

# The relationship between compassion fatigue and professional identity among vocational undergraduate nursing interns: a cross-section network analysis

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## Research Article

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# Abstract

## Background

Nursing interns are prone to physical and mental exhaustion due to frequent exposure to patients' suffering, the pressures of work, and the rigorous demands of their profession. These factors increase their risk of experiencing compassion fatigue, which in turn hinders the development of their professional identity and may ultimately affect their willingness to continue working in nursing. Understanding the correlation between compassion fatigue and professional identity is crucial for developing precise interventions. This study aimed to use the network analysis method to identify core nodes and bridge connection between compassion fatigue and professional identity among vocational undergraduate nursing interns.

## Methods

This study used a cross-sectional design. Between January and May 2025, a total of 271 vocational undergraduate nursing interns were recruited and surveyed. The research instruments included a general information questionnaire, the Chinese Version of Compassion Fatigue-Short Scale, and the Professional Identity Questionnaire for Nurse Students. Network analysis was conducted to examine the interconnections between compassion fatigue and professional identity. Relevant network indices were calculated using R 4.2.3 software.

## Results

Network analysis showed that "work-related disappointment" (JB\_8) was most central in the compassion fatigue cluster and the entire network, "professional happiness" (PS\_5) in the professional identity cluster, and "competence utilization" (RR\_2) was the main bridge node connecting compassion fatigue and professional identity. Negative associations mainly occurred between compassion fatigue and professional identity.

## Conclusions

Emotional exhaustion nodes occupy central positions in the CF network and are closely associated with diminished professional identity. Interventions targeting emotional exhaustion while enhancing the perceived value of nursing work may effectively strengthen professional identity and support workforce retention.

## 1 Introduction

Driven by the rapid development of the medical and health services, heightened public health awareness, and accelerated population aging, the demand for nursing professionals is increasing[1]. The *Nursing and midwifery report* from WHO estimates a shortage of 4.5 million nurses by 2030[2]. In response to the increasing demand for adequate and high-quality nursing professionals, many countries have emphasized the strengthening of nursing education and training policies[1]. In China, the rapid development of vocational undergraduate education has provided a new pathway for cultivating high-quality, practice-oriented nursing professionals. Vocational undergraduate nursing education places greater emphasis on clinical competence, integration between industry (hospital) and education and application of skills in real-world contexts, aligning closely with the needs of the healthcare system[3].

Despite these educational advances, nursing interns continue to face substantial work-related challenges, which may contribute to high turnover rates. Globally, nurse turnover has become a severe challenge. In particular, a recent meta-analysis across eight countries reported that turnover rates among newly graduated nurses ranged from 6% to 61%, with a pooled prevalence of 36%[4]. Nursing interns constitute a vital part of the future nursing workforce, and maintaining their career stability and professional identity (PI) is crucial to the sustainable development of the nursing profession[5]. Nurses' professional identity, integrated with personal identity and encompassing both the nurses' own feelings and experiences of being a nurse and others' perceptions of them, plays a crucial role in their career development[6]. Previous studies[5, 7, 8] have indicated that nurses with a higher level of PI tend to have a stronger sense of belonging to their work, higher satisfaction within the nursing role, and a greater intention to remain in their

positions, which in turn contributes to the provision of high-quality care and improved patient outcomes. PI plays a lasting and important role in shaping nurses' professional competence and decision-making[9].

Compassion fatigue (CF) is psychological and physical exhaustion resulting from prolonged exposure to trauma and suffering. It's characterized by exhaustion, frustration, and depression, accompanied by burnout and secondary trauma[10]. Subsequently, Peters conducted a concept analysis and defined CF as a preventable state of holistic exhaustion—physical, emotional, and spiritual—arising from chronic exposure to others' suffering, high stress, and intense occupational demands without adequate boundaries or self-care[11]. Previous researches[12–14] have shown that CF is associated with negative emotions, physical health issues, and declines in cognitive functioning. These adverse reactions can reduce nurses' enthusiasm and ability to care for patients, seriously affecting the quality of care and performance, while potentially affecting their well-being, job satisfaction and stability[15–18]. CF is not limited to registered nurses, nursing students may be even more vulnerable during clinical placements due to frequent exposure to patients' suffering, role transition stress, and insufficient clinical experience[19]. A previous meta-analysis[20] has shown that more than 90% of nursing students report moderate levels of burnout, and 59.4% report moderate levels of secondary traumatic stress. A recent study of CF among nursing interns reported that the prevalence of mild, moderate, and severe CF was 10.4%, 46.6%, and 43.0%, respectively[21]. High levels of CF or burnout may weaken students' academic engagement and PI, potentially reducing their intention to remain in the nursing profession and adversely affecting workforce stability[22, 23].

Previous studies[22, 24, 25] showed that CF is negatively related to PI among nurses (nursing students). However, most study methods have focus on traditional correlational or regression analyses, ignoring the complex relationships among the multiple dimensions of CF and PI. And network analysis is used to examine the complex interrelationships among variables by constructing partial correlation networks, in which variables are viewed as nodes and their associations as edges[26, 27]. Network analysis not only visualizes the overall network structure and facilitates a comprehensive understanding of relationship within the network[28], but also identifies central nodes and influential edges through quantitative indices[29]. These central nodes can be potential targets for intervention. Network analysis has been widely applied in epidemiology[30, 31], oncology symptom management[32, 33], as well as adolescent mental health[34, 35]. Simultaneously, a robust theoretical perspective is required to guide these analyses. Conservation of Resources theory (COR) has been widely regarded as a study framework for explaining stress responses[36–39]. COR theory suggests that individuals strive to build, maintain, protect, and foster resources that they value. And resources are perceived as sources of internal or external of support and resilience. Stress or burnout arises when valuable resources are lost or threatened[37]. According to the COR theory, CF represents the continuous exhaustion of individuals' emotional and psychological resources. When resources remain depleted persistently, individuals are more inclined to have negative cognitive evaluations of their professions, weakening their PI. This framework provides a theoretical foundation for exploring the relationship between CF and PI.

Therefore, this study aimed to explore the connections between CF and PI through network analysis method among vocational undergraduate nursing interns, and identify central nodes, providing references for educational interventions and clinical support strategies.

## 2 Method

### 2.1 Study design and participants

This study conducted a cross-sectional survey in a vocational university in Hainan Province, China. A convenience sampling was used to recruit vocational undergraduate nursing interns as research participants from January to May 2025. The inclusion criteria were as follows: 1) those who completed a clinical internship of at least six months' duration; 2) a clinical internship in a third-level hospital; and 3) those with informed consent and voluntarily participated in the study. The exclusion criteria included: 1) those who had experienced major adverse life events within the past six months (e.g., family bereavement); and 2) those who do not directly care for patients (e.g., clerical or administrative roles).

### 2.2 Measures

#### (1) General Information Questionnaire

The researcher designed a general information questionnaire, including sex, age, home location, only-child status, class officer experience, voluntary choice of nursing and willingness to choose it again, plans to work in nursing, family background in nursing, experience of prejudice in clinical work, and preference for the clinical work environment.

## (2) Chinese Version of Compassion Fatigue-Short Scale (C-CF-Short Scale)

The C-CF-Short Scale developed by Adams et al[40], was subsequently translated and culturally adapted into a Chinese version by Sun and Lou[41, 42]. The scale was used to assess CF among nursing interns, and it comprises two dimensions: secondary traumatic stress and job burnout. The scale contains 13 items in total, each item is rated on a 10-point Likert scale, from 1 ("never") to 10 ("very frequently"), yielding a total score of 13–130, with higher scores indicating greater perceived CF. The overall Cronbach's  $\alpha$  coefficient of the scale ranges from 0.87 to 0.95, indicating good reliability and validity among nursing population. In this study, the scale demonstrated a Cronbach's  $\alpha$  coefficient of 0.95.

