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Network analysis of stress and stigma symptoms and their associations with quality of life among Chinese female infertility patients

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Abstract

Background This study has employed network analysis while investigating the interrelationships among stress and stigma symptoms and their associations with quality of life among Chinese female infertility patients.

Methods In this cross-sectional study, 428 female patients who visited the Department of Reproductive Center of Dalian Women and Children's Medical Group with chief complaints of infertility symptoms were recruited using convenience sampling from November 2022 to December 2023. Fertility-related stress and stigma status were examined by the Fertility Problem Inventory (FPI) and Infertility Stigma Scale (ISS), respectively. Quality of life was examined by the Fertility Quality of Life (FertiQoL). Network analysis was conducted to estimate the network of stress and stigma symptoms. The flow network approach was used to identify specific stigma and stress symptoms related to quality of life. Expected influence (EI) and bridge expected influence (bEI) were used to quantify central and bridge symptoms in the network, respectively. The bootstrapping method evaluated the accuracy and robustness of the network estimates.

Results The average predictability of FPI and ISS symptoms was 0.67. The "relationship concern" was the most central symptom across all centrality indices, followed by "public stigma" and "social concern". The main symptoms bridging the FPI and ISS clusters were "self-devaluation", "social concern", and "relationship concern". The network demonstrated robustness in stability and accuracy tests. In the flow network, "social withdrawal" and "self-devaluation" showed strong negative associations with FertiQoL.

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Conclusions "Relationship concern," "public stigma," "social concern," and "self-devaluation" have been identified as the main central and bridge symptoms in the stress and stigma network in this study. Notably, stigma symptoms, particularly "social withdrawal" and "self-devaluation", showed stronger associations with FertiQoL compared to stress symptoms, highlighting their importance in potential treatment strategies.

Keywords Infertility, Stress, Stigma, Quality of life, Network analysis

Introduction

Infertility, defined as the failure to establish a clinical pregnancy after 12 months of regular, unprotected sexual intercourse or due to an impairment of reproductive capacity [1], is a growing global public health issue [2]. According to a 2023 World Health Organization report, approximately 17.5% of the adult population worldwide experiences infertility [3]. In China, the prevalence is even higher, affecting 25% of couples of reproductive age [4], with female infertility cases increasing by 7.06 million over the past 30 years [5]. Infertility extends beyond reproductive dysfunction because it often leads to significant psychological problems [6]. Some researchers speculate that psychological factors might be the primary cause of infertility rather than biological factors [7]. While assisted reproductive technology (ART) offers hope for many infertile women, evidence suggests that the treatment process itself can exacerbate psychological burdens [2, 8]. Invasive physical examinations, surgical procedures, medical expenses, uncertain pregnancy outcomes and other factors contribute to increased stigma and stress, seriously affecting the patients' quality of life [6].

Unlike personality traits, stress and stigma are not inherent characteristics; rather, they are responses shaped by specific environments and experiences. In the context of infertility, stigma manifests as negative self-perceptions among women, leading to feelings of alienation, isolation, and misunderstanding within society [9]. Approximately 53.08–64% of female infertility patients worldwide experience this stigma, which can severely impact their mental health and other components of quality of life [10]. This stigma is linked to adverse social consequences, including domestic violence, marriage breakdown, and delays in seeking necessary treatment [10]. In addition, infertility-related stress is characterized as overwhelming mental, emotional, or physical stress resulting from the desire—but inability—to conceive, as well as from associated infertility treatments [11]. Infertility can be considered one of the most stressful life events [7]. Globally, the prevalence of infertility-related stress is notably high, with studies reporting rates of 92.71% among Ethiopian women [12] and 80% among Indian women [13]. Moreover, evidence suggests a strong association between perceived stigma and increased infertility-related stress [14], with higher levels of stigma directly contributing to stress experienced by affected individuals [15].

Stress and stigma associated with infertility are multidimensional, comprising various symptoms that manifest differently in individuals. This variability creates unique 'symptom mosaics' among infertile women, potentially delineating distinct subgroups. Recognizing these subgroups is crucial for developing tailored management strategies, which could significantly enhance the specificity and effectiveness of interventions. Traditional approaches that sum symptoms to represent stress and stigma have failed to capture the complexity of individual symptom patterns and relationships. This limitation highlights the need for more nuanced examination of the underlying mechanisms under study.

Moreover, quality of life is an important outcome indicator in the new medical model during infertility treatment. Fertility quality of life (FertiQoL) is an individual's perception of and satisfaction with all aspects of life when faced with fertility problems [16]. Infertile women tend to have lower quality of life and greater psychological burden, compared to fertile women [6]. Both stress and stigma are negatively associated with FertiQoL [17, 18], suggesting that alleviating these factors could improve the quality of life for female infertility patients. Similarly, few studies have explored the associations of these variables with quality of life at the level of symptoms.

