Visual Analysis of Research Hotspots in Primary Health Care in the Context of COVID-19: Post-print

Authors: Yuge Yan, Huang Jiaoling, Huang Jiaoling

Date: 2023-04-03T00:00:00+00:00

Abstract

Background During the prevention and control period of COVID-19 infection, primary healthcare serves as the "first line of defense" in the response. Academic communities worldwide have conducted extensive research on primary healthcare work during the COVID-19 pandemic, yet differences in primary healthcare systems have led to varying research emphases. Objective To understand the progress, hotspots, trends, and differences in domestic and international primary healthcare-related research within the context of COVID-19 infection, thereby providing references for further research in this field. Methods On July 5, 2022, a search was conducted for primary healthcare-related research literature indexed in the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) Core Collection databases following the COVID-19 outbreak, with the search timeframe limited to January 1, 2020 to June 30, 2022. A total of 282 CNKI articles and 1,755 WOS articles were included. CiteSpace software was utilized for visual analysis, enabling author co-occurrence analysis, keyword co-occurrence, clustering, timeline analysis, and keyword burst detection. Results In terms of temporal distribution, the volume of domestic research literature grew rapidly in the early stage of the pandemic, then gradually declined and stabilized; international research started slightly later but has maintained a relatively high growth rate to date. Author collaboration was primarily characterized by small teams and individuals, with no large-scale cross-team cooperation. Domestic research hotspots focused on institutional and mechanism-related discussions and management practices for pandemic prevention and control, while international research emphasized changes in healthcare-seeking patterns and the fulfillment of patients' medical needs under pandemic impact. Both domestic and international research prioritized psychological issues arising from the pandemic's impact. Conclusion In the context of COVID-19 infection, domestic and international primary healthcare-related research share common ground while each maintaining distinct focuses. As domestic research continues to refine

and diversify, it can absorb international experiences, emphasize the development of relevant research capacity, improve the knowledge system in this field, and actively utilize information technology to perfect the primary healthcare service system under pandemic conditions.

Full Text

Visualization Analysis of Primary Healthcare Research Hotspots During the COVID-19 Pandemic

YAN Yuge, HUANG Jiaoling*

School of Public Health, Shanghai Jiao Tong University School of Medicine, Shanghai 200025, China

Corresponding author: HUANG Jiaoling, Associate Professor; E-mail: jiaoling_{huang}@sina.com

---

Abstract

Background: During the COVID-19 pandemic, primary healthcare served as the "first line of defense" in containment efforts. While academic circles worldwide conducted extensive research on primary healthcare during the pandemic, differences in healthcare systems led to varying research emphases across countries. **Objective:** To understand the progress, hotspots, trends, and differences in domestic and international primary care-related research during the COVID-19 pandemic, providing references for future studies in this field. **Methods:** On July 5, 2022, we searched CNKI and Web of Science Core Collection databases for primary healthcare-related studies published between January 1, 2020 and June 30, 2022, yielding 282 CNKI articles and 1,755 WOS articles. CiteSpace software was used for visualization analysis, including author co-occurrence, keyword co-occurrence, clustering, timeline analysis, and keyword burst detection. **Results:** In terms of temporal distribution, domestic publications grew rapidly in the early stage of the pandemic but gradually slowed and leveled off. International research started slightly later but maintained high growth rates. Author collaboration primarily occurred in small teams or individually, without large-scale cross-team cooperation. Domestic research hotspots focused on pandemic prevention and control systems, mechanism exploration, and management practices, while international research emphasized changes in healthcare-seeking patterns and fulfillment of patients' medical needs under the pandemic's influence. Both domestic and international research prioritized psychological issues arising from the pandemic. **Conclusion:** Primary healthcare research during the COVID-19 pandemic shares common ground while maintaining distinct focuses domestically and internationally. To continuously refine and diversify domestic research, it is recommended to absorb international experience, strengthen relevant research capacity building, improve the knowledge system in this field, and

actively utilize information technology to enhance the pandemic-era primary healthcare service system.

