Research Article

Optimizing healthcare worker well-being research: A bibliometric network analysis and temporal trend evaluation (2013-2022)

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Abstract

This study employs advanced bibliometric techniques to analyze and optimize the research landscape of healthcare workers' (HCWs) well-being from 2013 to 2022, with particular emphasis on the COVID-19 pandemic's impact. Utilizing the Scopus database, 2,026 relevant articles were extracted and subjected to rigorous bibliometric analysis. The study leverages VOSviewer software for network visualization and employs descriptive statistics, co-authorship analysis, and keyword co-occurrence analysis to identify key trends, influential contributors, and emerging research fronts. Results reveal a significant surge in publications post-COVID-19, with the United Kingdom, United States, and Australia emerging as primary contributors. The International Journal of Environmental Research and Public Health was identified as the most prolific source. Keyword analysis highlighted "COVID-19 pandemic," "mental health," and "burnout" as dominant themes, while uncovering understudied areas such as health promotion and work engagement. Co-authorship analysis exposed intricate global collaboration networks, with a notable presence of developing Asian countries. This study presents a novel, data-driven approach to mapping the intellectual structure of HCW well-being research, offering a strategic framework for future investigations. By identifying research gaps and trending topics, this analysis provides valuable insights for healthcare managers, policymakers, and researchers, enabling more targeted and efficient resource allocation in addressing HCW well-being. The findings underscore the need for increased focus on proactive well-being strategies and integrated care approaches in future research endeavors.

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1. Introduction

Health is "the absence of sickness or infirmity, as well as one's overall physical, mental, and social well-being" (World Health Organization, 2020). In the same vein, healthcare is a branch of science concerned with preserving or restoring physical and mental health. Any person who works in a medical setting is referred to as a healthcare worker (HCW), which includes but is not limited to nurses, physicians, operating room technicians, nursing assistants, pharmacists, community healthcare workers, etc (Joshi et al., 2006);(B. Zhu et al., 2020a).

Health and well-being are two concepts that go hand in hand. Well-being is another emerging topic of study (Rusdi & Wibowo, 2022). It is possible to describe it as the moment when a person's resource pool and the challenges they face are in a state of balance. (Jambrino-Maldonado et al., 2022). We conceptualize well-being as the overall health of a healthcare worker. Well-being is "quality of life concerning an individual's health and work-related environmental, organizational, and psychosocial factors. Well-being is the experience of positive perceptions and the presence of constructive conditions and work and beyond enables workers to thrive and achieve their full potential" (Chari et al., 2018) p. 590). Daniels et al. (2021) point out the importance of recognizing individual disparities in how much organizational support was perceived by workers during the COVID-19 epidemic.

Covid-19 was first identified in December 2019 in the Chinese province of Hubei (Li et al., 2020)(N. Zhu et al., 2020) , and since then it has rapidly spread both locally and worldwide. Healthcare providers continue to be the principal actors in diagnosing and treating Covid-19. Even though HCWs are accustomed to dealing with crisis-like situations, they are still susceptible to the psychological effects of COVID-19 (Alotaiby & Krenyácz, 2024;Rodríguez & Sánchez, 2020; Vanhaecht et al., 2021). Additionally, the frontline healthcare professionals dealing with these patients directly are more at risk than others. The abrupt transition from an HCW to being a patient may leave the medical personnel in a state of helplessness, stigmatization, and fear of discrimination (Rana et al., 2020). The data published during the SARS outbreak almost a decade ago revealed that HCWs were likelier to experience stress, anxiety, and depression amidst pandemics (Wu et al., 2005a); (Wu et al., 2005b). There is a comparable school of thought on the effects of the COVID-19 pandemic; various investigations have been conducted analyzing the psychological impact of Covid-19 on healthcare workers (having been infected directly or indirectly). However, there is a lack of comprehensive evaluation and critique of present studies. HCWs account for 12% of the workforce globally (Goniewicz et al., 2012) (B. Zhu et al., 2020b). Academics, public health practitioners, society, and healthcare management have expressed concern that HCWs fighting for the health of healthcare clients may suffer risks from strenuous manual labour, chemical hazards, infectious infections, strenuous manual labour, and unreasonable patients (Drebit et al., 2010)(Arnetz et al., 2015).

This study reviewed trends in research related to HCW well-being using bibliometric analysis. Bibliometric analysis is famous for analyzing literature trends and patterns (Sikandar et al., 2022). Bibliometric analysis is "a form of statistical analysis of publications that provides quantitative insight into academic literature" (Leung et al., 2017). Bibliometric analysis offers a powerful tool for mapping the intellectual structure of research domains, providing insights into collaboration patterns, influential publications, and thematic evolution (Aria et al., 2020). By employing advanced bibliometric techniques, including co-authorship analysis, keyword co-occurrence, and bibliographic coupling, researchers can gain a holistic understanding of the HCW well-being research landscape (van Eck & Waltman, 2022).

Previously a few bibliometric studies were conducted to determine trends of publication in Technology and Occupational Health in the healthcare sector, which include (Vaquero-álvarez et al., 2020), COVID-19 and mental health (Rani et al., 2022), healthcare workers' occupational health (B. Zhu et al., 2020b), intensive-care nurses' wellbeing (Jarden et al., 2019). Regardless of the growing researchers' interests, the available scientific records are considerably insufficient. The existing literature lacks studies that comprehensively examine the rapid expansion of research on the well-being of healthcare professionals through bibliometric analysis. The present study addresses a gap in the literature by examining research publications on the topic of HCW well-being in the past decade. To the best of our knowledge, there is no single study that has been conducted on the bibliometric analysis of papers in the field of HCWs wellbeing research, hence our study sheds light on this research area.

The present study aims to conduct a comprehensive bibliometric analysis of HCW well-being research from 2013 to 2022, with a particular focus on the impact of the COVID-19 pandemic. Specifically, this research addresses the following objectives:

1. To overview the publication growth and volume over years
2. To analyze the temporal trends in HCW well-being research output and identify key contributors (authors, institutions, and countries).
3. To map the intellectual structure of the field through keyword co-occurrence analysis, identifying major themes and emerging topics in healthcare worker well-being research.
4. To examine international collaboration patterns through co-authorship analysis of countries, highlighting key collaborative networks in the field and authors, identifying key research clusters and influential collaborations.
5. To conduct a bibliographic coupling analysis to uncover similarities in reference patterns among publications, revealing the conceptual structure and potential research fronts in the field of healthcare worker well-being.