## (3) Professional Identity Questionnaire for Nurse Students (PIQNS)

This study used the PIQNS to measure nursing interns' PI. The scale, developed by Hao et al[43], includes five dimensions: professional self-image, benefit of retention and risk of turnover, social comparison and self-reflection, independence of career choice, social modeling. The scale contains 17 items in total, each item is rated on a 5-point Likert scale (1= "strongly disagree" to 5 = "strongly agree"), item 12 is reverse-scored and the total score ranges from 17 to 85. The higher the individual's score, the more positive their PI. The Cronbach's  $\alpha$  coefficient was 0.83 in Hao's study[43] and 0.92 in this study.

## 2.3 Data collection

The survey was performed applying an anonymous, self-reporting online questionnaire platform (<https://www.wjx.cn>). Nursing interns who met the inclusion and exclusion criteria accessed the survey by scanning a QR code via WeChat. On the first page of the questionnaire, participants were required to provide electronic informed consent. Each device and WeChat account are only allowed to submit once, and all questions were set as mandatory to ensure complete responses. To ensure data quality and validity, responses were excluded if they were completed in less than 2 minutes or if 50% or more of the items showed consecutive identical responses.

## 2.4 Statistical Analysis

Data were analysed using R 4.2.3 software. Frequencies and proportions were used for describing the demographic characteristics of the participants. Mean (standard) were used for describing the continuous variables. Network estimation was conducted using the EBICglasso method with tuning parameter of 0.5. The visualization of network using the R package "*qgraph*". Each item was represented as a node in the network, and edges between nodes can be interpreted as partial correlations. Thicker edge reflects the stronger relationship, with green indicating positive correlation and red indicating negative ones. The magnitude of each edge weight represents how strong or important the link is, with larger values indicating stronger relationships[27].

Centrality indices were calculated to evaluate the importance of nodes, including strength, closeness, and betweenness[27]. Strength refers to the degree of direct connectivity between a node and others; higher values indicate stronger associations and greater influence within the network. Closeness was defined as the inverse of the distance between a node and all other nodes. Betweenness represents the frequency at which a node located on the shortest paths connecting any two other nodes[28, 33]. Given previous evidence[44, 45] suggesting that betweenness and closeness centrality may be unstable in psychological networks, strength was considered the primary index of node importance. To identify core nodes, standardized centrality indices (Z-scores) were computed[46], and following previous study[47], the weighted centrality score used the formula:  $0.3 \times \text{strength} + 0.2 \times \text{closeness} + 0.2 \times \text{betweenness}$ , followed by ranking.

Bridge centrality indices, including bridge strength and bridge expected influence (1-step and 2-step), were calculated using the package "*networktools*". Bridge strength reflects the role of a node in connecting different clusters of the network. This study applied the expected influence (2 step) method to comprehensively evaluate node influence, and the evaluation of the importance of nodes is more accurate[48].

The accuracy of edge weights was evaluated using nonparametric bootstrapping, generating 95% CIs, where narrower intervals indicate higher estimation precision. The stability of centrality indices was assessed using case-dropping bootstrap procedures implemented in the R package "*bootnet*". The stability of centrality is expressed by the correlation stability (CS) coefficient, with values above 0.25 considered acceptable stability and above 0.5 indicating good stability[45]. Additionally, bootstrapped difference tests were conducted to examine whether node centrality indices differed significantly from one another.[45].

## 3 Results

### 3.1 General Characteristics of the Participants

A total of 300 questionnaires were distributed, and 280 students participated in this study. After excluding 9 questionnaires with the same responses to all questions, there were 271 valid questionnaires remaining, with an effective response rate of 90.33%. The age of the participants ranged from 21 to 24 years ( $22.10 \pm 0.85$ ). Most students were female (79%). Descriptive analysis for the 271 participants was presented in Table 1.

Table 1  
Characteristics of the participants ( $n = 271$ )

| Characteristics                           | <i>N</i> | %    |
|-------------------------------------------|----------|------|
| Gender                                    |          |      |
| Female                                    | 214      | 79.0 |
| Male                                      | 57       | 21.0 |
| Age                                       |          |      |
| 21                                        | 64       | 23.6 |
| 22                                        | 138      | 50.9 |
| 23                                        | 48       | 17.7 |
| 24                                        | 21       | 7.8  |
| Residence                                 |          |      |
| Rural                                     | 156      | 57.6 |
| Urban                                     | 115      | 42.4 |
| Only-child                                | 76       | 28.0 |
| Class leader                              | 87       | 32.1 |
| Family member in healthcare               | 77       | 28.4 |
| Suffer from others' prejudice             | 165      | 60.9 |
| Voluntary choice of nursing major         | 130      | 48.0 |
| Willingness to choose nursing major again |          |      |
| Yes                                       | 58       | 21.4 |
| Unclear                                   | 155      | 57.2 |
| No                                        | 58       | 21.4 |
| Intention to pursue nursing career        |          |      |
| Yes                                       | 62       | 22.9 |
| Uncertain                                 | 167      | 61.6 |
| No                                        | 42       | 15.5 |
| Preference for clinical environment       |          |      |
| Dislike                                   | 55       | 20.3 |
| Neutral                                   | 157      | 57.9 |
| Like                                      | 46       | 17.0 |
| Strongly like                             | 13       | 4.8  |

### 3.2 Compassion Fatigue and Professional Identity

The mean scores for CF and PI among participants were  $72.61 \pm 24.90$  and  $49.84 \pm 12.70$ , respectively. Descriptive statistics for each item are detailed in Table 2.

Table 2  
Nodes labels and description statistics of each item

| Variable              | Dimension               | Item (Node) | Score     |     |             | Strength | Closeness | Betweenness | Weighted centrality indices |
|-----------------------|-------------------------|-------------|-----------|-----|-------------|----------|-----------|-------------|-----------------------------|
|                       |                         |             | min       | max | –           |          |           |             |                             |
|                       |                         |             | $X \pm S$ |     |             |          |           |             |                             |
| Compassion fatigue    | Job burnout             | JB_1        | 1         | 10  | 6.09 ± 2.16 | 0.01     | 0.02      | -0.30       | -0.05                       |
|                       |                         | JB_2        | 1         | 10  | 6.21 ± 2.28 | -1.28    | 0.03      | 1.00        | -0.18                       |
|                       |                         | JB_3        | 1         | 10  | 5.16 ± 2.46 | 0.37     | -1.37     | -1.03       | -0.37                       |
|                       |                         | JB_4        | 1         | 10  | 5.02 ± 2.64 | 0.80     | -0.09     | 0.28        | 0.28                        |
|                       |                         | JB_5        | 1         | 10  | 6.31 ± 2.48 | -0.95    | -1.18     | -0.59       | -0.64                       |
|                       |                         | JB_6        | 1         | 10  | 5.65 ± 2.40 | 1.70     | 1.02      | 1.58        | 1.03                        |
|                       |                         | JB_7        | 1         | 10  | 5.77 ± 2.41 | -0.22    | -0.01     | -0.74       | -0.21                       |
|                       |                         | JB_8        | 1         | 10  | 5.43 ± 2.59 | 1.12     | 1.83      | 2.60        | 1.22                        |
|                       | Secondary trauma        | ST_1        | 1         | 10  | 5.65 ± 2.51 | -0.16    | -1.42     | -1.24       | -0.58                       |
|                       |                         | ST_2        | 1         | 10  | 4.99 ± 2.52 | 0.41     | -0.03     | 1.00        | 0.32                        |
|                       |                         | ST_3        | 1         | 10  | 5.52 ± 2.49 | 0.19     | -1.05     | -0.95       | -0.34                       |
|                       |                         | ST_4        | 1         | 10  | 5.38 ± 2.47 | 0.32     | -1.01     | -1.17       | -0.34                       |
|                       |                         | ST_5        | 1         | 10  | 5.42 ± 2.52 | 0.61     | -0.47     | -0.08       | 0.07                        |
| Professional identity | Professional self-image | PS_1        | 1         | 5   | 2.87 ± 1.02 | 0.18     | 2.11      | 1.65        | 0.81                        |
|                       |                         | PS_2        | 1         | 5   | 2.99 ± 1.21 | 0.29     | 0.20      | -0.52       | 0.02                        |
|                       |                         | PS_3        | 1         | 5   | 2.85 ± 1.09 | 0.33     | -0.19     | -0.37       | -0.02                       |
|                       |                         | PS_4        | 1         | 5   | 2.90 ± 1.10 | 0.74     | 0.98      | 0.49        | 0.52                        |
|                       |                         | PS_5        | 1         | 5   | 2.85 ± 1.06 | 1.28     | 1.40      | 1.07        | 0.88                        |
|                       |                         | PS_6        | 1         | 5   | 2.87 ± 1.10 | 0.08     | 0.38      | -1.03       | -0.11                       |
|                       | Social modeling         | SO_1        | 1         | 5   | 2.99 ± 1.11 | 0.30     | 0.93      | -1.17       | 0.04                        |
|                       |                         | SO_2        | 1         | 5   | 3.02 ± 1.22 | 0.40     | 1.03      | 0.71        | 0.47                        |

