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Review Article

A decade in focus: occupational health and safety research trends - a bibliometric approach

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ABSTRACT

Introduction: Occupational health and safety (OHS) is a critical area of research due to its direct impact on worker well-being and productivity. Understanding the evolving trends and patterns within this domain provides valuable perspectives on the global focus and advancements made over the past decade. This study conducts a bibliometric analysis of OHS literature to map its intellectual structure, identify influential contributors, and highlight emerging themes.

Methods: A bibliometric study was conducted analyzing publications from 2014 to 2024 in Scopus on occupational health and safety. Descriptive statistics, co-word clustering, and citation network analysis were performed on 664 articles from 223 sources.

Results: Results reveal significant increases in annual publications and citations over time, indicating a growing priority in the field. The US, Canada, Turkey, and Iran emerged as leading contributors. Core institutions, such as NIOSH and selected universities, demonstrated intense leadership. Key researchers publishing the most include Hasle, Gibb, Iavolici, and Mori. Key thematic areas included occupational health nursing, diseases, construction safety, risk assessment approaches, and management strategies, with risk assessment emerging as a particularly influential methodology.

Conclusion: Occupational safety research is demonstrating dynamic global growth with sustained high-quality outputs from the leaders of core institutions. Methodological innovations and interdisciplinary priorities necessitate ongoing investigation.

Keywords: Occupational Health and Safety, Trends, Workplace

Introduction

Occupational health and safety (OHS) consists of various disciplines dedicated to protecting the health and well-being of workers in their workplaces.[1-2] Occupational health and safety has become an increasingly important issue for employees and employers worldwide.[3] Work-related accidents and illnesses take a heavy human and economic toll yearly. According to the ILO, millions of employees are victimized by job-related accidents and sicknesses annually, leading to significant human suffering, loss of productivity, and economic burdens.[4] These incidents not only impact the individuals involved but also affect families, communities, and the overall societal well-being. Advancements in technology and regulations aimed at enhancing workplace safety and reducing occupational hazards persist across

various industries. Industries such as construction, manufacturing, agriculture, and healthcare are particularly prone to workplace accidents and occupational diseases due to the nature of their operations and exposure to hazardous substances.[5] The consequences of work-related accidents and illnesses extend beyond physical injuries, encompassing mental health issues, disabilities, and long-term health implications. Moreover, workplace accidents can disrupt livelihoods, strain healthcare systems, and impede economic development, especially in regions with limited access to healthcare and social protection.[6-7]

A recent study by Abdelrahim et al., published in the Safety Journal, delves into a review of OHS Governance in Sudan.[8] Highlighting the frequent recurrence of workplace accidents in Sudan indicates a country's OSH governance deficiency. Despite several laws, there is limited proof of their execution, and no identifiable national-level organizations are responsible for overseeing such enforcement. Felknor et al. explore four probable alternative futures for OHS generated by the four futures for OHS describe project, offering knowledge into the key tendencies and inputs influencing or creating the future.[9] The major future course of action concerns refuting assumptions, which can help OSH businesses shift from a reactive to a proactive mindset regarding future planning. China's OSH: A comprehensive collection of 5,675 papers concerning occupational health and safety (OHS) in China from 1979 to 2022 was obtained from the WOS Primary Collection and CSCD. In addition to analyzing the cooperation networks of "productive institutions" and "productive authors," the collected articles' journal sources and time distribution were also investigated. The main research subjects (e.g., occupational health and safety, disease prevention, and occupational exposure) and prominent study techniques (e.g., risk modelling, epidemiological methods) related with OHS over time were recognized and examined using the keywords and bibliographic analysis.[10]

A bibliometric study by Febiyani et al., published between 2012 and 2022, addresses the evolution of literature, publishing patterns, authors, and keywords. “OHS," "system thinking," and "system dynamics" were used to get data from the Scopus database. 11 As many as 67 citations were found in the papers from 2012 to 2022, according to the data exploration results. Research utilizes bibliometric techniques by procuring datasets from WOS and Scopus. The datasets were analyzed using the ScientoPy and VOS viewer software packages. The topic "Occupational, Environmental, & Public Health" has received the highest ranking. The results of the bibliometric study show that academic interest in workplace safety research has been steady and expanding.[12] Another study utilized CiteSpace (6.1. R6 (64-bit) Basic) to conduct a bibliometric analysis of 473 construction risk assessment publications identified in the WoS. Research on deep neural networks is focused on improving application accuracy and interpretability, and incorporating emerging technologies like blockchain, the Internet of Things (IoT), and Building Information Modelling.[13] Bibliometric examination of 45 years of tourism safety and security research. Scopus contains 597 studies on the topic. Analysis was done with VOS viewer scientific mapping software. “Tourists' perceptions of safety and security while visiting Cape Town” is the most related study. Michael C. Hall is the author cited most in the discipline, and Tourism Management has the most significant influence.[14]

While the literature review provides an in-depth overview of different areas of (OHS) research, there is a noticeable research gap pertaining specifically to bibliometric analysis within the specified timeframe of 2014 through 2023. Even though there are many studies exploring topics like OHS governance in Sudan, future trends in occupational safety, advanced technologies in China, and integrating emerging technologies into OHS, it seems there is a lack of recent bibliometric research that compiles trends in the evolving field of OHS research globally. This gap

presents an opportunity to systematically analyze publication patterns, authorship trends, keyword networks, and thematic changes within the body of OHS literature using Biblioshiny for bibliometric analysis. Therefore, this bibliometric study seeks to fill the noted research gap by investigating occupational health and safety (OHS) literature from 2014 to 2024 through global research trends. By comprehensively analyzing publication patterns, authorship collaborations, keyword networks and topic evolution during this decade, insights may be provided into OHS research's expanding and changing landscape worldwide. The most prolific authors, institutions, and countries influencing the field over this period could be revealed. Additionally, visual theme mapping may help visualize and understand how OHS research priorities and focus areas have shifted internationally in recent years. Such analysis could guide continued work to promote worker health and safety on a global scale.

Methods

Study Design: A bibliometric analysis of occupational health and safety research publications was conducted to identify trends, patterns, and relations within the literature. Bibliometric is well-suited for this purpose as it applies quantitative methods to map a field's intellectual structure and evolution.[15-16]

Data Search: The Scopus database was accessed on April 8th, 2024, because it constitutes the largest repository of peer-reviewed articles and bibliographic citations available. Scopus offers extensive coverage of scholarly works spanning different fields related to occupational health and safety research. As such, it provides a comprehensive resource to examine research in this area across multiple disciplines. Publications from 2014-2024 were included to provide a contemporary 10-year overview. Articles were identified using keywords “occupational AND safety AND health” aligned with the research topic. Subject area limits to “business, management and accounting, engineering and Medicine” ensured relevance. Only final published articles and those published in English were included for quality control.

Data Analysis: The study utilized the Bibliometrix R package for quantitative and visual bibliometric analysis. This package facilitated the examination of influential countries, institutions, authors, sources, and references through network graphs, density displays, and quantitative indicators.[17] To streamline the analysis workflow and interpretation of multivariate bibliometric data, the study used Biblioshiny to leverage its user-friendly interface for displaying results.[18]

Results

The study measured eight major bibliometric factors to comprehensively identify patterns and trends in occupational health and safety research. These included: first, Source publications to highlight influential journals. Second, authorship analysis is used to identify prolific authors and international collaborations. Third, Affiliation networks to recognize leading institutions globally. Fourth, Country outputs and collaborations to showcase nationally productive research hubs. Fifth, Document types to uncover format preferences over time. Sixth, word section provides information concerning Tree Maps and Trending Topics. Seventh, Conceptual structure through keyword co-occurrence and analysis to discover emerging themes. Eighth, Social structure via citation and bibliographic coupling networks to illustrate the intellectual base and flow of ideas shaping the field. Examining these multiple dimensions through quantitative bibliometric indicators and visual network displays provided a robust picture of the research landscape.

General Information

The general information section of the Biblioshiny dashboard displayed three crucial bibliometric outputs related to the occupational health and safety research. Firstly, it provided key statistical indicators to give an overview of the most influential entities. Secondly, it depicted the

annual scientific production throughout the studied period using a line graph to reveal trends in publication output over time. Thirdly, it presented three interactive field plots that visualized the relationship between country authors and keywords.

Major information

This study covers 10 years from 2014 to 2024 regarding occupational health and safety research. A total of 664 documents were analyzed and published across 223 different journals, books, and other sources. The documents had an average age of 4.58 years, each receiving an average of 11.85 citations. The documents contained over 27,745 references collectively. In terms of keywords, 3,282 keywords plus terms and 1,943 authors' keywords were assigned to describe the document contents.

A total of 2,293 authors provided the research frame, with 52 being single-authored documents. On average, each document had 4.07 co-authors and 19.73% of collaborations were international. All 664 documents were research articles, highlighting the focus on peer-reviewed literature in the dataset about occupational health and safety.

