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Revisiting hospital patient safety culture in China: a nationwide network analysis

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Abstract

Background Patient safety culture (PSC) is crucial for reducing medical errors and improving patient outcomes globally. This study aims to identify key improvement targets in China's PSC to promote a safer healthcare environment.

Methods Data were extracted from two national PSC surveys conducted in 2016 and 2020 and were analyzed using the 12-dimensional Hospital Survey on Patient Safety Culture (HSOPSC) 1.0 questionnaire. Central targets were identified through strength, closeness, and betweenness centrality. Network stability was assessed using the case dropping bootstrap method.

Results A total of 24,529 responses were included, with an average positive response rate of 63.92%. Teamwork within units had the highest rate, and nonpunitive response to error the lowest. Feedback and communication about errors showed the greatest strength (1.302), closeness (0.008), and betweenness (22), occupying a core node position in both genders and correlating strongly with communication openness. After the COVID-19 pandemic, the core node position of management support for patient safety has become more prominent.

Conclusions While teamwork is a notable strength, there is room to enhance the nonpunitive response to errors. Improving feedback and communication practices can further bolster openness and collaboration within teams, leading to an overall healthier work environment.

Keywords Patient safety, Network analysis, Strength, Closeness, Betweenness centrality

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Text box 1. Contributions to the literature

• This study pioneers the application of network analysis to patient safety culture (PSC) in China, uncovering systemic interdependencies among PSC dimensions and identifying *feedback and communication about errors* as the most central node.

• It highlights the evolving impact of the COVID-19 pandemic on PSC, revealing heightened centrality of *management support for safety* post-pandemic, a novel insight into crisis-driven shifts in safety culture priorities.

• By comparing gender differences, the study underscores the need for gender-sensitive interventions, with males emphasizing managerial expectations and females prioritizing organizational support, enriching global PSC discourse.

• The findings bridge a critical gap in non-Western PSC literature, offering evidence-based levers (e.g., nonpunitive error reporting) to optimize safety strategies in resource-varied settings.

Introduction

Patient safety culture (PSC) refers to the common attitude, beliefs, perceptions, and values of health caregivers shared in the process of ensuring patient safety [1]. A positive PSC has been shown to reduce errors and enhance patient outcomes, such as decreasing the incidence of surgical site infections, while also benefiting the well-being of healthcare staff [2–4]. Since the launch of the Patient Safety 2030 initiative in 2016 and the subsequent Global Patient Safety Action Plan (2021–2030), there has been a consistent emphasis on fostering a culture of safety [5, 6].

There is an increasing global emphasis on evaluating the current state of PSC. Despite this heightened focus, tangible improvements remain limited, particularly in areas where change is most critical. Prior research has primarily utilized descriptive methodologies [7, 8], treating PSC dimensions as isolated entities. These studies typically concentrate on the scores of individual dimensions while neglecting the complex interactions between them, often employing regression analyses in their approach. However, healthcare operates as a complex adaptive system [9], where PSC is shaped by multifaceted interconnections and dynamic processes. The dimensions of PSC do not exist in isolation; instead, they interact in ways that can be synergistic, reinforcing, or even detrimental. Consequently, modifications in one dimension can significantly impact the development or deterioration of others [10]. Thus, there is a need to analyze the relationships among the various dimensions of PSC from a systemic perspective.

Network analysis is a method that examines the interactions and internal structures among various dimensions of a particular psychological construct through visualization [11]. The nodes within these networks represent the interacting dimensions of the structure, while the edges represent the relevant pathways connecting these dimensions. This approach also generates useful indexes to assess the centrality of each dimension [12]. Oreel et al. [13] were the first to apply network analysis to momentary health-related quality of life (HRQoL) data from patients with stable coronary artery disease (CAD), enhancing insights into HRQoL analysis at both the group and individual levels. A study that recruited 1,556 Chinese participants utilized network analyses to elucidate the intricate relationship between daily stressors, subjective wellbeing (SWB), psychological distress, and psychological capital (PsyCap) during the pandemic, with psychological distress emerging as the most influential community within the network [14]. Ge et al. [15] used network analysis to explore the interplay between different social interpersonal relationships and suicide. They discovered that the teacher-student relationship was particularly important for adolescents, which provides a comprehensive perspective on addressing suicidal ideation in adolescents.