Network analysis, a novel analytic technique, enables visualization and quantification of complex associations among symptom dimensions [19–22]. Unlike traditional approaches that sum symptoms for diagnoses, network analysis assumes that psychiatric disorders stem from a causal interplay between symptoms [23]. This approach allows for a more nuanced understanding of concrete symptoms that might be central to the experience of stress and stigma, as well as their associations with quality of life. Moreover, it allows for a more comprehensive understanding of the complex interplay between stress, stigma, and quality of life in the context of female infertility, potentially stimulating more powerfully effective and tailored treatment strategies.

Given all that has been said, the present study aims to achieve two primary objectives. First, we seek to investigate the network structure of stress and stigma in female infertility patients. Second, we aim to examine the associations of these variables with quality of life from a network perspective.

Methods

Study setting

This study was conducted in Dalian city, Liaoning Province, a megacity and an important central hub in the northern coastal region of China. Participants were recruited from the Dalian Women and Children's Medical Group, the largest public general hospital for women and children in Northeast China.

Participants

This cross-sectional study employed a convenience sampling method to recruit patients visiting the Department of Reproductive Center at the Dalian Women and Children's Medical Group, with primary complaints of infertility symptoms. The inclusion criteria were: (1) female patients; (2) inability to conceive for at least 12 months prior to participating in this study; and (3) age over 18 years and within childbearing age. Patients with a history of psychotic disorders were excluded from the study.

Procedure

The recruitment period spanned from November 2022 to December 2023. To ensure standardization and consistency in data collection, we conducted comprehensive training for doctors and nurses prior to the study's commencement. This training focused on uniform understanding and interpretation of each questionnaire item. Following clinical diagnosis, each participant was escorted to a private treatment room for the survey. All participants were thoroughly briefed on the study's background and objectives. Informed consent was obtained from those who agreed to participate, with the explicit understanding that they could withdraw from the study at any time without consequence. The electronic "Questionnaire Star" tool (https://www.wjx.cn/) was used to send questionnaire to the participants, with either a resident doctor or nurse administered the assessments. Ethical approval was obtained from the ethical review board of Dalian Women and Children's Medical Group (internal file number: 2024002).

Measures

Background characteristics

The study collected sociodemographic variables (age, residence, education level, only child status, only child status of the husband) and infertility-related characteristics (birth history, duration of infertility, and duration of treatment) as we attempted to provide a comprehensive profile of the participants.

The fertility problem inventory

Fertility-related stress was assessed using the Fertility Problem Inventory (FPI) [24]. The FPI is a self-rating scale consisting of 46 items across five subscales: social concern, sexual concern, relationship concern, need for parenthood, and rejection of childless lifestyle. Participants respond on a 6-point Likert scale (1=I don't agree to 6=I completely agree), with total scores ranging from 46 to 276. Higher scores indicate greater fertility-related stress. The Chinese version of the FPI has demonstrated reliability and validity for clinical assessment [25], and showed good internal reliability in this study (Cronbach's alpha=0.80).

The infertility stigma scale

Stigma status was assessed using the Infertility Stigma Scale (ISS), a reliable and validated instrument for assessing the stigma status experienced by infertile Chinese women [9]. The scale consists 27 items across four dimensions: self-devaluation, social withdrawal, public stigma, and family stigma. Responses are recorded on a five-point Likert scale (1=totally disagree to 5=totally agree), with total score ranging from 27 to 135. Higher scores reflect more severe stigma symptoms. The ISS demonstrated excellent internal reliability in this study (Cronbach's alpha=0.94).

The fertility quality of life

Quality of life was measured using the Fertility Quality of Life (FertiQoL) instrument, a reliable tool for assessing the impact of fertility problems and treatment on quality of life [26–28]. The FertiQoL has been validated across diverse infertile populations globally [6, 29–31], enhancing its cross-cultural applicability. It comprises 36 items assessing core (24 items) and treatment-related (10 items) quality of life, as well as overall life and physical health (2 items). Responses are recorded on a five-point Likert scale (0 to 4), with total scores ranging from 0 to 100. Higher scores indicate better quality of life. The FertiQoL demonstrated good internal reliability in this study (Cronbach's alpha=0.85).

