Visualization Analysis of Research Hotspots in Primary Health Care in the Context of COVID-19: Postprint

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

Abstract

Background During the prevention and control of novel coronavirus infection (abbreviated as COVID-19), 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 primary healthcare-related research domestically and internationally against the backdrop of COVID-19, thereby providing references for further research in this field.

Methods On July 5, 2022, we retrieved literature on primary healthcare-related research included in the China National Knowledge Infrastructure (CNKI) and the Web of Science (WOS) Core Collection databases after the onset of COVID-19. The search timeframe was limited to January 1, 2020, to June 30, 2022, yielding 282 CNKI articles and 1,755 WOS articles. CiteSpace software was employed 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, after which the growth rate gradually declined and stabilized. International research started slightly later but has maintained a relatively high growth rate to date. Author collaboration was dominated by small teams and individuals, with no large-scale cross-team cooperation. Domestic research hotspots focused on exploring and managing systems and mechanisms related to pandemic prevention and control, while international research emphasized changes in healthcare-seeking patterns and the fulfillment of patients' medical needs under the pandemic's impact. Both domestic and international research prioritized psychological issues arising from

the pandemic's impact.

Conclusion Primary healthcare-related research in the context of COVID-19 shares common ground yet maintains distinct focuses between domestic and international studies. As domestic research continues to refine and diversify, it can draw upon international experiences, emphasize the development of relevant research capacity, improve the knowledge system in this field, and actively utilize information technology to enhance the primary healthcare service system under pandemic conditions.

Full Text

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

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Abstract

Background: Primary healthcare serves as the first line of defense in COVID-19 pandemic containment. While academic circles worldwide have extensively studied primary healthcare during the pandemic, research priorities vary due to differences in healthcare systems across countries. **Objective:** To examine the advances, 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 systematically 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 employed for visualization analysis, including author co-occurrence analysis, keyword co-occurrence, clustering, timeline analysis, and burst detection. **Results:** Domestic publications grew rapidly in the early pandemic period but gradually slowed and leveled off. International research started slightly later but maintained high growth rates. Author collaboration predominantly occurred in small teams or individually, without large-scale cross-team cooperation. Domestic research 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:** Domestic and international primary healthcare research during COVID-19 shares common ground while maintaining distinct focuses. To continuously refine and

diversify domestic research, it is recommended to absorb international experience, strengthen research capacity building, improve the knowledge system in this field, and actively utilize information technology to enhance the primary healthcare service system under pandemic conditions.

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, primary healthcare has played a crucial role as the "first line of defense" in prevention and control efforts [1]. In China, grassroots communities serve as the smallest units of social governance and the "last mile" of urban pandemic control, bearing responsibilities for public education, epidemic surveillance, and social service provision [2-3]. Under foreign healthcare systems, general practitioners acting as patients' first point of contact have also served as pandemic "gatekeepers" for early warning [4]. Academic circles worldwide have conducted extensive research on primary healthcare content, achievements, and reforms during the pandemic, though differences in domestic and international primary healthcare systems likely lead to varying research emphases. This study employs bibliometric methods to systematically review domestic and international literature on primary healthcare during COVID-19, examining research progress, hotspots, trends, and particularly differences to identify research "blind spots" and "weaknesses," thereby providing references for future studies.

Methods

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 health," "grassroots medical care," or "community health," with synonym expansion enabled. WOS searches used terms "COVID-19" and "primary healthcare." The search timeframe was limited to January 1, 2020 to June 30, 2022. Inclusion criteria comprised papers related to primary medical care 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 eliminate 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 screening process is shown in [Figure 1: see original paper].

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 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 displays the development process and structural relationships of scientific knowledge [5]. CiteSpace, developed in Java, primarily employs co-citation analysis theory and pathfinder network algorithms to quantify literature in specific fields, identify key evolutionary paths and knowledge inflection points, and generate visual maps to analyze potential dynamic mechanisms and detect research frontiers [6].