Therefore, our study aimed to estimate the nationwide network structure of PSC and utilize network comparison tests to examine the similarities and differences in network characteristics across time periods and genders. By identifying key PSC dimensions requiring improvement, we seek to enhance the understanding of patient safety in healthcare settings, ultimately benefiting patients and the public.

Methods

Data collection

Data were extracted from the Hospital Survey of Patient Safety Culture (HSOPSC) conducted by the Chinese Hospital Association. As part of a national survey initiative, the survey was carried out in secondary or tertiary hospitals across 34 provinces/regions within large academic health systems in the east-middle-west regions of China. The two time periods of the survey were from November 2016 to November 2017 and from November 2020 to November 2021. For each surveyed institution, cluster sampling was conducted using a convenience sampling method, and an online survey was utilized to invite healthcare workers to participate. Eligible participants included clinical personnel who possessed pertinent professional qualification certificates and had direct or indirect contact with patients, such as physicians, nurses, pharmacists, rehabilitation therapists and managerial staff like head nurses. Individuals whose primary duties were confined to hospital operations rather than patient care were excluded, such as those engaged in finance, security, medical record management, and library management.

The data were distributed electronically through a complimentary questionnaire available at https://www.wjx.cn/. The Chinese Hospital Association sent the questionnaire link and promotional posters for the study to all potential participating hospitals. Subsequently, the hospital heads distributed these materials to each department or unit via WeChat. To ensure the quality of the study, a restriction was implemented to allow only one submission per IP address once all questions had been answered.

This study was approved by the Ethics Review Committee of the affiliated institution (2019-043). All participants were made aware of the purpose of the study on the opening page of the online questionnaire, and only those who expressed their consent to participate proceeded to complete the survey. This study adhered to the ethical principles for medical research involving human subjects in compliance with the Declaration of Helsinki.

Variables

Socio-demographic data including sex, age, types of occupation, professional title, education level, locations of hospital, and working time per week of the participants were collected.

The HSOPSC questionnaire 1.0, developed by the Agency for Healthcare Research and Quality (AHRQ) of the United States in 2004 [16], was used to assess the current status of healthcare providers' perceptions of patient safety culture. The questionnaire has good reliability and validity and has been widely used to measure patient safety culture awareness [17, 18]. The HSOPSC consists of 42 items categorized into 12 dimensions, with 7 dimensions measuring safety culture at the unit/department level, 3 at the hospital level, and 2 measuring their outcomes. Additionally, it includes 2 standalone questions: an overall grade on patient safety for their work unit and the number of events reported in the last 12 months. Each item was rated on a 5-point Likert scale (1= "never/strongly disagree" to 5= "always /strongly agree"). The overall average score of all dimensions could be calculated, or the average scores of all dimensions could be added together to obtain a comprehensive total score. The higher the score, the higher the level of PSC within the organization. After reversing negatively worded items, the percent positive response for each item and the overall survey was computed following the toolkit guide [19]. This metric represents the combined percentage of respondents who answered "Strongly agree" or "Agree", or "Always" or "Most of the time", depending on the response categories used for the item. In this study, a Chinese version of the HSOPSC questions translated by Xiao [20] was utilized, with an overall Cronbach α coefficient of 0.825.

Statistical analysis

In this study, the R software (Version 4.2.0; Vienna, Austria) was used to conduct network analysis on the data, aiming to explore the network structural relationships among the various dimensions of HSOPSC. The steps of the network analysis followed the standardized guidelines published by Epskamp et al. [11, 21, 22]. The analysis content consisted of five parts: network estimation, visualization of the network, estimation of centrality indices, network comparison, and estimation of network accuracy and stability.

Network estimation

This study uses the qgraph package (version 1.9.4) in the R software for network estimation. As the data were continuous, we estimated the network of partial correlation coefficients via Gaussian Graphical Model (GGM). Based on this, a Graphical least absolute shrinkage and selection operator (GLASSO) was used to remove the weaker links and obtain a concise network [23]. Visualized using the Fruchterman-Reingold algorithm [24], the network is composed of nodes and edges, with the node representing the different dimensions of the HSOPSC and the edge representing the relationship between the dimensions; blue edges indicate positive associations and red edges indicate negative associations between the connected nodes. The thickness of the lines indicates the strength of the edges.