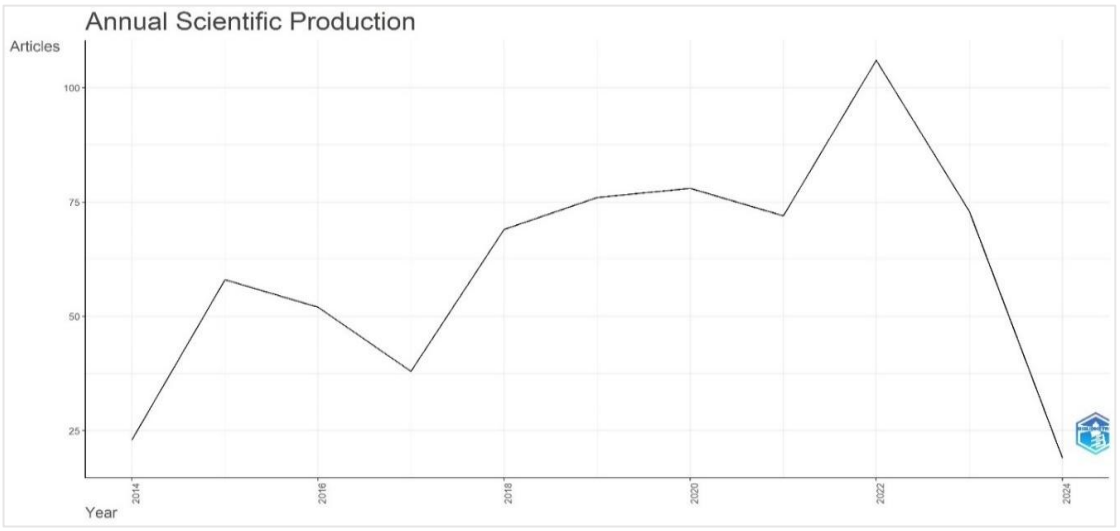

Figure 1: Annual scientific production on Occupational Health and Safety

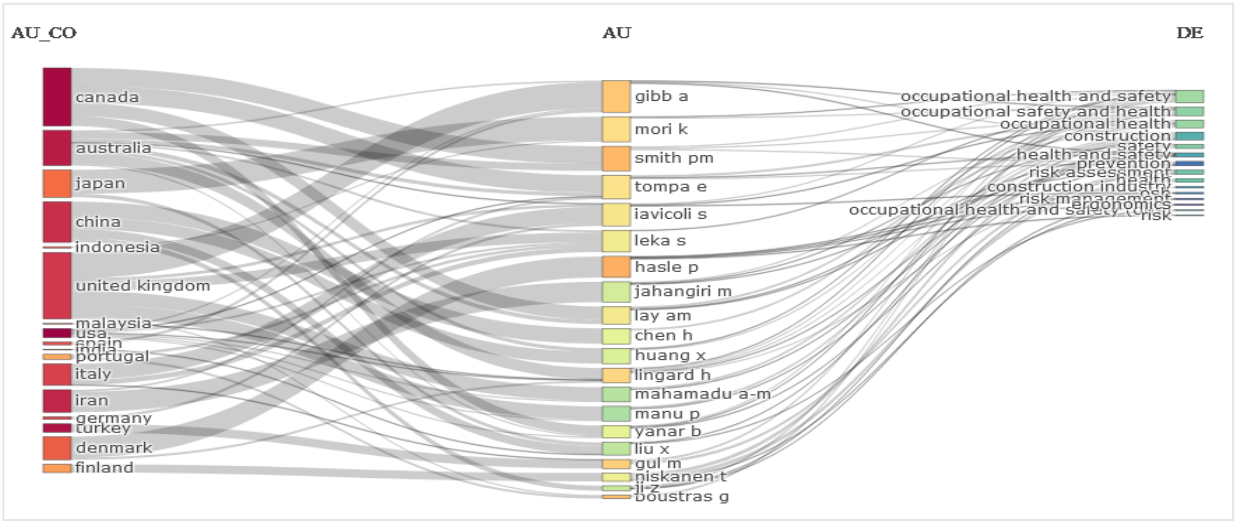

Figure 2: Three Field

Figure 1 shows the average number of citations per paper and total number of publications annually in the field of OHS from 2014 to 2023, revealing that earlier papers in the timeframe

generally had higher citation counts on average compared to more recent years as they have had more time to accumulate citations, with the highest being 21.57 citations per paper in 2014 and 21.36 in 2018, while annual publications have increased over time peaking at 106 papers in 2022. The three-field plot (Figure 2) illustrates the relationships between countries, authors, and keywords in occupational health and safety publications. The thickness of the connections (links) indicates the magnitude of information flow between different entities, with a higher rectangle indicating the element with the most relations. Authors from the UK, China, Canada, and Australia are highlighted for their influence. Similarly, authors Gibb A, Mori K, Smit PM, Tompa E, Iavicoli S, Leka S and Hasle P are noted for their significant impact. Moreover, keywords such as “occupational health and safety," appear to exert considerable influence within the discourse. These terms likely represent key concepts and areas of focus within the field of OHS.

Source

The source section of the Biblioshiny dashboard explored bibliometric indicators related to journals.[19] It first identified the most relevant sources publishing on occupational health and safety based on frequency. Additionally, it applied Bradford's Law to group sources into productivity zones to uncover the core, relevant and irrelevant publications.[20] The section also visualized the sources' production over the studied years through an interactive line chart.

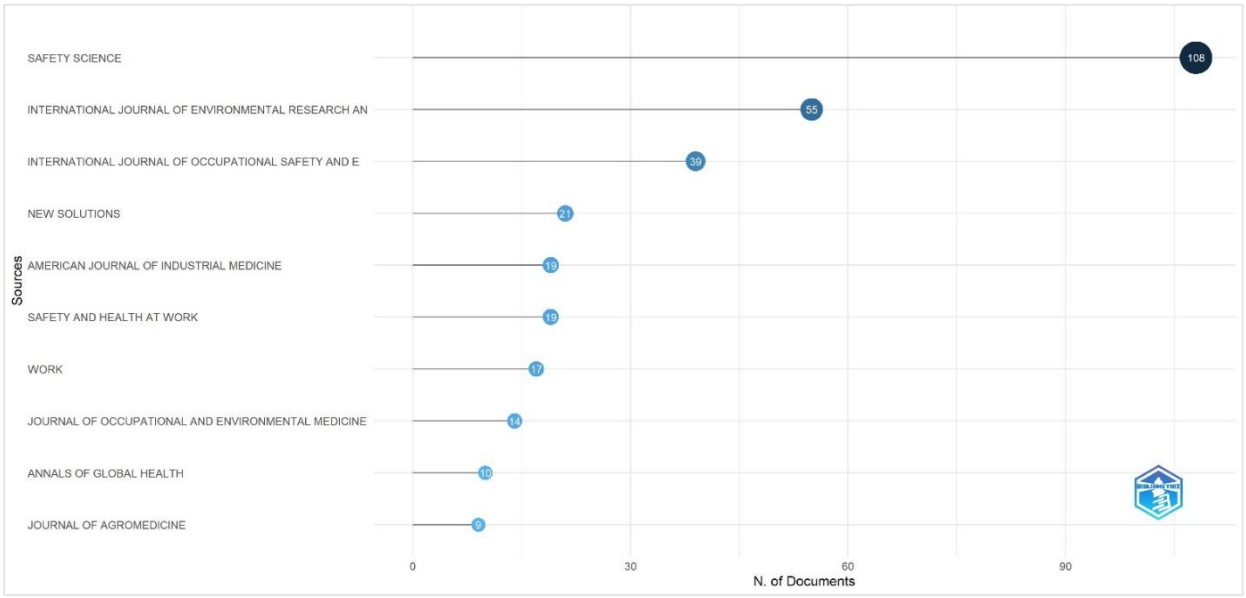

Figure 3: Most relevant source

Figure 3 shows the top 10 sources that have published the most articles relevant to occupational health and safety. Safety Science emerges as the single most important source, with 108 relevant articles. As the name suggests, the journal focuses specifically on research related to workplace safety. International Journal of Environmental Research and Public Health published the second-highest number of articles, at 55. This journal takes a broader perspective on environmental and public health issues, within which occupational safety is a significant theme. Two other prominent sources in the top 10 are the International Journal of Occupational Safety and Ergonomics and the American Journal of Industrial Medicine, reflecting the interdisciplinary nature of occupational health research. The remaining sources, such as New Solutions, Work, and the Annals of Global Health, demonstrate how research on this topic spans industrial engineering, medicine, and broader issues of socioeconomic development and workers' welfare globally.

A graphical interpretation of Bradford's law was employed to evaluate fundamental sources extracted from the Scopus database.[21] This approach sought to investigate the essential literature within a specific subject domain, which is typically concentrated in a select few highly cited journals.