Keywords: COVID-19; primary health care; healthcare disparities; internationality; research hotspot; public health; visualization analysis; CiteSpace

Funding: National Natural Science Foundation of China (72274122); Shanghai Science and Technology Innovation Action Plan Soft Science Key Projects (22692192300, 23692113400)

Introduction

During the COVID-19 pandemic prevention and control period, primary healthcare played a crucial role as the "first line of defense" in containment efforts [1]. As the smallest unit of social governance in China, grassroots communities served as the "last mile" in urban pandemic prevention, undertaking public education, epidemic monitoring, and social service provision [2-3]. Under foreign healthcare systems, general practitioners, as patients' first point of contact, also served as "gatekeepers" for early epidemic warning [4]. Academic circles worldwide conducted extensive research on primary healthcare work content, achievements, and reforms during the COVID-19 pandemic. However, differences between domestic and international primary healthcare systems likely led to divergent research emphases in this field. This study employs bibliometric methods to systematically review domestic and international literature on primary healthcare during the COVID-19 pandemic, understand relevant research progress and hotspots, examine trends and relationships, and particularly identify differences to discover research "blind spots" and "weaknesses," thereby providing references for future research.

1. Methods

1.1 Literature Search

On July 5, 2022, we systematically searched the China National Knowledge Infrastructure (CNKI) and Web of Science (WOS) Core Collection databases. For CNKI, we used subject retrieval with search terms "COVID-19" combined with "primary healthcare," "grassroots healthcare," "grassroots medical care," or "community health," with synonym expansion enabled. WOS search terms were "COVID-19" and "primary healthcare." The search timeframe was limited to January 1, 2020 through June 30, 2022. Inclusion criteria were papers related to primary healthcare in the context of COVID-19. Exclusion criteria included dissertations, conference papers, news reports, book chapters, data papers, and irrelevant literature. The search initially retrieved 465 CNKI articles and 2,154 WOS articles. After excluding dissertations, conference papers, and news reports, we further reviewed titles and abstracts to exclude correspondence, announcements, and non-academic literature without authors or with

"Editorial Department" as author, ultimately including 282 CNKI articles and 1,755 WOS articles. The literature search flowchart is shown in [Figure 1: see original paper].

1.2 Research Tools

This study utilized CiteSpace versions 5.8.R3 and 6.1.6, along with Microsoft Excel 2016, for analysis, data entry, and visualization knowledge mapping. Scientific knowledge mapping typically possesses dual characteristics of "graph" and "spectrum": it is both a visual knowledge graph and a serialized knowledge pedigree that can display the development process and structural relationships of scientific knowledge [5]. CiteSpace is an information visualization software developed using Java language, primarily based on co-citation analysis theory and pathfinder network algorithms. It performs bibliometric analysis on literature collections in specific fields to identify key evolutionary paths and knowledge inflection points, and through a series of visual mapping, analyzes the potential dynamic mechanisms of discipline evolution and detects research frontiers [6].

1.3 Research Methods

Literature search results were exported in Refworks and plain text formats as ".txt" documents with CiteSpace-compatible names. CiteSpace converted these to WOS format data and removed duplicates. Basic information from the processed valid literature was exported to Excel for preliminary analysis and organization to examine literature growth patterns. Visualization analysis parameters were set as follows: link strength was cosine, selection criteria were g-index k=25 (author analysis) and top N levels per slice=50 (keyword analysis), pruning method was pathfinder, time span was 2020-2022, and individual time slice length was 1 year. The specific visualization analysis process is shown in [Figure 2: see original paper].

1.3.1 Co-occurrence Analysis Co-occurrence analysis utilizes word pairs or co-occurring noun phrases in literature collections to determine relationships among topics within the represented discipline. In author co-occurrence analysis, author information was extracted with all authors included regardless of authorship order. In keyword co-occurrence analysis, keywords were extracted from titles, abstracts, author keywords, and index keywords. CNKI and WOS literature were imported into CiteSpace 5.8.R3 software for deduplication and analysis. The frequency of keyword or subject term pairs appearing together in the same literature was statistically analyzed to form a co-word network composed of these term associations, where the distance between network nodes reflects the closeness of topic content [7]. Centrality, proposed by American sociologist Linton Freeman, measures the degree to which a point occupies a core position in a network [8]. In literature co-citation network mapping, nodes with high centrality are considered key literature playing the role of knowledge "inflection points" in domain knowledge development [9]. In the visualization

maps of this study, larger nodes and larger label fonts indicate higher keyword frequency. The color of connections between nodes reflects research timing, with lighter colors indicating proximity to the search time (2022). Keywords with centrality >0.1 are considered important keywords, with corresponding nodes marked by purple outlines in the figures.