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 valid processed literature was exported to Excel for preliminary analysis of publication growth patterns. Visualization parameters were set as follows: link strength using cosine, selection criteria set to g-index k=25 (author analysis) and top N levels per slice=50 (keyword analysis), pruning method using pathfinder algorithm, time span set to 2020-2022 with one-year per slice. The visualization analysis workflow is shown in [Figure 2: see original paper].

Co-occurrence Analysis Co-occurrence analysis identifies relationships among topics in a literature set by analyzing word pairs or co-occurring noun phrases. For author co-occurrence analysis, all authors were included regardless of authorship order. For keyword co-occurrence analysis, keywords were extracted from titles, abstracts, author keywords, and index keywords. Synonymous keywords were manually identified and merged through alias files. CiteSpace extracted processed keywords to calculate co-occurrence frequencies between keyword pairs, forming a co-word network where node proximity reflects thematic similarity [7]. Centrality, proposed by sociologist Linton Freeman, measures the degree to which a point occupies a core position in a network [8]. In co-citation networks, nodes with high centrality represent key literature serving as knowledge "inflection points" [9]. In our visualizations, larger nodes and labels indicate higher keyword frequency, while link colors reflect research timing (lighter colors indicate proximity to the 2022 search

date). Keywords with centrality >0.1 were considered important and marked with purple outlines.

Clustering Analysis Cluster views reveal structural characteristics among clusters and highlight key nodes and connections. CiteSpace provides modularity (Q value) and silhouette (S value) metrics to evaluate mapping effectiveness. Q values range [0,1), with Q>0.3 indicating significant community structure and S>0.7 indicating credible clustering [1]. This study employed the log-likelihood ratio test algorithm for clustering analysis.

Timeline Analysis CiteSpace's timeline view delineates relationships among clusters and the historical span of literature within each cluster [1]. This view allows examination of keyword temporal changes by cluster to analyze research content evolution.

Burst Detection Burst indicates a variable's substantial short-term change. CiteSpace treats burst information as a means to measure deeper changes [10]. Compared with high-frequency term analysis, burst term detection better identifies emerging trends and sudden shifts in disciplinary development [11].

Results

Literature Temporal Distribution

Using publication quarters as the x-axis and article count as the y-axis, we plotted publication trend charts. Domestic research output grew rapidly in early 2020, then gradually slowed and stabilized. International research started slightly later but maintained high growth rates through the study period ([Figure 3: see original paper]).

Author Analysis

Running CiteSpace with "author" as the node type and setting appropriate thresholds generated author co-occurrence knowledge maps (FIGURES 4-5). The domestic author map contained 107 nodes, 86 links, and network density of 0.0152 ([Figure 4: see original paper]), while the international map had 161 nodes, 268 links, and density of 0.0208 ([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 dominated by small teams or individuals and no large-scale cross-team cooperation. Domestic research formed author groups centered around Du Zhaohui, Chi Chunhua, and Fang Pengqian, while the prominent international team centered on Sarah Tonkincrine. Given the 2020-2022 timeframe, overall

publication counts remained relatively low, with top domestic authors Du Zhaohui, Chi Chunhua, and Fang Pengqian (4 articles each) and top international author Sarah Tonkincrine (5 articles).

Keyword Analysis

Keyword Co-occurrence Analysis Using "keyword" as the node type generated keyword co-occurrence maps (FIGURES 6-7). The domestic keyword map contained 413 nodes, 761 links, and density of 0.0089 ([Figure 6: see original paper]), while the international map had 124 nodes, 245 links, and density of 0.0321 ([Figure 7: see original paper]). In Chinese literature, "epidemic prevention and control," "medical staff," "COVID-19," 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 work," and "fever clinics," serving as key network nodes around which most domestic research revolved. In international literature, high-frequency, high-centrality keywords included "impact," "COVID-19," "care," "health," "risk," "mental health," and "depression," representing research hotspots. The top 20 keywords by frequency and their centrality information are shown in .

