

Research paper

The network structures of depressive and insomnia symptoms among cancer patients using propensity score matching: Findings from the Health and Retirement Study (HRS)



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ARTICLE INFO

Keywords:

Cancer

Depression

Insomnia

Network analysis

ABSTRACT

Objective: Both depression and insomnia are found to be more prevalent in cancer patients compared to the general population. This study compared the network structures of depression and insomnia among cancer patients versus cancer-free participants (controls hereafter).

Method: The 8-item Center for Epidemiological Studies Depression Scale (CESD-8) and the 4-item Jenkins Sleep Scale (JSS-4) were used to measure depressive and insomnia symptoms, respectively. Propensity score matching (PSM) was used to construct the control group using data from the Health and Retirement Study (HRS). In total, a sample consisting of 2216 cancer patients and 2216 controls was constructed. Central (influential) and bridge symptoms were estimated using the expected influence (EI) and bridge expected influence (bridge EI), respectively. Network stability was assessed using the case-dropping bootstrap method.

Result: The prevalence of depression (CESD-8 total score ≥ 4) in cancer patients was significantly higher compared to the control group (28.56 % vs. 24.73 %; $P = 0.004$). Cancer patients also had more severe depressive symptoms relative to controls, but there was no significant group difference for insomnia symptoms. The network structures of depressive and insomnia symptoms were comparable between cancer patients and controls. “Felt sadness” (EI: 6.866 in cancer patients; EI: 5.861 in controls), “Felt unhappy” (EI: 6.371 in cancer patients; EI: 5.720 in controls) and “Felt depressed” (EI: 6.003 in cancer patients; EI: 5.880 in controls) emerged as the key central symptoms, and “Felt tired in morning” (bridge EI: 1.870 in cancer patients; EI: 1.266 in controls) and “Everything was an effort” (bridge EI: 1.046 in cancer patients; EI: 0.921 in controls) were the key bridge symptoms across both groups.

Conclusion: Although cancer patients had more frequent and severe depressive symptoms compared to controls, no significant difference was observed in the network structure or strength of the depressive and insomnia symptoms. Consequently, psychosocial interventions for treating depression and insomnia in the general population could be equally applicable for cancer patients who experience depression and insomnia.

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1. Introduction

Cancer is a major public health problem globally. Due to the aging population and the development of medical screening technology, the number of new cases of cancer diagnosed has been increasing year by year (Irwin, 2013). For example, in the United States, recent research reported that there were over 18 million cancer survivors nationwide, accounting for around 5 % of the total population (Miller et al., 2022). Cancer patients often experience impaired social functioning, reduced quality of life, and a loss of will to live, and thereby have an increased vulnerability to psychological problems (Mitchell et al., 2013). A meta-analysis revealed that the prevalence of depressive symptoms among cancer patients was up to 44.63 % (95%CI: 42.24 %–47.01 %) in China (Ding et al., 2023), which is six to seven times greater than the general population (Lu et al., 2021). Furthermore, insomnia symptoms are also common in cancer patients. For instance, a meta-analysis found that 45 % (95%CI: 33 %–58 %) of head and neck cancer patients globally had insomnia symptoms (Santoso et al., 2019), approximately three times higher than that in the general population (Wong et al., 2023). With the rapid improvement of diagnostic and treatment methods, the survival rate of cancer patients has steadily increased, with more than two-thirds of patients with cancer having an extended survival period (Miller et al., 2022). Hence, the mental health of cancer patients is critically important for both their recovery from cancer itself and their long-term quality of life (Chu et al., 2021; Cicchetti et al., 2022).

Psychiatric disorders or syndromes encompass distinct individual symptoms. For instance, depression consists of a cluster of individual symptoms such as hopelessness, worthlessness, sadness, anhedonia and impaired concentration (Thapar et al., 2022). Similarly, insomnia comprises various symptoms like difficulty falling asleep, difficulty staying asleep, and early awakening (Sutton, 2021). Neuropsychological mechanisms underlying different symptoms are often distinct and interrelated (Hackman and Farah, 2009). However, most studies on depression and insomnia in cancer patients only focused on the total or average scores of standardized rating scales, rather than examining the individual symptoms. This approach may mask the substantial differences among individual symptoms and the interrelationship between them (Fried and Nesse, 2015). Network analysis, an advanced data analysis approach, however, can be a useful tool to address this limitation.