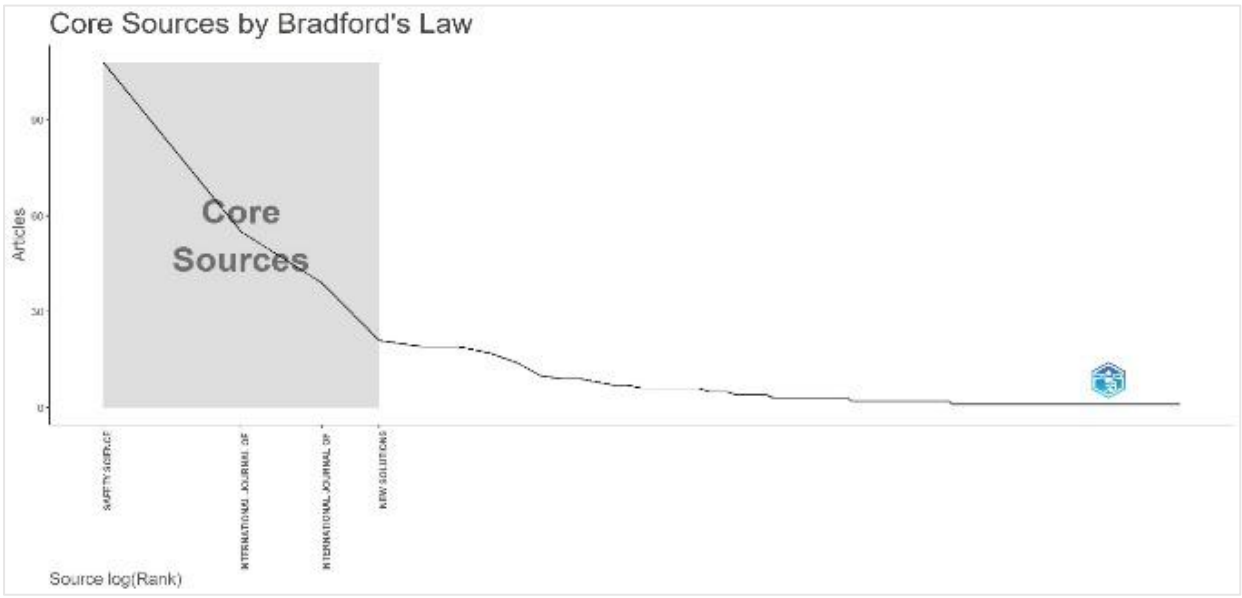

Figure 4: Bradford's Law on Occupational Health and Safety

The description elucidates the application of Bradford's law in pinpointing core references amidst a collection of journals.[22] Figure 4 shows a cluster of four journals, designated as the first zone, serves as the cornerstone for the broader range of journals. This principle is in harmony with Bradford's law, which suggests that a minority of journals will play a predominant role in the publication output of a given field.

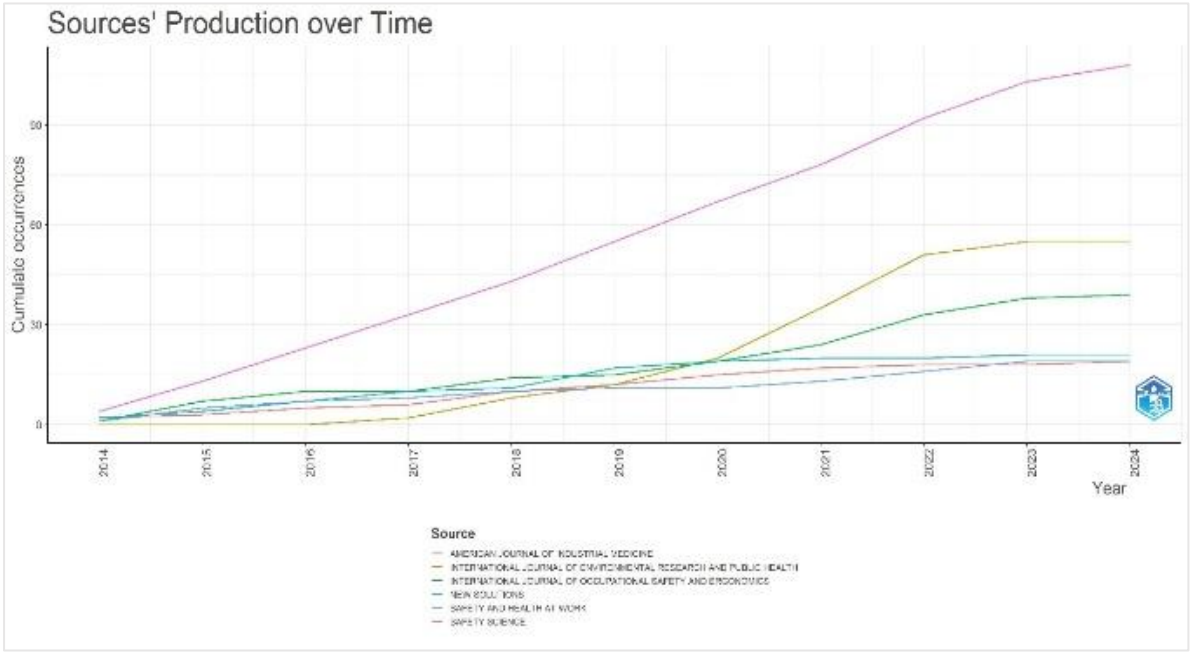

Figure 5: Sources production over time

Figure 5 shows the annual production numbers from 2014-2023 for the top journals publishing research on occupational health and safety. Safety Science showed consistent yearly growth, publishing just 4 articles in 2014 and steadily increasing output to 103 articles in 2023, cementing its position as the leading source. The International Journal of Environmental Research and Public Health and International Journal of Occupational Safety and Ergonomics also demonstrated strong growth over the decade. Meanwhile, though publishing fewer total articles, sources like New Solutions and American Journal of Industrial Medicine maintained moderate production levels each year. Safety and Health at Work similarly saw a rise from 1 article in 2014 to 19 in 2023. This upward trend across all sources illustrates both industry specialization through Safety Science's exponential rise, as well as broader research expansion exemplified by other journals integrating occupational concerns into their scope.

Authors

The authors section provided in-depth bibliometric analysis of authorship patterns in occupational health and safety research. The authors who were most productive within the dataset were initially identified based on the total number of documents they had published that were included in the analysis. The section also featured an interactive author production over time visualization. Additionally, Lotka's law of author productivity was applied. This quantification method categorizes authors as ultra-, super-, or norm-productive based on their adherence to the inverse square distribution of scientific work.[23]

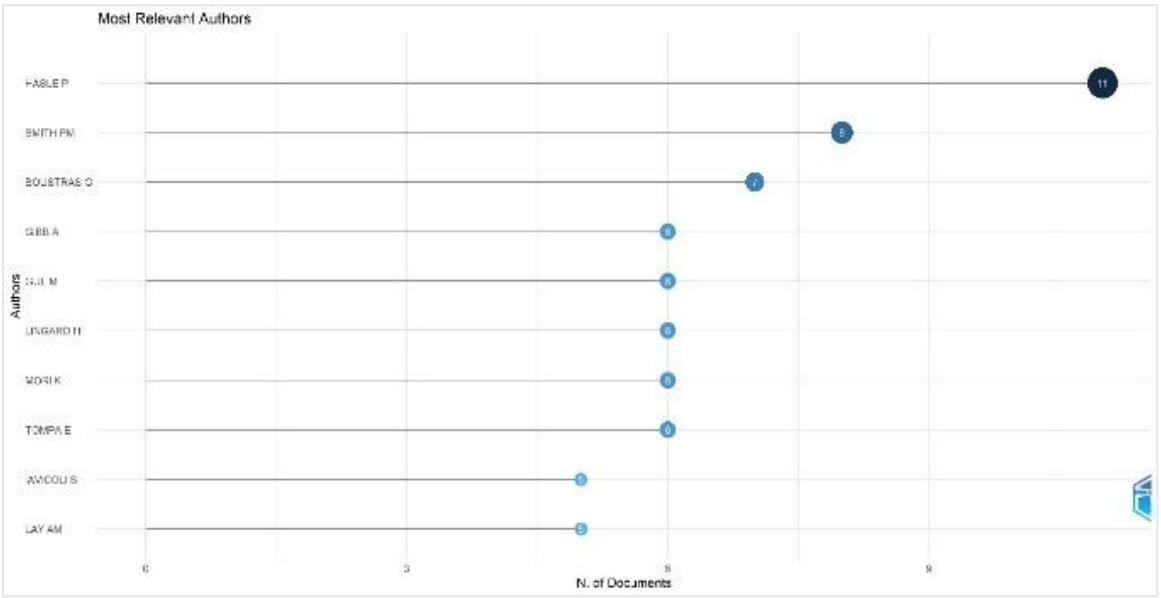

Figure 6(a): Most relevant authors

Figure 6(a) presents the authors who have published the most articles relevant to occupational health and safety research. Hasle P. emerges as the top contributor with 11 publications, demonstrating a sustained focus on advancing knowledge in this field. Several other prolific authors such as Smith PM, Boustras G, and Gibb A have authored 6-8 articles, reflecting their significant experience and expertise. Additionally, authors like Gul M, Lingard H, Mori K, and Tompa E have each published 6 studies, showing their valuable research efforts. Other leading scholar-practitioners including Iavicoli S and Lay AM have 5 publications apiece, reflecting holistic perspectives that integrate science with safety applications. Collectively, this data highlights the key individual researchers driving discourse in this important domain through their conceptual thought leadership and empirical work. Their contributions underscore the advancement of occupational safety as a dynamic scholarly endeavor.