Keyword Clustering Analysis CiteSpace keyword clustering produced 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, well-defined clusters (FIGURES 8-9). The top 10 keyword clusters by size were: domestic—"nucleic acid testing" (n=26), "epidemic prevention and control" (n=25), "COVID-19 epidemic" (n=23); international—"telemedicine" (n=20), "care" (n=20), "infection" (n=16) (TABLES 2-3). All clusters had S values >0.7000, demonstrating good clustering quality.

Timeline Analysis Using "timeline view" layout, CiteSpace displayed temporal distributions of keyword clusters, showing the top 10 clusters (FIGURES 10-11). In domestic research, seven clusters—"nucleic acid testing," "epidemic prevention and control," "COVID-19 epidemic," "medical staff," "fever clinics," "influencing factors," "joint prevention and control," and "family doctor contract services"—demonstrated continuity through the study period. Overall, research hotspots concentrated in 2020, with later keywords being more dispersed and less frequent. Immediately after the outbreak, keywords like "COVID-19 epidemic," "epidemic prevention and control," "medical staff," "primary-level hospitals," and "general practitioners" gained rapid attention, focusing on outbreak control and medical staff psychological issues. As prevention normalized, new keywords emerged: for nucleic acid testing—"key populations," "qualitative research," "protective equipment"; for epidemic prevention—"R&D centers," "population management," "knowledge lectures"; for the pandemic—"sleep disorders," "anxiety," "humanistic care"; for medical staff—"work pressure," "physical and mental health," "burnout"; for family doctor services—"normalization."

Research explored optimal prevention measures from multiple angles while addressing psychological issues among the general population and healthcare workers. Current hotspots include "CDC," "material organization" for testing; "functional positioning," "community health" for prevention; "community return" for COVID-19; "disinfection skills" for medical staff; "diagnosis and treatment" for fever clinics; "prevention pathways" for influencing factors; and "optimization" and "mechanisms" for joint prevention and control—emphasizing summary and optimization of past experiences ([Figure 10: see original paper]).

International research also concentrated on early keywords, but recently developed more focused hotspots. "Telemedicine," "care," "topic areas," and "depression" showed good temporal continuity. Early in the pandemic, international research similarly focused on outbreak occurrence and control, evident in "intervention" and "COVID-19" in care, and "outbreak" and "transmission" in infection. However, greater emphasis was placed on assessing COVID-19's multifaceted impacts: stress among "nurse groups," "mortality," depression "prevalence," "mental health," and COVID-related "acute myocardial infection." In 2021, "quality of life" during the pandemic gained attention, with research addressing equity issues like "disparity" and "access" in care, "psychological impact" and "resilience." Children, less studied domestically, became an international focus. As the pandemic persisted, "health economics" emerged as a recent hotspot, evolving from "burnout" to stress/burnout "models," with "women"-related employment equity gaining attention. The "reliability" and "validity" of past research are being evaluated. "Telemedicine," as the largest cluster, remained central throughout, with a clear timeline showing evolution from "management" and "outcome" evaluation to "experience" exploration and ultimately "performance" summarization ([Figure 11: see original paper]).

Keyword Burst Detection Domestic keywords showed relatively low burst intensity. "Medical community," "major epidemic," and "health education" were 2020 hotspots and research frontiers. Since 2021, "normalization" and "training" have gained prominence. Internationally, "wuhan" showed the highest burst intensity (4.02) in 2020, with COVID-19 "therapy" (3.01) also being a hotspot. "Perception," "telehealth," and "cancer" have been research hotspots and frontiers from 2021 to present ([Figure 12: see original paper]).

Discussion

As the pandemic's impact expanded, primary healthcare gained unprecedented societal attention. Domestic publications peaked in Q2 2020, then declined as prevention normalized and public attention decreased. Conversely, international publications surged after WHO declared COVID-19 a global pandemic on March 11, 2020 [12], maintaining high growth rates thereafter. Domestic and international author collaboration networks showed similar characteristics: most researchers had low publication counts and loose collaboration networks. While

high-output authors demonstrated close intrateam cooperation and rich research 成果, intergroup exchanges remained limited—suggesting a need for strengthened academic exchange and cross-regional, interdisciplinary, cross-domain research to build tighter collaboration networks.