Network analysis is a novel statistical approach that has been widely used in recent years to establish an ordered spatial network and elucidate the relationship between multiple symptoms simultaneously (Beard et al., 2016). In a network model, individual symptoms are defined as nodes, with the position of nodes reflecting the importance of each symptom (Mullarkey et al., 2019; van Borkulo et al., 2014). Interactions between symptoms are defined as edges, and the thickness of edges represents the intensity of symptom relationships (Epskamp et al., 2018). Additionally, node centrality indices reveal the connectivity of a variable with all other variables in the network. For instance, the expected influence (EI) is used to identify the most important symptoms of a network model, and the bridge EI is employed to elucidate the symptom influence and interconnection of symptoms cluster (Epskamp et al., 2018; Opsahl et al., 2010). Therefore, the application of network analysis can provide unique insights into potential causes and treatment of psychiatric disorders or syndromes that cannot be gleaned from overall symptom counts or severity scores (Cai et al., 2022).

To date, no studies have been published on the network analysis of depressive and insomnia symptoms among cancer patients. To address this gap and improve health outcomes for cancer patients, we compared the network structures of depression and insomnia symptoms between cancer patients and cancer-free participants (controls hereafter) based on the Health and Retirement Study (HRS). We hypothesized that the network structures of depression and insomnia symptoms in cancer patients would be significantly different compared to controls.

2. Method

2.1. Data source and study population

This study was a secondary analysis of the data collected in the 2020 wave of the HRS, which is an ongoing biennial, nationally representative survey since 1992 of U.S. community-dwelling adults aged 50 years or older (HRS, 2020). The HRS is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. The HRS has been investigating the health, economic, and social factors that impact on the well-being of participants (Sonnega et al., 2014); details of the study design and procedures have been reported previously (Heeringa and Connor, 1995). All HRS participants provided informed consent for their participation, and the research protocol was approved by the Health Sciences and Behavioral Sciences institutional review board at the University of Michigan. In each wave, participants completed a face-to-face or telephone interview that included assessments of demographic characteristics, socio-economic status, physical and mental health and health resource utilization (Power et al., 2021; Sonnega et al., 2014). Cancer patients self-reported receiving a diagnosis of cancer from a hospital.

A total of 15,644 individuals participated in the 2020 wave of HRS. After excluding those without any information on key variables such as gender, age, depression, and insomnia, the remaining 13,961 participants in the database formed the study sample.

2.2. Measurement tools

The severity of depression symptoms (depression hereafter) was measured using the 8-item dichotomous version of the Center for Epidemiological Studies Depression Scale (CESD-8) (Radloff, 1977). The CESD-8 includes two reverse-scored items (items 4 and 6). The final CESD-8 score ranges from 0 to 8, which was obtained through summation of participants' "yes/no" responses; The CESD-8 items include: 1) Felt depressed; 2) Everything was an effort; 3) Sleep quality; 4) Felt unhappy; 5) Felt lonely; 6) Could not enjoy life; 7) Felt sadness; 8) Could not get going. A higher CESD-8 total score indicates more severe depressive symptoms (Wu et al., 2022). The CESD-8 is a valid and reliable tool for assessing depressive symptoms in older adults (Briggs et al., 2018). Those with a CESD-8 total score of ≥ 4 was considered as "having depression" (Mojtabai and Olfson, 2004; Zivin et al., 2013). The item CESD3 ("Sleep quality") was deemed redundant as the component of Jenkins Sleep Scale was used, therefore, it was excluded from the network analysis.

The severity of insomnia symptoms (insomnia hereafter) was measured using the modified version of the 4-item Jenkins Sleep Scale (JSS-4), which is a reliable sleep questionnaire that is widely used in epidemiological studies (Jenkins et al., 1988; Monterrosa-Castro et al., 2016). The four items of JSS-4 include 1) Trouble falling asleep; 2) Trouble waking up during night; 3) Trouble waking up too early; 4) Felt tired in morning, with the item 4 being a reverse-scored item. Each JSS-4 item was scored from "1" ("Most of the time") to "3" ("rarely or never"). Following previous studies (Kaufmann et al., 2013; Qi et al., 2023), each JSS item score was dichotomized and encoded as "0" or "1" ("rarely or never" as "0", "Sometime" and "Most of time" as "1" in the first three questions; "Most of time" as "0", "Sometime" and "rarely or never" as "1" in the fourth questions). The JSS-4 total score ranges from 0 to 4, with a higher total score indicating more severe insomnia symptoms (Kaufmann et al., 2013).

2.3. Propensity score

The data of both cancer patients and controls were based on the data of the HRS 2020 wave. R software (version 4.2.2) (R Core Team, 2022) and R package *MatchIt* (version 4.5.3) (Spitzer et al., 2006) were used to perform propensity score matching (PSM). PSM was utilized to reduce

unbalanced baseline characteristics between the exposed cohort (i.e., cancer patients) and the non-exposed cohort (i.e., cancer-free controls) (Austin et al., 2018). To achieve adequate statistical power, matching was conducted based on 1:1 ratio with a caliper size of 0.05 on the propensity scale. Propensity scores were calculated using a multivariable logistic regression with the following covariates: gender, age, marital status and education. The 95 % confidence intervals (95%CI) and *p*-values were calculated. Significance level was set at *p*-value < 0.05 (two-tailed).

