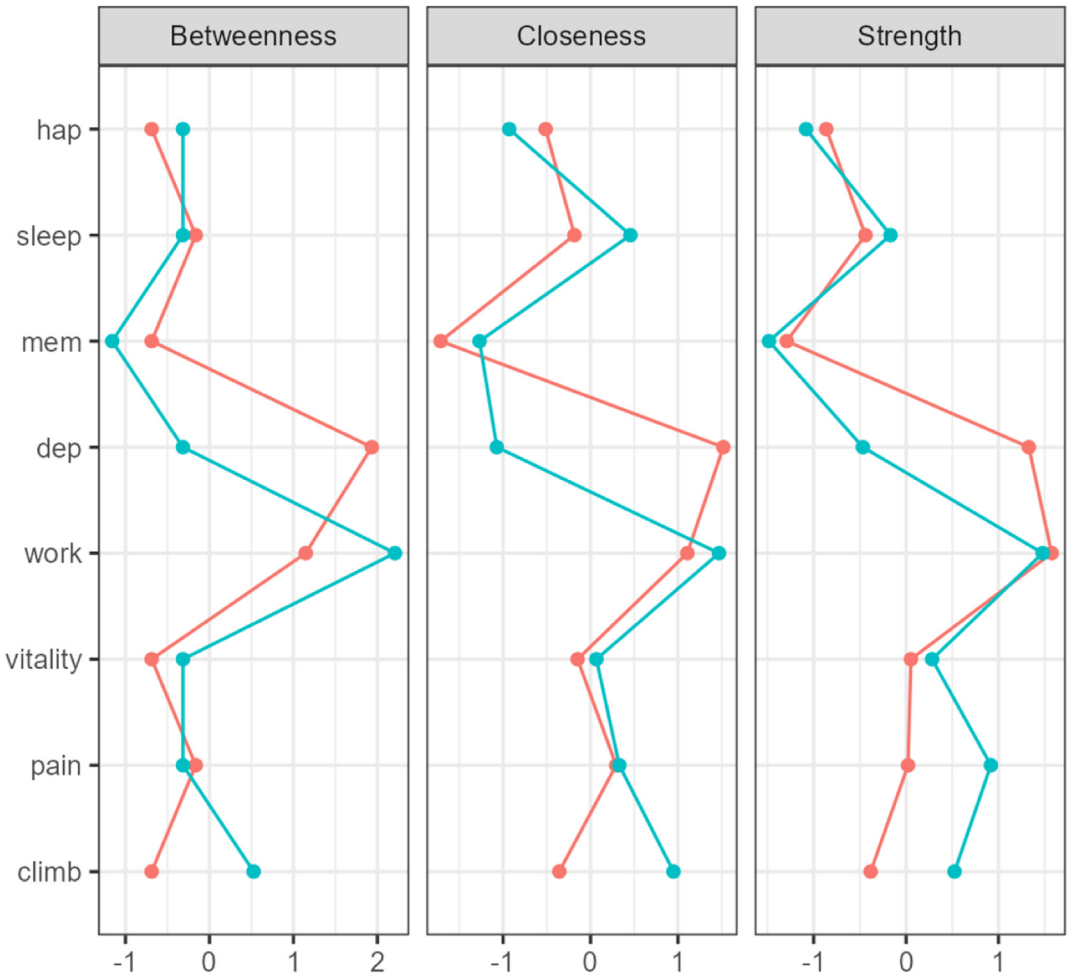


Fig. 2. Centrality plot. Red lines: cancer survivors with current cancer; blue lines: cancer survivors without current cancer. Hap, happiness; climb, climbing stairs; dep, depression; mem, memory; vit, vitality . All lines represent positive associations.

physical activity and functional recovery. This shift in emphasis is supported by studies demonstrating that physical exercise programs significantly enhance both QoL and functional capacity in cancer survivors.[46,47] These patterns suggest the need for targeted interventions: emphasizing emotional support for cancer survivors with current cancer while incorporating physical activity programs for those without current cancer.