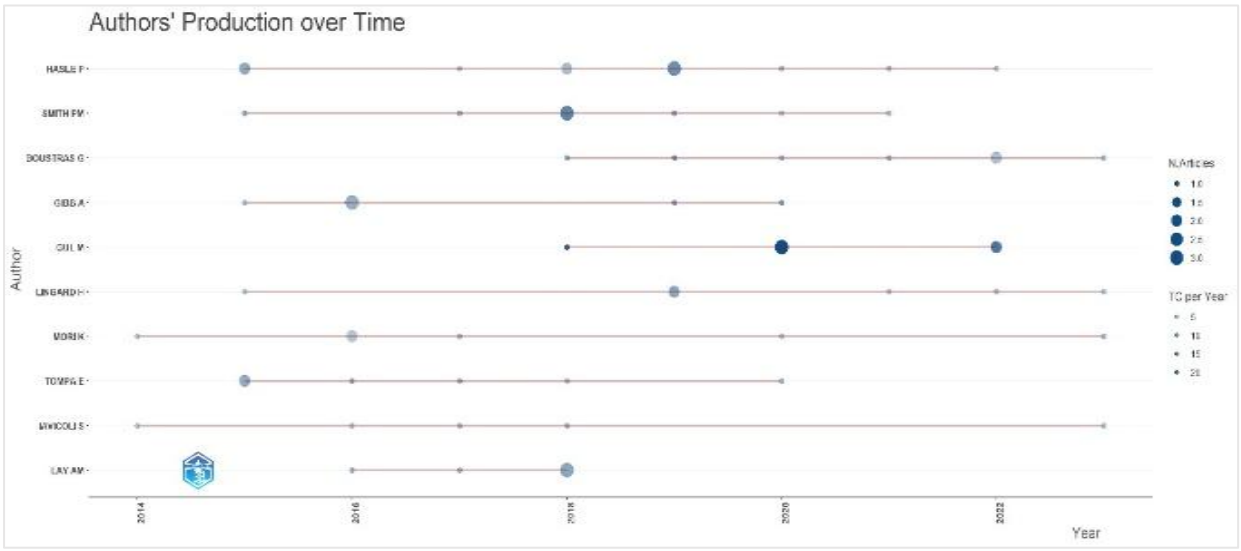

Figure 6(b): Author's production over time

Figure 6(b) shows publications from one of the most productive authors in occupational health and safety research, P. Hasle. Between 2015 and 2022, Hasle published 10 articles in various journals, including Safety Science, Work, Production and Manufacturing Research, and Annals of Work Exposures and Health. Hasle's research output has remained consistent at 1-2 articles per year, with topics ranging from OHS management systems and auditing psychosocial risks, to the impact of lean manufacturing approaches in industries like ready-made garments and agriculture. Her publications receive a respectable number of citations each year, with the 2015 Safety Science article garnering the most at 18 total citations. This sustained scholarly contribution spanning nearly a decade demonstrates Hasle's leadership role in advancing knowledge on key issues shaping effective occupational safety practices internationally.

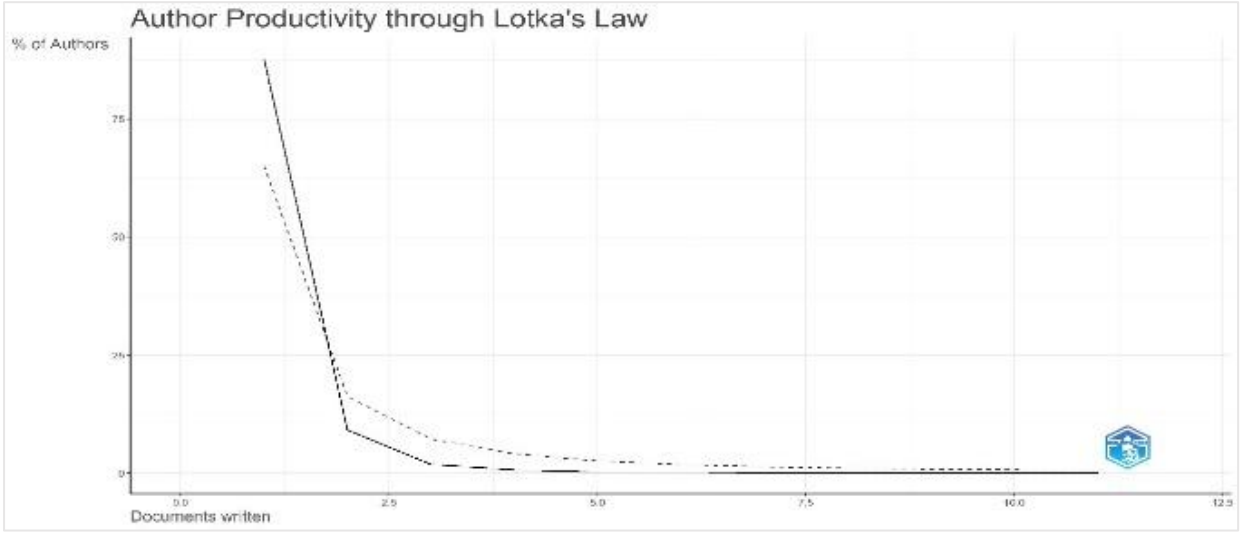

Figure 7: Lotka's law on Occupational Health and Safety

Figure 7 shows author productivity in OHS research according to Lotka's law of scientific productivity, which suggests that the number of authors publishing x papers is approximately $1/x^{\wedge 2}$ of the number publishing a single work.[24] As predicted by the law, the vast majority (2012 authors) have only written one document on the topic. The number of authors then sharply decreases as the number of publications increases, with only a small fraction (209 authors) having 2

publications, even fewer with 3-5 publications, and extremely few surpassing 6. This follows Lotka's inverse square law distribution, demonstrating that, like in many research fields, the contribution in occupational safety literature is also concentrated among the most productive authors. However, the long tail shows some authors have made careers out of sustained research on this subject.

Affiliation

The affiliation section analyzed institutional contributions to the literature. Firstly, it identified the most relevant affiliations based on the total publication count of documents affiliated with each institution. Additionally, it featured a line chart visualizing affiliation production over the period under review.

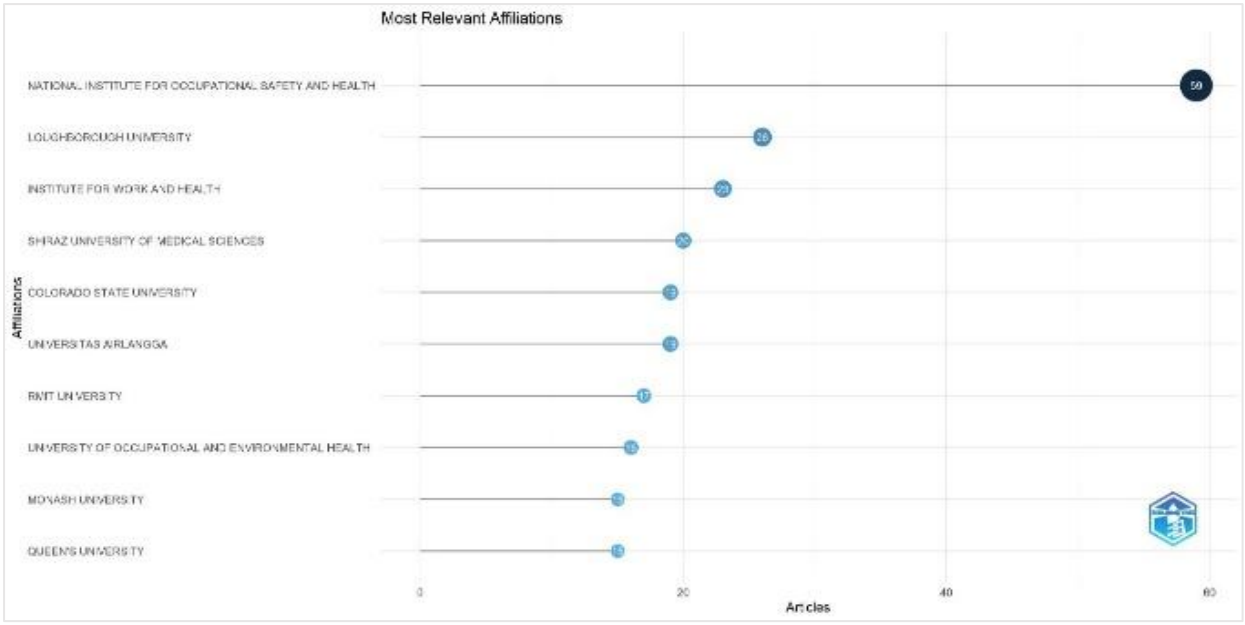

Figure 8: Most relevant affiliation

Figure 8 shows the top affiliations based on the number of articles published in occupational health and safety. The National Institute for OHS leads the list with 59 articles, cementing its position as the premier research institution devoted to this topic in the United States. Other prominent universities globally also made significant scholarly contributions, including Loughborough University in the UK, Shiraz University of Medical Sciences in Iran, and Universitas Airlangga in Indonesia, highlighting the international scope of research in this area. Additionally, research institutes focusing specifically on work and occupational health, like the Institute for Work and Health in Canada and the University of Occupational and Environmental Health in Japan, produced sizable volumes of research. Meanwhile, large research-intensive universities such as Colorado State University, RMIT University, Monash University and Queen's University round out the top ten based on their specialized publication output in this domain.