2.4. Statistical analyses

2.4.1. Network estimation

Network analyses were performed with R software (version 4.2.2) (R Core Team, 2022). Network structure was established using R-package *networktools* (version 1.2.3) (Payton, 2022). The partial correlations between depressive and insomnia symptoms were calculated based on the Ising Model with the graphic enhanced least absolute shrinkage and selection operator (ELASSO) and Extended Bayesian Information Criterion (EBIC) model in the R package *qgraph* (version 1.6.5) (Bringmann et al., 2019; Epskamp et al., 2017). EI was calculated to determine the most central (influential) symptoms in the network (Beard et al., 2016). For each node, EI represents the summed weight of all its edges, including positive and negative associations with its immediate adjacent nodes in the network model. The role of symptoms connecting depression and insomnia communities was assessed using the bridge EI. The bridge EI of one node refers to the summed edge weight to the nodes from other community and reflects the importance of an individual symptom linking two clusters of psychiatric symptoms (Cramer et al., 2010). Predictability was defined as the variance of a node that could be explained by its adjacent nodes in the network model, which was estimated using the package *mgm* (version 1.2–11) (Haslbeck and Waldorp, 2020). In this network analysis, each variable was defined as a node and each pairwise association between variables was defined as an edge. Thicker edges reflect higher correlations. Green and purple color edges reflect positive and negative correlations, respectively.

2.4.2. Network stability

To assess the accuracy and stability of the observed network models, R package *bootnet* (version 1.4.3) (Epskamp and Fried, 2021) was used based on 1000 bootstraps performed for each node. The centrality indexes of EI and bridge EI were assessed using correlation stability coefficients (CS coefficients); values >0.25 indicates moderate stability, and values >0.5 indicates strong stability (Epskamp et al., 2018). A bootstrapped difference test was conducted to assess the robustness of node EI and edges. Differences were significant between two nodes or between two edges if zero was not included in the 95%CI of 1000 bootstraps. Edge accuracy was estimated with bootstrapped 95%CI; a narrower confidence interval suggests a more reliable network.

2.4.3. Network comparison

To consider the associations of depression or insomnia symptoms with age, gender, marital status, Body Mass Index (BMI) (Chan et al., 2018; Lai et al., 2020; Spencer, 2008; Stewart et al., 2006; Zhao et al., 2021), smoking and alcohol consumption (Lardier Jr. et al., 2022; Ponzoni et al., 2020), network characteristic differences were examined based on age, gender, marital status, BMI, smoking, and alcohol consumption. Network Comparison Tests (NCT) were performed between sub-samples to assess differences in the network structures (e.g., distributions of edge weights) and global strength (e.g., total absolute connectivity among the symptoms). All analyses were performed using the R-package *NetworkComparisonTest* (version 2.2.1) (van Borkulo et al., 2022).

3. Results

3.1. Study sample

In total, 2216 cancer patients and 2216 controls were included in the analyses. There were no significant differences in age, gender, marital status, education, BMI, smoking, alcohol consumption or COVID-19 infection between the two groups. The prevalence of depression (CESD-8 total score ≥ 4) in cancer patients (28.56 %; 95%CI: 26.68–30.44 %) was significantly higher compared to the control group (24.73 %; 95%CI: 22.93–26.53 %; *P* = 0.004).

In terms of depression and insomnia symptoms, the CESD-8 total score were significantly higher in cancer patients than controls (3.09 ± 1.39 vs. 2.91 ± 1.32 , *P* ≤ 0.001). Conversely, there was no significant group difference in terms of the JSS-4 total score (2.54 ± 1.17 vs. 2.48 ± 1.19 , *P* = 0.084). Demographic characteristics and scores on depression and insomnia measures are presented in Table 1.

3.2. Network structure and centrality symptoms

Network models of depression and insomnia are shown in Fig. 1. The predictability of individual symptoms is represented as ring-shaped pie charts in Fig. 1. For cancer patients, the mean predictability was 0.717. The network model indicated that the connection CESD4 (“Felt unhappy”) – CESD6 (“Could not enjoy life”) was the strongest positive edge in the network model, followed by CESD1 (“Felt depressed”) – CESD7 (“Felt sadness”), and JSS1 (“Trouble falling asleep”) – JSS2 (“Trouble waking up during night”). The assessment of EI indicated that CESD7 (“Felt sadness”, EI value = 6.866) had the highest EI centrality, followed by CESD4 (“Felt unhappy”, EI value = 6.371) and CESD1 (“Felt depressed”, EI value = 6.003).