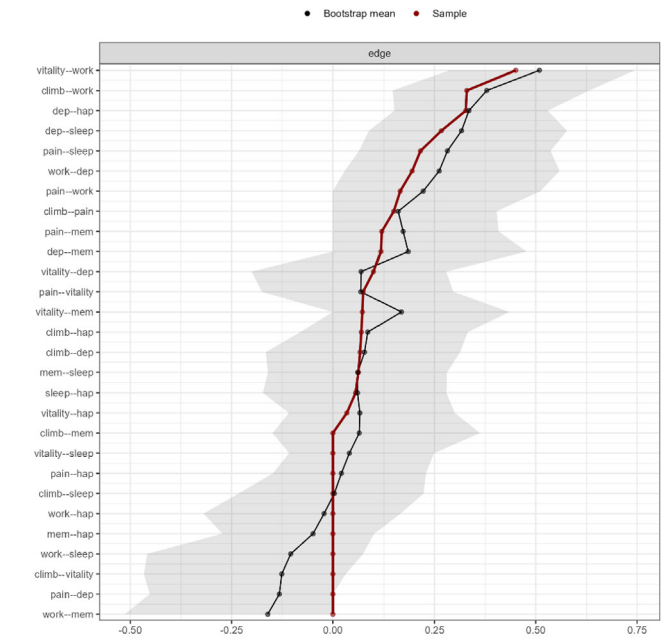
This interconnection between *work* and other components suggests that targeting one domain, such as enhancing work capacity or alleviating depression, could positively impact other areas of QoL, reinforcing the value of comprehensive, multidimensional interventions. It is crucial to recognize that physical, cognitive, and emotional fatigue—particularly depression—can adversely affect work outcomes.[48] This highlights the necessity for psychoeducational, vocational, and multi-component interventions to mitigate the adverse effects of depression on work performance among cancer survivors.[48] By comprehensively addressing these interconnected aspects, nurses can better support both cancer survivors with and without current cancer in achieving improved overall well-being and successful reintegration into daily life. Furthermore, it is important to note that *depression* and *pain*—which significantly affect daily life—may vary according to external variables such as gender, cancer type, stage, and systematic treatment protocols.[6] Future large-scale studies that incorporate these factors are essential to further elucidate these differences and guide the development of tailored, multidimensional interventions.

Implications for nursing practice and research

This study is among the first to apply network analysis to compare cancer survivors with and without current cancer in Korea. Utilizing data from the 2019–2021 KNHANES, we employed an innovative network approach to analyse the complex interrelations between various QoL components in these two distinct groups. This method allowed us to identify the most influential factors affecting QoL within each group's unique context. Our findings reveal complex network structures of QoL components in both groups, highlighting the evolving nature of survivors' needs and experiences. This nuanced understanding not only addresses a significant gap in the current literature but also provides valuable insights for developing targeted personalized interventions in oncology nursing practice. By illuminating the changing landscape of cancer survivorship, this research paves the way for more targeted, effective, and comprehensive care strategies that can potentially improve outcomes for cancer survivors.

Limitations

This study has several limitations. First, while we conducted network analysis, the limited sample size made it challenging to compare various subgroups. Future analyses that include comparisons based on cancer type and stage could provide more tailored insights into nursing care. Second, due to the nature of our dataset, we did not consider



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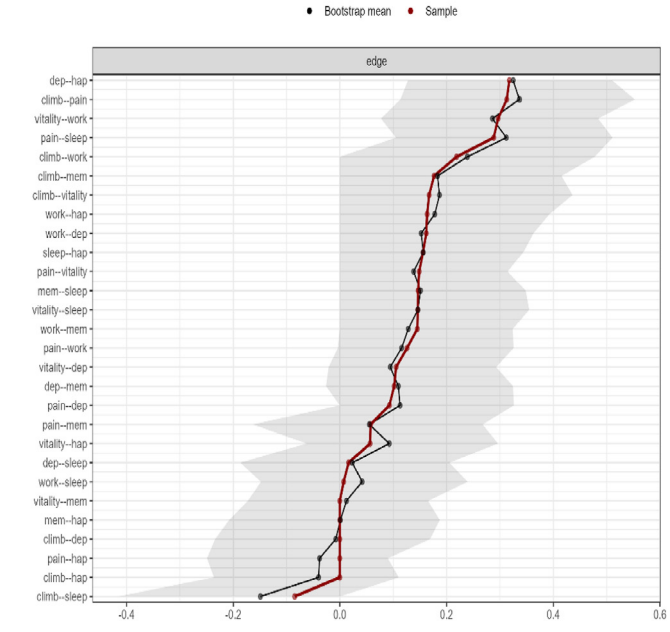
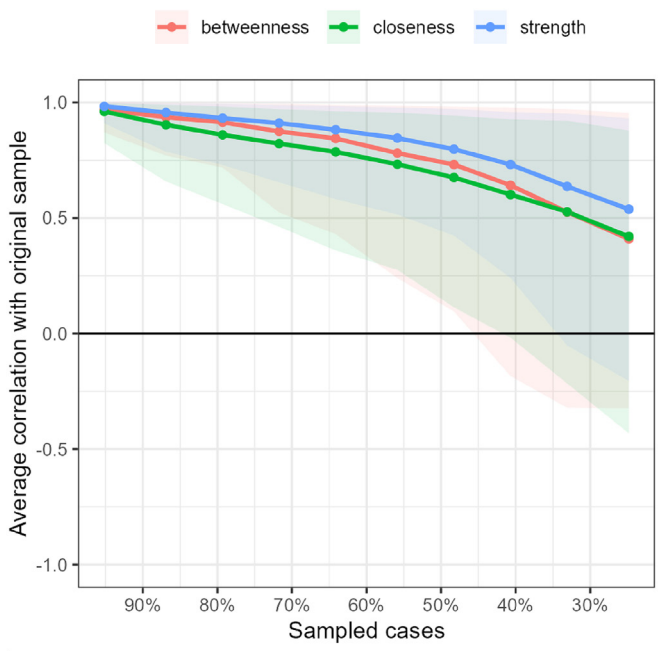
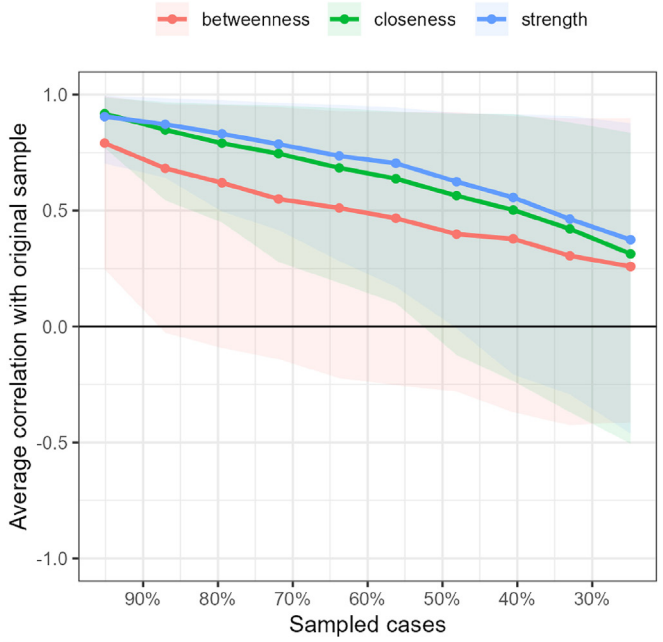