1.3.2 Cluster Analysis The cluster view demonstrates structural characteristics among clusters, highlighting key nodes and important connections. CiteSpace provides two indicators—modularity (Q value) and mean silhouette (S value)—to evaluate mapping effectiveness based on network structure and cluster clarity. Q values generally range [0,1), with Q>0.3 indicating significant community structure and S>0.7 indicating credible clustering [1]. This study used the log-likelihood ratio test algorithm provided by CiteSpace software for clustering.

1.3.3 Timeline Analysis CiteSpace's timeline view focuses on depicting relationships among clusters and the historical span of literature within a cluster [1]. The timeline view allows examination of keyword temporal changes by cluster category to analyze research content evolution.

1.3.4 Burst Detection Burst indicates a variable's value changing significantly in a short period. CiteSpace treats burst information as a means to measure deeper changes [10]. Compared with high-frequency term analysis, burst term detection is more suitable for identifying emerging trends and sudden changes in discipline development [11].

2. Results

2.1 Temporal Distribution of Literature

Using publication time as the horizontal axis and quarterly publication count as the vertical axis, we plotted trends in publication volume. Domestic research publications grew rapidly in early 2020, then gradually slowed and leveled off. International publications surged beginning in the second quarter of 2020 and maintained high growth rates (see [Figure 3: see original paper]).

2.2 Author Analysis

Running CiteSpace with "author" as the node type and setting appropriate thresholds yielded author co-occurrence knowledge maps for primary healthcare research during the pandemic (see [Figure 4: see original paper]~5). The domestic author co-occurrence map contained 107 nodes, 86 connections, and network density of 0.0152 (see [Figure 4: see original paper]). The international author co-occurrence map contained 161 nodes, 268 connections, and network density of 0.0208 (see [Figure 5: see original paper]). Both domestic and international author collaboration in COVID-19 primary healthcare research remained

limited. The maps showed overall loose structures, with collaboration primarily occurring in small teams or individually, without large-scale cross-team cooperation. Domestic research formed author groups centered around Du Zhaohui, Chi Chunhua, and Fang Pengqian, while a prominent international research team centered around Sarah Tonkincrine. With literature limited to publications since 2020, overall author productivity remained low. The most productive domestic authors were Du Zhaohui, Chi Chunhua, and Fang Pengqian (4 articles each), while the most productive international author was Sarah Tonkincrine (5 articles).

2.3 Keyword Analysis

2.3.1 Keyword Co-occurrence Analysis Using "keyword" as the node type generated keyword co-occurrence knowledge maps (see [Figure 6: see original paper]~7). The domestic keyword co-occurrence map contained 413 nodes, 761 connections, and network density of 0.0089 (see [Figure 6: see original paper]). The international keyword co-occurrence map contained 124 nodes, 245 connections, and network density of 0.0321 (see [Figure 7: see original paper]). In Chinese literature, "epidemic prevention and control," "medical staff," "COVID-19 pandemic," and "primary-level hospitals" appeared most frequently with high centrality, representing the most influential keywords. Other high-centrality keywords included "depression," "influencing factors," "mental health," "prevention and control work," and "fever clinics," all serving as key network nodes around which most domestic research revolved. In international literature, the most frequent and high-centrality keywords included "impact," "COVID-19," "care," "health," "risk," "mental health," and "depression," representing research hotspots in primary healthcare during the pandemic. Table 1 shows the top 20 keywords by frequency and centrality (see).

2.3.2 Keyword Clustering Analysis Further keyword clustering through CiteSpace produced cluster maps with Q values of 0.7956 and 0.8208 (>0.3), indicating significant clustering, and S values of 0.9517 and 0.8208 (>0.7), indicating credible and well-defined clusters (see [Figure 8: see original paper]~9). The top 10 keyword cluster labels and their information are presented by cluster order, with all keyword clusters showing S values >0.7000, indicating good clustering effects. The top three clusters by size were "nucleic acid testing" (n=26), "epidemic prevention and control" (n=25), and "COVID-19 pandemic" (n=23) for domestic research, and "telemedicine" (n=20), "care" (n=20), and "infection" (n=16) for international research (see ~3).