Centrality and stability

To evaluate the importance of individual nodes within the network, the centrality indices of strength, closeness, and betweenness were employed [25, 26]. The "strength" represents the sum of the absolute weights of the edges connecting a certain node to all the other nodes [27]. The "closeness" reflects the reciprocal of the average distance from a node to all other nodes, indicating the centrality of the node in the network. Meanwhile, the "betweenness" indicates the number of shortest paths that pass through a node.

This study examined the stability and accuracy of the network using the bootnet package (version 1.5.3). Specifically, the case-dropping bootstrap procedure (1000 bootstrap samples) was used to assess the stability of the centrality indices of nodes. The correlation stability coefficient (CS-C) quantifies the maximum proportion of cases that could be dropped to retain a 95% probability that the ranking correlation between the original network and the subsample network would have a significant effect (0.7). The CS-C exceeding 0.5 indicates good stability, with a minimum value of 0.25 required [28]. Additionally, the nonparametric bootstrap method (1000 bootstrap samples) was used to estimate the accuracy of the edge weight by calculating the 95% confidence intervals (CIs). A narrower 95% CIs indicated more accurate estimates.

Network comparison

To address the potential differences in the HSOPSC dimensions over time and gender, this study used the R package "NetworkComparisonTest" (version 2.2.1) for network comparisons [29]. Furthermore, the overall network structure, global strength, centrality indices of all nodes, and weight of all edges were compared between different times and genders. The level of significance was set at α = 0.05.

Results

Baseline characteristics of study participants

A total of 24,529 healthcare providers from all 34 provinces/districts of China were included in this study; of these, up to 52.39% of participants worked in the east (n = 12,851) of China. Furthermore, 78.48% (n = 19,251) of the participants were female, with over half falling within the age range of 26 to 35 years. Almost 53.85% of the participants were nurses who had direct contact with patients, while approximately 56.67% (n = 13,901) held primary professional titles. As is typical within the medical profession, 55.90% of the participants (n = 13,711) possessed a bachelor's degree. Furthermore, the majority of participants worked for 40 to 59 h per week, accounting for 70.84% of the total.

There were significant differences (P < 0.05) in total HSOPSC scores by genders, age brackets, type of occupations, professional titles, education levels, workplace, and weekly working hours, as detailed for the study participants in Table 1.

The HSOPSC scores of study participants

Table 2 demonstrates both the overall scores and the scores for each dimension of the HSOPSC and compares them with the percentage of positive responses reported by the AHRQ in 2018 [30]. The overall average positive response rate for the HSOPSC survey was 63.92%, which fluctuated between 32.83% (U6) and 84.40% (U3). Notably, the percentages of positive responses for three dimensions (U2, U3, and H1) above the upper 75%

Table 1 Baseline characteristics of the participants (N = 24,529)

Variables	*n*(%)	Score, Mean ± SD	Statistics	*P* value
Sex			-6.753*	<0.001
Male	5,278(21.52%)	43.75 ± 5.90		
Female	19,251(78.48%)	44.32 ± 5.99		
Age			186.74†	<0.001
≤ 25	3,685(15.02%)	45.36 ± 5.54		
26–35	12,583(51.30%)	44.11 ± 5.95		
36–45	5,533(22.56%)	43.63 ± 6.34		
≥ 46	2,728(11.12%)	44.17 ± 5.74		
Types of occupation			607.02†	<0.001
Doctors who have direct contact with patients	7,441(30.34%)	42.75 ± 6.18		
Nurses who have direct contact with patients	13,208(53.85%)	44.93 ± 5.78		
Pharmacists and other healthcare providers who do not have direct contact with patients	2,182(8.90%)	44.36 ± 5.93		
Managers	1,698(6.92%)	44.62 ± 5.56		
Professional title			134.00†	<0.001
Primary and below	13,901(56.67%)	44.61 ± 5.82		
Intermediate	7,317(29.83%)	43.73 ± 6.13		
Senior	3,311(13.50%)	43.50 ± 6.16		
Education level			319.76†	<0.001
Associate degree and below	4,840(19.73%)	44.40 ± 5.73		
Baccalaureate degree	13,711(55.90%)	44.68 ± 5.89		
Graduate degree	5,978(24.37%)	42.93 ± 6.19		
Locations of hospital			252.41†	<0.001
The east	12,851(52.39%)	44.01 ± 5.86		
The middle	4,629(18.87%)	45.48 ± 6.15		
The west	7,049(28.74%)	43.70 ± 5.96		
Working time per week			790.85†	<0.001
< 40 h	2,490(10.15%)	46.15 ± 5.95		
40–59 h	17,376(70.84%)	44.46 ± 5.84		
60–79 h	3,429(13.98%)	42.41 ± 5.92		
≥ 80 h	1,234(5.03%)	41.58 ± 6.12		