Statistical analysis

Statistical analyses were conducted using SPSS26 (IBM Corp., Armonk, NY, USA) and R (version 4.2.1). Descriptive statistical analyses were performed using SPSS26 to analyze participants' demographic profiles. Continuous variables (age, duration of infertility, and duration of treatment) were presented as means±standard deviations (SD). Categorical variables (residence, education level, only child status, only child status of the husband, and birth history) were described using frequencies (percentages). Network analysis was performed through the R package, following these detailed processes:

Network estimation

The R package "qgraph" was used to construct the network through a graphical Gaussian model (GGM),

allowing direct interpretation of edges as partial correlation coefficients [32]. In this network, each node represents a symptom. For the FPI and ISS, dimensions rather than individual items were included in the network analysis, resulting in five dimensions from the FPI and four from the ISS. Node positioning is determined by an algorithm that clusters strongly correlated symptoms in the center, while symptoms with weaker connections appear in the periphery [33]. The associations between nodes are called edges. The thicknesses of the edges represent the weights of associations between nodes. Correlations were determined using the cor_auto function from the "qgraph" package, which automatically detects ordinal variables and utilizes the R package "lavaan" to compute appropriate correlations (polychoric, polyserial, or Pearson) between FPI and ISS dimensions [32]. The graphic least absolute shrinkage and selection operator (LASSO) and extended bayesian information criterion (EBIC) models were utilized, with the hyperparameter set to 0.5 [32]. Positive associations are represented by blue lines, while negative relationships are shown in red.

Node predictability, reflecting how well a particular node can be predicted by all other nodes, was estimated using the "mgm" R package and computed by the predict function for each node in the network [34]. Predictability is visualized as a ring-shaped pie chart around each node, with fuller rings indicating higher predictability values [19]. Additionally, a flow network was created using the flow function to pinpoint specific stigma and stress symptoms related to FertiQoL, providing insights into the interconnections between these factors [19, 20].

Centrality estimation

Expected influence (EI) was used to quantify the central symptom in the network, calculated using the "centralityPlot" function in the "qgraph" package. EI, representing the sum of all partial correlations, indicates a node's association with others in the network structure [35]. Higher EI scores signify more central symptoms [19], which may play a crucial role in the onset and/or maintenance of psychiatric syndromes. Consequently, targeting these central symptoms through preventive measures and interventions may prove more efficient. "Bridge symptoms" connect two mental disorders and may increase the risk of other disorders when an individual suffers from a psychiatric condition. Improving these bridge symptoms could potentially reduce psychiatric comorbidities [36]. The Bridge Expected Influence (bEI) quantifies the bridge symptoms between clusters experiencing stress and stigma symptoms [37]. bEI was estimated using the bridge function in the "networktools" package, representing the sum of connectivity between a given node and all nodes of different clusters [37]. Bridge symptoms may play a critical role in developing and perpetuating comorbidities, providing valuable insights for clinicians in preventing and treating psychiatric comorbidities.

Accuracy and stability estimation

The bootstrapping method was utilized to evaluate the accuracy and stability of the network estimates using the "bootnet" package [32, 38]. The stability of centrality indices and the correlation stability coefficient (CS-coefficient) were estimated using the case-dropping bootstrap test with 1000 bootstrap samples [32]. The plot function was used to illustrate how centrality indices changed when the proportion of participant subsets decreased (e.g., from 100 to 10% of the sample) after bootnet. Faster changes in centrality indicate lower stability. The CS-coefficient of the EI and bEI centrality was assessed using the corstability function after bootnet, with values above 0.25 indicating adequate stability and values above 0.5 suggesting good stability [19]. The 95% confidence interval (CI) of the edge weight accuracy was estimated by the non-parametric bootstrapping test with 1000 bootstrap samples [32]. A narrower 95% CI in the figure represented more accurate edge weights and a more reliable network. Finally, significant differences in EI were also examined using the non-parametric bootstrapping test ($\alpha = 0.05$) [32].

Covariates control

Following the approach of previous study [39], we constructed an additional network structure including: age, residence, educational level, only child status, only child status of the husband, birth history, duration of infertility and duration of treatment using them as covariates. This was done to examine the impact of confounding factors on stress and stigma symptoms in Chinese female infertility patients.

Results

Sample characteristics

A total of 428 female infertility patients participated in the survey, with 427 included in the final analysis after eliminating one participant due to incomplete information. This resulted in an effective response rate of 99.77%. The mean age of participants was 34.14±4.31 years. The majority of participants were from urban areas (84.07%) and held a junior college degree (69.79%). A total of 46.14% were only children, and 60.66% had only-child partners. The great majority had no previous birth history (91.57%). The mean duration of infertility was 3.62±2.79 years, and the mean duration of treatment was 1.58±2.46 years (Table 1). The descriptive statistics of the FPI and ISS symptoms, such as the mean scores with SDs are summarized in Table 2.