Figure 9 shows the number of articles published annually by some top affiliations in occupational health and safety research from 2014 to 2024. The National Institute for Occupational Safety and Health demonstrated steady growth, starting at 5 articles in 2014 and increasing consistently to reach 59 articles in 2024, cementing its leadership role. Similarly, Colorado State University ramped up output from 6 to 19 articles between 2015 to 2019. The Institute for Work and Health also grew substantially from just 2 articles in 2015 to 23 by 2021. Loughborough University had no publications in 2014-2015 but then a surge to 26 articles in later years. Shiraz University of Medical

Sciences exhibited accelerated growth, going from 8 articles in 2016 to publishing 20 articles by 2022. This upward trend across time periods illustrates the increasing prioritization and specialization various institutions have placed on occupational safety research through expanded publication activities. It also highlights the dynamic and continually evolving nature of the evidence base in this field

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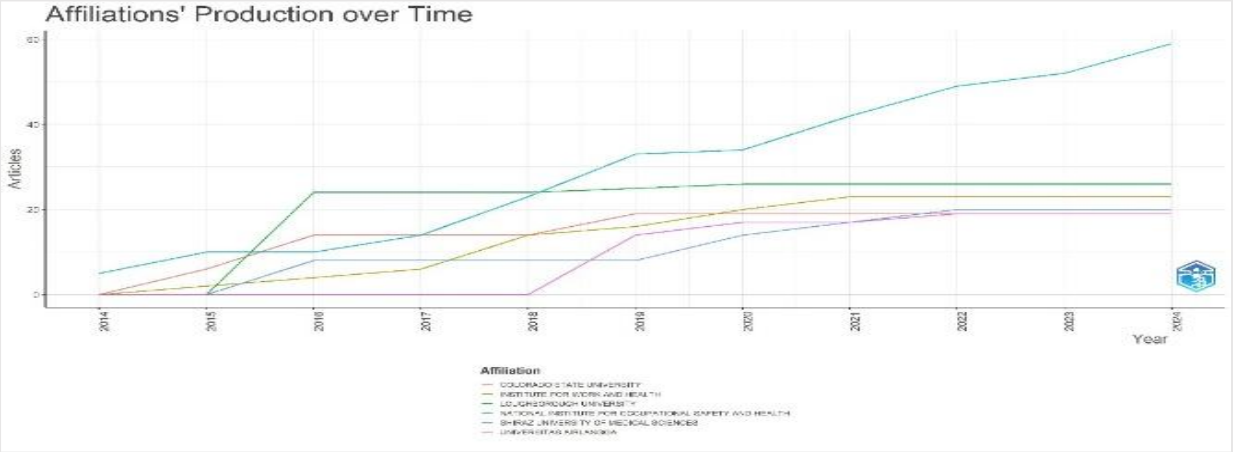

Figure 9: Affiliation production over time

Countries

The countries section provided comprehensive bibliometric insights into national involvement and collaboration patterns within occupational health and safety research. It first identified the countries of corresponding authors based on document address data, highlighting nations driving publication initiatives internationally. A sorted figure displayed the total research output of all countries to recognize the most scientifically productive. An interactive line graph tracked each country's temporal contributions, enabling analysis of rising, falling, or steady publication trends by nation over the timespan. Additionally, the total citations per article in the field of OHS are as follows:

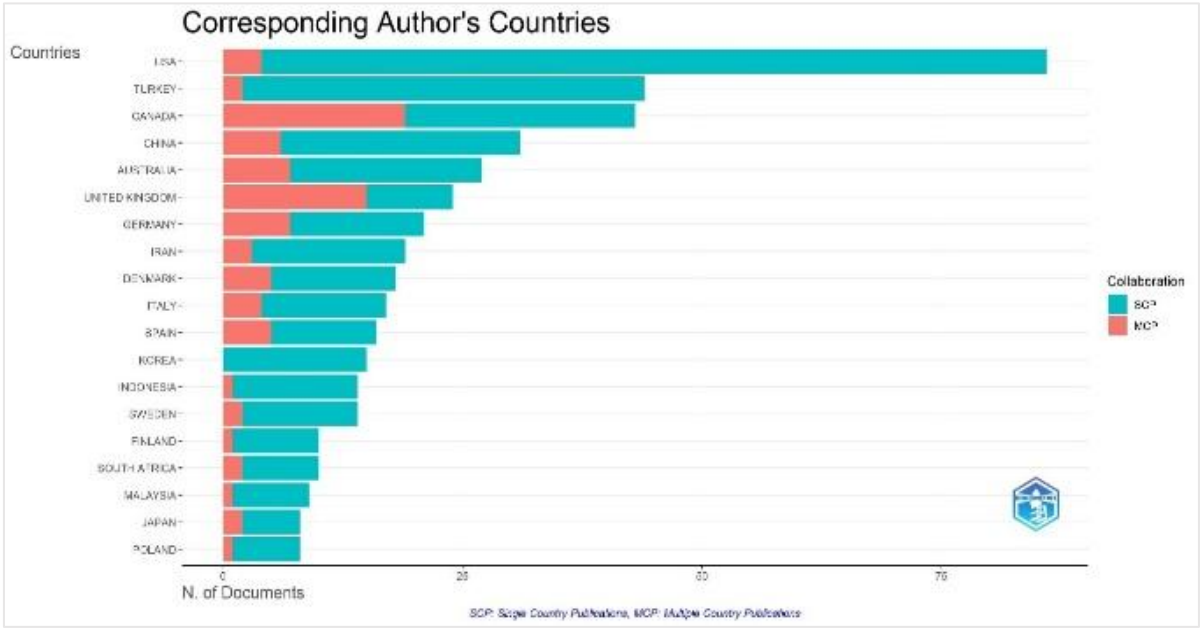

Figure 10: Corresponding Authors' Countries

Figure 10 provides insight into the countries of corresponding authors publishing research on occupational health and safety. The US and Turkey also published many articles led

predominantly by in-country authors. In contrast, Canada saw a higher proportion (19/43=0.442) of multi-country partnerships among its authors. Australia, the UK, and Germany also demonstrated greater international collaboration rates above 25%. China and Iran exhibited moderate levels of cross-border work. While most research was nationally based, as is typical, some countries incorporated more multi-national perspectives into their scholarly contributions. This reflects diverse approaches in the globally important area of ensuring workforce welfare. The data shows knowledge networks driving the field's development worldwide.

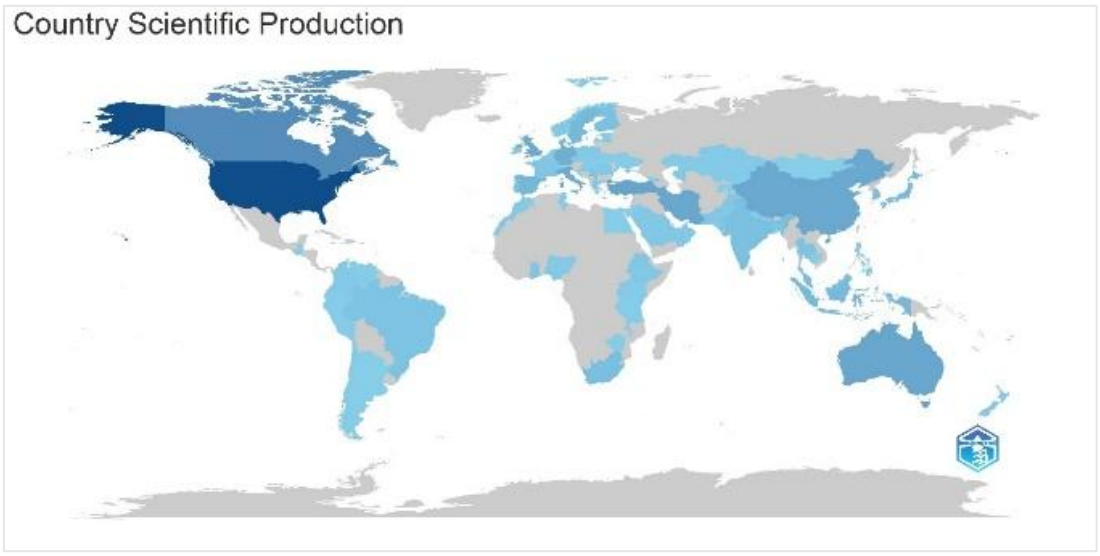

Figure 11: Countries scientific production

Figure 11 shows the top 10 countries based on the frequency of occupational health and safety research publications. The United States leads with 440 publications, underscoring its prominence in developing the evidence base in this field. Canada and Turkey follow with over 200 and 130 articles demonstrating substantive research activity, respectively. Australia, Iran, and China also made notable contributions, with 120-126 publications each. Long-established scholarly powers like the UK, Italy and Germany produced 100 articles each. Spain rounds out the top 10 with 75 publications. While high-income Western nations traditionally dominate global research, this data indicates emerging economies in the MENA and Asia-Pacific regions are increasingly engaging with occupational safety science as well.

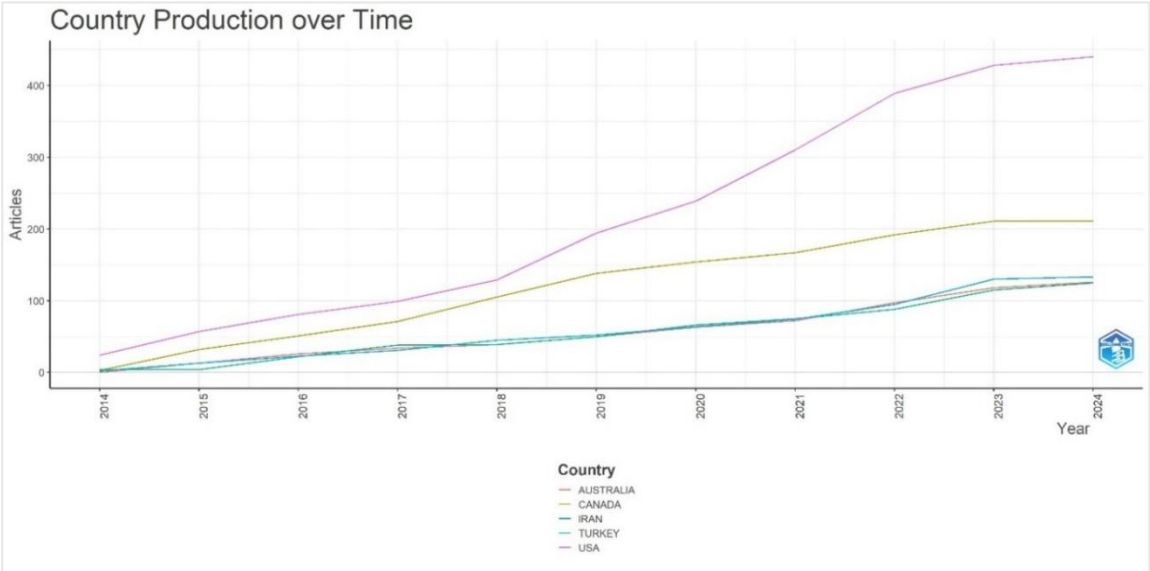

Figure 12: Country production over time

Figure 12 shows the annual scientific publications from 2014-2024 for several leading countries in occupational health and safety research. Canada steadily increased output from 3 articles in 2014 to 211 by 2023, demonstrating long-term growth. Iran increased even more dramatically from 4 to 125 articles during this period. Turkey grew consistently from just 2 to over 130 articles annually. The United States maintained a high publication rate that expanded from 24 to over 400 articles per year. Australia also grew moderately from 13 to around 50 articles each year. These upward trends depict the intensifying investments several nations have made over the past decade to advance knowledge and understanding within their jurisdictions.