This study is critical to the literature as it examines the most important areas concerning HCW well-being. The remaining part of this paper is structured as follows; the methods and data are presented in Section Two, Part Three evaluates the bibliometric results; section four summarises

the findings, and section five proposes future study directions.

2. Methodology

This study is a cross-sectional descriptive review of literature on the wellbeing of HCWs utilizing bibliometric analysis. Bibliometrics is a method that is frequently used to assess and quantify the characteristics and growth of particular fields. It uses mathematical and statistical techniques to measure the literature's structures, relationships, characteristics, and patterns (Pinto-López et al., 2020) (Sikandar et al., 2022). The bibliometric visualizations offer academics, decision-makers, and those involved in public health an accessible way to communicate the main findings.

For the data collection process, we used the Scopus database. Scopus is often utilized in bibliometric studies and is believed to be appropriate for this purpose due to its high number of indexed journals (Vaicondam et al., 2022)(Sikandar et al., 2021). The document selection process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). Besides, bibliometric analysis was performed to comprehensively and

systematically evaluate the past research on HCWs wellbeing. The investigation was conducted in January 2023 The keywords used in the search query string are "healthcare workers" or "healthcare professionals" and well-being or wellbeing. The Scopus database was searched for data on annual publishing numbers, active countries, journals, institutions, and citation information. Scopus data were transferred to Excel for tabulation or mapping purposes.

The period from 2013 to 2022 was chosen for analysis to examine trends in the available literature on HCWs' wellbeing over the last decade because academicians and professionals seem more interested in healthcare workers' well-being now than ever. The total number of articles received was 2788. We applied several filters to find the desired articles to perform the analysis. After excluding book chapters, review papers, etc., and only selecting articles published on the chosen topic, the remaining number of documents was 2171. In our analysis, we limited the sample journal articles, reducing the number to 2082. Finally, we included only English language articles, resulting in a final dataset for our data analysis consisting of 2026 documents. The article's inclusion and exclusion process are described in Figure 1 below.
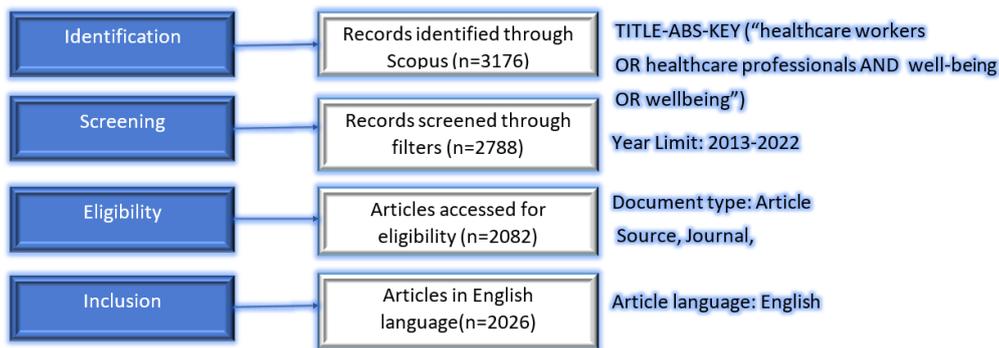

Fig. 1. Search strategy for choosing articles following the PRISMA protocol

These methods are mainly used together with science mapping tools like VOS (Visualization of Science) Viewer (van Eck & Waltman, 2010) for visualization of the structure of a given discipline (Walsh & Renaud, 2017); (Zupic & Čater, 2015)

3. Descriptive Statistics

3.1.1 Volume and annual growth of publications

This study focuses on determining the development of publication output on HCW wellbeing. Figure 2 shows that

the 2026 documents focused on HCW wellbeing showed an annual increase in the number of publications for the given timeframe. The frequency of article production per year increased from 43 publications (2.12% of total publications) in 2013 to 599 published articles (29.5% of total publications) in 2022, while the volume and frequency of publications vary depending on the year. This shows the interest of scholars in the said subject.
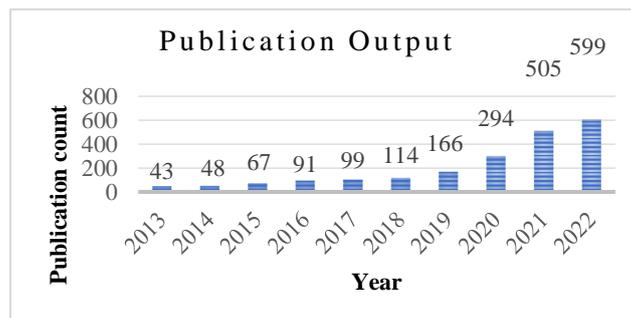