For controls, the mean predictability was 0.739. The three strongest positive edges were similar as those in the cancer group: CESD4 (“Felt unhappy”) – CESD6 (“Could not enjoy life”), CESD1 (“Felt depressed”) – CESD7 (“Felt sadness”), and CESD5 (“Felt lonely”) – CESD7 (“Felt sadness”). In the analysis of EI, CESD1 (“Felt depressed”, EI value = 5.880) had the highest EI, followed by CESD7 (“Felt sadness”, EI value = 5.861) and CESD4 (“Felt unhappy”, EI value = 5.720).

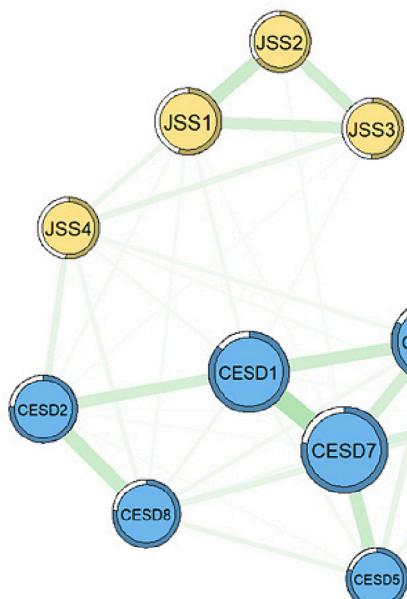
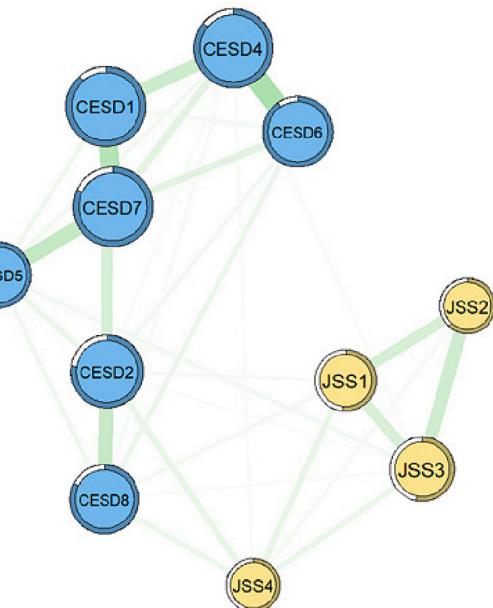
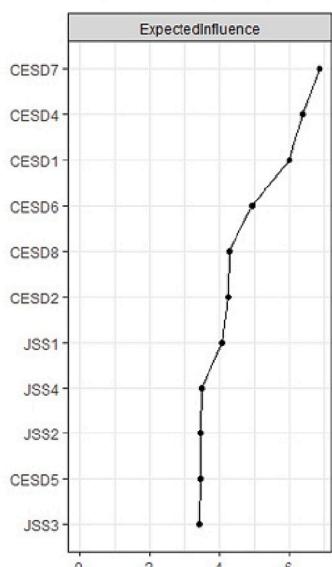
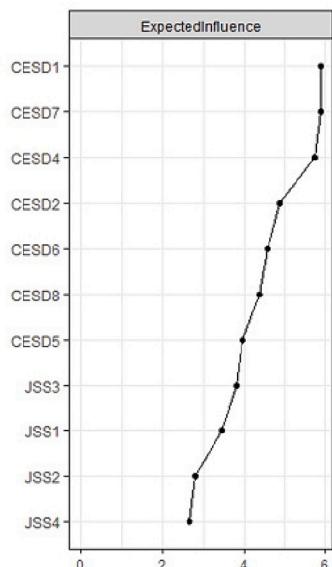
Table 1
Characteristics of participants included in the study (*N* = 4432).

Characteristics	Cancer patients (<i>N</i> = 2216)		Cancer-free controls (<i>N</i> = 2216)		<i>P</i>
Age (years; mean, SD)	72.31	10.17	72.09	10.08	0.478
Male (n, %)	913	41.20	892	40.25	0.541
Married/partnered (n, %)	1322	59.66	1336	60.29	0.690
Current smoking, (n, %) ¹	203	15.54	212	18.06	0.095
Alcohol consumption, (n, %) ¹	1267	57.72	1287	58.63	0.541
COVID-19 infection (n, %) ¹	30	2.19 %	47	3.46 %	0.050
Education (years; mean, SD)	13.41	2.69	13.54	2.53	0.114
BMI (mean, SD) ¹	28.79	6.42	28.64	6.10	0.590
CESD total score (mean, SD)	3.06	1.39	2.91	1.32	<0.001
CESD ≥ 4 (n, %)	633	28.56	548	24.73	0.004
JSS total score (mean, SD)	2.54	1.17	2.48	1.19	0.084

Abbreviation: BMI, Body Mass Index; CESD, Center for Epidemiological Studies Depression Scale; JSS, Jenkins Sleep Scale.

