

Global Research on Public Health Emergency Preparedness From 1997 to 2019: A Bibliometric Analysis

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ABSTRACT

Objectives: To access the trends and focuses of publications on public health emergency preparedness in the timeframe 1997-2019.

Methods: Publications related to public health emergency preparedness (PHEP) were retrieved from the Web of Science Core Collection database. Bibliometric analyses including output statistics, co-authorship analysis, citation analysis, co-citation analysis, and co-occurrence analysis were performed and mapped using VOSviewer.

Results: A total of 1058 publications on PHEP were included in this study. There was an increasing trend of publication output and citations since 2002. A total of 4605 authors from 1587 institutes and 92 countries contributed to the publications, and the United States lead the field. *Disaster Medicine and Public Health Preparedness* was the most active and co-cited journal among 243 journals. The knowledge foundation mainly focused on the professionals' capacity, education, and conceptions of PHEP. Epidemics, natural disasters, terrorism, education, and communication were the principle topics; while "vulnerable populations," "disaster medicine," and "hurricane" were the recent hotspots in this field.

Conclusions: Significant progresses had been achieved worldwide in the past 2 decades, however, improvement of research activity and international collaboration is still a need for most countries.

Key Words: bibliometric, emergency preparedness, public health, scientometric

Public health emergencies (PHEs) including pandemic diseases, natural disasters, and human-made catastrophes have caused considerable mortality and economic and social destructions.^{1,2} The term "public health emergency preparedness" (PHEP) had been used earlier, but the clear definition of it was first developed in 2007, which referred to the capability of the public health systems to prevent, protect against, quickly respond to, and recover from PHEs.³ The advance PHEP plays important roles in mitigating the adverse impacts of catastrophes,⁴ and strengthening PHEP is a primary task of PHEs management and also an essential element for effective response and recovery.^{5,6} Components of PHEP systems range from governmental agencies, the health-care delivery system, homeland security, communities, employers and business, academia, the media, to individuals.⁷

Since the 9/11 and anthrax attacks in 2001, the United States (US) had accelerated efforts for preparedness for bioterrorism^{8,9}; spurred by consequent severe acute respiratory syndrome (SARS) and Hurricane Katrina, the focus of PHEP was expanded to all hazards.¹⁰ The outbreak of pandemic influenza A (H1N1) triggered the world's attention to influenza,¹¹

the "Whole-of-Society" approach was proposed by the World Health Organization (WHO) in 2009, and 38 documents were released by other international organizations to propel influenza preparedness for member countries.⁴ In 2013, the European Union (EU) adopted Decision 1082 to strengthen PHE planning and response to protect populations from a wide range of threats.¹² Over the past decades, frequent PHEs had stressed the increasing importance on PHEP, along with policies and funding aimed at improving PHEH, significant progresses in both practice and academia have been achieved in many countries.¹³⁻¹⁷

Bibliometrics analysis is used to quantitatively and qualitatively assess the historical evolutions and trends of publications in a certain field,¹⁸ which can also be used to evaluate scientific performance of individual authors or institutions¹⁹ and discover the main topics and frontiers.²⁰ Global scholars have published a substantial number of papers on PHEP,²¹⁻²³ and previous reviews had characterized the knowledge growth and gaps in this field.^{7,21,24-27} However, to the best of our knowledge, no bibliometric analysis of PHEP is available to date. Therefore, in this study, a bibliometric analysis on PHEP was performed to access the output trend, the contributions of certain countries,

institutions, authors, journals, and identify research hotspots in this field. Findings of this study could provide an overview of global research patterns on PHEP.

METHODS

Data Source and Search Strategy

Data involving PHEP documents were retrieved from the Web of Science Core Collection (WoSCC) of Thomson Reuters on March 10, 2020. Because the first document was published in 1997, the timespan was set from 1997 to 2019. The search strategy was as follows: TS = (public NEAR health AND emergenc * AND preparedness) AND Languages: (English) AND document type: (Article OR Review).