Fig. 2. Development of publication output over the past decade

3.1.2 Geographic distribution of the retrieved documents

To answer the second research question of this study, we examined the countries with the most publications on HCW well-being research. Our analysis of the geographic distribution of published articles over the globe revealed that the United Kingdom, the United States, and Australia are the top 10 counties with the most published documents, with 489, 364, and 197 articles, respectively. The top ten productive countries are shown in Figure 3.
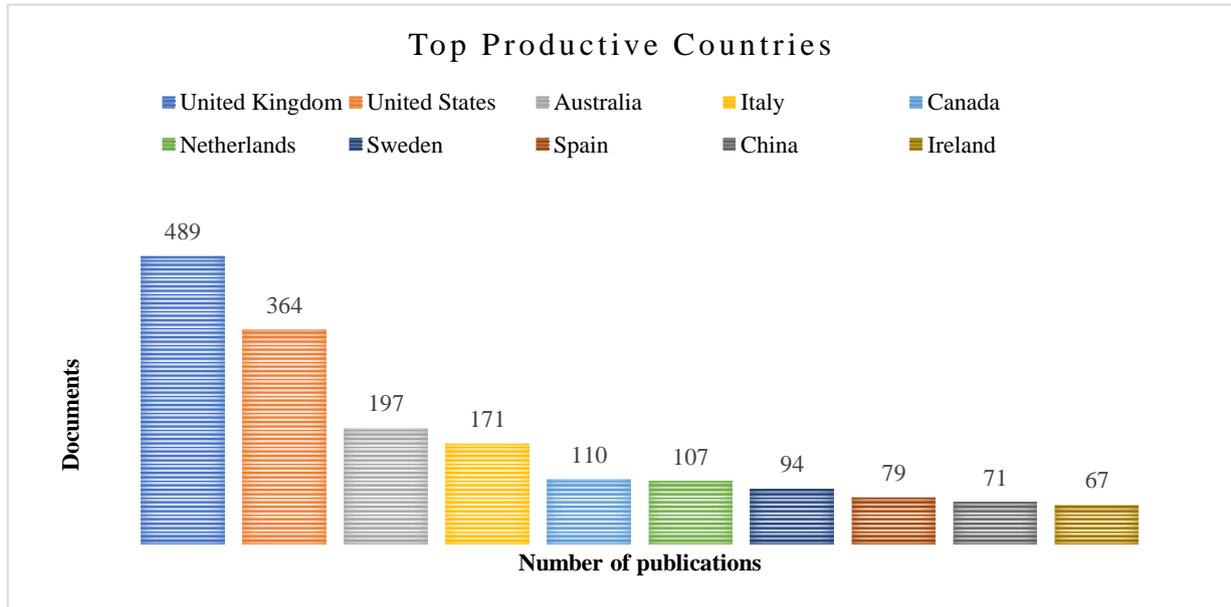

Fig. 3. Top productive countries

3.1.3 Top ten active journals

We analyzed the top-tier journals, total publications, top-cited articles, and other details to understand the most productive journals better. We found that the International Journal of Environmental Research and Public Health (n=118), BMJ Open (n=81), and Plos One (n=52) are the top three journals with the most publications in the selected period. Not only did these journals publish the most articles on HCW wellbeing-related research topics, but they also had the highest citations, as shown in Table 1. Table 1 displays the top 10 journals together with their essential details. TP represents the total publications, TC represents the total sources of each journal, and CS represents the cite score for 2021 in the table below.

Table 1

Top ten active journals in HCWs well-being research

Rank	Journal	TP	CS	SJR 2021	SNIP 2021	TC	Most cited article	Times Cited	Publisher
1	International Journal of Environmental Research and Public Health	118	4.5	0.814	1.44	1015	Mitigating the psychological impact of covid-19 on healthcare workers: A digital learning package	287	Multidisciplinary Digital Publishing Institute (MDPI)
2	BMJ Open	81	3.9	0.982	1.294	929	Perceptions and Experiences of healthcare workers during the COVID-19 Pandemic in the UK	119	BMJ Publishing Group
3	Plos One	52	5.6	0.852	1.368	749	Exposure to COVID-19 patients increases physician trainee stress and burnout	196	Public Library of Science
4	Frontiers In Psychology	48	4	0.873	1.605	418	Mental Health Challenges of United States Healthcare Professionals During COVID-19	54	Frontiers Media S.A.
5	BMC Health Services Research	42	3.9	0.997	1.516	804	Social media use in healthcare: A systematic review of effects on patients and their relationship with	331	Springer Nature

						healthcare professionals		
6	Journal Of Clinical Nursing	36	5.3	0.831	1.532	339	The quality of life of people who have chronic wounds and who self-treat	47	Wiley-Blackwell
7	Frontiers In Public Health	27	4	1.298	1.949	153	Prioritizing the Mental Health and Well-Being of Healthcare Workers: An Urgent Global Public Health Priority	80	Frontiers Media S.A.
8	Frontiers In Psychiatry	22	4.6	1.279	1.522	249	The impact of quarantine and physical distancing following covid-19 on mental health: Study protocol of a multicentric Italian population trial	137	Frontiers Media S.A.
9	Healthcare Switzerland	22	2	0.529	1.055	97	Burnout prevalence and its associated factors among Malaysian healthcare workers during covid-19 pandemic: An embedded mixed-method study	37	Multidisciplinary Digital Publishing Institute (MDPI)
10	Journal Of Advanced Nursing	20	4.3	0.774	1.368	464	Emotional Rescue: The Role of emotional intelligence and emotional labour on well-being and job-stress among community nurses	147	Wiley-Blackwell

3.1.4 Top ten productive institutions

The top ten most productive institutions participating actively in the HCW wellbeing research are depicted in Figure 4. Monash University, University College London, and King's College London are the top three active institutions contributing to the research on the wellbeing of healthcare workers.
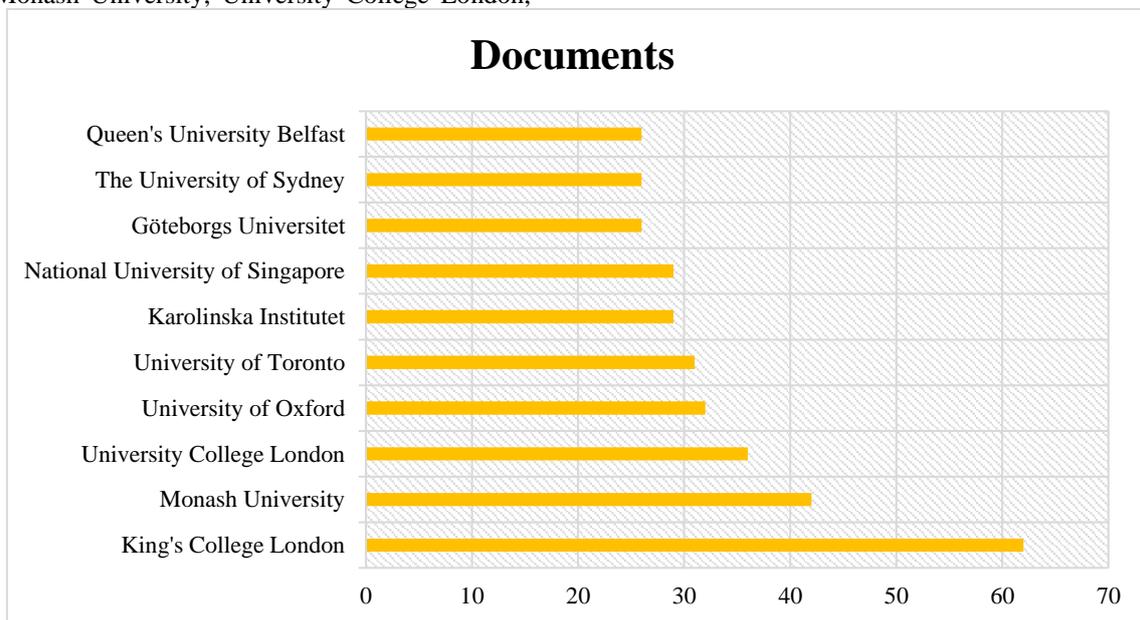