¹ Bold data signify *P* < 0.05.

¹ The frequencies are calculated from available data.

A. Cancer patients (N = 2,216)**Cancer-free controls (N = 2,216)****B. Cancer patients (N = 2,216)****Cancer-free controls (N = 2,216)**

Depressive symptoms

- ◊ CESD1: Felt depressed
- ◊ CESD2: Everything was an effort
- ◊ CESD4: Felt unhappy
- ◊ CESD5: Felt lonely
- ◊ CESD6: Could not enjoy life
- ◊ CESD7: Felt sadness
- ◊ CESD8: Could not get going

Insomnia symptoms

- ◊ JSS1: Trouble falling asleep
- ◊ JSS2: Trouble waking up during night
- ◊ JSS3: Trouble waking up too early
- ◊ JSS4: Felt tired in morning

Fig. 1. The network structure of depressive and insomnia symptoms among cancer patients and controls

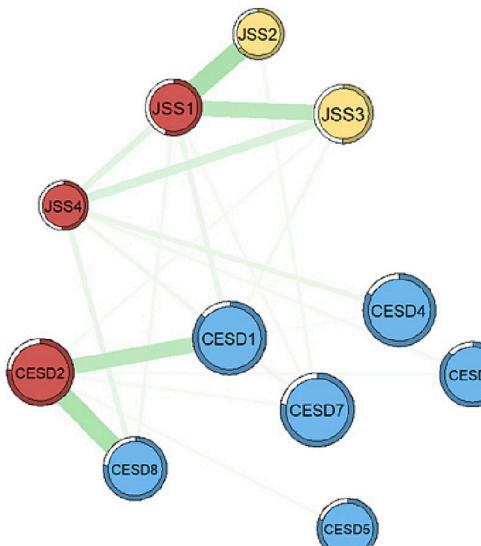
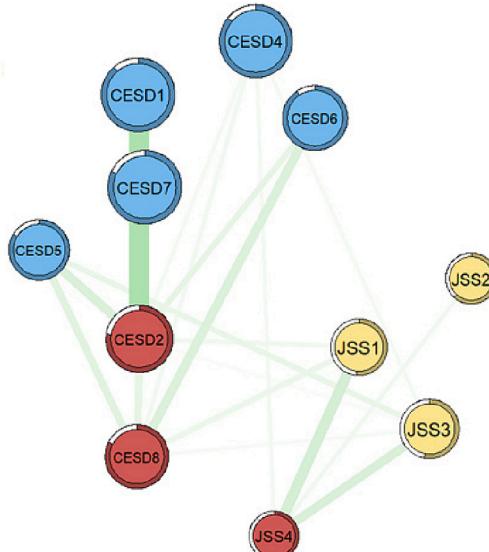
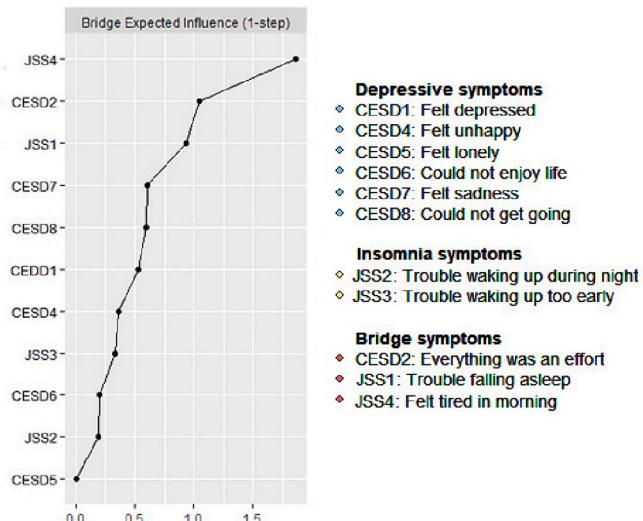
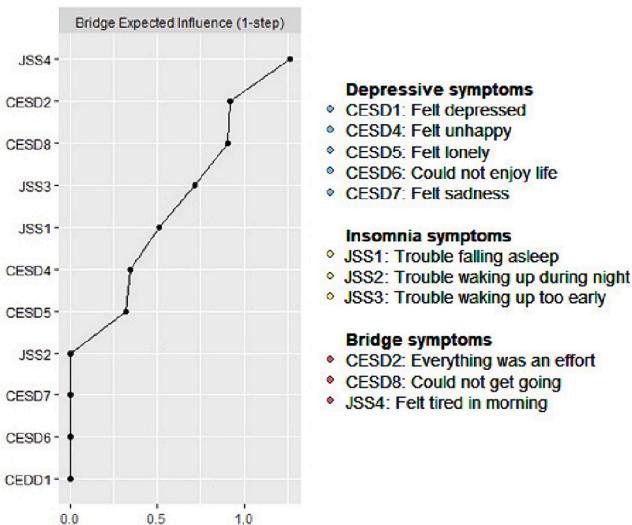
Note: A. Symptom network of depressive and insomnia symptoms among cancer patients or healthy controls; B. Expected Influence and node information of corresponding symptom network.

