

Analysis Impact of Positive Psychological Capital on Quality of Life Among Patients Post Percutaneous Coronary Intervention: A Cross-Sectional Study

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Objective: Using network analysis, this study examined the interactions between positive psychological capital (PsyCap) and quality of life (QoL) in patients after percutaneous coronary intervention (PCI), identifying core psychological dimensions and cross-domain bridging symptoms to inform targeted psychological interventions.

Methods: In this cross-sectional study, 186 post-PCI patients were enrolled. PsyCap dimensions (resilience, optimism, hope, self-efficacy) were measured with the Positive Psychological Capital Scale (PPC), and QoL domains (physical strength, illness, medical conditions, daily activities, social psychology, work status) were assessed using the Chinese Quality of Life Questionnaire for Cardiovascular Patients (CQQC). Gaussian graphical models combined with LASSO regularization were employed to construct network structures. Centrality and bridge strength analyses identified key nodes, and bootstrap resampling was used to evaluate network stability.

Results: PsyCap demonstrated a dual-core structure comprising “self-efficacy–hope” and “resilience–optimism.” Among QoL dimensions, the strongest interaction was observed between “daily activities” and “social psychology.” “hope” emerged as the central hub within the PsyCap network and a critical bridge node, forming a robust link with the “daily function” domain of QoL. Stability analyses confirmed high network reliability, with statistically significant differences in edge weights and node strength.

Conclusion: As the first application of network analysis in this population, this study elucidates the multilevel psychological rehabilitation mechanisms post-PCI and reveals that “hope” is associated with synergistic improvements in both PsyCap and QoL through the integration of goal-directed cognitive and behavioral activation. These findings transcend conventional unidimensional intervention approaches and provide actionable network-based targets for implementing integrated psychological–functional rehabilitation models.

Keywords: coronary heart disease, percutaneous coronary intervention, positive psychological capital, quality of life, network analysis

Introduction

Coronary heart disease (CHD) remains a leading cause of global mortality and morbidity.^{1,2} Cardiovascular diseases account for approximately 18.6 million annual deaths worldwide, with CHD representing over 40% of these cases.³ Although percutaneous coronary intervention (PCI) significantly improves revascularization and reduces acute risks, patients continue to face substantial challenges, including in-stent restenosis (occurring in up to 30% of cases) and recurrent cardiovascular events (10–20% in the long term).⁴ The burden of CHD extends beyond physiological impacts to include considerable social and economic consequences; for example, annual healthcare costs for CHD patients are 2.3 times those of healthy individuals, and lost productivity due to disability accounts for an estimated 1.2% of GDP in some economies.⁵

Post-PCI patients often report impaired quality of life (QoL) compared to the general population. While physical functioning may improve by up to 28% following PCI, psychological recovery is frequently limited, with gains below 15%.⁶ Psychological factors such as anxiety and depression are established independent predictors of diminished QoL in this population.^{7,8} In recent years, positive psychological capital (PsyCap)—a multidimensional construct comprising hope, self-efficacy, resilience, and optimism—has gained attention for its role in chronic disease management.^{9,10} Higher levels of PsyCap are associated with reduced incidence of post-operative angina, likely mediated through improved treatment adherence and health behaviors.¹¹ Moreover, improvements in QoL may further enhance PsyCap, suggesting a reinforcing feedback cycle.^{12,13}

However, prior studies have predominantly examined PsyCap and QoL as separate constructs or using traditional statistical approaches, which are limited in capturing the complex, dynamic interactions among their subdimensions. Network analysis offers a novel methodological framework that transcends conventional correlational or regression techniques by modeling systems of variables as interconnected networks, thereby visualizing intricate relationship patterns and identifying central features and bridging elements.^{14,15} Compared with traditional statistical methods (such as factor analysis or regression model), its core advantages are as follows: (1) Reject the latent variable hypothesis and conceptualize mental constructs as dynamic systems of observable variables;¹⁶ (2) Identify core or bridge symptoms in the network using node centrality metrics (such as strength and tightness) providing a quantitative basis for intervention target selection.¹⁵ This approach provides a quantitative basis for developing targeted interventions and optimizing resource allocation in clinical settings.¹⁷