For document screening, 2 authors independently reviewed the title and abstract of each searched document to include the documents as following: (1) preparedness for all kinds of emergencies, based on the definition provided by the WHO²⁸ and Emergency Events Database (EM-DAT) of the International Disasters Database²⁹; (2) original articles or reviews focused on PHEP, either empirical or nonempirical, such as survey, framework, policy analysis, or literature review. The exclusion criteria were the following: (1) documents about personal health protection, but not relevant to public health; (2) documents focused on medical emergencies, such as obstetric emergencies; (3) biological or medical studies not related to preparedness, such as etiology and immunology studies. In case of a lack of consensus, the third author resolved the disagreement. All data were downloaded in plain text format for further analysis.

Data Analysis and Visualization

Five types of analyses were conducted using Microsoft Excel and VOSviewer1.6.8 software to generate following indicators: (1) publication statistics to assess research activity; (2) co-authorship analysis to explore collaboration among countries, institutes and authors; (3) citation analysis to evaluate publication impact; (4) co-citation analysis to identify the knowledge foundation³⁰; (5) co-occurrence analysis of author keywords to explore hotspots. The publication output for each country or institution was based on the affiliation of all authors participating in a certain document, thus, overlaps would exist. Publication's impact was evaluated by the value of citations per document, along with an impact factor of Journal Citation Report 2018 (Clarivate analytics, US).

The networks visualization was mapped by VOSviewer1.6.8.³¹ In the networks, nodes represent countries, institutions, authors, journals, or keywords; links between the nodes represent the relationships of collaboration, co-citation, or co-occurrence. The nodes' size represents the number of documents; the links' thickness along with the distance between any 2 nodes represents the relationship strength; different colors represent different clusters or time periods.

RESULTS

Annual Trend of Publications and Citations

A total of 1168 documents were searched according to the search strategy; after screening, a total of 1058 documents were included. [Figure 1](#) shows a growth trend of annual publications and total citations between 1997 and 2019. The publication output increased since 2002, with the biggest production of 143 (13.52%) documents in 2019, and 55.77% documents were published after 2013. The included documents received 9256 total citations, with an average of 8.75 citations per document and H-index of 37, which means 37 documents had been cited at least 37 times.³²

Country Distribution

Authors from 92 countries contributed to the documents, with an average of 11.5 publications per country. The top 10 active countries were shown in [Table 1](#). Authors from the United States participated in the most publications (775; 73.25%); followed by those from England and Canada. However, Germany had the highest citations per document of 12.23, followed by the United States (9.58) and Israel (8.35).

[Figure 2A](#) shows 30 countries had contributed at least 5 publications. The United States had the most collaborations with other 29 countries, and the strongest collaboration was between the United States and England (link strength = 20). What's more, Saudi Arabia, Italy, Brazil, Ghana, Uganda, and Nepal were the recently active countries.

Institution Distribution

A total of 1587 institutions contributed to the documents, with an average of 1.5 institutions per document. The top 10 active institutions are shown in [Table 2](#), all these institutions are from the United States. The US Centers for Disease Control Prevention (CDC) ranked the first, with 101 (9.55%) publications, followed by the Harvard University and Johns Hopkins Bloomberg School of Public Health. However, University of California Los Angeles and Georgetown University owned the highest value of citations per document of 23.61 and 19.32, respectively. [Figure 2B](#) shows 35 institutions had contributed at least 10 publications, the US CDC collaborated with the most institutions (23).

Authorship Distribution

A total of 4605 authors participating in the documents; every document has 4.35 authors on average. [Table 3](#) shows 11 active authors with at least 8 publications. The most productive author was E. Savoia, with 18 (1.70%) publications, followed by D.J. Barnett and F.M. Burkle.