Table 1 Demographics of survey participants ($n=427$)

Variable	Total	Percentage (%)
Residence		
Urban	359	84.07
Township	37	8.67
Village	31	7.26
Educational level		
Secondary school or below	74	17.33
High school	25	5.85
Junior college	298	69.79
College or above	30	7.03
Only child status		
Yes	197	46.14
No	230	53.86
Only child status of the husband		
Yes	259	60.66
No	168	39.34
Birth history		
Yes	36	8.43
No	391	91.57

Table 2 Descriptive statistics of the FPI and ISS symptoms

Item content	Mean (SD)	Expected influence	Predictability
Fertility Problem Inventory (FPI)			
Social concern	33.22 (7.84)	0.92	0.66
Sexual concern	25.38 (7.09)	-0.19	0.58
Relationship concern	34.47 (8.09)	1.06	0.71
Need for parenthood	39.32 (9.56)	-0.99	0.53
Rejection of childless lifestyle	31.82 (7.61)	-1.89	0.28
Infertility Stigma Scale (ISS)			
Self-devaluation	15.28 (7.52)	0.37	0.83
Social withdrawal	12.05 (5.47)	-0.47	0.73
Public stigma	18.59 (9.18)	1.04	0.90
Family stigma	12.06 (5.74)	0.14	0.86

Network structure

The predictability of the FPI and ISS symptoms is shown in Table 2. The average predictability was 0.67, indicating that surrounding nodes could typically explain 67% of each node's variance. All items from the ISS and FPI demonstrated stronger connections with other items within the same questionnaire compared to across questionnaires. The edge weights, representing partial correlations between two nodes, are shown in Fig.S1. Nodes with high edge weights may be influential in the network structure. The two strongest edges were observed between "public stigma" (ISS3) and "family stigma" (ISS4) (average edge weight range=0.62) among the stigma items and between "relationship concern" (FPI3) and "need for parenthood" (FPI4) (average edge weight range=0.38) among the stress items (Fig. 1).

Centrality indices

In the entire network, "relationship concern" (FPI3) emerged as the most central symptom across all centrality indices, followed by "public stigma" (ISS3) and "social concern" (FPI1) (Fig. 2A). The primary symptoms bridging the FPI and ISS clusters were "self-devaluation" (ISS1), "social concern" (FPI1), and "relationship concern" (FPI3) (Fig. 2B).

Accuracy and stability estimation

The stability of EI was 0.749, while the bEI was 0.672, indicating excellent stability levels for both centrality indices. These values suggest that the centrality indices remained relatively consistent even when 74.9% and 67.2% of the sample was dropped, respectively (Fig. 3). The edge weight plot showed a narrower 95% CI, indicating high accuracy of the edge weight in this study (Fig. S2). Furthermore, the bootstrapped stability test for EI revealed that the central symptoms were significantly different from the other nodes (Fig.S3).

The confounding effects of the covariates

In the network that included the covariates, birth history emerged as the most influential factor, showing a negative association with the symptoms of "rejection of childless lifestyle" (FPI5) (average edge weight range=-0.14). The remaining covariates exhibited only slight associations with a few symptoms (edge weight <0.1), indicating the covariates did not significantly impact the network model. (Fig. 4, Table. S1)

Flow network of FertiQoL

In the flow network, six symptoms were linked to the FertiQoL. Among these, "social withdrawal" (ISS2) demonstrated the strongest negative association with FertiQoL (average edge weight range=-0.20), followed by "self-devaluation" (ISS1) (average edge weight range=-0.16) (Fig. 5, Fig.S4). Furthermore, the node "FertiQoL" predictability was 0.36, indicating that FPI and ISS could typically explain 36% of the fertility quality of life among Chinese female infertility patients in this study.

Discussion

In this study, we utilized network analysis to elucidate the intricate relationships among stress and stigma symptoms and their associations with quality of life in female infertility patients. Our findings reveal that "relationship concern," "public stigma," and "social concern" were the most central symptoms in the networks, suggesting their potential as key targets for therapeutic interventions. Additionally, "self-devaluation," "social concern," and "relationship concern" emerged as the main bridge symptoms, while "social withdrawal" and