Epidemic prevention and control dominated domestic primary healthcare research, with "epidemic prevention and control" ranking first in both frequency and clustering. Related keywords like "prevention work" and "prevention principles" also reflected this focus. "Nucleic acid testing," a crucial identification policy tool, emerged as another clustering hotspot. Optimizing testing procedures, timeliness, accuracy, and new technology development are significant for improving prevention efficiency and warrant deeper investigation. "Primary-level hospitals," "general practitioners," and "joint prevention and control" were frequently mentioned. Community governance served as a vital prevention anchor in China, with President Xi Jinping emphasizing communities' blocking role and calling for cadres to support community work in building a people's defense line [13]. Community importance manifested in multiple prevention responsibilities: establishing epidemic control teams, investigating residents' basic living and travel conditions, managing access control, and supervising environmental sanitation [14]. Additionally, deep synergy existed between primary healthcare institutions and communities: (1) community doctors and cadres collaborated horizontally to form infectious disease screening teams for "grid-based" resident management; (2) vertical linkage with designated higher-level hospitals enabled pre-screening, referral, and daily medical services; (3) with CDC support, primary doctors conducted community sampling, testing, and other prevention work [15].

International research also addressed COVID-19 infection and prevalence but focused more on healthcare-seeking pattern changes and patient need fulfillment, with extensive studies on telemedicine and care. Telemedicine represents the top international research frontier. Developed countries' earlier telemedicine development and broad coverage, combined with social distancing requirements, 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 spread, using apps to identify/track infected subpopulations, providing self-assessment capabilities to alleviate healthcare system pressure, and offering mental health support to mitigate isolation's psychological impact. However, these achievements rely 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 promote regulatory changes and application framework development [18-20]. "Care" also encompassed clinical experience, statistics, racial disparities, healthcare expenditure, and system reform. Additionally, international research hotspots included emergency and critical care during the pandemic—both COVID-19-related conditions like acute myocardial infection and other diseases like cancer—providing scientific evidence for clinicians managing COVID-19 patients, addressing vac-

cine concerns among those with underlying conditions, and calling for attention to non-COVID critical patients under isolation policies [21-24].

Both domestic and international research extensively addressed psychological issues among residents and healthcare workers. Studies show COVID-19 induced a global mental health crisis, triggering individual and collective psychological problems including panic, anxiety, depression, PTSD, infodemia, and racism [25-26]. Further research targeted specific populations—adolescents, medical students, patients with specific diseases, healthcare workers—to identify unique psychological characteristics and develop effective interventions. Research on primary healthcare workers' psychological issues was particularly prominent. Protecting healthcare workers' mental health is crucial for maintaining a safe workforce and effective health system operation [27]. Facing the same mental health crisis as the public while additionally bearing overloaded prevention work, higher infection risks, and societal scrutiny, healthcare workers showed higher prevalence of mental health symptoms, requiring early identification and intervention to prevent severe consequences [28-30].

Domestic research topics were relatively consistent but demonstrated strong continuity and deepening processes. As prevention normalized and complexities increased, domestic research directions diversified, reflecting exploration of efficient prevention pathways. However, later themes showed lower intensity without high-centrality key nodes, indicating no breakthrough research and correlating with slowed publication growth. International research featured broader, more balanced hotspots with recent high-frequency keywords like telemedicine "experience," care "access," and health economics "models." This aligns with higher international publication volumes and reflects the advantage of gradually expanding and improving knowledge systems. While leveraging community prevention strengths, absorbing international experience, emphasizing multidisciplinary construction, and utilizing information technology like telemedicine to improve primary healthcare service levels holds significant importance for China's primary healthcare development during the pandemic.

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Author Contributions: HUANG Jiaoling conceptualized and designed the study, revised the manuscript, provided quality control and final approval, and takes overall responsibility. YAN Yuge collected and organized literature, analyzed and interpreted results, and drafted the manuscript.

Conflict of Interest: The authors declare no conflict of interest.

Received: October 12, 2022; **Revised:** March 21, 2023; **Accepted:** [Not specified]

Digital Publication Date: March 30, 2023

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