Top Cited Documents

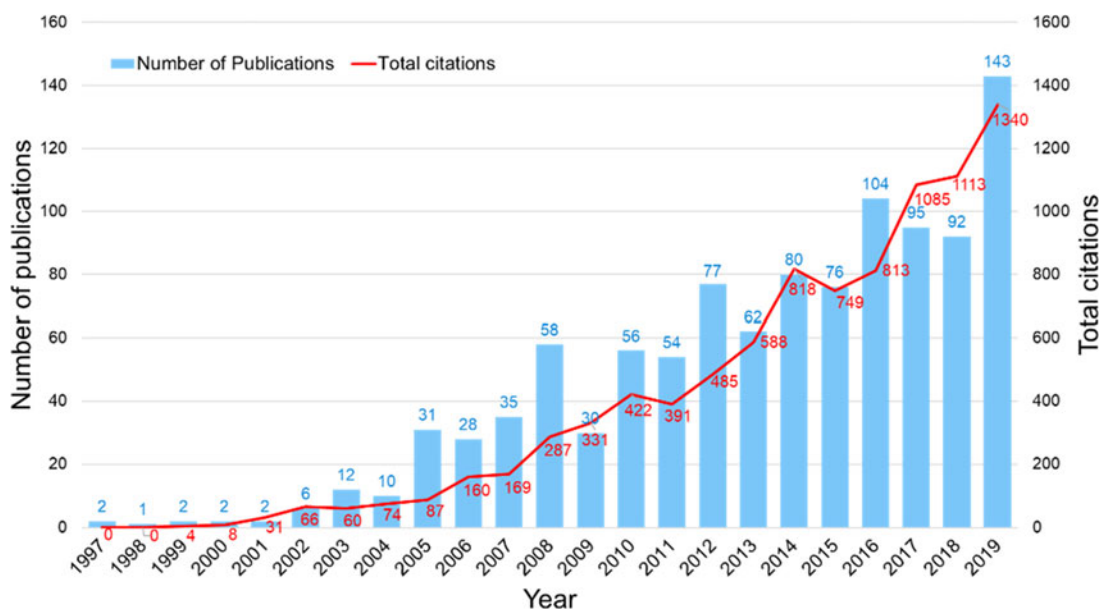
[Table 4](#) shows the top 10 cited documents, in aspects of emergencies, (bio)terrorism, infectious diseases, natural disasters, climate change, and weapons contamination were covered.

TABLE 1

Top 10 Active Countries			
Country	Publications (%)	Citation	Citation per Document
US	775(73.25)	7421	9.58
England	63(5.95)	499	7.92
China	57(5.38)	375	6.58
Canada	52(4.91)	336	6.46
Australia	49(4.63)	250	5.10
Germany	26(2.46)	318	12.23
Sweden	26(2.46)	201	7.73
Israel	23(2.17)	192	8.35
Switzerland	23(2.17)	127	5.52
Italy	18(1.70)	107	5.94

FIGURE 1

Annual Trend of Publications and Total Citations on PHEP (1997–2019).



Note: The blue bar chart represents the number of documents published each year, and the red broken line chart represents the cumulative number of total citations of the included documents from year to year.

In aspects of emergency management, communication, resilience building, and education were contained; in terms of practitioners, professionals, hospital, individual, and community were included.

Top Active Journals

The 1058 documents were published on 243 journals, the top 10 active journals contributed 559 (52.84%) documents (Table 5). *Disaster Medicine and Public Health Preparedness* published the most documents (275; 25.99%), followed by *Public Health Reports* and *Prehospital and Disaster Medicine*. In terms of publication impact, the IF values ranked from 0.734 to 5.381, with the average IF value of 2.08. The journal had the highest

citations per document was *American Journal of Preventive Medicine* (46.11), followed by *Academic Medicine* (36) and *Health Affairs* (24.86), the latter 2 journals were not in the Table 5.

Co-citation Analysis

Disaster Medicine and Public Health Preparedness was the most co-cited journal, with the TLS of 10246 and citations of 672, followed by *Public Health Reports* and *Lancet* (Figure 3A). The top 2 co-cited journals coincided with the top active journals. In aspect of authors, institutions as authors were included, the WHO was the most co-cited, followed by the US CDC and HHS (Figure 3B). Table 6 lists the documents

TABLE 2

Top 10 Active Institutions

Institute	Publications (%)	Citations	Citations per Document
Centers for Disease Control Prevention USA	101(9.55)	1009	9.99
Harvard University	55(5.20)	578	10.51
Johns Hopkins Bloomberg School of Public Health	43(4.06)	385	8.95
Johns Hopkins University	32(3.02)	397	12.41
Rand Corporation	26(2.46)	409	15.73
University of California Los Angeles	23(2.17)	543	23.61
Columbia University	22(2.08)	279	12.68
Emory University	22(2.08)	271	12.32
Georgetown University	22(2.08)	425	19.32
University of Pittsburgh	21(1.98)	209	9.95