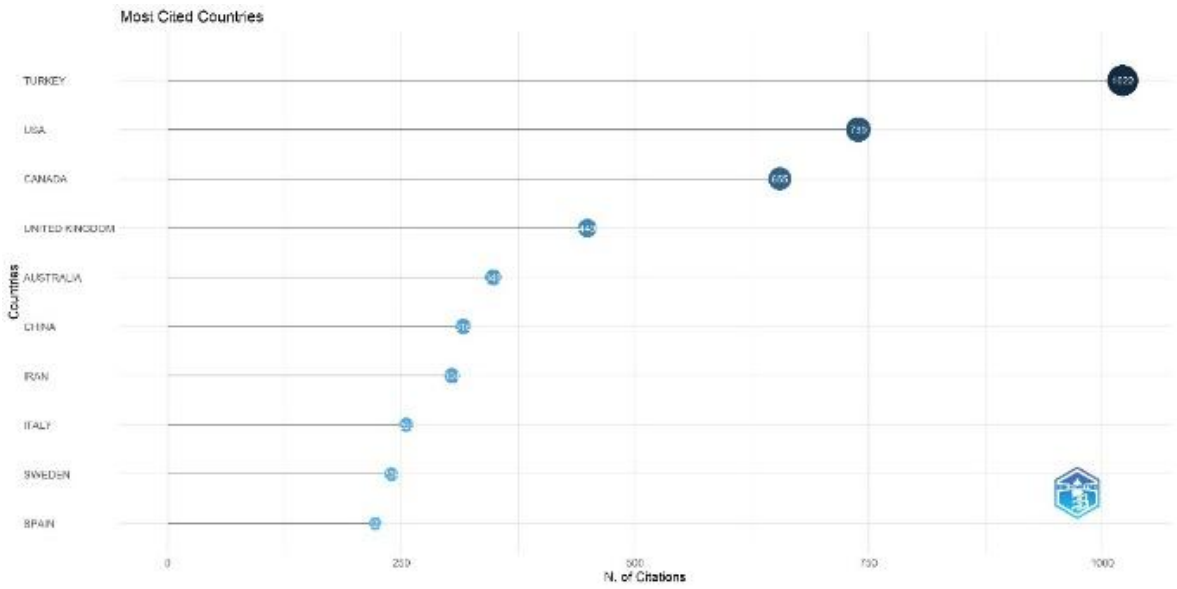

Figure 13: Most cited countries

Figure 13 presents the top 10 countries based on total citations per article in the field of OHS. Turkey received the most total citations at over 1,000 and also had the highest average of 23 citations per article. This suggests researchers in Turkey are making highly influential contributions. Canada, the UK, and Iran also saw average citations well above 15. Meanwhile, countries with large publication volumes like the US, China, and Italy still achieved average citations between 8-15 times per paper. More specialized research powers such as Sweden and Spain approached or exceeded averages of 13-17 citations respectively. Overall, this benchmark demonstrates the globally leading countries at integrating science with real-world impact through their occupational safety research.

Documents

The Documents section provides two useful factors. One factor indicated is the "Most Global Cited Document", which points out the single paper from the results that has received the highest total number of citations in all subsequent published works worldwide. Another is Reference publication year spectroscopy (RPYS) which used in academic literature to evaluate the impact of scientific publications by examining the frequency of their citations over time.[25]

Figure 14 presents the top 10 most cited research papers in the field of occupational health and safety. The paper receiving the highest number of total citations at 393 is a 2018 article published in Safety Science by authors Ilbahar et al. additionally, a 2018 paper in the Journal of Cleaner Production by Gul et al garnered 137 citations to date. Other highly influential studies include those by Sinelnikov et al in Safety Science in 2015 and Chari et al. in the Journal of Occupational and Environmental Medicine in 2018, each cited over 100 times.

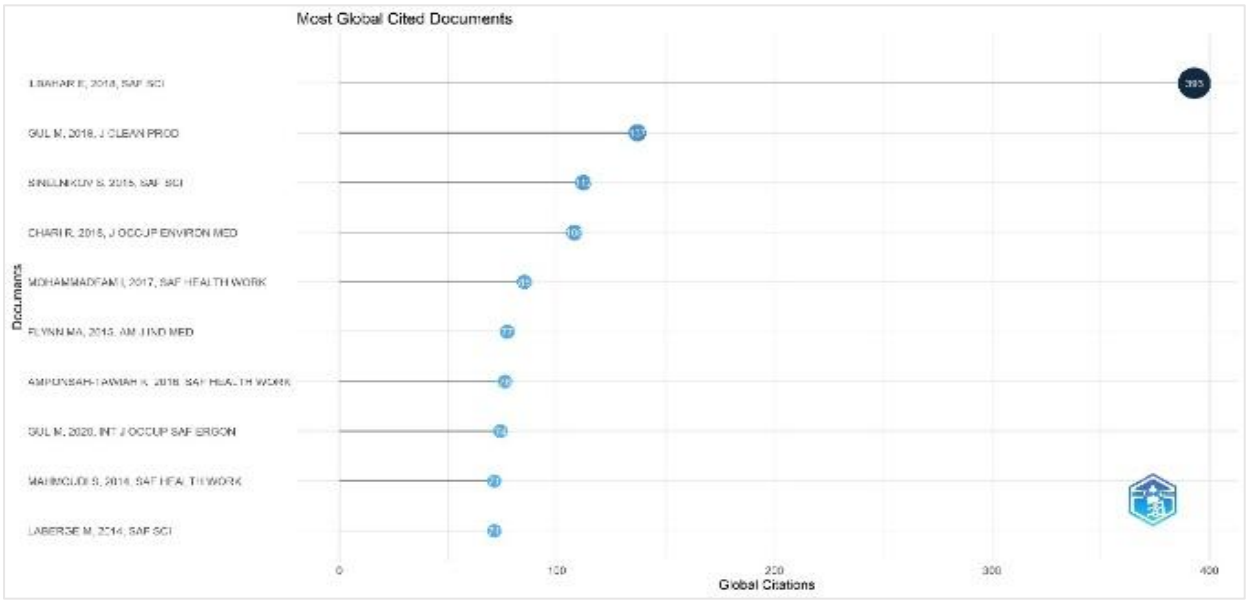

Figure 14: Most global cited document

Papers by Mohammadfam et al, Flynn et al, Amponsah-Tawiah et al, and Gul et al have also received considerable attention, ranging from 70 to 85 citations each. This identifies the specific scholarly works that have driven scientific dialog and informed policy/practice globally through the impact metric of citations.

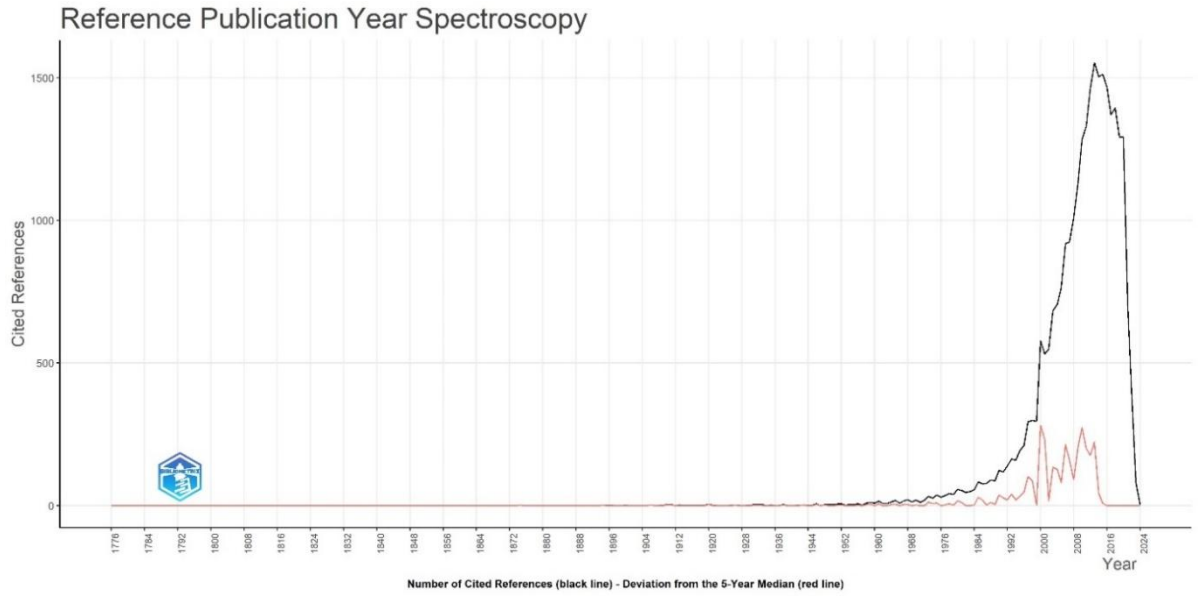

Figure 15: Reference publication year spectroscopy

Publication year spectroscopy visualizes the distribution of cited references' publication years. It creates a histogram, with publication years and citation frequency.[26] Trends in the histogram in Figure 15 reveal temporal patterns and influential periods in research. This spectroscopy, the black line represents the number of cited references, indicating a notable increase starting around the year 2000, with a peak observed in 2014-2015, where the number of cited references exceeds 1500. The red line in the figure represents the deviation from the 5-year median. This deviation appears to fluctuate between 2000 and 2014-2015. Fluctuations in the deviation from the median indicate variations in citation patterns compared to the average citation rate over a 5-year period. The peak observed in the black line around 2014-2015, accompanied by fluctuations in the red line, and indicates a period of heightened activity and possibly diverse research directions within the OHS field during that time frame.