Despite these advantages, the application of network analysis to elucidate the interplay between PsyCap and QoL specifically in CHD patients after PCI remains underexplored. Therefore, this study aims to: (1) delineate the network structure connecting PsyCap dimensions and QoL domains in post-PCI patients; (2) identify core and bridge nodes that sustain network connectivity or facilitate interactions between psychological and functional outcomes; and (3) quantify the strength and direction of node interactions to uncover potential nonlinear relationships. By doing so, this research seeks to provide evidence for precise, mechanism-based interventions and contribute to a more integrated biopsychosocial model of cardiovascular rehabilitation.

Method

Study Design and Participants

This cross-sectional study consecutively enrolled patients who had undergone at least their second PCI procedure at the Heart Center of the First Affiliated Hospital of Xinjiang Medical University between November 2024 and January 2025. A total of 197 patients were initially invited; 4 declined participation, and 7 were excluded due to incomplete questionnaires (>20% missing items or implausibly short response time <3 minutes), resulting in a final sample of 186 participants (Figure 1).

The inclusion criteria of this study are as follows: (1) Diagnosis of CHD confirmed by coronary angiography according to WHO/International Society of Cardiology criteria;¹⁸ (2) age ≥ 18 years; (3) Consciousness and adequate auditory/verbal capacity; (4) Provision of informed consent. Exclusion criteria: (1) Severe impairment of heart, brain, kidney, or other organs; (2) Critical conditions (eg, massive myocardial infarction, malignant arrhythmia, cardiogenic shock); (3) Unwillingness to participate. The sample size was determined using the common heuristic of 3–5 observations per parameter in network modeling.¹⁹ With 10 nodes yielding 25 off-diagonal parameters in the Gaussian Graphical Model,²⁰ a minimum sample size of 105–175 was required. Our final sample of 186 meets this requirement.

Ethical Principles and Procedures

This study complied with the Helsinki Declaration and human biomedical research ethics, approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (K202410-24). After being informed of the research objectives, process, and privacy protection, all participants signed informed consent.

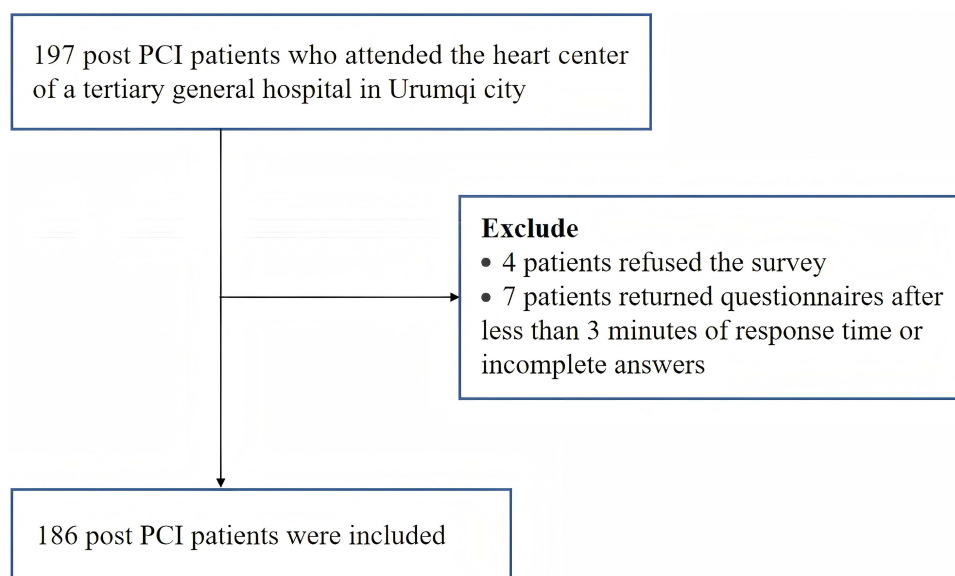


Figure 1 Flow chart for inclusion of post PCI patients.