3.3. Bridge symptoms

Among cancer patients, JSS4 ("Felt tired in morning", bridge EI value = 1.870), CESD2 ("Everything was an effort", bridge EI value = 1.046), and JSS1 ("Trouble falling asleep", bridge EI value = 0.934) were the top three bridge symptoms linking the depression and insomnia communities. For controls, JSS4 ("Felt tired in morning", bridge EI value = 1.266), CESD2 ("Everything was an effort", bridge EI value = 0.921), and CESD8 ("Could not get going", bridge EI value = 0.909), were the top three bridge symptoms (Fig. 2).

3.4. Network stability

As shown in Fig. S1, the results of case-dropping sub-set bootstrapping indicated the EIs and bridge EIs remained stable in various analyses. CS coefficients for EI and bridge EI were 0.750 and 0.439, respectively in cancer patients. For controls, CS coefficients for EI and bridge EI were 0.750 and 0.361, respectively. Bootstrapping CIs of edge weights revealed that the edge values of the top three edges in cancer patients and controls were significantly higher than zero, indicating that the edges were trustworthy (Fig. S2). The bootstrapped difference test revealed that most of the edge weights and node expected influence had statistically significant differences from one another in individual comparisons, indicating that the primary results were reliable (Figs. S3

A. Cancer patients (N = 2,216)**Cancer-free controls (N = 2,216)****B. Cancer patients (N = 2,216)****Cancer-free controls (N = 2,216)****Fig. 2.** The network structure of depressive and insomnia symptoms among cancer patients and controls with bridge connections

Note: A. Symptom network of depressive and insomnia symptoms among cancer patients or healthy controls with bridge connections; B. Bridge expected influence and node information of corresponding symptom network.

and S4).

3.5. Network structure and edge differences between groups

The comparison of network models between cancer patients and controls based on NCT results did not show significant difference in global strength (25.265 vs. 23.990, $S = 1.275$, $P = 0.394$) or network structure ($M = 0.429$, $P = 0.932$). The specific edge weights for cancer patients and controls are illustrated in Tables S1 and S2. NCT results also did not find any edge difference in the networks between cancer patients and controls (all $P > 0.05$).

3.6. Sub-group analyses

The comparison between BMI > 25 and BMI < 25 groups among the controls showed significant difference on the network structure ($M = 2.093$, $P = 0.034$) but not on the global strength ($S = 5.125$, $P = 0.296$); in contrast, the comparison between BMI > 25 and BMI < 25 groups

among cancer patients did not show any significant difference in the network structure ($M = 1.077$, $P = 0.573$) and global strength ($S = 4.908$, $P = 0.199$) (Fig. 3). In addition, the NCT comparison did not show any significant difference on global strength and network structure among cancer patients and controls between different age groups (≥ 65 years old vs. < 65 years old), gender (male vs. female), marital status (married or partnered vs. unmarried and unpartnered), smoking (with vs. without smoking) and alcohol consumption (with vs. without alcohol consumption) (all $P > 0.05$). Plots are presented in the supplementary materials (Figs. S5-S9).

4. Discussion

To the best of our knowledge, this was the first study to compare the network structures of depression and insomnia between participants with cancer and those without cancer. The prevalence of depression ($\text{CESD-8} \geq 4$) in cancer patients was significantly higher compared to controls (28.56 % vs. 24.73 %; $P = 0.004$), which is consistent with