*Z test

†Kruskal-Wallis H test

Table 2 Scores of the HSOPSC and each dimension

Variables	Scores, Mean ± SD	Percent Positive Response: Current Study	Percent Positive Response: AHRQ 2018 [30]
Level 1—work area/unit			
U1: Manager expectations for safety	3.84 ± 0.67	72.21%	80%
U2: Organizational learning	4.01 ± 0.64	78.39%	72%
U3: Teamwork within units	4.17 ± 0.67	84.40%	82%
U4: Communication openness	3.65 ± 0.72	59.33%	66%
U5: Feedback about error	4.02 ± 0.73	73.77%	69%
U6: Nonpunitive response to error	2.90 ± 0.84	32.83%	47%
U7: Staffing	3.01 ± 0.71	37.74%	53%
Level 2—Hospital			
H1: Management support for safety	3.94 ± 0.72	75.26%	72%
H2: Teamwork across units	3.83 ± 0.70	69.84%	62%
H3: Handoffs and transitions	3.78 ± 0.81	69.82%	48%
Outcomes			
O1: Overall perceptions of safety	3.63 ± 0.66	62.79%	66%
O2: Frequency of event reporting	3.40 ± 1.02	46.31%	67%
Overall	3.68 ± 0.50	63.92%	65%

control limit were identified as positive areas, while three dimensions (U6, U7, and O2) below the lower 55% control limit were regarded as negative areas. The heatmap of the correlation coefficient matrix for each dimension of the HSOPSC reveals that item G (events reported in the past 12 months) exhibits a low correlation with all other variables in the matrix, as shown in Supplementary Fig. 1.

The network structure of HSOPSC

The network structure of each dimension of the HSOPSC is shown in Fig. 1. Items belonging to the same dimension tend to cluster together, while items spanning different dimensions also maintain interconnections. Within this network, several strong interconnections between edges have been identified, including those between H2 and H3 (edge weight = 0.428), U2 and U3 (0.412), U4 and U5 (0.344), U6 and U7 (0.330), H1 and H2 (0.324), as well as U5 and O2 (0.270). The edge weights in this network are shown in Supplementary Table 1.

As shown in Fig. 2, the analysis of the network structure's node centrality indicators reveals that U5, pertaining to communication feedback about errors, occupies the core node position with notable strength (1.302), closeness (0.008), and betweenness (22). Furthermore, H1, which represents management support for patient safety, also has high strength (1.223), closeness (0.007), and betweenness (12). On the contrary, G, signifying events reported in the past 12 months, emerges as the least interconnected node in the network. The centrality indicators of the nodes in the HSOPSC network are presented in Supplementary Table 2. The bootstrapped node strength, closeness, and betweenness tests are presented in Supplementary Figs. 2–4.

The network stability of HSOPSC

In terms of network stability, the CS-coefficients for strength, closeness, and betweenness were all 0.75, indicating that the overall network structure would remain largely unaffected even when up to 75% of samples were removed, as shown in Fig. 3. Furthermore, the