Measures

Data were collected using a self-administered questionnaire covering sociodemographic characteristics (eg, gender, age, disease history, household income) and two validated scales: the Positive Psychological Capital Scale (PPC) and the Chinese Quality of Life Questionnaire for Cardiovascular Patients (CQQC). The PPC scale, originally developed by Luthans et al²¹ and adapted into a 26-item Chinese version by Zhang et al,²² assesses four dimensions of psychological capital: resilience, optimism, hope, and self-efficacy. Items are rated on a 7-point Likert scale, with total scores ranging from 26 to 182; higher scores indicate higher levels of PsyCap. The scale has demonstrated good reliability and validity in CHD populations in China.^{11,23} In this study, Cronbach's α was 0.875. The CQQC, developed in 1996 and revised in 2008 by the Cardiovascular Professional Committee of the Chinese Rehabilitation Medicine Association, assesses cardiovascular patients' QoL.²⁴ The CQQC comprises 6 dimensions (physical strength, illness, medical condition, daily activities, social psychology, and work status) with 24 items, scored 0–154. Higher scores mean better QoL, and it's widely used for assessing Chinese CHD patients' QoL,^{25,26} with good reliability and validity. In this study, Cronbach's α was 0.893 (The PPC and CQQC domain/dimension items are in [Supplementary Material Table 1](#)).

Statistical Analysis

Network Analysis

Data analysis used SPSS 24.0. Categorical variables (eg, gender, age) are described with frequency/percentage. Normally distributed continuous variables (eg, PsyCap, QoL) are presented as mean \pm SD.

Network analysis was performed using R (v4.1.1) with the qgraph (v1.6.9) and bootnet (v1.4.3) packages.²⁷ In the network graph, the finer edges mean that the correlation between nodes is weak, and the coarser edges indicate that the correlation is strong.²⁷ Extended Bayesian Information Criterion (EBIC) and Least Absolute Shrinkage and Selection Operator (LASSO) network model are used to establish a highly interpretable PsyCap and QoL network.^{28,29} Centrality indices (strength, betweenness, closeness) were computed to identify key nodes; however, following recommendations by Bringmann et al.³⁰

Based on this, this study uses the most commonly used strength centrality index for analysis.³¹ Bridge centrality was calculated using the networktools package (v1.2.3) to identify nodes connecting the PsyCap and QoL communities.¹⁵ Accurate identification of bridge symptoms can indicate key intervention targets and significantly enhance intervention effectiveness.

Network Stability and Accuracy

Network stability and accuracy were rigorously assessed. The bootstrap method was used to estimate 95% confidence intervals for edge weights;³² narrow intervals indicate precise estimation. The correlation stability coefficient (CS-coefficient) was calculated to evaluate the stability of centrality indices under case-dropping subsampling; a CS-value above 0.5 is acceptable, and above 0.7 indicates high stability.²⁰ Finally, a bootstrap difference test compared edge weights and node centrality to examine significant differences between network parameters. All stability and accuracy results are reported in the Results.

Results

Study Sample

Initially, 197 patients were invited to participate in this study. After screening, 186 valid questionnaires were retained, yielding an effective response rate of 94.42%. The sociodemographic characteristics of the participants are summarized in Table 1. The overall QoL score was 113 ± 26.59 . Domain-specific scores were as follows: physical condition, 43.78 ± 24.69 ; disease condition, 20.12 ± 3.75 ; medical condition, 5.8 ± 0.53 ; daily activities, 13.17 ± 2.23 ; social psychology, 11.56 ± 0.17 ; and work status, 7.39 ± 1.27 . The mean PsyCap score was 155.42 ± 11.56 , with mean subscale scores of 40.67 ± 3.69 for self-efficacy, 41.56 ± 4.12 for resilience, 36.16 ± 3.36 for hope, and 36.80 ± 2.99 for optimism.