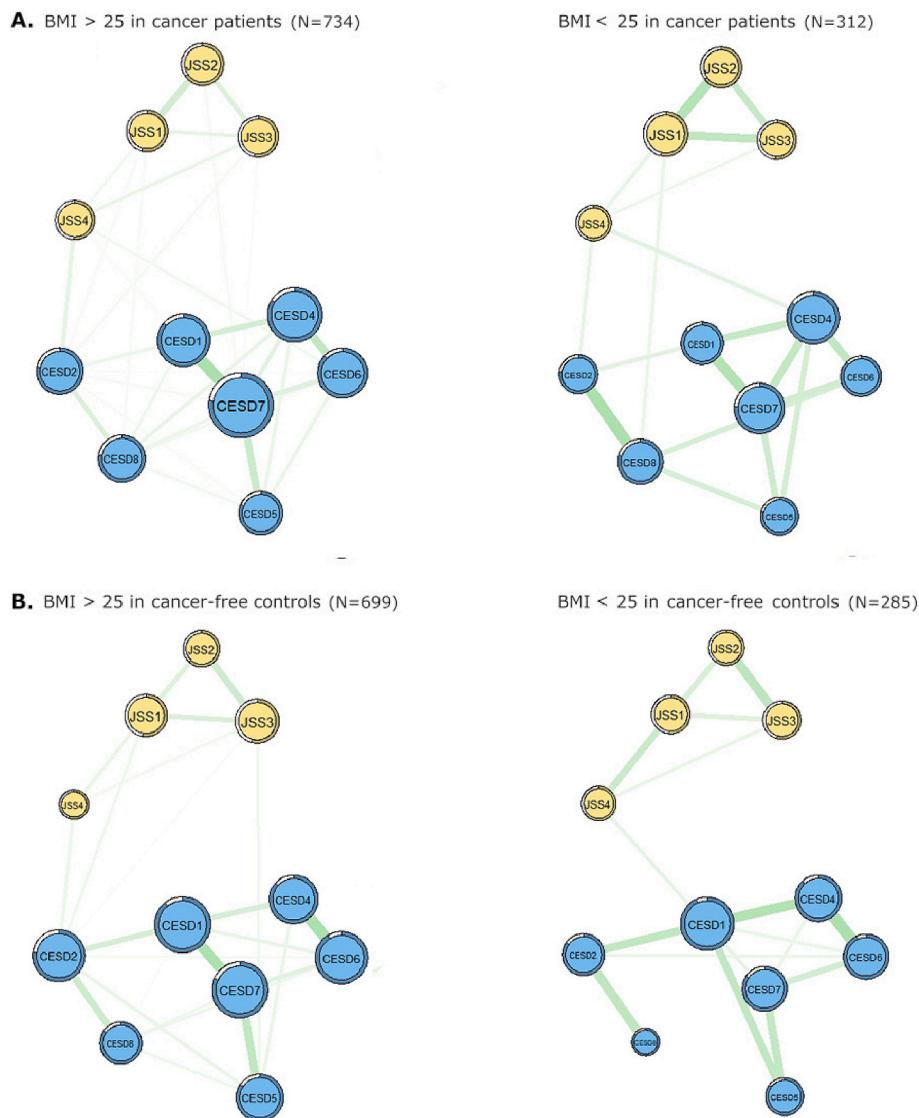


Fig. 3. Network model for depressive and insomnia symptoms based on subgroups by BMI.

previous findings (Kim et al., 2010; Mitchell et al., 2013) that found depression was more common in cancer patients than controls. Furthermore, the severity of depression in cancer patients was significantly more severe than that in controls, which is in line with the findings of a recent meta-analysis (Tao et al., 2023).

In this study no difference in the severity of insomnia was found between cancer patients and controls, which was similar to the findings of a study comparing black women with and without multiple cancers (Yusufov et al., 2022), but inconsistent with another study comparing individuals with and without breast cancer (Otte et al., 2010). The discrepancy might be partly due to different stages of cancer diagnosis and treatment. Studies have indicated that insomnia in cancer patients usually occurred immediately after the diagnosis of cancer and during the first six months following chemotherapy (Fleming et al., 2019; Savard et al., 2011).

“Felt sadness”, “Felt unhappy” and “Felt depressed” were the central symptoms in network models of both cancer patients and controls, which is almost the same as the results of a network analysis of depressive symptoms conducted among German cancer patients and the general population (Hartung et al., 2019). Negative emotion was both a core symptom of depression and a common symptom in individuals with insomnia; long-term negative emotion could lead to a wide range of adverse consequences such as poor attention, reduced work efficiency,

impaired immune system function, and increased risk of cancer (Andersen et al., 2017; Chen and Lin, 2011). As such, negative emotion could be a risk factor for poor prognosis in cancer patients (Nakamura et al., 2019). In this study, despite the disease burden and poor physical and mental health status faced by cancer patients, the network model of cancer patients appeared similar to the control group. This might reflect the remarkable stability of network analysis regardless of the diagnosis of cancer. Therefore, controlling negative emotions could be beneficial for both cancer patients and those without cancer (Ruan et al., 2023).