TABLE 3

Top 11 Active Authors

Author	Publications (%)	Institution
Savoia, E.	18(1.70)	Harvard University, School of Public Health, Boston, US
Barnett, D.J.	17(1.61)	Johns Hopkins Bloomberg School of Public Health, Baltimore, US
Burkle, F.M.	14(1.32)	Harvard Humanitarian Initiative, Cambridge, US
Stoto, M.A.	14(1.32)	Georgetown University, Department of Health System Administration, Washington, US
Links, J.M.	12(1.13)	Johns Hopkins Bloomberg School of Public Health, Baltimore, US
Rutkow, L.	11(1.04)	Johns Hopkins Bloomberg School of Public Health, Baltimore, US
Biddinger, P.D.	9(0.85)	Massachusetts Gen Hospital, Boston, US
Chandra, A.	9(0.85)	RAND Corp, Arlington, US
Dobalian, A.	9(0.85)	University of Memphis, School of Public Health, Memphis, US
Lurie, N.	9(0.85)	US Department of Health and Human Services (HHS), Washington, US
Thompson, C.B.	9(0.85)	Johns Hopkins Bloomberg School of Public Health, Baltimore, US

DISCUSSION

There has been an obvious increasing trend of publication output and citations since 2002 (Figure 1), reflecting rising research activity in PHEP. The included documents received 9256 citations in total and the H-index of 37, the output and impact of PHEP publications was lower compared with researches on PHEs.^{8,33-36} Although understanding of PHEs serves the purpose of further preparedness, moreover, citations could not completely measure the practical impacts of these PHEP researches, the findings suggested the deficiency of attention on PHEP research to some extent.

Ninety-two countries contributed to the publications. Saudi Arabia, Italy, Brazil, Ghana, Uganda, and Nepal started to increase the publications recently, indicating these countries had started to put more attention on the PHEP researches and knowledge sharing, after experiencing several epidemics in recent years.³⁷ It is notable that 73.25% of the output and all the active institutions and authors came from the United States (Tables 1-4). What's more, the most co-cited institutions were the WHO and the US CDC and HHS. Since the 9/11 and anthrax attacks in 2001, the United States had led the world in the exploration of PHEP policies

and had invested large funds, which could partly explain its leading position in this field.^{9,10,17} Whereas, publication output from other countries was far less than the United States.

Developing countries, where medical care systems are already weak, will be in a potential vicious circle confronting complex emergencies.^{28,38} China, the United States, the Philippines, Indonesia, and India are the 5 countries most hit by natural disasters³⁹; African countries are buffeted by frequent and widespread threats.³⁸⁻⁴¹

Disappointingly, vulnerable countries/regions, including China, Bangladesh, Congo, Guinea, India, Indonesia, Kenya, Kiribati, Liberia, Nepal, Nigeria, Pakistan, the Philippines, Saudi Arabia, South Africa, Uganda, Yemen, together contributed only 120 (11.34%) publications. Figure 2 shows that the international collaboration level was limited, compared with others.^{42,43} In this case, there is a call for improving PHEP researches and international collaboration for most countries, especially developing countries under various threats.^{35,37,44} Countries that lack experts in this field should cultivate more professionals and develop related education as well.⁴⁵ In addition to the lack of attention and

TABLE 4

Top 10 Cited Documents			
Title	Source Title	Year	Citation
Risk Communication for Public Health Emergencies	Annual Review of Public Health	2007	178
Building Human Resilience the Role of Public Health Preparedness and Response as an Adaptation to Climate Change	American Journal of Preventive Medicine	2008	169
The Model State Emergency Health Powers Act - Planning for and Response to Bioterrorism and Naturally Occurring Infectious Diseases	JAMA-Journal of The American Medical Association	2002	117
Public-Health Preparedness for Biological Terrorism in the US	Lancet	2000	102
Weapons of Mass Destruction Events with Contaminated Casualties - Effective Planning for Health Care Facilities	JAMA-Journal of The American Medical Association	2000	99
Preparing Health Professions Students for Terrorism, Disaster, and Public Health Emergencies: Core Competencies	Academic Medicine	2005	96
Hospital Preparedness for Victims of Chemical or Biological Terrorism	American Journal of Public Health	2001	89
Differences in Individual-Level Terrorism Preparedness in Los Angeles County	American Journal of Preventive Medicine	2006	78
Building Community Disaster Resilience: Perspectives from a Large Urban County Department of Public Health	American Journal of Public Health	2013	72
Communication Management and Trust: Their Role in Building Resilience to Surprises Such as Natural Disasters, Pandemic Flu, and Terrorism	Ecology and Society	2008	65