Note: Core nodes with higher standardized weighted centrality scores are bolded and shaded.

| Variable | Dimension                                 | Item (Node) | Score     |     |                 | Strength | Closeness | Betweenness | Weighted centrality indices |
|----------|-------------------------------------------|-------------|-----------|-----|-----------------|----------|-----------|-------------|-----------------------------|
|          |                                           |             | min       | max | –               |          |           |             |                             |
|          |                                           |             | $X \pm S$ |     |                 |          |           |             |                             |
|          | Independence of career choice             | IC_1        | 1         | 5   | $3.03 \pm 1.13$ | -0.73    | 0.98      | -0.01       | -0.02                       |
|          |                                           | IC_2        | 1         | 5   | $2.77 \pm 1.21$ | -2.80    | -0.50     | -0.01       | -0.94                       |
|          | Benefit of retention and risk of turnover | RR_1        | 1         | 5   | $2.90 \pm 1.11$ | -1.11    | -1.40     | -1.17       | -0.85                       |
|          |                                           | RR_2        | 1         | 5   | $2.92 \pm 1.09$ | 1.09     | -0.21     | 0.35        | 0.36                        |
|          |                                           | RR_3        | 1         | 5   | $2.58 \pm 1.02$ | -2.56    | -1.87     | -1.17       | -1.37                       |
|          |                                           | RR_4        | 1         | 5   | $2.89 \pm 1.06$ | 0.27     | 0.50      | 1.07        | 0.40                        |
|          | Social comparison and self-reflection     | SC_1        | 1         | 5   | $3.12 \pm 1.18$ | -0.70    | -0.70     | -0.52       | -0.45                       |
|          |                                           | SC_2        | 1         | 5   | $3.04 \pm 1.13$ | 0.37     | 0.00      | 0.21        | 0.15                        |
|          |                                           | SC_3        | 1         | 5   | $3.25 \pm 1.21$ | -0.36    | 0.09      | 0.06        | -0.08                       |

Note: Core nodes with higher standardized weighted centrality scores are bolded and shaded.

### 3.3 Network Structure and Pathway Analysis of CF - PI network

Figure 1 shows the estimated network structure, comprising 30 nodes of components of CF and PI. Among the 435 possible edges, 202 (46.44%) were non-zero. Positive edges accounted for 76.24% of all associations, negative edges (23.76%) mainly occur in cross-cluster connections between CF and PI.

The detailed edge weights for all node pairs are listed in Additional file 1. The strongest edge was identified between node SC\_2 ('I have explored various professional fields to strengthen my career convictions') and node SC\_3 ('When choosing a career, it is essential to consider not only one's personal ideals but also the influence of the external environment'), with an edge weight of 0.316.

To further explore the CF–PI network, we analyzed the cross-network associations between CF and PI nodes. The results of edge weight showed that the core node CF JB\_8 ('My work makes me feel disappointed, worthless, and even resentful') showed strong negative associations with the PS\_1 ('I am willing to be a nurse'; edge weight = -0.104) and node IC\_1 ('No matter what others say, I will choose the job I like'; edge weight = -0.086). The core node CF JB\_6 ('My job makes me feel frustrated') was negatively associated with node SO\_2 ('I enjoy learning about the growth stories of people who have achieved success in the field of nursing'; edge weight = -0.059) and PS\_5 ('Working in the nursing profession makes me happy'; edge weight = -0.055). Additionally, the core node CF ST\_1 ('I will recall the scenes related to the "rescue recipients"') was negatively linked to PS\_1 ('I am willing to be a nurse'; edge weight = -0.051).

#### Note

Red edges represent negative correlations, whereas green edges represent positive correlations; thicker edges indicate stronger associations.

### 3.4 Centrality, Bridge Centrality Indices and Difference Test

The weighted centrality scores showed a pattern largely consistent with the primary centrality indices. Centrality indices and the weighted centrality indices for all nodes are presented in Table 2 and Fig. 2A. Within the CF cluster, JB\_8 ('My work makes me feel disappointed, worthless, and even resentful') exhibited the highest weighted centrality ( $Z = 1.22$ ), followed by JB\_6 ('My job makes me feel frustrated';  $Z = 1.03$ ). In the PI domain, PS\_5 ('Working in the nursing profession makes me happy.') and PS\_1 ('I am willing to be a nurse') demonstrated the highest weighted influence ( $Z = 0.88$  and  $0.81$ , respectively).

Bridge centrality analysis indicated that RR\_2 ('Nursing work enables me to exert my personal abilities and specialties'), exhibited high scores across all three metrics: bridge strength was  $0.81$ , bridge expected influence (1-step) was  $0.75$ , and bridge expected influence (2-step) was  $1.23$ . Within the PI cluster, RR\_4 ('Nursing work enables me to exert my creativity') showed the highest bridge strength ( $0.86$ ).

The results of the bootstrapped node difference test are shown in Additional file 2. The bootstrapped node difference test indicated that JB\_6 ( $DT_s = 1.20$ ) differed significantly from most other nodes, suggesting its potentially important and distinctive role within the network.

## 3.6 Accuracy, Stability of the Network

The bootstrap analysis results of the edge weights are shown in Fig. 3A. The narrow intervals indicate good accuracy of the network. The CS coefficient was used to calculate the stability of node centrality (see Fig. 3B), the strength centrality and expected influence demonstrated acceptable stability ( $CS = 0.439$ ).

## 4 Discussion

To our knowledge, this is the first study to apply network analysis to provide a comprehensive exploration of relationship between CF and PI among vocational undergraduate nursing interns. The network structure showed satisfactory precision. Node centrality indicated sufficient stability, suggesting the sample size met the modelling requirements, ensuring the statistical robustness of the findings. Centrality analysis found that JB\_8 and JB\_6 are the most influential components of the network. In the PI domain, PS\_5 has become the most influential node. In addition, RR\_2 exhibited high value in all three bridge centrality indicators, indicating that the node RR\_2 is the key bridging node connecting different nodes in the CF-PI network.

Network analysis revealed that the positive correlation between SC\_2 and SC\_3 is the strongest. Further edge weight analysis showed that JB\_8 is significantly negatively correlated with PS\_1. In addition, other pathways were negatively correlated in the CF-PI network, indicating that the higher the level of work-related disappointment and emotional exhaustion, the more reluctant it is to continue to stay in the nursing position or identify with the nursing role.