2.3.3 Timeline Analysis Using "timeline view" layout, CiteSpace displayed keyword cluster timeline views, showing the top 10 keyword cluster temporal distributions (see [Figure 10: see original paper]~11). In domestic research, seven clusters—"nucleic acid testing," "epidemic prevention and control," "COVID-19 pandemic," "medical staff," "fever clinics," "influencing factors," "joint prevention and control," and "family doctor contract services"—continued to the

present, demonstrating good temporal continuity. Overall, research hotspots concentrated in 2020, with subsequent keywords being more dispersed and less frequent. Immediately after the outbreak, keywords like "COVID-19 pandemic," "epidemic prevention and control," "medical staff," "primary-level hospitals," and "general practitioners" quickly gained attention, focusing on rapid outbreak control while also addressing medical staff psychological issues. As prevention and control normalized, new keywords emerged including "key populations," "qualitative research," and "protective supplies" for nucleic acid testing; "R&D centers," "population management," and "knowledge lectures" for epidemic prevention; "sleep disorders," "anxiety," and "humanistic care" for the pandemic; "work pressure," "physical and mental health," and "burnout" for medical staff; and "normalization" for family doctor contract services. Research explored optimal pandemic prevention methods from multiple perspectives while addressing psychological issues among both general populations and medical staff under normalized prevention and control. Current research hotspots include "CDC," "material organization" for nucleic acid testing; "functional positioning," "community health" for prevention and control; "community return" for COVID-19; "disinfection skills" for medical staff; "disposal and treatment" for fever clinics; "prevention paths" for influencing factors; and "optimization" and "mechanisms" for joint prevention and control, focusing on summarizing and optimizing past experiences (see [Figure 10: see original paper]).

International research hotspots also concentrated on early keywords, but recently developed more concentrated discussion topics. "Telemedicine," "care," "topic areas," and "depression" demonstrated good temporal continuity. Early in the pandemic, international research similarly focused on COVID-19 occurrence and control, reflected in "intervention" and "COVID-19" for care, and "outbreak" and "transmission" for infection. However, greater emphasis was placed on assessing COVID-19 impacts across population dimensions, including stress among "nurse groups," "mortality," depression "prevalence," "mental health," and COVID-related "acute myocardial infection." In 2021, "quality of life" for people during the pandemic gained research attention, raising equity issues such as "disparity" and "access" in care, and addressing "psychological impact" and "resilience." Children, less frequently addressed in domestic research, also became a hotspot. As the pandemic's long-term societal impacts became apparent, "health economics" emerged as a recent research hotspot, evolving from early "burnout" to "models" of stress and burnout, while employment equity issues related to "women" gained attention. The "reliability" and "validity" of past research findings are being evaluated. "Telemedicine," as the top keyword cluster, runs throughout the research field, with a clear timeline showing the development from "management" and "outcome" evaluation during the pandemic, to "experience" exploration, and finally to "performance" summarization (see [Figure 11: see original paper]).

2.3.4 Keyword Burst Detection Domestic keywords showed relatively low overall burst intensity, with "medical community," "major epidemic," and

"health education" as hotspots and research frontiers in 2020 domestic primary healthcare research. Since 2021, "normalization" and "training" have shown high research interest. Internationally in 2020, the Wuhan outbreak received the most attention, with "wuhan" showing the highest burst intensity (4.02). "Therapy" for COVID-19 (3.01) was also a research hotspot. "Perception," "telehealth," and "cancer" have been research hotspots and frontiers in the international field from 2021 to present (see [Figure 12: see original paper]).