TABLE 5

Top 10 Active Journals					
Journal	Publication Number (%)	IF	Total Citations	Citations per Document	Country
Disaster Medicine and Public Health Preparedness	275(25.99)	1.031	1020	3.71	US
Public Health Reports	64(6.05)	2.039	605	9.45	US
Prehospital and Disaster Medicine	45(4.25)	1.01	247	5.49	US
BMC Public Health	39(3.69)	2.567	534	13.69	England
American Journal of Public Health	30(2.84)	5.381	490	16.33	US
International Journal of Environmental Research and Public Health	23(2.17)	2.468	194	8.43	Switzerland
Journal of Law Medicine & Ethics	22(2.08)	0.734	111	5.05	US
Public Health Nursing	20(1.89)	1.111	286	14.30	US
Public Health	17(1.61)	1.696	133	7.82	England
PLoS One	15(1.42)	2.776	104	6.93	US

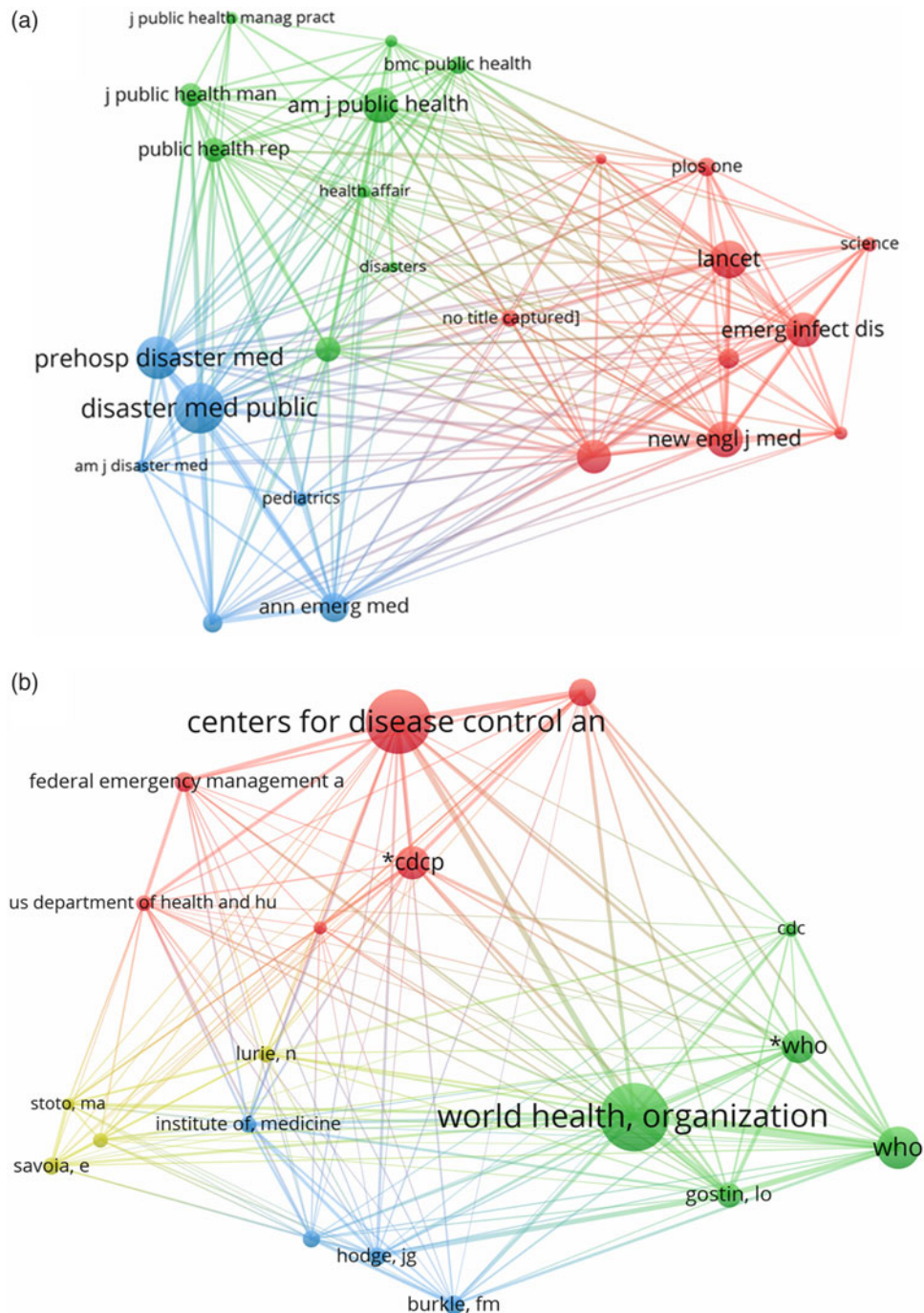
underdevelopment of economy, medical, and professional education, another potential reason for the deficiency of publications might be the language barriers for some non-English speaking countries.