## 4.1 Core Nodes and Bridge Nodes in the CF-PI Network

In the CF cluster, JB\_8 ('My work makes me feel disappointed, worthless, and even resentful') and JB\_6 ('My job makes me feel frustrated'), both belonging to the job burnout domain. They are key nodes, representing the core work-related negative emotional experiences. When individuals regard their work as a source of disappointment rather than satisfaction, which destroys the psychological professional framework, exerting negative impact on other nodes. This finding is consistent with a study on job burnout[49], which showed that when compassion is exhausted, the resulting emotional exhaustion leads to job burnout, and work burnout becomes the core source of pain. In the clinical environments, nursing interns face a high-pressure environment defined by intense patient contact and complex healthcare needs. According to the compassion fatigue conceptualization[10, 11], the above factors are the key prerequisites for overwhelming an individual's coping capacity. The continuous difference between internal resources and external demands catalyzes a dose-dependent reaction, where initial "compassion discomfort" evolves into emotional exhaustion[50, 51]. Consequently, this long-term exposure may form a cycle of job burnout[52], where JB\_8 and JB\_6 emerges as a central node that reflects a decreased sense of fulfillment and disengagement, weakening the long-term career commitment of nursing interns.

'Working in the nursing profession makes me happy' (PS\_5) emerged as the most influential node in the PI cluster, indicating that a positive affective professional self-image strengthens is closely associated with stronger PI. According to *the broaden-and-build theory of positive emotions*, positive emotions broaden momentary thought-action repertoires and build lasting personal resources[53]. When nursing work elicits positive emotions, nursing students are more likely to internalize the "nurse" role into their self-concept, thereby sustaining long-term PI and work engagement. A previous study[54] has shown that positive mental health

enhances job satisfaction and self-actualization, which contribute to the development of PI, and further indicated that psychological resilience mediates the relationship between positive mental health and PI. A higher levels of resilience enable nursing students to better cope with clinical pressures and challenges, promotes self-reflection and a sense of self-worth, and thus enhance their PI[54]. Therefore, nursing educators and clinical managers should timely recognize the job burnout and emotional pressure of nursing, especially in the internship transition stage, and reasonably arrange psychological counselling to alleviate the negative psychology and emotions of interns, to establish resilience and then improve PI.

Network analysis further found that two PI elements, RR\_2 ("Nursing work enables me to exert my personal abilities and specialties") and RR\_4 ("Nursing work enables me to exert my creativity"), were key bridge nodes in the CF-PI network. RR\_2 and RR\_4 both belong to the dimensions of "benefit of retention and risk of turnover" of PI, which mainly reflects experiences of nursing interns to realize intrinsic professional value and perceive occupational rewards in their work. From the perspective of COR theory[37], the "sense of competence" reflected by RR\_2 and RR\_4, is an important resource acquisition, reflecting that effective utilization of professional ability in clinical settings. This kind of resource gained can promote the recovery of emotional load, thus strengthening the positive construction of professional value[55]. Therefore, clinical management should improve competence of nursing interns through active clinical engagement and structured feedback. And form a correct professional understanding. In addition, CF interventions should not be limited to reducing the emotional burden but also cultivate competence-based resource access, thereby indirectly promoting the development of PI and better provide high-quality care for patients.

## 4.2 Pathways Between Compassion Fatigue Node and Professional Identity Node

The present study further explored the item-level pathways linking CF and PI, revealing a complex interaction among job burnout, secondary trauma-related experiences and students' PI.

The positive correlation between node SC\_2 ('I have explored various professional fields to strengthen my career convictions') and node SC\_3 ('When choosing a career, it is essential to consider not only one's personal ideals but also the influence of the external environment') was the strongest. In the process of career pursuit, active professional exploration is closely related to the balanced evaluation of personal ideals and external realities[56]. It is suggested that nursing interns continuously improve their professional cognition through the combination of self-reference evaluations and environmental feedback. The formation of PI is influenced by multiple factors and evolves dynamically at various stages of career[57]. When individuals encounter inconsistencies between personal values and professional expectations, it prompts individuals to reflect and explore, to promote the clarification and internalization of professional values[57, 58]. School and clinical supervisors should encourage nursing interns to participate in diversified clinical experiences, reflect on discrepancies between expectations and reality, and combine personal aspirations with professional needs. These efforts can promote the internalization of professional values and promote the more stable development of PI.

This study also found that a significant negative correlation between node JB\_8 ('My work makes me feel disappointed, worthless, and even resentful') and PS\_1 ('I am willing to be a nurse'), as well as IC\_1 ('No matter what others say, I will choose the job I like'). This finding suggested that work-related negative emotional experiences may significantly weaken nursing interns' willingness to continue nursing careers, thus undermining the core components of PI. Similarly, node JB\_6 ('My job makes me feel frustrated') was negatively related to SO\_2 ('I enjoy learning about the growth stories of successful nurses') and PS\_5 ('Working in the nursing profession makes me happy'), which means that work-related frustration may reduce both positive emotional engagement with the profession and interest in professional role models. These findings are consistent with previous study[59], indicating that clinical practice plays a crucial role in shaping nursing students' PI. Specifically, adverse events encountered in clinical practice may cause frustration and emotional distress that hinder the internalization of professional values and weaken positive impact on nursing. Especially, their autonomous motivation to choose nursing as a career may be impaired. Previous evidence[60] showed that nurses with high CF level tend to experience emotional resource depletion and increased psychological burden, reducing their attachment and identify to the profession.

This study further found that node ST\_1 ('I will recall the scenes related to the 'rescue recipients') was negatively connect to PS\_1 ('I am willing to be a nurse'; edge weight).

Suggesting that invasive memories of painful clinical scenarios may undermine students' willingness to stay in the career. Compassion is essential in nursing care, but repeated exposure to patients' suffering may lead to secondary traumatic stress. Over

time, this continuous emotional stress may exhaust psychological resources of nurses, trigger negative emotional responses, and ultimately weaken their PI[61–63]. These findings underscore the importance of addressing trauma-related cognitive processes among nursing interns. Interventions such as reflection exercises, and emotional regulation training may help reduce the impact of intrusive memories[64].

## 4.3 Strengths and Limitations

The advantage of this research is that the network analysis method is used for the first time to explore the relationship between CF and PI of vocational undergraduate nursing interns at the node level. However, this study had several limitations. Firstly, the cross-sectional design limits the investigation of causal relationship between CF and PI. Secondly, the sample came from the same school, which may lead to sampling bias. It restricts the promotion of the research results. Thirdly, data relies on self-reporting, it is prone to measurement deviations, future research should combine self-reporting tools with objective measures.

## 5 Conclusion

This study used network analysis to explore the relationship between CF and PI among vocational undergraduate nursing interns. The results showed that job burnout related nodes occupied central positions in the CF network and were negatively related to the PI; moreover. And perceived value of nursing work were the most important bridge nodes. Clinical managers should cultivate students' emotional regulation ability and professional happiness, and guide them to integrate emotional, cognitive and compassion skills in nursing practice. According to the bridge node, educators should adopt a strategy to enhance the sense of competent to motivate nursing interns to realize professional value, thereby enhancing professional identity and promoting retention.

## Abbreviations

PI  
Professional identity  
CF  
Compassion fatigue  
COR  
Conservation of Resources theory  
C  
CF-Short Scale-Chinese Version of Compassion Fatigue-Short Scale  
PIQNS  
Professional Identity Questionnaire for Nurse Students  
CS coefficient  
Correlation stability coefficient

## Declarations

### *Ethics approval and consent to participate*

Ethical approval for this study was granted by the Academic Ethics Review Panel of the School of International Nursing at Hainan Vocational University of Science and Technology, China (approved on 1 December 2024). As the institution does not maintain a formal serial numbering system for ethical review, no specific approval number was assigned to this study. All research procedures were conducted in accordance with the Declaration of Helsinki and the institutional ethical standards. To protect participants' privacy, the survey was administered anonymously. Electronic informed consent was obtained from all participants on the first page of the survey prior to participation.

### *Consent for publication*

Not applicable.

### *Availability of data and materials*

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

### Competing Interests

The authors declare no conflict of interest.

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### Author contributions statement (CRediT)

**Zhao:** Writing—original draft; Methodology; Investigation; Formal analysis; Visualization; Conceptualization, Supervision.