B

Fig. 3. Network accuracy. A: cancer survivors with current cancer; B = cancer survivors without current cancer. Hap, happiness; climb, climbing stairs; dep,-depression; mem, memory; vit, vitality. Black lines: bootstrap mean; red lines: sample. Edge weights (solid lines) are surrounded by 95% confidence intervals (gray bars), with each horizontal line representing one edge of the network (ordered from the highest to the lowest edge weight).



A



B

Fig. 4. Network stability. A: cancer survivors with current cancer; B: cancer survivors without current cancer. Hap, happiness; climb, climbing stairs; dep, depression; mem, memory; vit, vitality. Lines show correlations of the centrality—in terms of betweenness, closeness, and strength—of nodes in the original network with the centrality of nodes sampled while dropping participants.

relationships with variables beyond QoL measures. Future research should incorporate factors that may influence QoL, such as socioeconomic status, comorbid conditions, and symptoms that cancer survivors might experience. Lastly, since this study relied on cross-sectional data, we cannot infer causal relationships. Longitudinal studies would be beneficial for exploring the causality of relationships and gaining deeper insights into the experiences of cancer survivors. Future longitudinal research could elucidate the temporal dynamics and causal relationships among QoL-related variables, addressing gaps in our understanding of the evolving challenges faced by cancer survivors. Moreover, incorporating qualitative or extended follow-up studies may further bridge the gaps identified in our study.

Conclusions

This study highlights the complex interactions among QoL components in cancer survivors, revealing key differences between those with and without current cancer. Work was central in both groups, particularly for cancer survivors without current cancer, reflecting the importance of returning to and maintaining work functions. Depression

emerged as a critical component for cancer survivors with current cancer, highlighting the need for ongoing psychological support, while pain became more prominent in those without current cancer, highlighting the necessity for long-term pain management.

The study emphasizes the need for tailored interventions based on current cancer status, focusing on psychological and physical distress for cancer survivors with current cancer while supporting occupational reintegration and chronic symptom management for those without current cancer. This network-based approach provides a holistic understanding of cancer survivorship, guiding nursing care toward more comprehensive and effective strategies that can improve overall QoL for cancer survivors.

CRediT authorship contribution statement

YK: Conceptualization, Investigation, Project administration, Writing – original draft, Writing – review & editing. **DW:** Investigation, Formal analysis, Methodology, Writing - original draft, Writing – review & editing. **JL:** Investigation, Formal analysis, Methodology, Visualization, Writing - original draft, Writing – review & editing. **EK:** Investigation, Formal analysis, Methodology, Visualization, Writing - original draft, Writing – review & editing. All authors have read and approved the final manuscript.

Ethics statement

This study was approved by the Institutional Review Board of Hallym University (Approval No. HIRB-2024-092). The data used in this study were obtained from the Korea National Health and Nutrition Examination Survey (KNHANES), a publicly available dataset that adheres to strict ethical guidelines. All participants in the original KNHANES survey provided written informed consent prior to their participation.

Data availability statement

Data supporting this study are from the Korea National Health and Nutrition Examination Survey (KNHANES), publicly available for qualified researchers. Access details are provided on the KNHANES website.

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

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

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Declaration of competing interest

The authors declare no conflict of interest.

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