Co-citation is defined as the frequency with which pairs of documents, authors, or journals are cited jointly, which is used to identify the main intellectual foundation and evolution of a discipline.^{30,46} The top 5 co-cited documents were focused on delineating competencies required for health-care workers, and proposing training and education frameworks^{47,52} (Table 6). The sixth and seventh co-cited documents provided the concepts, measurement, and methodology of PHEP^{3,53}; the eighth co-cited document was a survey about health-care

workers' ability and willingness to report to duty during different disasters.⁵⁴ The findings illustrated the professionals' capacity building, education, and conceptions constructed the core knowledge foundation of PHEP in the past decade, which is similar with previous studies.^{7,24}

Co-occurrences of key words are based on the frequencies of any 2 key words occur together, frequently co-occurrence key words give a general idea of research hotspots.⁵⁵ Combined the results of author keywords burst and the top cited documents (Figure 4; Table 4), epidemics, natural disasters and (bio)terrorism, in other words, PHEP for all hazards were discussed. Besides education, communication was the ever-lasting hot topic. The most cited document published

FIGURE 3

Co-citation Networks of Journals (A, $n = 33$) and Authors (B, $n = 19$).

Note: The nodes represent journals, authors or institutions as authors, and the links represent the co-citation relations among them. The size of nodes represents the number of documents published by corresponding journals or authors, the thickness of links and the distance between 2 nodes represents the co-citation strength. (A) The co-citation network of journals. The journals were classified into 3 clusters shown as 3 kinds of colors, according to their co-citation relations. (B) The co-citation network of authors. The authors were classified into 4 clusters shown as 4 kinds of colors, according to their co-citation relations.

been screened manually so as to make sure the documents were appropriate to the theme. However, this study has a few limitations inherent in the bibliometric methodology. First, only 1 database was used, because data from more than 1 database cannot be combined and analyzed, which led to the omission of some documents. Second, due to the wide range of objectives covered by PHEP, it was unrealistic to enter all relevant search terms; the search strategy we used might result in some omissions. What needs to be explained is that, because the term “disaster” tends to refer to natural disaster in a narrow sense, which is included within PHEs, we did not search “disaster” separately, and the bibliometric researches on disaster medicine had been made previously.^{38,39,48} Third, we used the formal term “preparedness” for searching, but it was inevitable that some documents related to the theme used informal topic words, such as “planning,” which might lead to some literature being wrongly excluded. Last, publication language was confined in English, which may miss some valuable documents.

CONCLUSIONS

This study provides a comprehensive overview of global research patterns on PHEP during the last 2 decades. First, significant progress had been made over the years; however, research activity and international collaboration still needs to improve for most countries. Second, professionals’ capacity building, education, and conceptions constructed the primary intellectual foundation of PHEP; epidemics, disasters, terrorism, education, and communication were the focuses; “vulnerable populations,” “disaster medicine,” and “hurricane” were the recent hotspots in this domain. Third, this study might encourage policy-makers to make meaningful changes for PHEP researches. Last, this study could assist researchers to choose an appropriate institution for collaboration or journals for publication.

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Author Contributions

Tong Lin contributed with study design, data analysis, and wrote the article. Yuqin Qiu and Wenya Peng did the data acquisition and screening. Lisheng Peng provided critical revisions. All authors approved the final manuscript.

Conflict of Interest Statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this study.

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