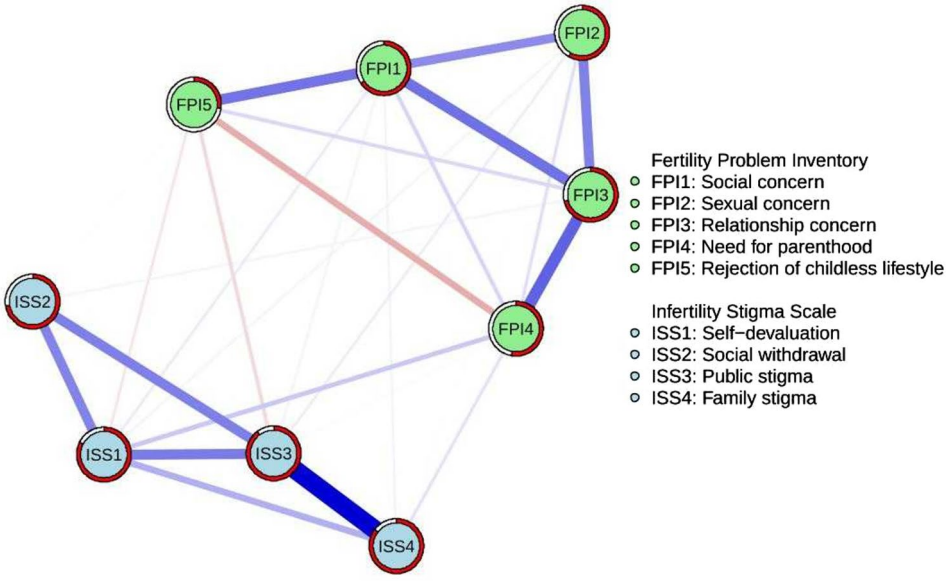

Fig. 1 Networks for symptoms of the FPI and ISS. Note: FPI: Fertility Problem Inventory; ISS: Infertility Stigma Scale. The predictability of each symptom is shown as ring-shaped pie charts

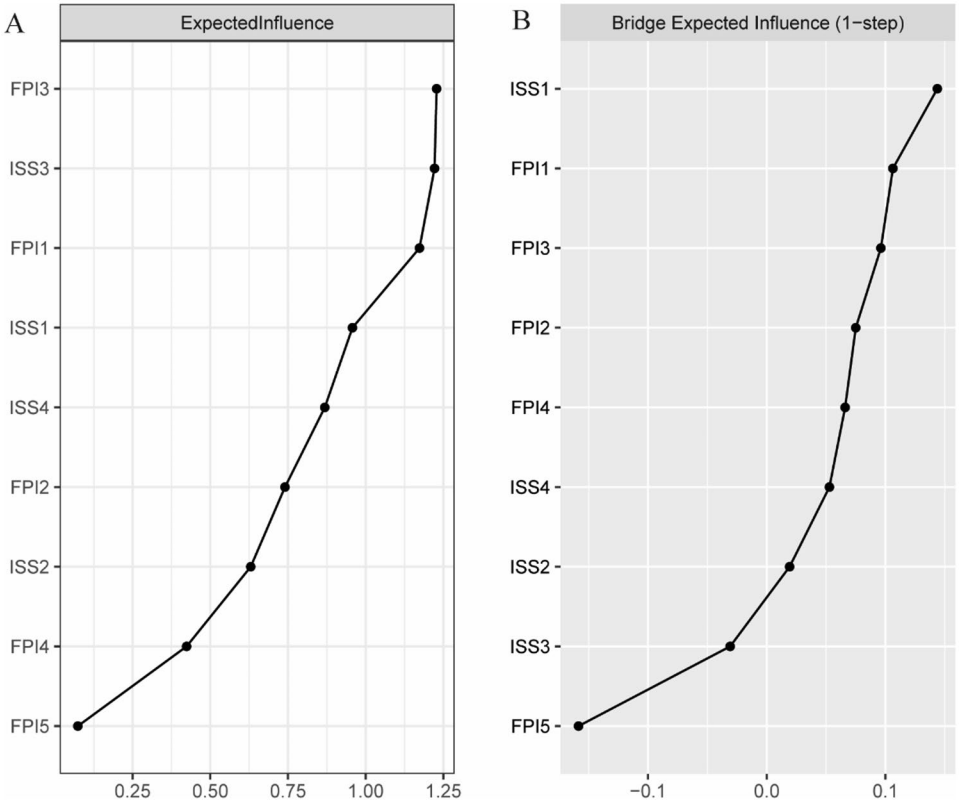

Fig. 2 Centrality indices for symptoms of the FPI and ISS. Note: A: Expected influence; B: Bridge expected influence (1-step); Fertility-related stress symptoms (FPI1-FPI5); Infertility stigma symptoms (ISS1-ISS4). The x-axis represents the node standardization results of the EI and bEI. The y-axis represents each symptom of the FPI and ISS