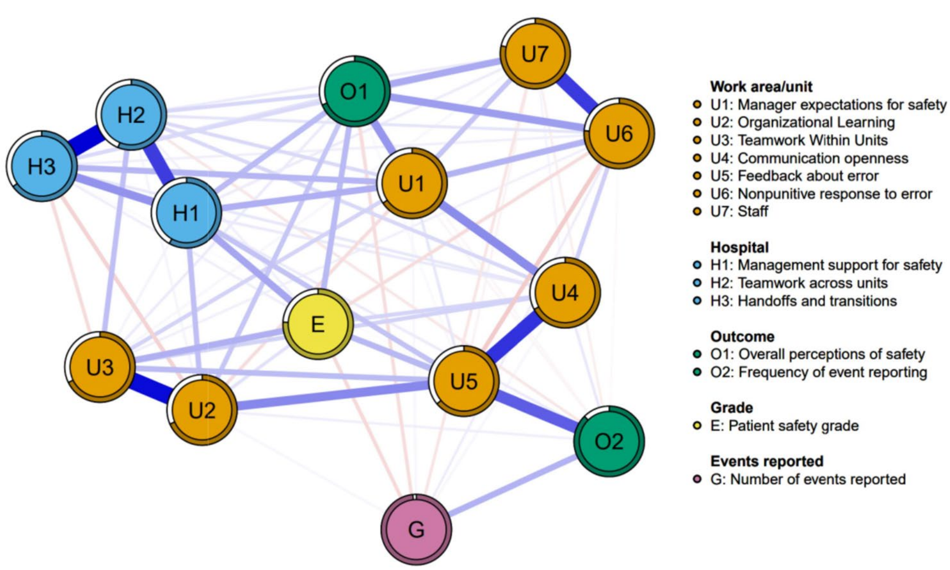

Fig. 1 Estimated network structure of HSOPSC for healthcare workers (*N* = 24529). Figure legend: The different dimensions of HSOPSC are represented by nodes of different colors, with blue edges indicating positive associations, while red edges indicate negative associations between the connected nodes. The thickness of the lines indicates the strength of the edges

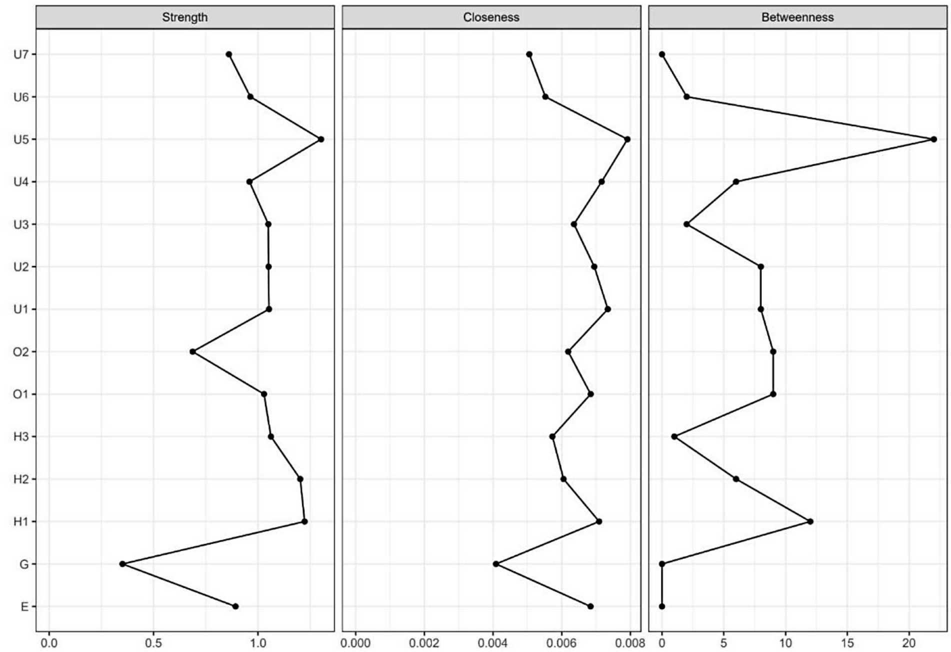

Fig. 2 The node centrality indicators in network structure for HSOPSC ($N = 24529$)