Fig. 4. Top ten productive institutions

3.1.5 Top authors in the field

We also analyzed the top authors in our investigation. Adair, Li, Reid, and Willis. are the principal authors with seven publications each on healthcare workers' wellbeing. It is worth noticing that Chan and Rafferty may have fewer publications but are the most cited authors in healthcare workers' wellbeing, with 8391 and 7952 citations, respectively. The top authors are listed in Table 2, along with information about their total publications (TP), affiliations, h-index, and total citations (TC). The authors are ranked according to their citation count.

Table 2
Top ten influential authors in HCWs wellbeing research

Rank	Author	TP	h-index	Current affiliation	Country	TC
1	Chan, G.C.F.	5	48	The University of Hong Kong Li Ka Shing Faculty of Medicine, Hong Kong	Hong Kong	8391
2	Rafferty, A.M.	5	29	King's College London, London, United Kingdom	UK	7952
3	Magnavita, N.	6	39	Università Cattolica del Sacro Cuore, Campus di Roma, Rome, Italy	Italy	5213
4	Li, W.H.C.	7	27	Chinese University of Hong Kong, Hong Kong, Hong Kong	Hong Kong	2679
5	Willis, K.	7	24	Victoria University Melbourne, Institute for Health and Sport, Melbourne, Australia	Australia	2426
6	Noble, H.	6	18	Queen's University Belfast, Belfast, United Kingdom	UK	1624
7	Adair, K.C.	7	18	Duke Center for Healthcare Safety and Quality, Duke, United States	USA	1168
8	Ho, K.Y.	6	17	Hong Kong Polytechnic University, Kowloon, Hong Kong	Hong Kong	1002
9	Sexton, J.B.	5	17	Duke University School of Medicine, Durham, United States	USA	938
10	Reid, J.	7	15	Queen's University Belfast, Belfast, United Kingdom	UK	757

3.1.6. Top cited articles

This study aims to analyze the top cited articles in the field of HCW wellbeing. With 482 citations and published in General Hospital Psychiatry in 2020, the most-cited article is "Psychological Distress, coping behaviours, and Preferences for Support among New York healthcare workers during the COVID-19 Pandemic". The authors (Shechter et al., 2020) investigated the pandemic's effects on NYC HCWs' distress levels, coping strategies, and support preferences. The authors studied distress,

managing, and support choices among NYC HCWs and found that NYC HCWs suffer from psychological distress during COVID-19. Authorities should integrate HCWs' preferences in mitigating stress among HCWs during the pandemic. Similarly, other highly cited articles relating to HCW well-being before and after the COVID-19 pandemic are mentioned in the table below. The top noted articles published in the Scopus database, along with their publication year, source title, and citation count, are listed in Table 3.

Table 3
Top cited articles in HCWs wellbeing research

Authors	Titles	Year	Source Title	Cited by
(Shechter et al., 2020)	Psychological distress, coping behaviors, and preferences for support among New York healthcare workers during the COVID-19 pandemic	2020	General Hospital Psychiatry	482
(Nicolucci et al., 2013)	Diabetes attitudes Wish and need second study (DAWN2™): Cross-national benchmarking of diabetes-related psychosocial outcomes for people with diabetes	2013	Diabetic Medicine	426
(Khalid et al., 2016)	Healthcare workers' emotions, perceived stressors, and coping strategies during a MERS-CoV outbreak	2016	Clinical Medicine and Research	402

(Elbay et al., 2020)	Depression, anxiety, stress levels of physicians, and associated factors in Covid-19 pandemics	2020	Psychiatry Research	333
(Smailhodzic et al., 2016)	Social media use in healthcare: A systematic review of effects on patients and their relationship with healthcare professionals	2016	BMC Health Services Research	331
(Barello et al., 2020)	Burnout and somatic symptoms among frontline healthcare professionals at the peak of the Italian COVID-19 pandemic.	2020	Psychiatry Research	313
(Brooks et al., 2018)	A Systematic, Thematic Review of Social and Occupational Factors Associated with Psychological Outcomes in Healthcare Employees during an Infectious Disease Outbreak	2018	Journal of Occupational and Environmental Medicine	306
(Eccles et al., 2013)	Critical research gaps and translational priorities for the successful prevention and treatment of breast cancer	2013	Breast Cancer Research International	288
(Blake et al., 2020)	Mitigating the psychological impact of covid-19 on healthcare workers: A digital learning package	2020	Journal of Environmental Research and Public Health	287
(De Kock et al., 2021)	A rapid review of the impact of COVID-19 on the mental health of healthcare workers: implications for supporting psychological well-being	2021	BMC Public Health	269
(Shreffler et al., 2020)	The impact of COVID-19 on healthcare worker wellness: A scoping review	2020	Western Journal of Emergency Medicine	215
(Cascio, 2018)	Wildland fire smoke and human health	2018	Science of the Total Environment	212
(Kannampallil et al., 2020)	Exposure to COVID-19 patients increases physician trainee stress and burnout	2020	PLoS ONE	196
(Lamiani et al., 2017)	When healthcare professionals cannot do the right thing: A systematic review of moral distress and Its Correlates	2017	Journal of Health Psychology	193
(Naser et al., 2020)	Mental health status of the general population, healthcare professionals, and university students during the 2019 coronavirus disease outbreak in Jordan: A cross-sectional study	2020	Brain and Behavior	181

3.2 Bibliopmetric Analysis
3.2.1 Co-occurrence of keywords

We used an entire counting method to conduct the keyword co-occurrence analysis with the minimum number of occurrences set to 10. The analysis yielded 4507 keywords, of which 103 items meet the threshold. Afterward, we grouped similar keywords into one to avoid repeating keywords such as COVID-19, COVID-19, pandemic, COVID19 pandemic, etc. and were named COVID-19 pandemic. Similarly, healthcare workers, professionals, and personnel are all similar words, so we grouped all these keywords under healthcare workers. The number of keywords we got after the grouping of similar keywords

was 83 out of 4486 keywords forming 6 clusters, with the threshold of minimum occurrences set to 10.