Network Structure

The estimated network structure is visualized in Figures 2 and 3. Within the PsyCap dimensions, the strongest edge weight was observed between self-efficacy and hope (PsyCap1–PsyCap2), followed by resilience and optimism (PsyCap3–PsyCap4).

Table 1 Sociodemographic Characteristics of PCI Patients with Coronary Heart Disease

Characteristics	Categories	N	Percentages (%)
Gender	Male	131	70.4
	Female	55	29.6
Age	<60	92	49.5
	≥60	94	50.5
Course of disease	<0.5 year	40	21.5
	0.5≤t< 1 year	28	15.1
	1≤t<5 year	38	20.4
	≥5 year	80	43.0
Monthly per capita household income	<3000RMB/month	36	19.4
	3000-5000RMB/month	67	36.0
	5000-10000RMB/month	65	34.9
	>1000RMB/month	18	9.7
Complication	Yes	139	74.7
	No	47	25.3
Daily sleep duration	<3h	13	7.0
	3-6h	61	32.8
	>6h	112	60.2
Number of implanted stents	1	61	32.8
	2	51	27.4
	3	54	29.0
	≥4	20	10.8

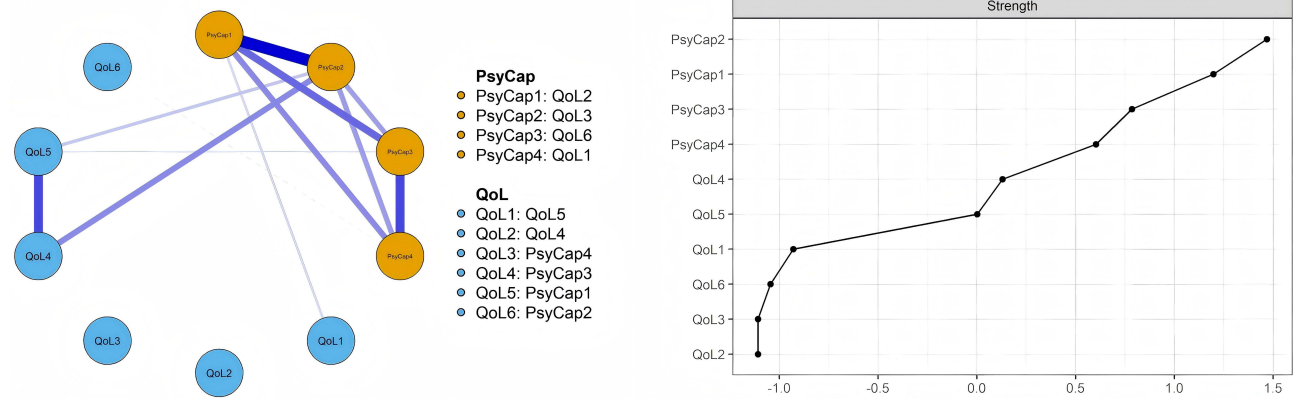


Figure 2 Network structure of positive psychological capital and quality of life in coronary atherosclerotic heart disease post percutaneous coronary intervention. The left panel shows the visualization of the network structure; the right panel shows the value of strength in order.

Abbreviations: PsyCap, Positive Psychological Capital; QoL, Quality of Life.