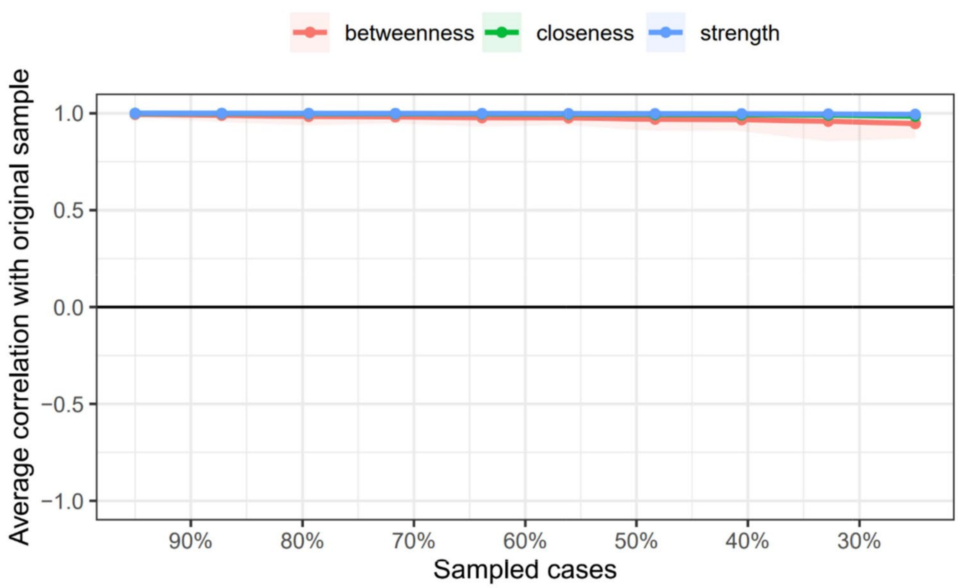

Fig. 3 The stability of the network model of the HSOPSC using case-dropping bootstrap method. Figure legend: The x-axis represents the percentage of cases of the original sample remained at each case-dropping subset. The y-axis represents the average of correlations between the centrality indexes from the original network and the re-estimated network after case-dropping procedure

bootstrapped edge weight difference test showed that most comparisons between edge weights were statistically significant, and the bootstrapped confidence intervals for the edge weights were narrow (Supplementary Fig. 5–6). Therefore, the network structure demonstrated acceptable stability and accuracy.

Network comparison test by time (pre-COVID-19 era vs. post-COVID-19 era)

Network models by time are shown in Supplementary Fig. 7. In the comparison of different models, a significant difference was found in the network global strengths (pre-COVID-19 era: 6.290; post-COVID-19 era: 7.640; S = 1.350, $P = 0.010$; Supplementary Fig. 7). There was also a significant difference in the network structure-distribution of edge weights (M = 0.181, $P = 0.010$).

The analysis of the network structure node centrality indicators at both times showed that the pre-COVID-19 era occupied the core node position with U5 (pertaining to communication feedback about errors), and the post-COVID-19 era occupied the core node position with H1 (management support for patient safety). Moreover, the strength, closeness, and betweenness of U2 (organizational learning and continuous improvement) increased after COVID-19, as shown in Supplementary Fig. 8.

Network comparison test by gender (male vs. female)

Network models by gender are shown in Supplementary Fig. 9. In the comparison of different models, a significant difference was found in the network global strengths (male: 7.533; female: 7.151; S = 0.382, $P = 0.020$; Supplementary Fig. 9). However, the difference in the network structure-distribution of edge weights was not statistically significant (M = 0.045, $P = 0.297$).

As shown in Supplementary Fig. 10, U5, which is pertaining to communication feedback about errors, occupied the core node position with significant strength, closeness, and betweenness in both female and male participants. Notably, compared to the opposite sex, male participants had higher betweenness at nodes U1 (expectations of manager and actions to promote safety) and H3 (handoffs and transitions), and female participants' had higher betweenness at nodes O1 (overall perceptions of safety), H1 (management support for patient safety), and H2 (teamwork across units).

Discussion

This study was the first to utilize network analysis to explore the interrelationships among the different dimensions of PSC among healthcare workers nationwide. Our study has four main contributions and implications. First, this study systematically reviewed the current status of PSC in China. Second, it identified the key points for improvement in PSC and analyzed their potential causes. Third, the core dimensions within the PSC network were identified and targeted interventions were proposed. Fourth, this study highlighted the impact of public health emergencies such as the COVID-19 pandemic on PSC, and also uncovered that gender had a certain influence.