The results of the concurrence of keywords analysis showed that the top 10 keywords in HCW- wellbeing research are COVID-19 pandemic (occurrences=497, TLS=1016), healthcare workers (occurrences=372, TLS=809), mental health (occurrences=201, TLS=483), qualitative research (occurrences=172,TLS=262), well-being (occurrences=171, TLS=371), burnout (occurrences=148, TLS=364), anxiety (occurrences=121, TLS=386), depression (occurrences=109, TLS=363), stress (occurrences=100, TLS=308) and nurses (occurrences=99, TLS=195). Table 4 shows the hotspot keywords with the highest occurrence, along with their total link, total link strength, and average publication year.

Table 4
Top hot topics in HCWs wellbeing research

Keyword	cluster	Links	Total link strength	Occurrences	Avg. pub. year
COVID-19 Pandemic	3	70	1016	497	2021.3
Mental Health	5	54	483	201	2020.9
Anxiety	5	38	386	121	2020.8
Resilience	2	40	173	64	2020.8
Public Health	1	21	58	34	2020.7
Depression	5	40	363	109	2020.7
Stress	2	49	308	100	2020.5
Health Care Workers	2	71	809	372	2020.5
Psychological Distress	4	32	164	70	2020.5
Burnout	2	50	364	148	2020.2
Well-Being	2	62	371	171	2020.1
Qualitative Research	1	57	262	172	2020.1
Psychological Well-Being	3	35	92	43	2020.0
Patient Experience	1	33	76	38	2019.6
Nurses	1	59	195	99	2019.5
Quality Of Life	1	47	125	86	2019.5
Palliative Care	1	26	80	44	2019.4
Healthcare	6	43	112	62	2019.4
Physical Activity	1	29	64	33	2019.3
Cancer	1	29	66	40	2018.5

Figure 5 depicts six clusters in colours red, green, dark blue, yellow, purple, and light blue. The first red cluster has 37 items, with "qualitative research" being the most often used term (12 occurrences). The second cluster (green) has 16 entries, the most common of which is "health care workers" (372 events). The third group, coloured dark blue, contains 14 items with "covid-19 pandemic" (497 occurrences) as the most frequent keyword. The fourth cluster is yellow in colour and has eight items, with the most frequent word as "psychological anguish" (70 occurrences). The fifth purple, cluster contains five items with the most often used term, "mental health" (201 events). The sixth cluster, shown in light blue, has three items with the most often used keyword "healthcare" (62 occurrences).

Figure 5 illustrates the network visualization map. Different coloured nodes in the keyword co-occurrence analysis represent the various clusters to which the keyword belongs. The density increases as the number of nodes and weight increase. Each cluster's keywords represent several current topics and those that may be developed in the future.
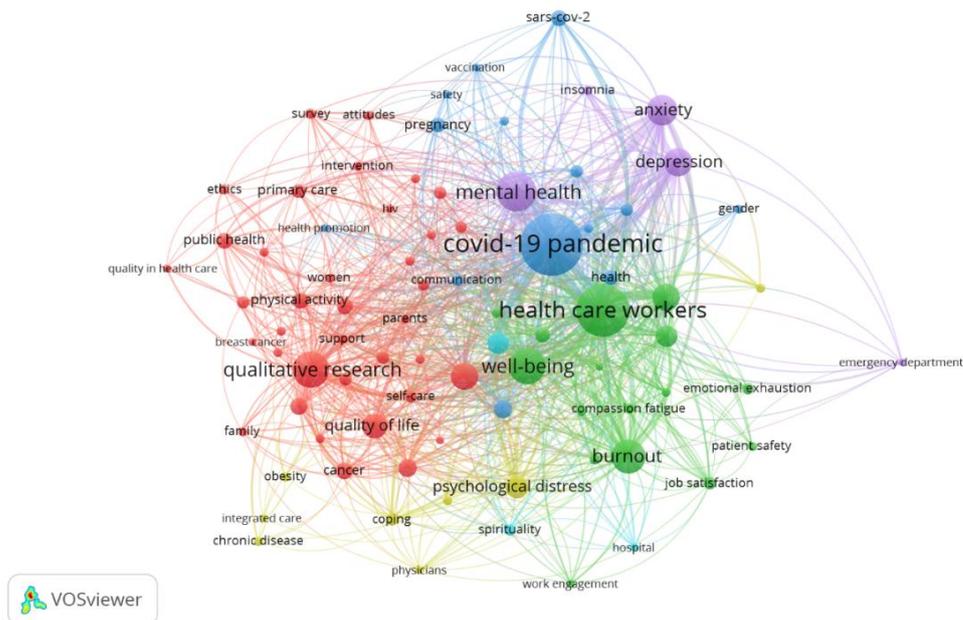

Fig. 5. Snapshot of the bibliometric map representing author keywords co-occurrences (n=10) in network visualization mode. Available online at https://app.vosviewer.com/

Some of the least explored keywords in the selected field are health promotion, integrated care, phenomenology, physicians, quality in health care, safety, self-compassion, vaccination, work engagement, healthcare providers, insomnia, and psychological impact (table 5). This proposes that these areas receive the minimum attention, providing future research opportunities.