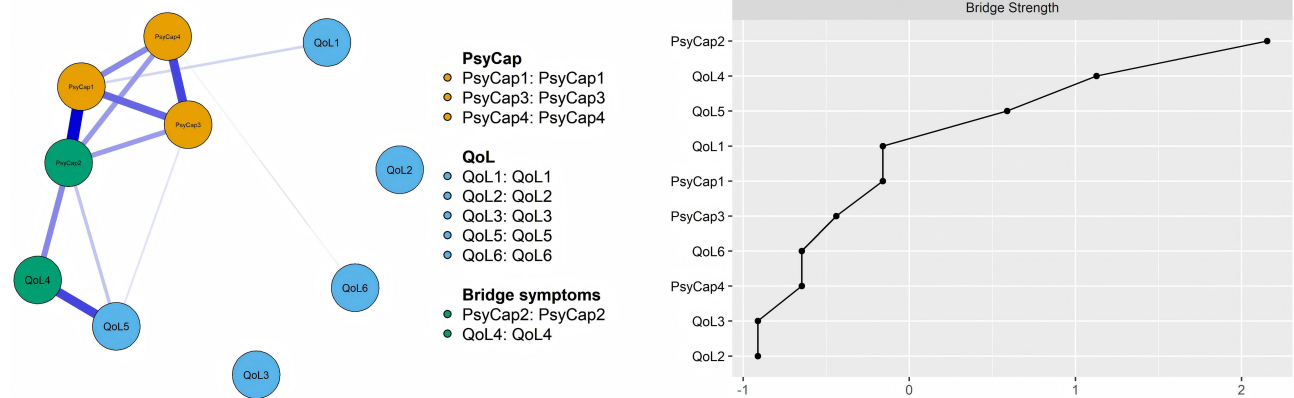


Figure 3 Network structure of positive psychological capital and quality of life showing bridge symptoms in coronary atherosclerotic heart disease post percutaneous coronary intervention. The left panel shows the visualization of the network structure of bridging symptoms; the right panel shows the value of bridge strength in order.

Abbreviations: PsyCap, Positive Psychological Capital; QoL, Quality of Life.

Among QoL domains, the most substantial connection emerged between daily activities and social psychology (QoL4–QoL5). Centrality analysis identified hope (PsyCap2) as the node with the highest strength centrality within the network, indicating its pivotal role in connecting PsyCap and QoL elements (Supplementary Table 2). Self-efficacy (PsyCap1) and resilience (PsyCap3) also showed considerable influence on network stability and cross-domain interactions.

Bridge centrality analysis further revealed hope (PsyCap2) and the daily activities domain (QoL4) as key bridge symptoms linking the PsyCap and QoL communities. Hope exhibited the highest bridge strength, underscoring its critical function in facilitating interactions across psychological and functional domains. The daily activities (QoL4) and social psychology (QoL5) domains also served as prominent bridge nodes, highlighting their role in the functional-psychosocial interface during recovery (Figure 3 and Supplementary Table 2).

Network Stability and Accuracy

The network demonstrated high stability and accuracy under robustness checks. The correlation stability coefficient (CS-coefficient) for strength centrality was 0.75, indicating that the centrality indices remained reliable even after excluding up to 75% of the sample via case-dropping bootstrap (Figure 4). Nonparametric bootstrap analysis showed that most edge weights were statistically significant, with narrow 95% confidence intervals, supporting the precision of