Discussion

As the pandemic's impact expanded, primary healthcare received unprecedented societal attention. Domestic publication volume peaked in Q2 2020, then declined as pandemic prevention and control normalized and social attention decreased. Conversely, international publications surged beginning Q2 2020 after the WHO declared COVID-19 a global pandemic on March 11, 2020 [12], calling for active global action, and have maintained high growth rates. Domestic and international author knowledge maps show similar characteristics, with most researchers having low publication volumes and loose cooperation networks. On one hand, authors with higher publication volumes demonstrated close collaboration within their teams and rich research output; on the other hand, exchanges between different author groups were limited, suggesting the need to strengthen academic exchanges and cooperation, develop cross-regional, cross-disciplinary, and cross-field research, and build tighter cooperation networks.

Epidemic prevention and control represents the research priority in domestic primary healthcare. "Epidemic prevention and control" ranked first in frequency and was also a clustering hotspot, with related keywords like "prevention work" and "control principles." "Nucleic acid testing," as an important identification policy tool, was also a clustering hotspot. Optimizing testing process standardization, timeliness, accuracy, and developing new technologies are crucial for improving prevention efficiency and require in-depth investigation. Additionally, "primary-level hospitals," "general practitioners," and "joint prevention and control" were frequently mentioned. Community governance serves as an important pandemic prevention tool in China, with General Secretary Xi Jinping emphasizing community prevention's importance, requiring "the entire country to fully leverage communities' blocking role in epidemic prevention and control" and "cadres' focus and strength to shift downward to support community work, building a people's defense line" [13]. Community importance in prevention manifests in multiple aspects: establishing prevention teams, investigating residents' basic living and travel conditions, controlling community access, and supervising environmental sanitation [14]. Additionally, it stems from deep coordination between primary healthcare institutions and communities: (1) community doctors and cadres collaborate horizontally to establish infectious disease investigation teams for "grid-based" resident management; (2) vertical linkage with higher-level designated hospitals for triage, referral, and daily medical services; and (3) primary doctors conducting community nucleic

acid sampling, testing, and other prevention work with CDC support [15].

International research also covered COVID-19 infection and prevalence, focusing on healthcare-seeking pattern changes and patient needs fulfillment, with extensive research on telemedicine and care. Telemedicine represents the highest-priority research frontier. Developed countries' telemedicine developed earlier with broad coverage, and social distancing requirements during the pandemic powerfully promoted telemedicine as an alternative to face-to-face care [16-17]. Research examined telemedicine outcomes, limitations, and improvements: reducing hospital interactions to prevent virus transmission, using apps to identify and track infected subpopulations and areas, providing self-assessment capabilities to reduce healthcare system pressure, and offering mental health professional support to mitigate isolation's negative psychological impacts. However, these outcomes depend on broadband access and smart devices, while facing strict regulatory restrictions in many regions. Consequently, international research explores eliminating telemedicine access barriers to ensure equitable use rights for vulnerable groups and promoting regulatory changes and application framework development [18-20]. "Care" also encompasses clinical experience and statistics, racial disparities, healthcare expenditure, and health system reform across multiple levels. Additionally, critical care during the pandemic was an international hotspot, including both COVID-19-related conditions like acute myocardial infection and other diseases like cancer, providing scientific evidence for clinicians managing COVID-19 patients, addressing vaccination concerns among patients with underlying conditions, and calling attention to non-COVID-19 critical patients under isolation policies [21-24].

Both domestic and international research extensively addressed psychological issues, including public mental health and primary healthcare workers' occupational stress and burnout. Studies show COVID-19 affected all life aspects, causing global psychological health crises and triggering individual and collective mental health problems such as panic, anxiety, depression, PTSD, infodemia, and racism [25-26]. Further research targeted specific populations—adolescents, medical students, patients with specific diseases, and healthcare workers—to identify unique psychological characteristics and develop effective countermeasures. Research on primary healthcare workers' psychological issues was particularly prominent. On one hand, protecting healthcare workers' mental health and maintaining a safe medical workforce is crucial for effective health system operation [27]; on the other hand, healthcare workers face higher infection risks, excessive workloads, and intense public scrutiny, resulting in higher prevalence of mental health symptoms than the general population and requiring early identification and intervention to prevent more severe consequences [28-30].