Table 5
Top least explored topics in HCWs wellbeing research

Keyword	cluster	Links	Total link strength	Occurrences	Avg. pub. year
Quality In Health Care	1	7	18	10	2021.2
Insomnia	5	13	43	11	2021.1
Psychological Impact	4	9	31	11	2021.0
Safety	3	13	18	10	2020.9
Healthcare Providers	3	12	15	11	2020.8
Vaccination	3	14	29	10	2020.8
Work Engagement	2	13	26	10	2020.8
Health Promotion	3	15	21	10	2019.8
Integrated Care	4	6	6	10	2019.6
Physicians	4	19	26	10	2019.4

3.2.2   Co-authorship Analysis of Countries

In identifying the main association patterns between countries, a co-authorship analysis of countries was conducted. The least number of documents per country was set to 10, which resulted in 50 countries that met the threshold of 172 countries. Figure 6 graphically presents the results of the analysis. The node size indicates the number of collaborations. The circle size in a map is determined by the weight attribute Total link strength (TLS), representing countries' collaboration intensity.

The countries with the uppermost collaboration include the United Kingdom, Australia, and the United States. Our results revealed that the United Kingdom has the most collaborative publications and a total link strength (TLS) of 194 with 7169 citations. The number of published documents in the United Kingdom is also the highest (n=486). The United States is the second-ranked country with a TLS of 144, with 364 published documents and 5677 citations. The third-ranked country in collaborative research is Australia having a TLS of 98, with 196 published papers and 2380 citations.

Interestingly, developing Asian countries like India, Malaysia, Hong Kong, Saudi Arabia, and Pakistan also rank in the top 25 countries in collaborative research. It is also noteworthy that these are the only Asian countries involved in research related to HCW wellbeing that made it to the top list with respect to the number of publications. The topmost collaborative countries regarding their total link strength with the highest number of published documents are listed in Table 4.
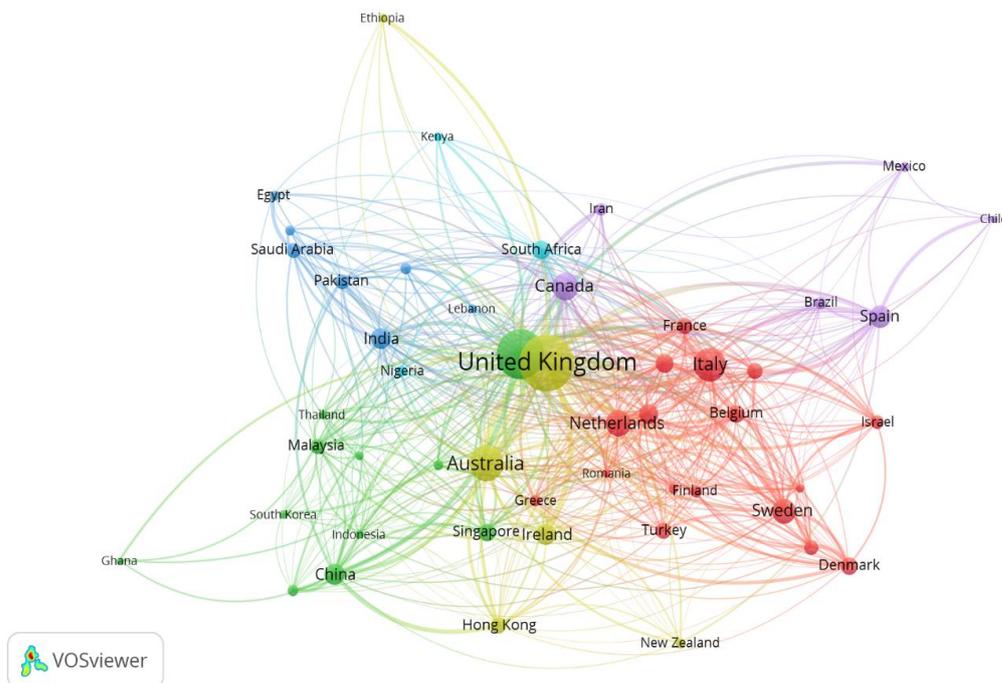

Fig. 6. Snapshot of the bibliometric map representing co-authorships in network visualization mode in network visualization mode. Available online at https://app.vosviewer.com/

Table 6
Top countries involved in collaborative research.

Country	Links	Total link strength	Documents	Citations
United Kingdom	47	194	486	7169
United States	47	144	364	5677
Australia	44	98	196	2380
Italy	38	60	170	2665
Canada	32	51	110	1379
Netherlands	37	46	106	1997
China	26	45	70	644
Sweden	30	40	94	1159
Switzerland	33	38	52	672
Germany	33	37	61	1104
Spain	29	37	78	708
Ireland	25	35	66	901
Belgium	32	34	48	994
South Africa	29	27	51	420
Denmark	24	26	49	1137
France	33	26	41	317
India	33	24	65	410
Malaysia	28	24	35	387
Hong Kong	28	23	40	494
Saudi Arabia	22	23	35	877
Pakistan	21	22	35	516
Portugal	24	22	39	535
Norway	22	21	36	430
Singapore	23	20	48	741

3.2.3 Co-authorship analysis of authors

The co-authorship analysis of authors, with a minimum threshold of 2 documents per author, reveals interesting collaboration patterns in the field of healthcare worker well-being research. The analysis identified 600 authors out of 10657 with the threshold set to minimum2 documents per author. The largest set of connected authros consisted of 34 authors as shown in figure 7. The authors are distributed in 5 distinct clusters, indicating different collaboration groups within the research community.
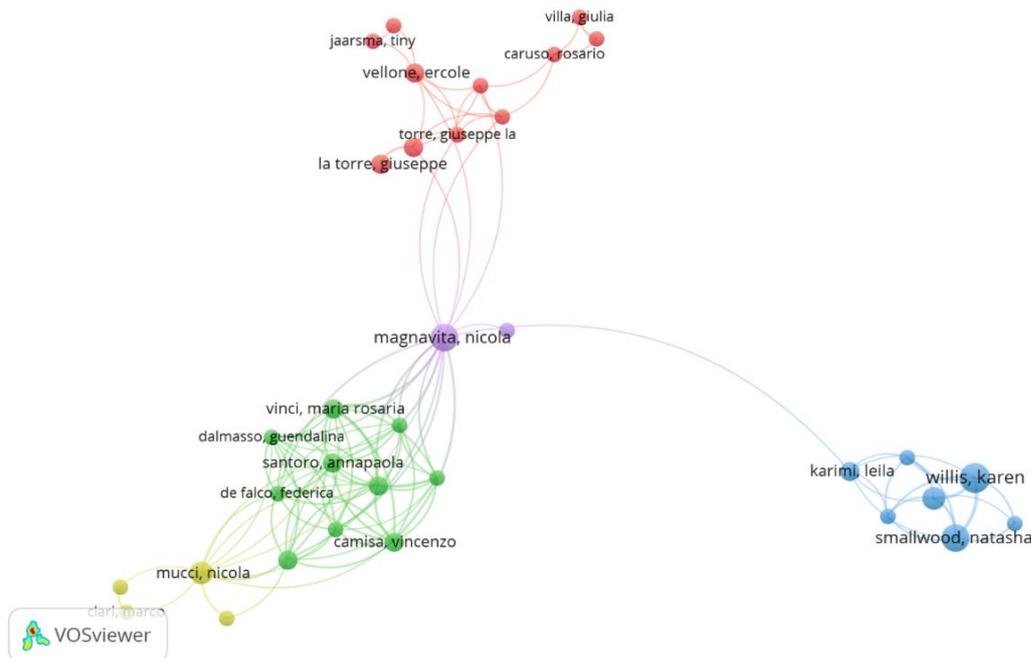