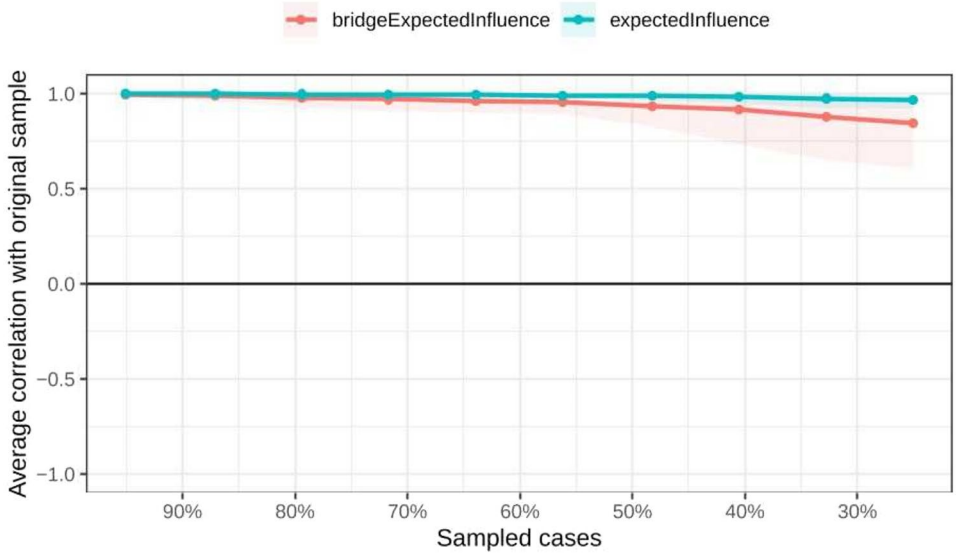

Fig. 3 The stability of centrality and bridge centrality indices according to a case-dropping bootstrap method. Note: The x-axis represents the percentage of cases in the original sample used at each step. The y-axis represents the average correlation with original sample. The coloured areas indicate 95% confidential intervals

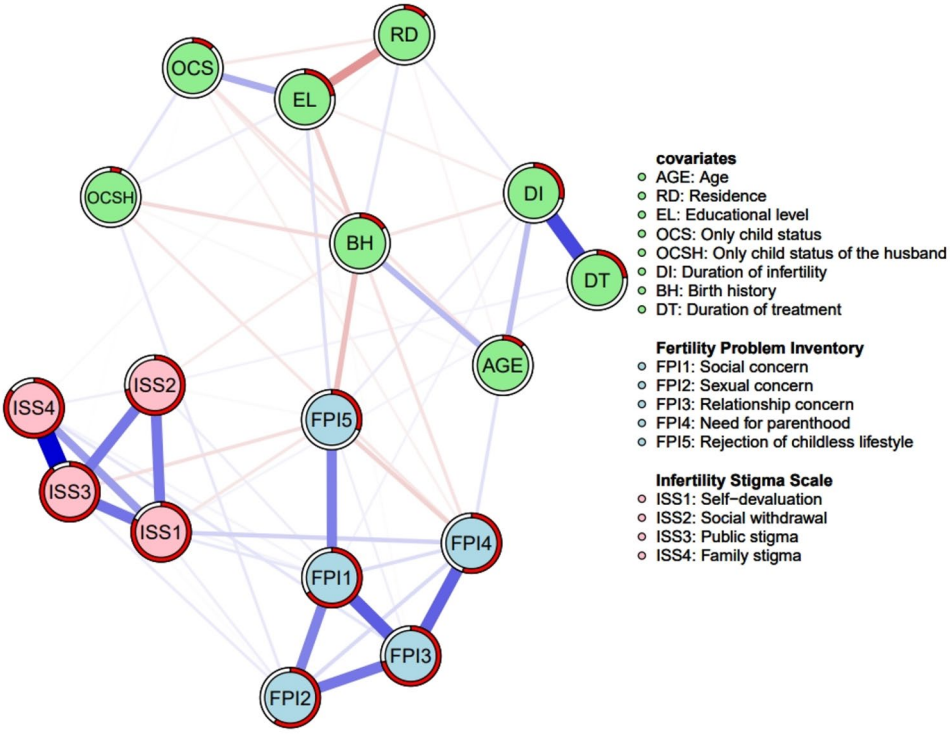

Fig. 4 Network displaying the relationship between the FPI and ISS after controlling for covariates. Note: Blue edges constitute positive partial correlations between variables, red edges constitute negative partial correlations; rings around nodes convey variance in a given variable with shadowed parts displaying that part of the variance in each node that is explained by nodes that connect with it

"self-devaluation" demonstrated strong negative associations with FertiQoL.

According to our stress and stigma network model, "relationship concern" emerged as the most central symptom across all centrality indices. This finding is unsurprising, given that infertility is a major event affecting family relationships [40]. The infertility treatment process is often prolonged, complex, and yields uncertain results [41]. Consequently, it can lead to emotional frustration, family conflicts, and even marital breakdown.