Word

Word section present the information related to Tree Map and Trend Topic. Here, Tree Map analysis in Occupational Health and Safety highlights the distribution of various risk factors, visually representing their relative importance and occurrence within the workplace. Meanwhile, Trend Topic analysis identifies emerging concerns and recurring issues over time, offering insights into evolving priorities and areas requiring heightened attention within the field.

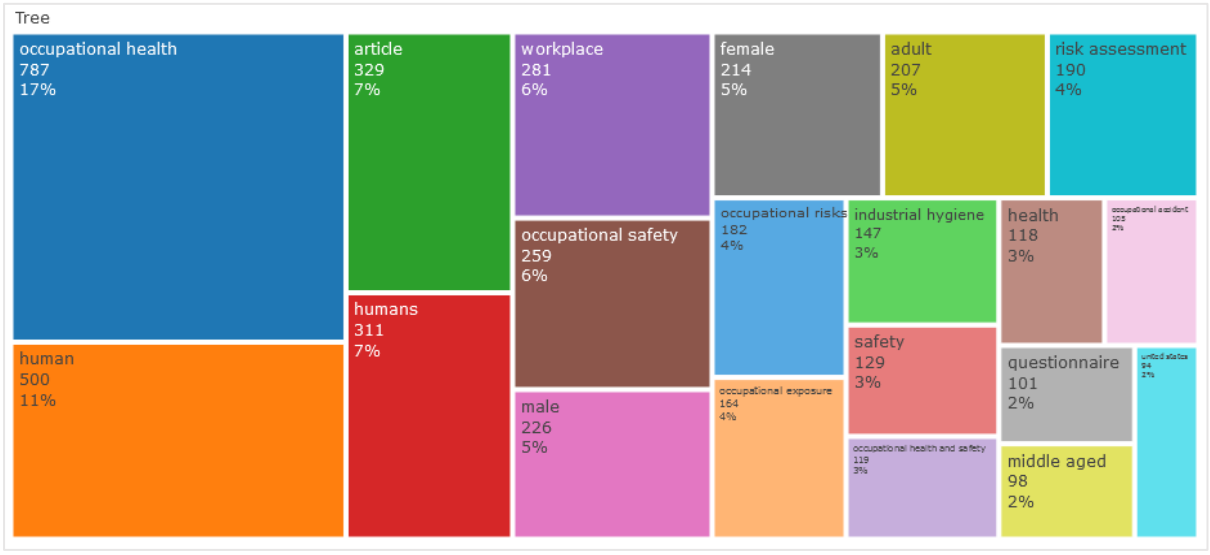

Figure 16: Tree Map

Figure 16 provides an overview of the most common terms used in publications on OHS. 'Occupational health' emerges as the most frequent term, reinforcing its central role as the main subject of inquiry. High counts for broader concepts like 'human' and 'humans' reflect the human-centered nature of the field in protecting worker well-being. Additionally, terms such as 'article', 'workplace' and 'occupational safety' amongst the most used underline key areas of focus. References to demographic details like 'male' and 'female' highlight attention to differences. The appearance of 'adult' suggests that studies examine adult worker populations primarily. Meanwhile, the frequent use of 'risk assessment' emphasizes its importance as a methodology.

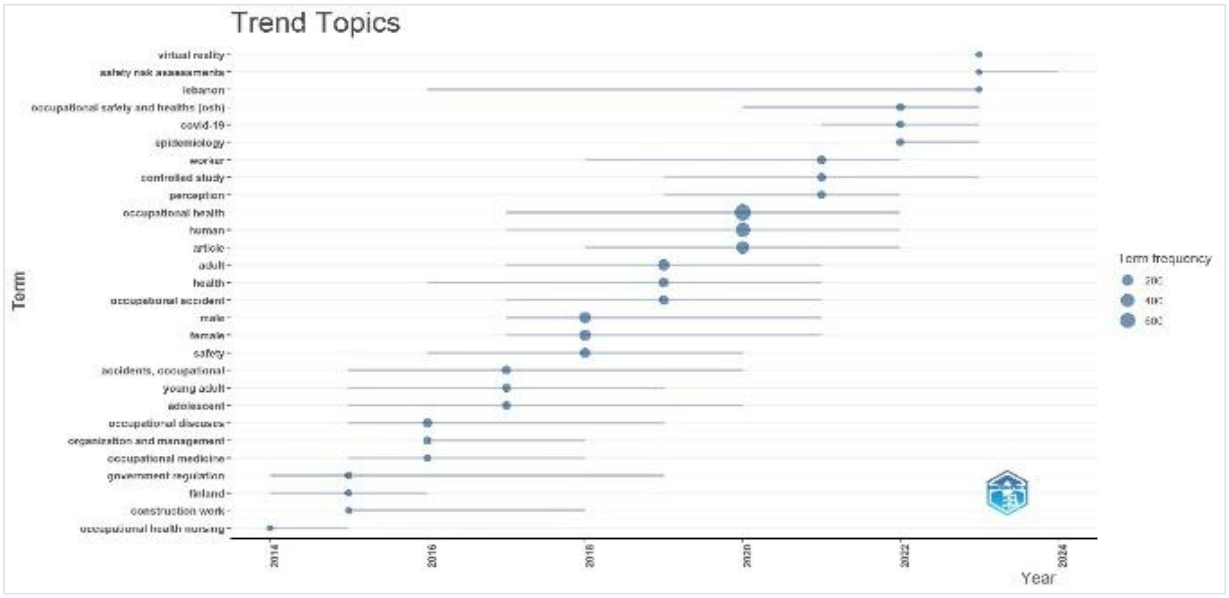

Figure 17: Trend Topics

Figure 17 depicts the top 10 trend topics in occupational health and safety research from 2014 to 2020 based on frequency and average publication year. Occupational health nursing emerged as the earliest trending topic based on its low median publication year of 2014, although with a relatively small total count. Government regulation saw continued interest from 2014 to 2019 as reflected by its wider range of years. Occupational diseases significantly dominated discussions, with over 60 publications. Construction work, organization and management, and occupational accidents also featured prominently, indicated by higher frequencies in the later years from 2015 onwards.

Conceptual Structure

In the conceptual structure of Occupational Health and Safety, the co-occurrence network clarifies the interconnectedness of different factors contributing to workplace safety incidents, revealing potential correlations and dependencies. Meanwhile, Multiple Correspondence Analysis (MCA) delves into the intricate relationships between various categorical variables, offering a comprehensive understanding of the complex factors influencing occupational health outcomes.[27]

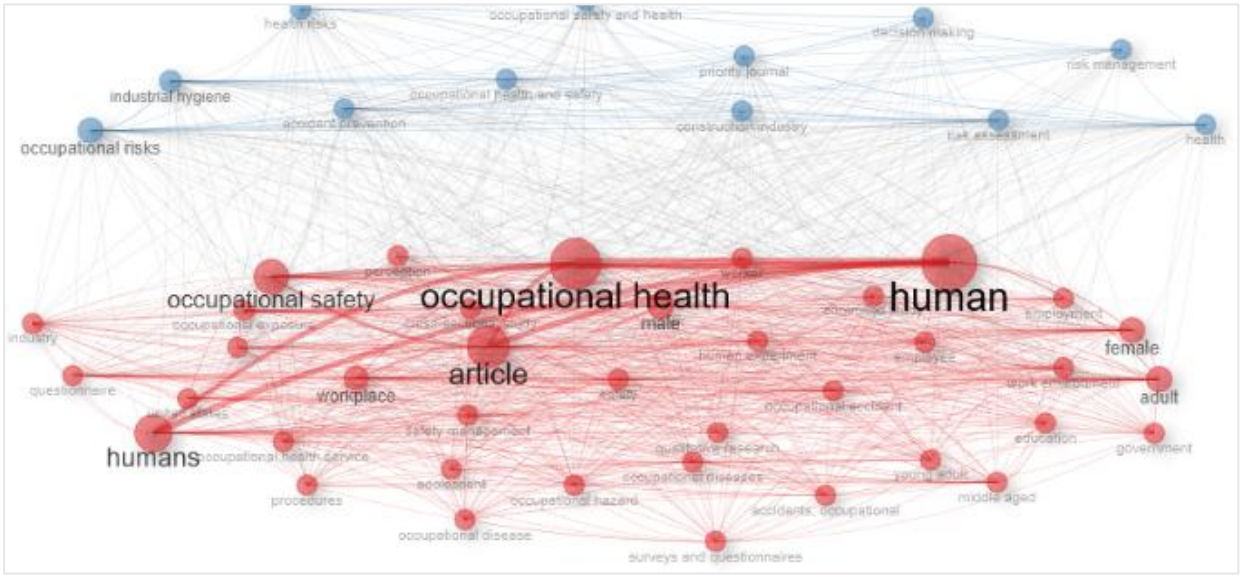

Figure 18: Co-occurrence Network

Keyword co-occurrence analysis was conducted to reveal meaningful associations and thematic research areas.[28] Figure 18 illustrates keyword co-occurrence using nodes and edges, where node size and label depict keyword frequency, and edge thickness signifies co-occurrence frequency. Node color denotes cluster association, with thicker edges indicating closely related keywords within the same research theme. The largest cluster is represented by a red color, and it shows that the top five keywords, i.e., occupational health, human, article, occupational safety, and humans. The data indicates that most papers focused on occupational health, while occupational safety articles primarily targeted human well-being. Furthermore, the cluster represented by the blue color, which is the majority, seems similar, i.e., occupation risk, industrial hygiene, health risk, accident prevention, construction industry, risk management, and risk assessment, all highlight humans.