Fig. 7. The authors are distributed in 5 distinct clusters

The visualization represents a co-authorship network where authors are nodes, and collaborations between them are links. It is divided into color-coded clusters, each representing groups of authors working closely together. The red cluster contains authors like Vellone and Jaarsma, likely focused on a specific healthcare worker well-being topic. The green cluster, including Vinci and Dalmasso, has strong internal ties and links to other clusters. The purple cluster, centered around Magnavita, connects multiple groups, indicating this author's central role. The blue cluster, with authors like Willis, suggests significant publication activity. Node size reflects publication volume or collaboration strength, and thicker links indicate frequent co-authorships. This visualization highlights the structure and key players in healthcare worker well-being research.

As shown in table 7, Nicola Magnavita emerges as a central figure in this network, belonging to cluster 5 with the highest number of links (18), total link strength (32), documents (6), and citations (34). This suggests that Magnavita is not only prolific but also well-connected within the research community. The second cluster, which is the largest, includes Vincenzo Camisa, Annapaola Santoro,

Maria Rosaria Vinci, and Salvatore Zaffina, all sharing identical metrics (11 links, 25 total link strength, 3 documents, and 15 citations), indicating a tight-knit collaboration group.

Cluster 3 features Natasha Smallwood and Karen Willis, who have fewer links but maintain a strong total link strength, suggesting focused collaborations. Willis stands out with the highest number of documents (7) in this analysis. The fourth cluster, represented by Nicola Mucci, shows strong connectivity (12 links) and a high citation count (53) relative to the number of documents (4), indicating impactful research.

Interestingly, cluster 1, including Alessandro Sili and Ercole Vellone, shows lower link strengths but Vellone has the highest citation count (80) despite having only 3 documents, suggesting highly influential work. This analysis reveals a research field with several distinct collaboration groups, varying levels of productivity, and impact, with some authors like Magnavita and Willis showing high connectivity and productivity, while others like Vellone demonstrate high impact with fewer but highly cited publications.

Table 7
Top athors involved in collaborative research

Author	Links	Total link strength>	Documents>	Citations
Magnavita, Nicola	18	32	6	34
Camisa, Vincenzo	11	25	3	15
Santoro, Annapaola	11	25	3	15
Vinci, Maria Rosaria	11	25	3	15
Zaffina, Salvatore	11	25	3	15
Giorgi, Gabriele	12	21	3	55
Dalmasso, Guendalina	11	19	2	10
De Falco, Federica	11	19	2	10
Di Prinzio, Reparata Rosa	11	19	2	10
Smallwood, Natasha	6	17	6	34
Willis, Karen	6	17	7	35
Gilardi, Francesco	10	16	2	12
Raponi, Massimiliano	10	16	2	12
Mucci, Nicola	12	14	4	53
Pascoe, Amy	6	14	4	33
Ng, Irene	5	9	2	24
Putland, Mark	5	9	2	24
Mannocci, Alice	6	7	3	8
Sili, Alessandro	6	7	2	7
Vellone, Ercole	7	7	3	80

3.2.4 Bibliographic coupling

The bibliographic coupling analysis, as illustrated by the VOSviewer visualization (figure 8) and the accompanying table, offers a comprehensive view of the research landscape in healthcare worker well-being. The network diagram reveals a complex, interconnected field with multiple color-coded clusters, indicating diverse but related research themes. The predominance of publications from 2020-2021 suggests a surge in research activity, likely prompted by the COVID-19 pandemic. Central nodes such as Shechter (2020), Barello (2020b), and Blake (2020b) appear to be pivotal studies, potentially representing key conceptual or methodological contributions. The dense

network of connections between nodes indicates strong bibliographic coupling, implying that many studies share common references and build upon similar foundational works.

High Total Link Strength (TLS) documents like Mekonen (2020) and Kreh (2021) demonstrate strong connections within the literature, while highly cited works such as De Kock (2021) show significant impact on the field. The presence of earlier publications with high TLS, such as Ahmad (2015) and Kingdon (2015), suggests their role in shaping the theoretical foundation of the field. The diversity of journal sources points to a multidisciplinary approach to the topic. Notably, papers like Naser (2020) and Søvold

(2021), with high link counts, may serve as bridges between different research subfields.