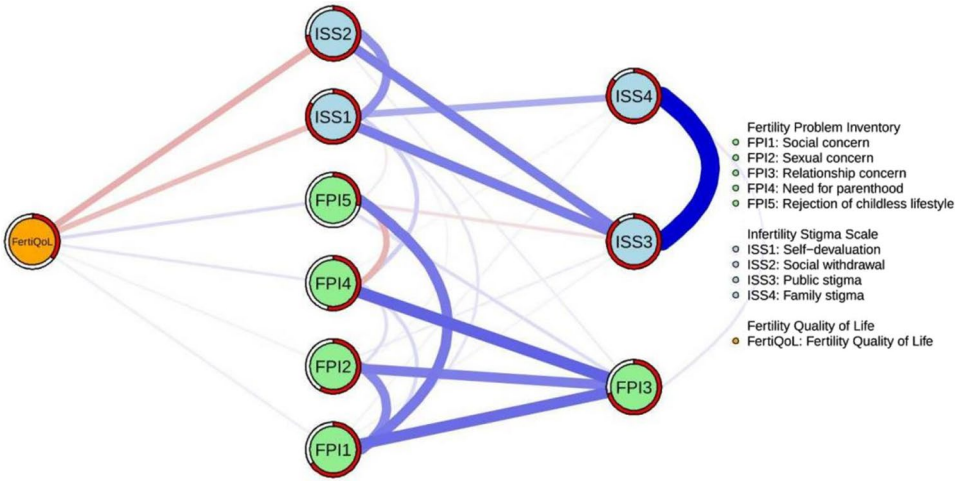

Fig. 5 Flow network of the FertiQoL with the FPI and ISS symptoms. Note: FertiQoL: Fertility Quality of Life; FPI: Fertility Problem Inventory; ISS: Infertility Stigma Scale

Moreover, sexual activity becomes a regular and important task related to therapeutic outcome—pregnancy, and frames of "success" or "failure" tend to diminish spontaneity [42], potentially further exacerbating couples' relationships. "Public stigma" was another central symptom in our network. While Chinese society has become increasingly open and inclusive [43], traditional beliefs such as "more children, more happiness", "unfilial acts there are three, no posterity is great" remain deeply rooted in some regions [44]. Carrying on the family line is often regarded as one of the most important functions of women, and failure to have children can be seen as a disgrace to her family [18]. Due to the great importance attached to fertility and childbearing ability, there is a societal tendency to believe that childlessness is always the woman's fault [45]. Similarly, "social concern" emerged as an important symptom in the network. This concern included sensitivity to comments, reminders of infertility, feelings of social isolation, and alienation from family or peers [24]. Furthermore, China's recent introduction of policies to increase birth rates, including the "two-child" and subsequent "three-child" policies [46], has also placed considerable pressure on female infertility patients.

"Self-devaluation," "social concern," and "relationship concern" were identified as the main symptoms bridging the FPI and ISS clusters. Self-devaluation is the internalization of negative beliefs about oneself and its association with negative characteristics due to stigmatization [47]. This symptom is particularly common among female infertility patients. Larissa Remennick revealed that most infertile women across the world perceive their condition as a hidden disability that devalues them as women [48]. Additionally, Marta Bornstein et al. found that women are particularly ostracized when perceived as infertile, leading individuals to potentially exclude themselves to alleviate feelings of otherness [49]. Notably, "social concern" and "relationship concern" were the most central symptoms and main bridge symptoms, which emphasizes the importance of these two symptoms for female infertility patients.

In the network that included the covariates, birth history emerged as the most influential factor, showing a negative association with the symptoms of "rejection of childless lifestyle". This may partially be explained by the fact that women who have birth history may have already experienced motherhood, potentially attaining some emotional and psychological satisfaction and achievement. Consequently, even if individuals are unable to have children due to various reasons, they may be more readily accepted by society. While other covariates in this study did not significantly affect the network model, it is worth noting that some potential confounders, such as menstrual pain [50] and other mental health issues [10], which could influence the observed associations, were not included. Future research should aim to incorporate these variables to provide a more comprehensive understanding of the relationships between stress, stigma, and infertility.

Our flow network analysis revealed that stigma symptoms were more closely associated with the FertiQoL than stress symptoms. Specifically, "social withdrawal" and "self-devaluation" demonstrated strong negative associations with FertiQoL, aligning with findings from other studies that identified these factors as significant predictors of FertiQoL scores [17]. A study conducted in Zhejiang, China, revealed that infertile women experience moderate to high levels of stigma, primarily manifesting as social withdrawal [45]. Similarly, in the United States, social withdrawal is one of the mechanisms used by infertile women to cope with stigma [51]. From a practical standpoint, most of their peers already have

children, leading to discomfort when faced with questions or comments about their own childlessness. To escape these inner thoughts and avoid uncomfortable situations, they often withdraw from social activities and interactions [45]. Moreover, the treatment of infertility requires repeated periodic interventions, with some patients even quitting their jobs to accommodate these demands. As fertility treatment becomes their "full-time job," it significantly reduces their social engagement. This reduced social activity, coupled with self-devaluation, have exacerbated the stigma-induced psychological burden, negatively impacting their FertiQoL [49, 52]. It's worth noting that one study identified social concern as the strongest predictor of FertiQoL [6]. These inconsistent findings highlight discrepancies in central symptoms across study samples and periods [20], underscoring the need for further research in this area.