Factorial Analysis

MCA assists in identifying patterns and relationships between categorical variables, such as keywords or authors, in bibliometric data.[29,30] This analysis aids in understanding thematic clusters and co-occurrence patterns within a research field. In this study, Multiple Correspondence Analysis (MCA) revealed

distinct clusters of keywords: the Red cluster comprising 26 keywords associated primarily with human health and safety, the Blue cluster consisting of 10 keywords related to industrial health and safety, and the Green cluster representing occupational hazards with 4 keywords.

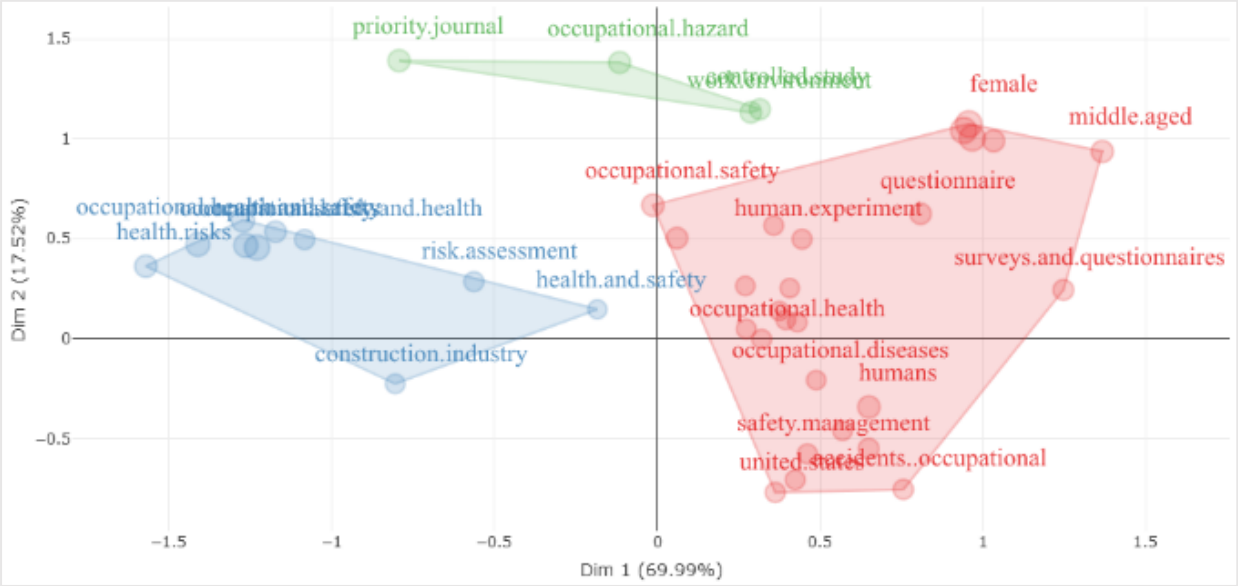

Figure 19: Multiple correspondence analysis

The analysis indicated that Dimension 1 explains approximately 69.88% of the total variance in the data, highlighting the primary axis of variation among the keywords. Meanwhile, Dimension 2 accounts for 17.52% of the variance, indicating secondary patterns or distinctions among the keywords orthogonal to Dimension 1.

Social Structure

This section explores international collaboration in Occupational Health and Safety, analyzing partnerships and knowledge exchange initiatives among countries to enhance best practices, regulatory frameworks, and research efforts for global workplace safety improvement.

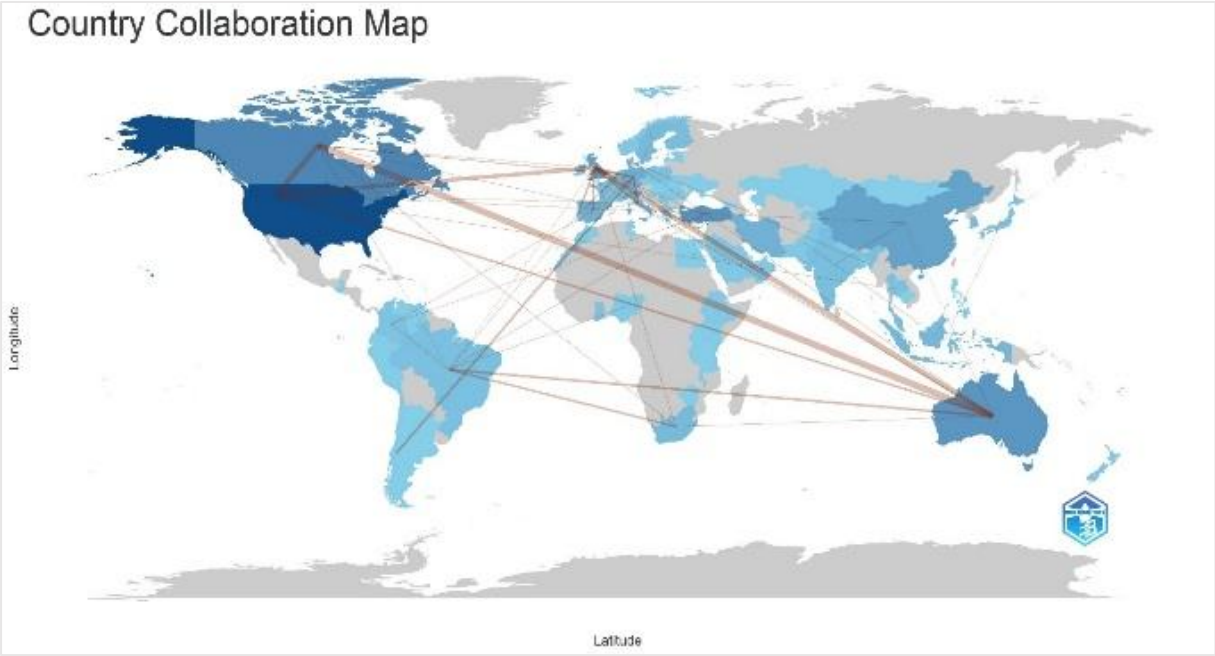

Figure 20: Country Collaboration Map

Figure 20 presents a Countries' Collaboration World Map, where brown coloring highlights the existence of international research collaborations. Among the nations, Canada, Australia, the UK, and the US demonstrate the highest levels of engagement in international research networks in title occupational Health and Safety.

Discussion

The presented bibliometric data provides meaningful information on the current state and trends within the field of occupational health and safety research. The data shows that this is a rapidly growing domain, with nearly all metrics such as annual publications, citations received, and number of contributing authors and institutions exhibiting upward trends over the past decade. This rapid growth indicates the increasing priority, resources, and scientific advancement being dedicated to this critical area of research globally. Certain countries, such as the United States, Canada, Turkey, and Iran, have emerged as clear leaders based on both large research publication volumes and high citation impact. However, high levels of international collaboration are also evident, reflecting the shared, global nature of the challenges being addressed. A few core institutions like the National Institute for Occupational Safety and Health and select universities have established themselves as hubs driving the evidence base forward through sustained high quantities of publications over long periods of time. Additionally, individual high-impact scholars from diverse locations have made seminal contributions and established themselves as thought leaders, such as Hasle, Gibb, Iavicoli, and Mori. Key thematic areas represented in trend topics, co-word analyses, and clustered keywords include occupational health nursing, diseases, construction safety, risk assessment approaches, and management strategies. Risk assessment has explicitly proven to be an especially influential methodology based on its frequent usage and central positioning in co-citation networks. Overall, the literature appears to exhibiting increasingly diverse research frontiers and directions over time, as depicted by fluctuations in citation patterns across the review period. This multifaceted analysis therefore demonstrates that occupational health and safety research constitutes a dynamic, globalized, and impactful scientific domain advancing protections for workers internationally.

Conclusion

This bibliometric analysis reveals the dynamic and globalized nature of occupational health and safety research, underscored by rapid growth and increasing collaboration. Leading countries, institutions, and scholars have emerged, driving advancements in key thematic areas such as risk assessment and management strategies. The evolving research frontiers and diverse directions indicate the field's responsiveness to emerging challenges and its pivotal role in advancing worker protections worldwide. This comprehensive analysis emphasizes the significance of ongoing scientific efforts in ensuring occupational health and safety, ultimately contributing to a safer and healthier work environment for all. Future researchers are encouraged to continue advancing methodological innovations, exploring emerging priorities like psychosocial risks, and strengthening global partnerships to further elevate occupational safety science.

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