**Yang:** Methodology; Investigation; Data curation, Formal analysis.

**Su and Yin:** Visualization, Methodology; Formal analysis; Supervision.

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## References

1. WHO. State of the world's nursing 2025. World Health Organization; 2025.
2. WHO, Nursing. 2025. <https://www.who.int/news-room/fact-sheets/detail/nursing-and-midwifery>. Accessed 25 Sept 2025.
3. Ministry of Education of the People's Republic of China. Nursing. 2025. [http://www.moe.gov.cn/s78/A07/zcs\\_ztzt/2017\\_zt06/17zt06\\_bznr/bznr\\_zyjzyjxbz/gdzyjy\\_bk/bk\\_yywsdl/yywsdl\\_hll/](http://www.moe.gov.cn/s78/A07/zcs_ztzt/2017_zt06/17zt06_bznr/bznr_zyjzyjxbz/gdzyjy_bk/bk_yywsdl/yywsdl_hll/). Accessed 25 Sept 2025.
4. Lay KSM, Masingboon K. Turnover prevalence and the relationship between transition shock and turnover intention among new nurses: A meta-analysis. *Int J Nurs Stud Adv*. 2025;9:100390. <https://doi.org/10.1016/j.ijnsa.2025.100390>.
5. Zeng L, Chen Q, Fan S, Yi Q, An W, Liu H, et al. Factors influencing the professional identity of nursing interns: a cross-sectional study. *BMC Nurs*. 2022;21:200. <https://doi.org/10.1186/s12912-022-00983-2>.
6. Ohlén J, Segesten K. The professional identity of the nurse: concept analysis and development. *J Adv Nurs*. 1998;28:720–7. <https://doi.org/10.1046/j.1365-2648.1998.00704.x>.
7. Hinkley T-L (Terri), Kuhl L, Liebig D, editors. Professional Identity in Nursing: The Role of Efficacy in Navigating the Work Environment. *Nurse Leader*. 2023;21:174–8. <https://doi.org/https://doi.org/10.1016/j.mnl.2022.12.006>
8. Zheng X, Song J, Shi X, Lu G, Qu Z, Lu X, et al. The effect of professional identity on new nurses' turnover intention: the mediating role of psychological capital and achievement motivation. *BMC Psychol*. 2025;13:924. <https://doi.org/10.1186/s40359-025-03295-7>.
9. Hu F, Ding X-B, Zhang R-H, Li S-Y, Cao R, Deng L, et al. A transition programme to enhance ICU new graduate nurses' professional identity and intention to remain employed: A pre- and postevaluation. *Nurs Open*. 2023;10:1517–25. <https://doi.org/10.1002/nop2.1401>.
10. Figley CR. Compassion Fatigue. New York: Routledge; 1995.
11. Peters E. Compassion fatigue in nursing: A concept analysis. 2018. <https://doi.org/10.1111/nuf.12274>
12. Nolte AG, Downing C, Temane A, Hastings-Tolsma M. Compassion fatigue in nurses: A metasynthesis. *J Clin Nurs*. 2017;26:4364–78. <https://doi.org/10.1111/jocn.13766>.
13. Yu H, Gui L. Compassion fatigue, burnout and compassion satisfaction among emergency nurses: A path analysis. *J Adv Nurs*. 2022;78:1294–304. <https://doi.org/10.1111/jan.15034>.
14. Zhang Y-Y, Han W-L, Qin W, Yin H-X, Zhang C-F, Kong C, et al. Extent of compassion satisfaction, compassion fatigue and burnout in nursing: A meta-analysis. *J Nurs Manag*. 2018;26:810–9. <https://doi.org/10.1111/jonm.12589>.
15. Drury V, Craigie M, Francis K, Aoun S, Hegney DG. Compassion satisfaction, compassion fatigue, anxiety, depression and stress in registered nurses in Australia: phase 2 results. *J Nurs Manag*. 2014;22:519–31. <https://doi.org/10.1111/jonm.12168>.

16. Hegney DG, Craigie M, Hemsworth D, Osseiran-Moisson R, Aoun S, Francis K, et al. Compassion satisfaction, compassion fatigue, anxiety, depression and stress in registered nurses in Australia: study 1 results. *J Nurs Adm Manag*. 2014;22:506–18. <https://doi.org/10.1111/jonm.12160>.
17. Stewart DW. Casualties of war: compassion fatigue and health care providers. *Medsurg Nurs*. 2009;18:91–4. quiz 95.
18. Xie W, Chen L, Feng F, Okoli CTC, Tang P, Zeng L, et al. The prevalence of compassion satisfaction and compassion fatigue among nurses: A systematic review and meta-analysis. *Int J Nurs Stud*. 2021;120:103973. <https://doi.org/10.1016/j.ijnurstu.2021.103973>.
19. Karabey T. Compassion fatigue and psychological resilience levels of nursing final students: A descriptive, cross-sectional, and relational study. *Palliat Support Care*. 2023;1–7. <https://doi.org/10.1017/S1478951523001645>.
20. Yi L, Hu S, Liao M, Cheng L, Liu Y, Tian X, et al. Prevalence and related factors of compassion fatigue among registered nurses and nursing students during the internship: a systematic review and meta-analysis. *BMC Nurs*. 2024;23:956. <https://doi.org/10.1186/s12912-024-02597-2>.
21. Ye L, Tang X, Li Y, Zhu Y, Shen J, Zhu Y, et al. The prevalence and related factors of compassion fatigue among nursing interns: a cross-sectional study. *BMC Nurs*. 2024;23:762. <https://doi.org/10.1186/s12912-024-02384-z>.
22. Yi L, Shuai T, Zhou J, Cheng L, Jiménez-Herrera MF, Tian X. Development and validation of a machine learning-based predictive model for compassion fatigue in Chinese nursing interns: a cross-sectional study utilizing latent profile analysis. *BMC Med Educ*. 2024;24:1495. <https://doi.org/10.1186/s12909-024-06505-9>.
23. Yi L-J, Cai J, Ma L, Lin H, Yang J, Tian X, et al. Prevalence of Compassion Fatigue and Its Association with Professional Identity in Junior College Nursing Interns: A Cross-Sectional Study. *Int J Environ Res Public Health*. 2022;19:15206. <https://doi.org/10.3390/ijerph192215206>.
24. Wei J, Yun Z, Zhang Y, Liang Y, Hu Z, Gao C, et al. Mindful Self-Care and Compassion Fatigue in Nurses: The Chain Mediating Roles of Resilience and Professional Identity. *J Nurs Manag*. 2025;2025:8572654. <https://doi.org/10.1155/jonm/8572654>.
25. Zhang Y, Peng Q, Dong W, Hou C, Chen C. Professional identity and sense of coherence affect the between compassion fatigue and work engagement among Chinese hospital nurses. *BMC Nurs*. 2023;22:472. <https://doi.org/10.1186/s12912-023-01596-z>.
26. Epskamp S, Fried EI. A tutorial on regularized partial correlation networks. *Psychol Methods*. 2018;23:617–34. <https://doi.org/10.1037/met0000167>.
27. Hevey D. Network analysis: a brief overview and tutorial. *Health Psychol Behav Med*. 2018;6:301–28. <https://doi.org/10.1080/21642850.2018.1521283>.
28. Zhou S, Zhang Y, He H, Wang X, Li M, Zhang N, et al. Symptom clusters and networks analysis in acute-phase stroke patients: a cross-sectional study. *Sci Rep*. 2025;15:2539. <https://doi.org/10.1038/s41598-024-84642-3>.
29. Zhu Z, Xing W, Hu Y, Wu B, So WKW. Paradigm shift: Moving from symptom clusters to symptom networks. *Asia Pac J Oncol Nurs*. 2022;9:5–6. <https://doi.org/10.1016/j.apjon.2021.12.001>.
30. Xie M, Liu X, Wang A, Hao Y. Symptom network connectivity and interaction among people with HIV in China: secondary analysis based on a cross-sectional survey. *BMC Public Health*. 2024;24:2331. <https://doi.org/10.1186/s12889-024-19728-8>.
31. Zhu Z, Wen H, Yang Z, Han S, Fu Y, Zhang L, et al. Evolving symptom networks in relation to HIV-positive duration among people living with HIV: A network analysis. *Int J Infect Dis*. 2021;108:503–9. <https://doi.org/10.1016/j.ijid.2021.05.084>.
32. Bergsneider BH, Armstrong TS, Conley YP, Cooper B, Hammer M, Levine JD, et al. Symptom Network Analysis and Unsupervised Clustering of Oncology Patients Identifies Drivers of Symptom Burden and Patient Subgroups With Distinct Symptom Patterns. *Cancer Med*. 2024;13:e70278. <https://doi.org/10.1002/cam4.70278>.
33. Jing F, Zhu Z, Qiu J, Tang L, Xu L, Xing W, et al. Contemporaneous symptom networks and correlates during endocrine therapy among breast cancer patients: A network analysis. *Front Oncol*. 2023;13:1081786. <https://doi.org/10.3389/fonc.2023.1081786>.
34. Jiang X, Wang X, Yu L, He J, Wu S, Zhou Y, et al. Network analysis of central symptoms in Chinese young adults with subthreshold depression. *Transl Psychiatry*. 2025;15:103. <https://doi.org/10.1038/s41398-025-03307-5>.
35. Schwaren L, van Borkulo CD, Fried E, Goodyer IM. Assessment of Symptom Network Density as a Prognostic Marker of Treatment Response in Adolescent Depression. *JAMA Psychiatry*. 2018;75:98–100. <https://doi.org/10.1001/jamapsychiatry.2017.3561>.
36. Egozi Farkash H, Lahad M, Hobfoll SE, Leykin D, Aharonson-Daniel L. Conservation of Resources, Psychological Distress, and Resilience During the COVID-19 Pandemic. *Int J Public Health*. 2022;67:1604567. <https://doi.org/10.3389/ijph.2022.1604567>.