In this study, the healthcare workers were positive about PSC in their organization, and the overall average positive response rate for the PSC was 63.92%, which was below the target of 75% but acceptable. Overall, Chinese healthcare workers may rate the PSC higher compared to Saudi Arabia [7] and some African countries [18, 31, 32] that use the HSOPSC tool, but lower than the United States [30, 33]. The reasons for the discrepancies may be related to cultural variations between regions, different implementations of the survey, contextual factors in healthcare systems, etc [34, 35]. For instance, the relatively low positive response rate (59.33%) in the "Communication Openness" dimension may reflect culturally embedded communication norms within Chinese healthcare settings. In Chinese society, people prioritize interpersonal harmony, and many Chinese believe that communication openness may undermine this harmony [34]. The ultimate goal of the Global Patient Safety Action Plan is to achieve the maximum possible reduction in avoidable harm due to unsafe health care globally [6]. The Chinese government has successively issued multiple policies to safeguard patients' health rights and interests, ensuring their safety [36, 37]. Medical institutions worldwide need to improve their patient safety management capabilities, and it is necessary to conduct regular annual PSC assessments.

In this nationwide survey, the dimension that garnered the highest positive response rate was "teamwork within units" (84.40%), similar to the results reported in the United States [30] and Dutch [38]. On the other hand, the two dimensions with the lowest percentage of positive responses were "nonpunitive response to error" (32.83%) and "staffing" (37.74%), which are key points for improvement. This indicates that the majority of the participants believe that making errors at work will lead to punishment for themselves and that the staff allocation was inadequate to handle the workload related to patient safety, which is also similar to the finding of other scholars [39–41]. It has been shown that positive healthcare worker perceptions of nonpunitive responses to errors are associated with lower rates of surgical site infections [3]. Hospitals should develop a nonpunitive culture that allows healthcare workers to report errors without fear, thereby identifying systemic problems and preventing the occurrence of future errors [42]. In the context of global population aging, along with the impact of the COVID-19 pandemic during the second national survey of this study, healthcare workers are faced with an increase in patient numbers and the intensity of care, leading to potentially unprecedented challenges to staffing [43, 44]. Therefore, Chinese hospitals should adopt measures to allocate staff and working hours more adequately in the future.

The results of the overall sample network analysis revealed that U5, "feedback and communication about errors" was the central dimension of PSC, occupying the most significant position in the network. Furthermore, it is closely associated with communication openness and the frequency of event reporting within the network, consistent with previously reported findings [35, 45]. Effective feedback mechanisms create an environment where staff feel safe to communicate openly, while open communication channels facilitate more comprehensive error feedback. Feedback and communication about errors refer to healthcare workers' perceptions of being informed about errors, receiving feedback about changes put into place based on event reports, and discussing ways to prevent errors [16]. The centrality of this dimension implies that interventions targeting feedback and communication about errors may effectively enhance the overall PSC among healthcare workers in the network. For policymakers and hospital administrators, establishing effective feedback mechanisms should be a top priority to enhance PSC. This could include regular safety briefings, visible documentation of improvements made in response to reports, and leadership walkarounds focused on discussing safety concerns and solutions. Multiple studies have shown that healthcare workers' positive perceptions of feedback and communication openness are associated with better patient safety and more positive hospital experiences for patients [45–47]. Feedback and sharing errors among colleagues not only prevent the repetition of errors but also increase job satisfaction [48, 49]. A lack of feedback on proposed corrective measures for adverse events may lead to negative perceptions among healthcare workers [50]. It is recommended to establish an anonymous error reporting system and regular feedback sessions, while conducting non-punitive communication training to encourage healthcare workers to submit improvement suggestions through standardized protocols. Future improvement initiatives should focus on measuring not just error reporting rates, but also staff perceptions of feedback quality and timeliness, as these may be more sensitive indicators of PSC.