The bridge symptoms observed in both cancer patients and controls were “Felt tired in the morning” and “Everything was an effort”. “Felt tired in morning” was of clinical significance in the diagnosis of insomnia, as it referred to daytime functioning impairment caused by insomnia (Marway et al., 2023). Moreover, it was also an important indicator of the safety of hypnotic use in patients (Puustinen et al., 2007). “Felt tired in the morning” was identified as a bridge symptom between insomnia and depression network models among health professionals during the COVID-19 epidemic (Zhao et al., 2023). “Everything was an effort”, another bridge symptom in both groups, referring to the perception that “everything was difficult, tiring, or boring to do” (Frank et al., 2021). Both these symptoms underscored the fatigue experienced by individuals due to depression and insomnia. For controls, fatigue could negatively influence their quality of life (Anic et al.,

2022). For cancer patients, it might also undermine their treatment confidence and compliance (Lin et al., 2023). Studies have found that cancer itself could affect neuronal circuits controlling sleep, and cancer-related pain and emotional distress could exacerbate fatigue (Sharma et al., 2012; Wiggins et al., 2020). Therefore, in cancer patients with mental health problems due to depression and insomnia, psychological counselling and, in some cases, drug intervention might be required (Thasman, 2023).

We further found that “Trouble falling asleep” was a bridge symptom of cancer patients, while “Could not get going” was another bridge symptom of controls. Both these symptoms were also bridge symptoms of the network model of depression and insomnia in patients with post-traumatic disorders (Ma et al., 2022; Spiller et al., 2017). “Trouble falling asleep” tended to be the initial symptom of insomnia in cancer patients (Berisha et al., 2022), which was associated with a higher mortality and shorter survival in cancer patients (Ge et al., 2019; Gottfried et al., 2020). “Could not get going”, which was also referred to as “Lack of energy” in some studies, was a prominent symptom of depression generally.

The results of the NCT did not show any significant differences in the overall network structure of depression and insomnia between cancer patients and controls. The network global strength showed a slight decrease in cancer patients, but this decrease did not reach significance level. Contrary to our hypothesis, the network models of depressive and insomnia symptoms in cancer patients and controls showed similar characteristics in network structure, global strength, central symptoms and bridge symptoms. Consequently, evidence-based interventions [e.g., Mindfulness-based Cognitive Therapy (MBST) (Tan et al., 2022), Morita therapy (Nakamura et al., 2023), Dialectical behavior therapy (DBT) (Wu et al., 2023), Cognitive-behavioral therapy (CBT) (Chen et al., 2024)] targeting the identified central and bridge symptoms of depression and insomnia could be effective for cancer patients.

Subgroup analyses found that high BMI could significantly affect the network structure but not the global strength in controls, which aligns with previous findings in the general population that high BMI was a risk factor for both depression and insomnia (Chan et al., 2018; Duan et al., 2022). However, similar results were not found in cancer patients, perhaps due to the effects of cancer or cancer treatment on diet and lifestyle.

The strengths of this study included the use of a large nationally representative database, propensity score matching to ensure homogeneity in sample characteristics, and network analysis. However, several limitations needed to be acknowledged. First, the causality between different depressive and insomnia symptoms could not be inferred in network analysis. Second, the sample was limited to US community-dwellers aged over 50, therefore, the findings in this study might not extend to the younger cancer patients or patients in other parts of the world. Third, depressive and insomnia symptoms were measured by self-report questionnaires, which might lead to recall bias. Fourth, the symptoms of depression and insomnia in cancer patients might change with the course of the disease or chemotherapy, which could not be examined in this study.

In conclusion, compared to controls, cancer patients had more frequent and severe depression, but there was no significant group difference in the severity of insomnia, or network strength and structure of depression and insomnia. As such, psychosocial interventions for depression and insomnia targeting the central (“Felt sadness”, “Felt unhappy” and “Felt depressed”) and bridge symptoms (“Felt tired in morning” and “Everything was an effort”) could be equally useful in both cancer patients and the general population.

CRediT authorship contribution statement

Meng-Yi Chen: Data curation, Writing – original draft. **Wei Bai:** Data curation. **Xiao-Dan Wu:** Data curation. **Sha Sha:** Formal analysis. **Zhaohui Su:** Data curation. **Teris Cheung:** Data curation. **Ying Pang:**

Data curation. **Chee H. Ng:** Writing – review & editing. **Qinge Zhang:** Writing – review & editing, Conceptualization. **Yu-Tao Xiang:** Conceptualization, Writing – original draft.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Acknowledgements

The authors are grateful to all participants and clinicians involved in this study.

Financial disclosure

The HRS is sponsored by the National Institute on Aging (grant number NIA U01AG009740) and is conducted by the University of Michigan. The study was supported by the National Science and Technology Major Project for investigational new drug (2018ZX09201-014), the Beijing Hospitals Authority Clinical Medicine Development of special funding support (XMLX202128), and the University of Macau (MYRG2019-00066-FHS; MYRG2022-00187-FHS).

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jad.2024.04.035>.

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