37. Hobfoll SE. Conservation of resources: A new attempt at conceptualizing stress. *Am Psychol.* 1989;44:513–24. <https://doi.org/10.1037/0003-066X.44.3.513>.
38. Prapanjaroensin A, Patrician PA, Vance DE. Conservation of resources theory in nurse burnout and patient safety. *J Adv Nurs.* 2017;73:2558–65. <https://doi.org/10.1111/jan.13348>.
39. Sanecka E, Stasiła-Sieradzka M, Turska E. The role of core self-evaluations and ego-resiliency in predicting resource losses and gains in the face of the covid-19 crisis: the perspective of conservation of resources theory. *Int J Occup Med Environ Health.* 2023;36:551–62. <https://doi.org/10.13075/ijomeh.1896.02113>.
40. Adams RE, Boscarino JA, Figley CR. Compassion fatigue and psychological distress among social workers: a validation study. *Am J Orthopsychiatry.* 2006;76:103–8. <https://doi.org/10.1037/0002-9432.76.1.103>.
41. Lou B. The structure and mechanism of compassion fatigue: a study on different groups of helper. master. Zhejiang Normal University; 2013.
42. Sun B, Hu M, Yu S, Jiang Y, Lou B. Validation of the Compassion Fatigue Short Scale among Chinese medical workers and firefighters: a cross-sectional study. *BMJ Open.* 2016;6:e011279. <https://doi.org/10.1136/bmjopen-2016-011279>.
43. Hao Y, Niu H, Li L, Yue S, Liu X. Measurement of professional identity in Chinese nursing students. *Int J Nurs Sci.* 2014;1:137–44. <https://doi.org/10.1016/j.ijnss.2014.05.002>.
44. Bringmann LF, Elmer T, Epskamp S, Krause RW, Schoch D, Wichers M, et al. What do centrality measures measure in psychological networks? *J Abnorm Psychol.* 2019;128:892–903. <https://doi.org/10.1037/abn0000446>.
45. Epskamp S, Borsboom D, Fried EI. Estimating psychological networks and their accuracy: A tutorial paper. *Behav Res.* 2018;50:195–212. <https://doi.org/10.3758/s13428-017-0862-1>.
46. Opsahl T, Agneessens F, Skvoretz J. Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks.* 2010;32:245–51. <https://doi.org/10.1016/j.socnet.2010.03.006>.
47. Ye L, Xu Y, Cui L, Zhang Q, Li Q, Zhou H, et al. The Relationship Between Occupational Stressors and Resilience Among Emergency Department Nurses: A Multicenter Cross-Sectional Network Analysis. *J Adv Nurs.* 2025. <https://doi.org/10.1111/jan.70317>.
48. Wang Y, Zhuge R, Wang K, Meng N, Huang W, Wang Y, et al. Core capabilities of Chinese centers for disease control and prevention public health personnel: a network analysis from Northeast China. *BMC Med Educ.* 2025;25:235. <https://doi.org/10.1186/s12909-025-06829-0>.
49. Velando-Soriano A, Suleiman-Martos N, Pradas-Hernández L, Membrive-Jiménez MJ, Ramírez-Baena L, Gómez-Urquiza JL, et al. Factors related to the appearance and development of burnout in nursing students: a systematic review and meta-analysis. *Front Public Health.* 2023;11:1142576. <https://doi.org/10.3389/fpubh.2023.1142576>.
50. Pérez-García E, Ortega-Galán ÁM, Ibáñez-Masero O, Ramos-Pichardo JD, Fernández-Leyva A, Ruiz-Fernández MD. Qualitative study on the causes and consequences of compassion fatigue from the perspective of nurses. *Int J Ment Health Nurs.* 2021;30:469–78. <https://doi.org/10.1111/inm.12807>.
51. Wang J, Okoli CTC, He H, Feng F, Li J, Zhuang L, et al. Factors associated with compassion satisfaction, burnout, and secondary traumatic stress among Chinese nurses in tertiary hospitals: A cross-sectional study. *Int J Nurs Stud.* 2020;102:103472. <https://doi.org/10.1016/j.ijnurstu.2019.103472>.
52. Gómez-Urquiza JL, Velando-Soriano A, Membrive-Jiménez MJ, Ramírez-Baena L, Aguayo-Estremera R, Ortega-Campos E, et al. Prevalence and levels of burnout in nursing students: A systematic review with meta-analysis. *Nurse Educ Pract.* 2023;72:103753. <https://doi.org/10.1016/j.nepr.2023.103753>.
53. Fredrickson BL. The Role of Positive Emotions in Positive Psychology. *Am Psychol.* 2001;56:218–26. <https://doi.org/10.1037/0003-066x.56.3.218>.
54. Jilili A, Weng X, Zhao SZ, Wang L, Fang Q, Guo N. How positive mental well-being influences professional identity and the mediating mechanisms in Chinese nursing students. *Int Nurs Rev.* 2024;71:1044–52. <https://doi.org/10.1111/inr.12972>.
55. Tang W, Zhou J, Yang W, Zheng J, Zhao S, Tan Q, et al. Qualitative study on the feeling of accomplishment experienced by nursing students during clinical internships. *BMC Nurs.* 2025;24:1491. <https://doi.org/10.1186/s12912-025-04116-3>.
56. Miao C, Liu C, Zhou Y, Zou X, Song L, Chung JWY, et al. Nurses' perspectives on professional self-concept and its influencing factors: A qualitative study. *BMC Nurs.* 2024;23:237. <https://doi.org/10.1186/s12912-024-01834-y>.
57. Mao A, Lu S, Lin Y, He M. A scoping review on the influencing factors and development process of professional identity among nursing students and nurses. *J Prof nursing: official J Am Association Colleges Nurs.* 2021;37.

<https://doi.org/10.1016/j.profnurs.2020.04.018>.