Domestic research content was relatively consistent, but under the same themes, studies showed strong continuity and deepening research processes. As pandemic prevention normalized and became more complex, domestic research directions gradually diversified and refined, reflecting exploration of efficient prevention pathways from multiple perspectives. However, later research themes showed

low popularity without high-centrality key nodes, indicating no breakthrough research had emerged, consistent with slowing domestic publication growth. International research featured broad, balanced hotspots. Recent high-frequency keywords include telemedicine "experience," care "access," and health economics "models," reflecting both high international publication volumes and the gradual establishment of an expanding and improving knowledge system. While leveraging community prevention advantages, absorbing international experience, emphasizing multi-disciplinary construction, and using information technology like telemedicine to improve primary healthcare service levels are important for China's pandemic-era primary healthcare development.

Author contributions: HUANG Jiaoling conceptualized and designed the study, revised the manuscript, provided quality control, and is responsible for the overall article; YAN Yuge collected and organized literature, analyzed and interpreted results, and drafted the manuscript.

Conflict of interest: None declared.

References

[1] People's Daily. Xi Jinping: Improve the national public health emergency management system [EB/OL]. (2020-02-29) [2022-08-14]. https://www.chinacourt.org/article/detail/2020/02/id/4824409.shtml.

[2] LIU M L. Analysis on the limitations and countermeasures of grassroots community governance in public crisis events: Taking China's response to the COVID-19 pandemic as an example [J]. Administrative Science Forum, 2020, 7(8): 18-22.

[3] WU Y, GE D S. Public health security risks in mega-cities and grassroots governance responses: Community epidemic prevention experience in Beijing, Shanghai, and Wuhan based on the COVID-19 pandemic [J]. Learning and Practice, 2020, 37(9): 75-84. DOI: 10.19624/j.cnki.cn42-1005/c.2020.09.009.

[4] LU Z X, XU H B, LI L Q, et al. Suggestions on strengthening primary healthcare service construction: Also on advancing the frontline shift in epidemic prevention and control [J]. Administration Reform, 2020, 12(3): 23-29. DOI: 10.14150/j.cnki.1674-7453.2020.03.003.

[5] LIU Z Y, CHEN Y, HOU H Y. Mapping knowledge domains: Methods and applications [M]. Beijing: People's Publishing House, 2008: 3-5.

[6] CHEN Y, CHEN C M, LIU Z Y, et al. The methodological function of CiteSpace mapping knowledge domains [J]. Studies in Science of Science, 2015, 33(2): 242-253. DOI: 10.16192/j.cnki.1003-2053.2015.02.009.

[7] WU X Q, LYU N. Research on hotspot analysis methods based on keyword co-occurrence frequency [J]. Information Studies: Theory & Application, 2012,

35(8): 115-119. DOI: 10.16353/j.cnki.1000-7490.2012.08.026.

[8] LIU J. Whole network analysis: A practical guide to UCINET software [M]. 2nd ed. Shanghai: Truth & Wisdom Press, 2014.

[9] CAI J D, MA J, YUAN Y. Evolution of foreign CSCL theory and frontier hot issues: A visualization analysis based on CiteSpace [J]. Modern Educational Technology, 2012, 22(5): 10-16. DOI: 10.3969/j.issn.1009-8097.2012.05.002.

[10] CHEN C M. Burst detection in CiteSpace [EB/OL]. (2012-05-03) [2022-08-14]. https://blog.sciencenet.cn/blog-496649-566289.html.

[11] QIN X N, LU X L, WU C Y. Knowledge mapping of domestic ecological security research: A bibliometric analysis based on CiteSpace [J]. Acta Ecologica Sinica, 2014, 34(13): 3693-3703. DOI: 10.5846/stxb201211081566.

[12] WHO. Timeline: WHO's COVID-19 response [EB/OL]. (2022-03-28) [2022-08-14]. https://www.paho.org/en/news/2-7-2020-timeline-whos-response-covid-19.

[13] People's Daily. Latest instructions from General Secretary on epidemic prevention and control! [EB/OL]. (2020-02-14) [2022-08-14]. http://news.cnr.cn/native/gd/20200212/t20200212_{524971120}.shtml.

[14] TANG Y. Challenges and responses of community governance in COVID-19 epidemic prevention and control: Based on urban-rural planning and public health perspectives [J]. Nanjing Journal of Social Sciences, 2020, 31(3): 8-14, 27. DOI: 10.15937/j.cnki.issn1001-8263.2020.03.002.