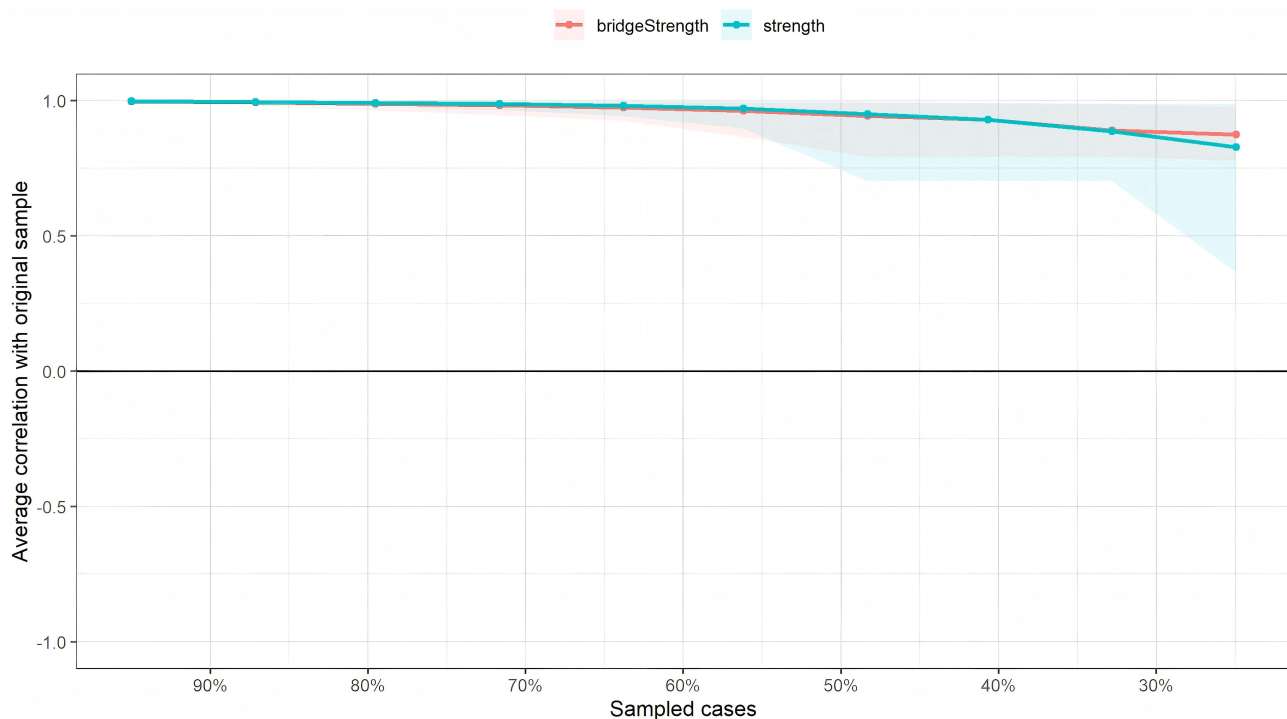


Figure 4 The stability of strength and bridge strength using case-dropping bootstrap. The x-axis indicates the percentage of cases of the original sample included at each step. The y-axis indicates the average of correlations between the centrality indices from the original network and the centrality indices from the networks that were re-estimated after excluding increasing percentages of cases.

the network estimation ([Supplementary Figures 1 and 2](#)). These results confirm that the network model is robust and replicable, providing a reliable foundation for identifying intervention targets.

Discussion

This study employed network analysis to delineate the complex interrelationships between positive psychological capital (PsyCap) and quality of life (QoL) in patients following percutaneous coronary intervention (PCI). The resulting network revealed a tightly interconnected structure, with “hope” and “self-efficacy” forming the core of PsyCap, and “daily activities” and “social psychology” central to QoL. Notably, “hope” also functioned as the primary bridge node, facilitating cross-domain interactions between psychological and functional outcomes. These findings align with previous reports that highlight the beneficial role of PsyCap in chronic disease management through enhancement of hope, self-efficacy, resilience, and optimism, leading to improved physiological and psychological status as well as QoL.^{33–35} For instance, Hu et al observed that patients with higher PsyCap exhibited greater adaptability and resilience, along with a lower frequency of post-operative angina.

The strongest correlation within the PsyCap dimensions was between self-efficacy and hope—consistent with their established roles as core components of PsyCap.^{36,37} Self-efficacy reflects an individual’s confidence in accomplishing tasks and overcoming challenges,³⁸ while hope entails positive future expectancies and persistent goal pursuit.³⁹ Their synergy likely fosters a proactive mindset and adaptive coping, encouraging sustained engagement in rehabilitation. The second strongest correlation emerged between resilience and optimism, both critical resources for adversity management.^{40,41} Resilient individuals recover more quickly from setbacks, while optimists maintain positive outcome expectancies;^{42,43} together, they help mitigate disease-related stress and promote rehabilitation continuity and quality.^{42,44} Among QoL domains, daily functioning and psychosocial well-being shared the strongest connection, underscoring the reciprocal influence between functional capacity and mental health—a well-documented phenomenon in health-related quality of life research.⁴⁵