58. Li J, Li X. Professional values education for undergraduate nursing students: developing a framework based on the professional values growth theory. BMC Nurs. 2024;23:226. <https://doi.org/10.1186/s12912-024-01743-0>.
59. Wei L-Z, Zhou S-S, Hu S, Zhou Z, Chen J. Influences of nursing students' career planning, internship experience, and other factors on professional identity. Nurse Educ Today. 2021;99:104781. <https://doi.org/10.1016/j.nedt.2021.104781>.
60. Zhai S, Dai C, Liu Q, Lu Y, Chen C. Clinical Nurses' Job Embeddedness and Its Relationship to Professional Identity, Organizational Climate, and Compassion Fatigue: A Structural Equation Model. J Nurs Manag. 2025;2025:3700369. <https://doi.org/10.1155/jonm/3700369>.
61. Cocker F, Joss N. Compassion Fatigue among Healthcare, Emergency and Community Service Workers: A Systematic Review. Int J Environ Res Public Health. 2016;13:618. <https://doi.org/10.3390/ijerph13060618>.
62. De La Rosa GM, Webb-Murphy JA, Feserman SF, Johnston SL. Professional quality of life normative benchmarks. Psychol Trauma. 2018;10:225–8. <https://doi.org/10.1037/tra0000263>.
63. Geoffrion S, Morselli C, Guay S. Rethinking Compassion Fatigue Through the Lens of Professional Identity: The Case of Child-Protection Workers. Trauma Violence Abuse. 2016;17:270–83. <https://doi.org/10.1177/1524838015584362>.
64. Zhang H, Xia Z, Yu S, Shi H, Meng Y, Dator WL. Interventions for Compassion Fatigue, Burnout, and Secondary Traumatic Stress in Nurses: A Systematic Review and Network Meta-Analysis. Nurs Health Sci. 2025;27:e70042. <https://doi.org/10.1111/nhs.70042>.

## Figures

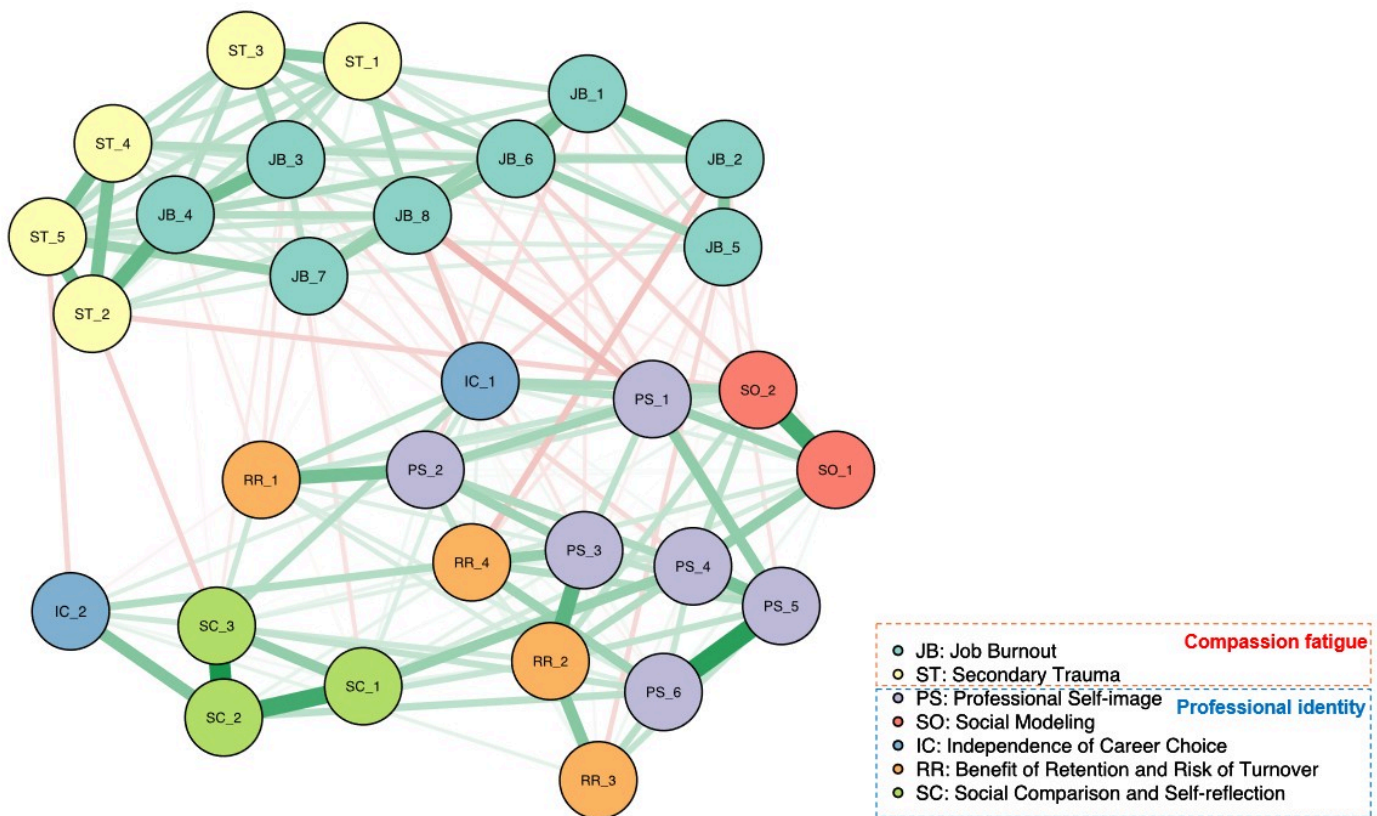


**Figure 1**

Network structure of CF and PI

Note: Red edges represent negative correlations, whereas green edges represent positive correlations; thicker edges indicate stronger associations.