[15] CHEN Y C, CHANG J J, ZHANG Q H, et al. Analysis of joint prevention and control mechanisms in Hubei primary healthcare institutions during COVID-19 [J]. Medicine and Society, 2020, 33(9): 10-14. DOI: 10.13723/j.yxysh.2020.09.003.

[16] MOU L, JIN X Z. Review of telemedicine development status [J]. Soft Science of Health, 2012, 26(6): 506-509.

[17] MANN D M, CHEN J, CHUNARA R, et al. COVID-19 transforms health care through telemedicine: Evidence from the field [J]. J Am Med Inform Assoc, 2020, 27(7): 1132-1135. DOI: 10.1093/jamia/ocaa072.

[18] OHANNESSIAN R, DUONG T A, ODONE A. Global telemedicine implementation and integration within health systems to fight the COVID-19 pandemic: A call to action [J]. JMIR Public Health Surveill, 2020, 6(2): e18810. DOI: 10.2196/18810.

[19] LEITE H, HODGKINSON I R, GRUBER T. New development: "Healing at a distance"—telemedicine and COVID-19 [J]. Public Money Manag, 2020, 40(6): 483-485. DOI: 10.1080/09540962.2020.1748855.

[20] CALTON B, ABEDINI N, FRATKIN M. Telemedicine in the time of coronavirus [J]. J Pain Symptom Manage, 2020, 60(1): e12-14. DOI:

10.1016/j.jpainsymman.2020.03.019.

[21] DESAI A, GAINOR J F, HEGDE A, et al. COVID-19 vaccine guidance for patients with cancer participating in oncology clinical trials [J]. Nat Rev Clin Oncol, 2021, 18(5): 313-319. DOI: 10.1038/s41571-021-00487-z.

[22] FREER P E. The impact of the COVID-19 pandemic on breast imaging [J]. Radiol Clin North Am, 2021, 59(1): 1-11. DOI: 10.1016/j.rcl.2020.09.008.

[23] LONG B, BRADY W J, KOYFMAN A, et al. Cardiovascular complications in COVID-19 [J]. Am J Emerg Med, 2020, 38(7): 1504-1507. DOI: 10.1016/j.ajem.2020.04.048.

[24] HWANG J K, ZHANG T, WANG A Z, et al. COVID-19 vaccines for patients with cancer: Benefits likely outweigh risks [J]. J Hematol Oncol, 2021, 14(1): 38. DOI: 10.1186/s13045-021-01046-w.

[25] JAKOVLJEVIC M, BJEDOV S, JAKSIC N, et al. COVID-19 pandemia and public and global mental health from the perspective of global health security [J]. Psychiatr Danub, 2020, 32(1): 6-14. DOI: 10.24869/psyd.2020.6.

[26] SU B Y, YE Y X, ZHANG W, et al. Psychological stress response characteristics of the public at different time points of the COVID-19 pandemic [J]. Journal of South China Normal University (Social Science Edition), 2020, 65(3): 79-94.

[27] SMALLWOOD N, HARREX W, REES M, et al. COVID-19 infection and the broader impacts of the pandemic on healthcare workers [J]. Respirology, 2022, 27(6): 411-426. DOI: 10.1111/resp.14208.

[28] LU L. Caring for the mental health of frontline healthcare workers is urgently needed [J]. Chinese Mental Health Journal, 2020, 34(3): 240-242. DOI: 10.3969/j.issn.1000-6729.2020.3.018.

[29] ZHANG Y P, CHU L F, ZHUANG K C, et al. Study on stress, anxiety, depression and influencing factors among healthcare workers during COVID-19 [J]. Modern Preventive Medicine, 2021, 48(1): 38-43.

[30] BENFANTE A, DI TELLA M, ROMEO A, et al. Traumatic stress in healthcare workers during COVID-19 pandemic: A review of the immediate impact [J]. Front Psychol, 2020, 11: 569935. DOI: 10.3389/fpsyg.2020.569935.

Note: The original manuscript was received on October 12, 2022 and accepted after revision on March 21, 2023. The digital publication date was March 30, 2023.

Note: Figure translations are in progress. See original paper for figures.