With regard to the impact of public health emergencies on PSC, this study found that the centrality of H1 "management support for patient safety" has become more prominent post-COVID-19, despite it always occupying a relatively important position within the network. This heightened significance likely stems from several pandemic-specific mechanisms. First, the unprecedented resource constraints during COVID-19 - including staff shortages, equipment limitations, and rapidly changing protocols - made visible management's critical role in prioritizing and allocating scarce resources for patient safety. Second, the constant state of crisis demanded more frequent and transparent safety-related decision-making from leadership, bringing management support into sharper focus for frontline staff. Third, the emotional and physical toll of pandemic conditions increased staff dependence on organizational support systems. "Management support for patient safety" refers to hospital management that provides a work climate that promotes patient safety, with patient safety being a top priority rather than merely being addressed after adverse events occur. The research conducted by Gilmartin et al. [51] supports this finding, in which the increased workload intensity due to the COVID-19 pandemic has made healthcare workers more prone to emotional exhaustion, affecting PSC [52], and hospital leadership support was associated with lower burnout, higher psychological safety, and PSC. A national study in Sweden targeting registered nurses revealed that when hospital management prioritized patient safety in their actions, it resulted in a 1.51-fold increase in registered nurses' assessments of patient safety [47], which was also similar to the report by Saleh et al. [45] Effective hospital management leadership plays a key role in shaping attitudes towards safety and cultivating a robust PSC, while also influencing teamwork climate, working conditions, and stress recognition [53].

Interestingly, we found that gender also has a certain impact on PSC, with higher betweenness of U1 "expectations of manager and actions to promote safety" among male participants, and a higher betweenness of H1 "management support for patient safety" among female participants. Two studies based on the safety attitudes questionnaire (SAQ) indicate that male healthcare workers have higher satisfaction than females in terms of job satisfaction, working conditions, and safety climate, whereas female healthcare workers express a higher perception of stress recognition [52, 54]. Given the potential causal relationships between the dimensions of the PSC, it is crucial to implement individualized measures for healthcare workers of different genders to reduce perceived differences in patient safety. To this end, patient safety education and training should be strengthened, and cases of abnormal events should be analyzed regularly and used as training materials to be shared with departmental staff once the cases have been resolved, to prevent the recurrence of similar cases.

Strength and limitations

The strengths of the present study lie in its nationwide network analysis in China, which offers a systemic perspective on the interactions among different dimensions of PSC and identifies key targets for enhancement. Our findings can inform targeted interventions to enhance PSC, particularly regarding nonpunitive responses to errors and management support for patient safety which have become more prominent post-COVID-19. Strengthening feedback and communication practices may bolster openness and collaboration within healthcare teams, potentially leading to a healthier work environment and improved patient safety. By identifying gender differences in PSC perceptions, this research may prompt the development of gender-sensitive patient safety policies and practices, contributing to a more inclusive and effective PSC globally.

This study has several limitations. Firstly, although this study has a large sample size and is somewhat representative of the national healthcare workers, it is derived from convenience sampling. Secondly, owing to the cross-sectional data, inferences of causality need to be made with caution. This is also an inherent constraints of network analysis. Moreover, important latent factors not captured by the survey instrument may be overlooked. Finally, this study relied on self-reports to assess PSC, and participants may be inclined to give more positive responses, with an unavoidable ceiling effect. In the future, it will be necessary to employ longitudinal studies to further verify the dynamic changes revealed by network analysis, and to combine qualitative interviews to investigate the specific manifestations of self-report bias. Additionally, further exploring the potential impacts of variables such as professional titles and hospital locations would provide a more comprehensive understanding of PSC.

Conclusions

PSC is a global concern that requires continuous improvement. Our network analysis of PSC dimensions revealed that feedback and communication about errors constitute the most central element in the network. Improving practices in this area can further bolster openness and collaboration within teams. While teamwork within units is a notable strength, there is room to enhance the nonpunitive response to errors. These findings suggest hospital management should prioritize patient safety by: optimizing staffing levels, cultivating a nonpunitive culture that encourages error reporting, and strengthening departmental feedback mechanisms. Such targeted interventions would help identify systemic issues, prevent error recurrence, and ultimately create healthier work environments that enhance both staff well-being and patient safety outcomes.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13690-025-01612-5.

Tables and figures in the Supplementary Material

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Author contributions

HH and MX designed the study, participated in writing and revising the manuscript. HS and ZC performed the statistical analysis. XD, SZ, YP and JJ collected the data. NW contributed to interpreting the data. QH was responsible for the submission of the manuscript. QZ and HH responsible for overall supervision of the research, manuscript writing, and final approval of the version to be published. All authors have read and approved the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study is a secondary analysis of de-identified data originally collected under the approval of the Medical Ethics Committee of The First Affiliated Hospital of Chongqing Medical University (No. 2019-043). The re-use of these data for the current analysis was separately approved (Approval No. 2024-033-01).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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