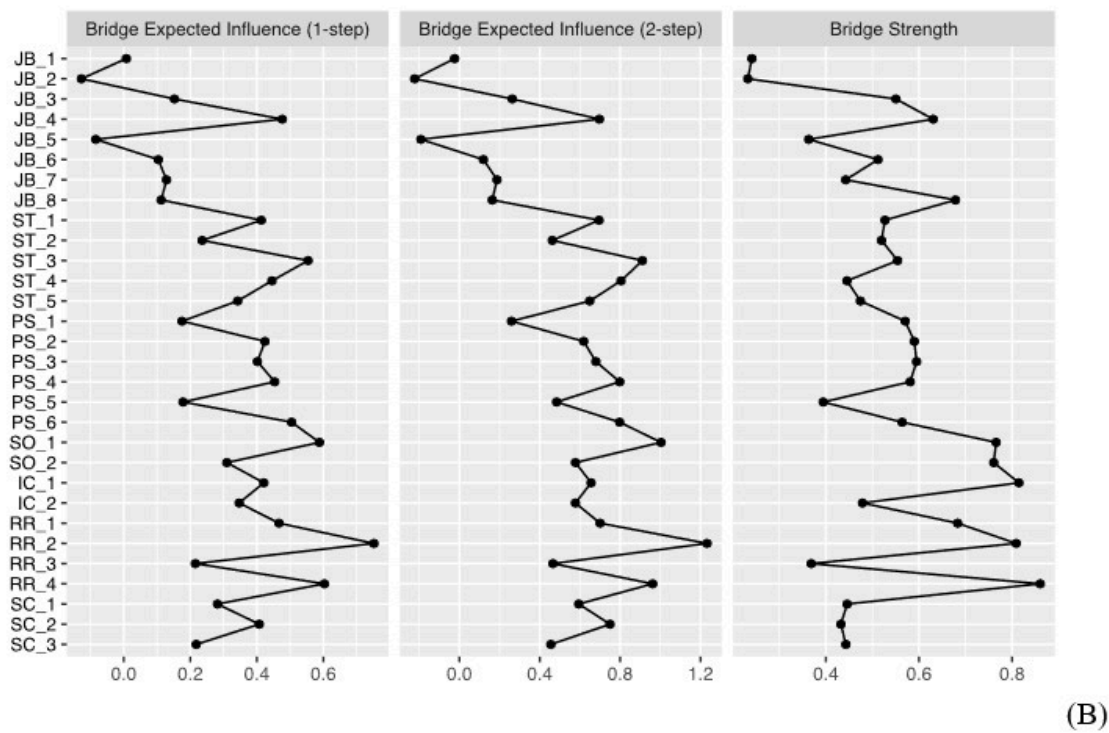
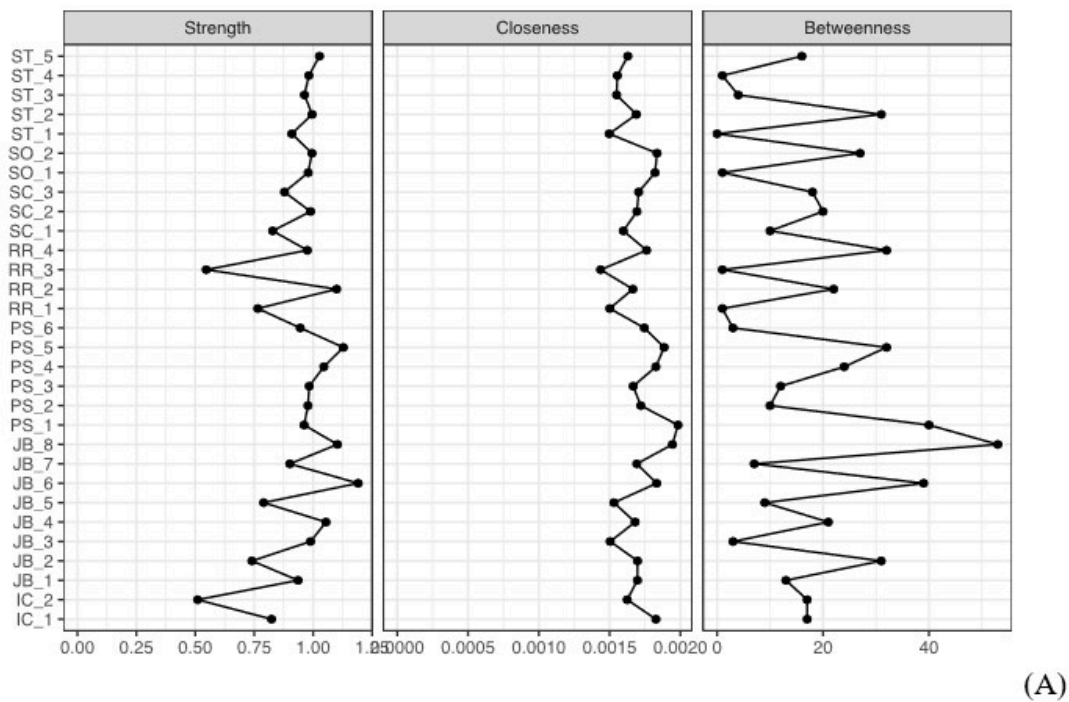


**Figure 2**

(A) Node centrality indices and (B) Node bridge centrality indices

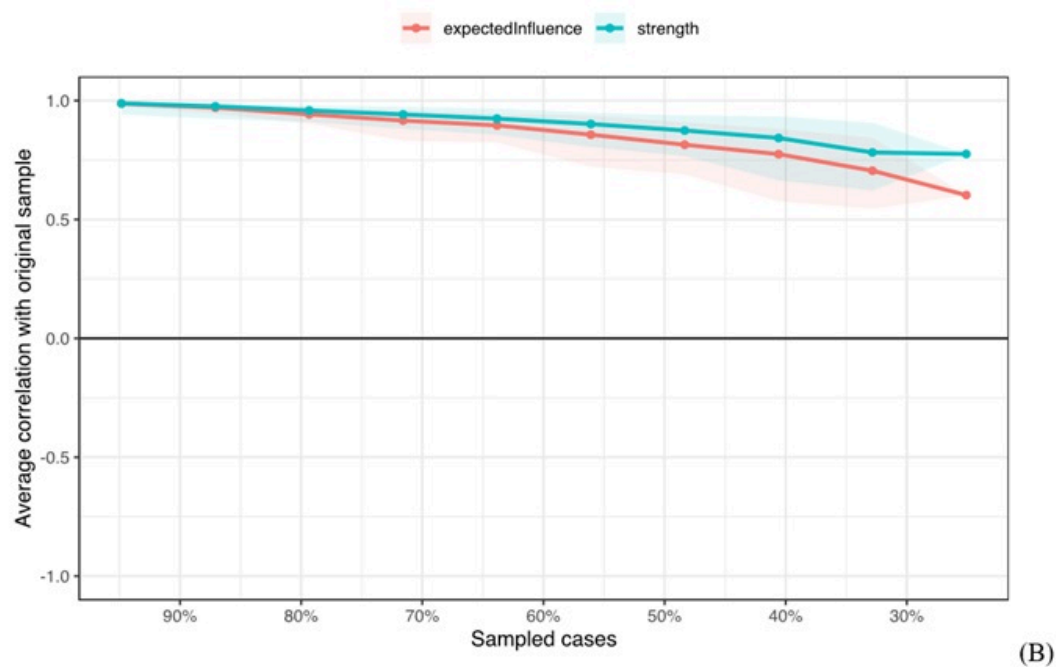
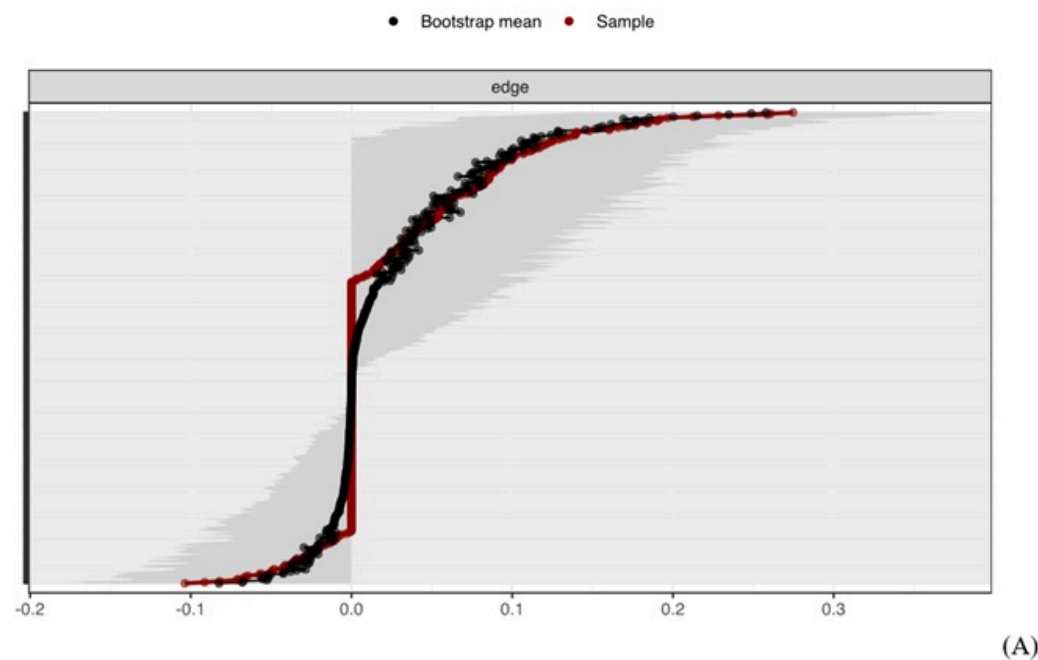


**Figure 3**

(A) Edge weight accuracy analysis of the CF-PI network (B) Stability analysis of strength centrality and expected influence in the CF-PI network

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