Centrality analysis identified hope as the most influential node within the network. Hopeful patients demonstrate greater confidence and future orientation, which promotes psychological resilience and motivates health-affirming behaviors such as treatment adherence and active participation in rehabilitation.⁴⁶ These behavioral mechanisms may explain how hope contributes to improved QoL.⁴⁶ The position of hope as both a central and bridging node suggests that interventions specifically designed to

enhance hope—for example, through cognitive-behavioral techniques focusing on goal-setting and future-oriented visualization—could serve as efficient and powerful strategies within cardiac rehabilitation programs.⁴⁷ Similarly, the key roles of self-efficacy and resilience indicate that these dimensions should be targeted concurrently, such as through mastery-based exercises and stress-adaptation training, which may further amplify treatment efficacy and promote functional recovery.⁴⁸

Bridge centrality analysis further highlighted hope and the daily activities domain as key connectors between the PsyCap and QoL communities. This suggests a positive feedback loop: hope motivates improved daily functioning, which in turn reinforces hopefulness. From an intervention perspective, this close coupling indicates that combining psychological strategies with functional rehabilitation—for instance, integrating hope-enhancing protocols with graded activity regulation and social participation exercises—may create synergistic effects, simultaneously improving mental well-being and physical outcomes.⁴⁹ Similarly, daily functioning and psychosocial status serve as mutual enhancers, whereby functional independence supports social participation and mental health, and positive psychosocial states facilitate daily adaptation.⁵⁰ These cross-domain interactions emphasize the potential of multi-dimensional interventions that simultaneously target psychological assets and functional outcomes.

To our knowledge, this is the first study to apply network analysis to elucidate the PsyCap–QoL interface in post-PCI patients. The central and bridging role of hope illustrates how psychological mechanisms can synergize with behavioral and functional domains, supporting a bio-psycho-social approach to cardiac rehabilitation. The network model offers a clinically actionable framework for developing targeted rehabilitation strategies; modifying central and bridge nodes (eg, hope, self-efficacy, daily functioning) may propagate positive changes across the psychological and functional spectrum, ultimately enhancing recovery efficiency and long-term outcomes.

Several limitations must be acknowledged. The cross-sectional design precludes causal inference regarding the dynamic evolution of PsyCap and QoL over time. Longitudinal network analyses are needed to trace temporal relationships and identify causal pathways. Additionally, self-reported measures of PsyCap and QoL may be susceptible to recall and social desirability biases. Future studies would benefit from incorporating objective behavioral measures or collateral reports to improve validity. Finally, the single-center sampling may limit generalizability. Multi-center studies involving diverse cultural and regional populations are necessary to enhance the external validity and clinical applicability of these findings.

Notwithstanding these limitations, this study provides a novel network perspective on the interrelationships between PsyCap and QoL post-PCI. It shifts the focus from isolated variables to interactive mechanisms, offering a scientifically grounded framework for integrating psychological and functional rehabilitation strategies. Future research should prioritize longitudinal designs to establish causal links and evaluate network-informed interventions aimed at improving long-term health outcomes in CHD patients.

Although network analysis has been applied in other chronic conditions such as diabetes⁵¹ and depression,⁵² its use in post-PCI populations remains novel. Unlike previous studies focusing solely on symptom networks, this research highlights the interplay between psychological resources and functional outcomes, providing a more comprehensive rehabilitation model.

Conclusion

This study mapped the interactions between PsyCap and QoL in post-PCI patients using network modeling. Results indicate that PsyCap and QoL form a coherent system organized around self-efficacy–hope and resilience–optimism cores. Hope (PsyCap2) functioned as both a central hub and key bridge node, strongly linked to daily activities (QoL4), suggesting it amplifies QoL through goal-directed cognition and behavior. These findings support a bio-psycho-social approach to cardiac rehabilitation and highlight hope as a candidate interventional target for integrated care. Future longitudinal and multicenter studies are warranted to validate these network-informed intervention strategies.

Author Contributions

Zakeer Kudelati performed conceptualization, prepared the original draft, and provided resources. Shengnan Yin and Song Chen were responsible for the methodology. Siyue Han and Shuanglong Yuan conducted formal analysis and investigation. Huicai Wang performed writing - review and editing, and also took on the role of supervision. All authors read and approved the final manuscript.

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Disclosure

The authors report no conflicts of interest in this work.

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