Our findings have advanced our understanding of the core features of stress and stigma symptoms during infertility and have significant implications for targeted interventions to improve quality of life in clinical practice. Fertility clinicians should consider implementing supportive care measures, such as fertility counselling, to assist patients in managing these challenges. When counselling female infertile patients, doctors should prioritize psychological support, particularly targeting the central and bridge symptoms of "relationship concern", "public stigma", "social concern" and "self-devaluation". Doctors could also provide additional relationship health education and social support to infertility patients, aiming to reduce avoidance responses. Regarding FertiQoL improvement, our results suggested that targeting stigma symptoms might be more effective than focusing on stress symptoms. Patients should be encouraged to maintain normal work and life routines with a peaceful and relaxed mindset while undergoing treatment.

Strengths and limitations

A main strength of the current study lies in its innovative use of network analysis to examine the central and bridge symptoms of stress and stigma, and their associations with the quality of life among Chinese female infertility patients. The approach has provided us with a more explicit structure for understanding the relationships between those symptoms, thereby enhancing the specificity and targeting of interventions addressing female infertility patients' mental health.

Several limitations should be noted. Firstly, the cross-sectional design might, to some extent affect our determination of the directionality or extent of interactions among stress, stigma, and infertility. Secondly, focusing exclusively on infertile women is likely to restrict our ability to control confounds that might affect this group, hindering the assessment of how relationships might differ between infertile and fertile women. This limitation impacts the generalizability of the findings and could obscure stressors or stigma manifestations unique to infertility. A related issue is the neglect of men or the husbands, which might also be a limit of this study as previous research has shown that the emotions of wives may interact with those of their husbands [53]. An increase in infertile women's stress not only results in a decrease in their quality of life but also affect their partners' quality of life [18]. Future studies should consider involving spouses in interventions [54]. Thirdly, there is also the concern of the sample's heterogeneity issue, with participants at various stages of treatment as evidence suggests that psychological states during in vitro fertilization-embryo transfer differ across phases [55]. To remedy this heterogeneity issue, future longitudinal studies should ascertain specific treatment stages (before-, after-, immediately after- and post) so as to provide better tailored interventions [29, 56]. Additionally, some nodes may measure overlapping constructs (e.g., "social concern" in the FPI and "public stigma" in the ISS), potentially inflating edge weights and centrality. Currently, there is no canonical approach within networks for determining topological overlap or combining overlapping items [21]. This methodological consideration is well-recognized in psychometric network analysis, and researchers are continuously developing techniques to address such complexities.

To conclude, based on our strengths and weaknesses, we suggest future studies take good account of the following aspects or steps: (1) conducting longitudinal studies in order to track the evolution of stress, stigma, and quality of life throughout the infertility journey and treatment process; (2) comparing infertile and fertile populations so as to isolate unique psychological challenges associated with infertility; (3) incorporating male partners for a more comprehensive understanding of infertility's psychological impact on couples; (4) investigating cultural variations in infertility-related stigma in order to develop culturally sensitive interventions and evaluating the efficacy of stigma-reduction strategies in improving patients' quality of life. By addressing such research concerns, we are hopeful to further refine our understanding of the psychological dimensions of infertility and contribute to the broader goal of destigmatizing infertility and promoting a more compassionate, informed approach to supporting individuals and couples facing fertility challenges.

Conclusion

As illustrated earlier, the aim of the present study is to investigate the relationship between stress, stigma, and quality of life in female infertility patients. For that purpose, our adopted method of network analysis has enabled us to identify relationship concern, public

stigma, and social concern as central symptoms, with self-devaluation, social concern, and relationship concern as main bridge symptoms in the stress-stigma network. Among stigma symptoms, social withdrawal and self-devaluation have showed remarkably stronger associations with FertiQoL than stress symptoms. Those findings emphasize the need for more accurately targeted interventions addressing stigma-related issues in order to enhance the life quality of female infertility patients.

Abbreviations

ART	Assisted Reproductive Technology
FertiQoL	Fertility Quality of Life
FPI	Fertility Problem Inventory
ISS	Infertility Stigma Scale
SD	Standard Deviations
GGM	Graphical Gaussian Model
LASSO	Least Absolute Shrinkage and Selection Operator
EBIC	Extended Bayesian Information Criterion
EI	Expected Influence
bEI	Bridge Expected Influence
CS-C	Correlation Stability Coefficient

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12905-024-03469-2.

Supplementary Material 1

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Author contributions

LF, QW, SXQ and ZDQ designed the study; HWJ and QJQ performed the data collection; CZH and LF analyzed the data; LF drafted the manuscript with the input from all authors; CZH, HWJ, CYB, LRN and YXX reviewed and edited the manuscript. All authors read and approved the final version of the report.

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Data availability

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

Declarations

Ethics approval and consent to participate

This study was approved by the ethical review board of Dalian Municipal Women and Children's Medical Center (internal file number: 2024002). All participants gave informed consent to participate and they have the right to refuse and terminate the survey at any time. Moreover, all data were collected anonymously and treated with absolute confidentiality.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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