This analysis reveals a rapidly evolving, highly interconnected research field centered around healthcare worker well-being, with a strong influence from the COVID-19 pandemic. The multiple clusters indicate diverse sub-themes within the broader topic, while several key papers serve as central nodes or bridges between different research areas. This bibliographic coupling analysis not only highlights the current state of research but also points to emerging trends and potential areas for future investigation in the field of healthcare worker well-being.
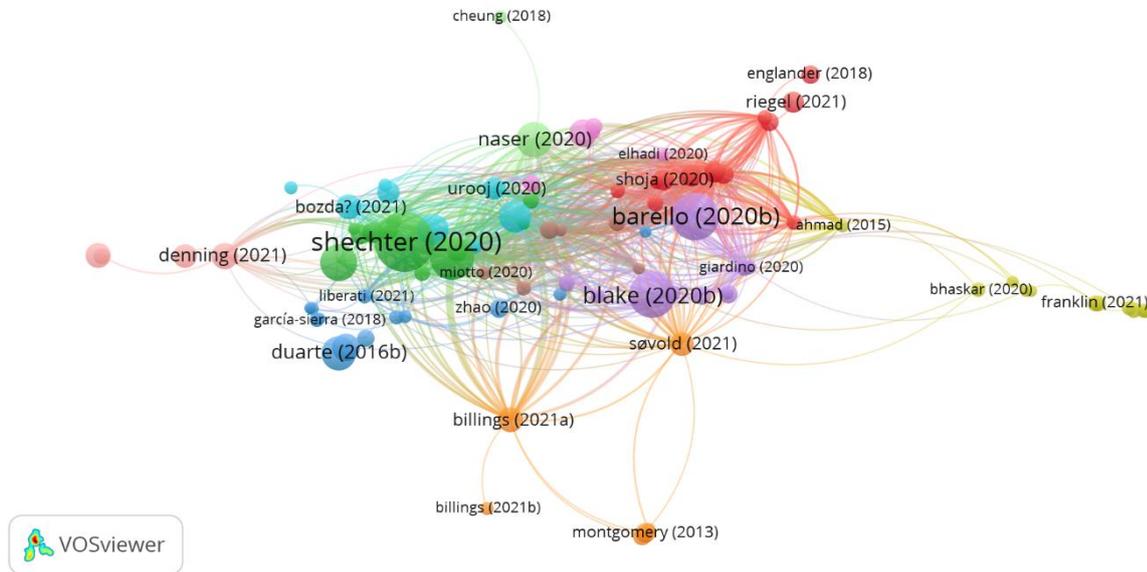
Fig. 8. Bibliographic coupling

Document	URL	Links	Total link strength	Citation
mekonen (2020)	https://doi.org/10.2147/prbm.s291446	49	218	22
kreh (2021)	https://doi.org/10.1371/journal.pone.0249609	51	214	22
pearman (2020)	https://doi.org/10.3389/fpsyg.2020.02065	53	199	54
naser (2020)	https://doi.org/10.1002/brb3.1730	52	184	181
phiri (2021)	https://doi.org/10.1016/j.eclinm.2021.100806	45	165	37
giallonardo (2020)	https://doi.org/10.3389/fpsyt.2020.00533	47	141	137
lim (2020)	https://doi.org/10.1007/s00417-020-04682-z	33	134	60
billings (2021a)	https://doi.org/10.1186/s12913-021-06917-z	32	132	85
di trani (2021)	https://doi.org/10.3389/fpsyg.2021.646435	46	130	49
de kock (2021)	https://doi.org/10.1186/s12889-020-10070-3	34	127	269
kingdon (2015)	https://doi.org/10.1371/journal.pone.0130059	29	126	27
salameh (2020)	https://doi.org/10.1016/j.psychres.2020.113520	22	113	32
alsairafi (2021)	https://doi.org/10.3390/ijerph18042203	30	99	34
elhadi (2020)	https://doi.org/10.3389/fpsyt.2020.579563	34	94	28
shoja (2020)	https://doi.org/10.1186/s12889-020-09743-w	33	94	62
søvold (2021)	https://doi.org/10.3389/fpubh.2021.679397	46	91	80
moorthy (2020)	https://doi.org/10.1093/pubmed/fdaa096	33	91	33
ahmad (2015)	https://doi.org/10.7717/peerj.1250	30	89	27
lowe (2018)	https://doi.org/10.1016/j.msksp.2018.01.009	30	87	29
colloca (2019)	https://doi.org/10.3389/fphar.2019.01372	29	86	43

4. Conclusion

This comprehensive bibliometric analysis of healthcare workers' (HCWs) well-being research represents a significant contribution to the field, as it is the first study to provide an in-depth examination of this crucial area. Our research offers a panoramic view of the evolving landscape of HCW well-being literature, particularly in the context of the COVID-19 pandemic, which has dramatically impacted the healthcare workforce globally.

The analysis reveals a substantial growth in research output and citations related to HCW well-being, especially in the wake of the COVID-19 pandemic. This surge in scholarly interest underscores the growing recognition of the importance of healthcare professionals' mental health and overall well-being. The study identified key contributors to this burgeoning field, including influential authors, institutions, and countries, providing valuable insights into the global research network addressing this critical issue.

Our keyword co-occurrence analysis highlighted the dominance of COVID-19-related themes, reflecting the pandemic's profound impact on HCW well-being research. This finding emphasizes the rapid response of the scientific community to emerging healthcare challenges. Simultaneously, the analysis uncovered several understudied areas within the field, offering promising directions for future research. These less explored topics present opportunities for researchers to address critical gaps in our understanding of HCW well-being.

The co-authorship analysis revealed intricate collaboration patterns among countries, highlighting the international nature of HCW well-being research. This global collaboration is crucial for developing comprehensive strategies to support healthcare workers worldwide. Furthermore, the bibliographic coupling analysis provided insights into the intellectual structure of the field, identifying clusters of related research and potential emerging research fronts.

In conclusion, this bibliometric study not only maps the current state of HCW well-being research but also serves as a valuable resource for researchers, policymakers, and healthcare administrators. By identifying key trends, influential works, and research gaps, our analysis provides a roadmap for future investigations in this vital area. As the healthcare landscape continues to evolve, particularly in the face of global challenges like the COVID-19 pandemic, ongoing research into HCW well-being remains crucial. This study lays the groundwork for more targeted, collaborative, and impactful research efforts aimed at enhancing the well-being of those at the forefront of healthcare delivery..

5. Limitations and future directions

The choice of keywords used for the present research may have limited the number of papers included in the screening and selection process, which may have limited the findings. Additionally, it's critical to consider any potential bias in the present findings due to using a single database rather than merging two or more datasets from different databases. The data of the articles were extracted from the Scopus database. Other databases, including Web of Science and Google Scholar, among others., were left out, which is one of this study's limitations. Conclusively, based on the sample size and the screening process, the possible errors are considerably insignificant, promoting minimal or no change to the current study's findings.

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