



Review article

Revealing the unseen: a bibliometric analysis of workplace safety

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Abstract

Ensuring workplace safety is paramount for organisations operating in the health or industrial sectors, as it mitigates the risk of accidents, injuries, and illnesses that may arise during job-related activities. This study employs bibliometric methods to analyse and evaluate published literature on workplace safety, identifying major themes, authors, and publications in the field and assessing the impact and influence of research in this area. The investigation obtains datasets from Scopus and Web of Science (WoS). The ScientoPy and VOSviewer software were utilised to analyse the datasets. The findings indicate a steady rise in the literature on workplace safety since the 1970s. In 2019, a notable quantity of publications amounting to 537 across both databases was documented. The subject of “Public, Environmental & Occupational Health” has achieved the highest ranking with 1,669 publications. The top five author keywords associated with this subject are “occupational health and safety”, “health and safety”, “safety”, “occupational safety”, and “occupational health”. The term “COVID-19” has garnered significant attention recently, particularly in 2021 and 2022. The bibliometric analysis indicates that workplace safety research has been a consistent and growing topic of scholarly interest. The findings can guide future research undertakings, decision-making processes in policy formulation, and practical measures aimed at augmenting occupational safety and preserving workers’ well-being and general welfare.

Keywords: Bibliometric; COVID-19; Occupational health and safety; Workplace safety

Introduction

Workplace safety is vital to any organisation in the health or industrial sectors. It aims to prevent accidents, injuries, and illnesses while performing job tasks. Importantly, for practical significance and considerations, ensuring workplace safety is a moral responsibility and a legal requirement for employers (Awais-E-Yazdan et al., 2022; Christie, 2015). Workplace accidents and injuries can have severe consequences for employees (Roslan et al., 2023), including physical harm, mental trauma, loss of income, and long-term disabilities (Applebaum et al., 2019; Koo and Ki, 2020). Also, they can lead to legal liabilities, lawsuits, and damage to the organisation’s reputation (Heydari and Fallah-Aliabadi, 2021; Roldán, 2019).

Research in workplace safety is essential to prevent employee injuries and reduce safety-related incidents. A potential reason is that investing in workplace safety can help reduce the incidence of accidents and injuries, leading to increased productivity, improved employee morale, and decreased healthcare and insurance costs (Andersen et al., 2018; Huang et al., 2021; Jilcha and Kitaw, 2017). Studies have shown that leadership involvement and implementing preventive, directive, and corrective controls can significantly reduce workplace injuries (Abdullah et al., 2020; Liang et al., 2020; Tao et al., 2020). Moreover, a safe work environment can help retain employees and attract potential talent, leading to higher employee satisfaction, lower turnover rates, and a positive brand image (Lee, 2022; Nazir et al., 2021; Sadatsafavi et al., 2015).

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Workplace safety practices have changed in response to evolving workforce needs (Abdullah, 2022; Roslan et al., 2023). Early safety precautions were mainly focused on industrial mishaps in mines and factories (Ismail et al., 2021). Safety equipment, safety protocols, and protection gear were among the steps implemented. Workplace safety practices have evolved to reflect these changes as the workforce has become more diverse and new dangers have emerged (Abdrakhmanov et al., 2022). Training, hazard assessments, personal protection equipment, and safety management systems have recently been included in workplace safety practices (Daba et al., 2022; Liu et al., 2022; Zaira and Hadikusumo, 2017). Developing new technologies, such as artificial intelligence and machine learning, results in new workplace safety approaches (Abdullah and Sofyan, 2023; Anastasi et al., 2021; Danis, 2019).

Workplace hazards and risks can be broadly classified into four categories: physical hazards, chemical hazards, biological hazards, and ergonomic hazards. Physical hazards include noise, vibration, temperature extremes, radiation, and ergonomic stresses that can cause physical harm or discomfort to employees (Harmse et al., 2016). Chemical hazards involve exposure to toxic substances, such as gases, fumes, and vapours, which can cause acute or chronic health effects (Perkins et al., 2019). Biological hazards refer to exposure to infectious agents such as viruses, bacteria, fungi, or parasites, leading to infections, illnesses, and diseases (Mansor et al., 2019). Ergonomic

hazards are associated with repetitive motions, awkward postures, and manual handling tasks, leading to musculoskeletal disorders (Harmse et al., 2016).

In order to mitigate these hazards, workplaces often implement safety measures and procedures. Personal protective equipment (PPE), such as safety goggles, gloves, respirators, and hard hats, is commonly used to protect workers from physical and chemical hazards. Safety training programs educate workers on the proper use of PPE, safe work practices, and emergency procedures (Abdullah and Abd Aziz, 2020). Hazard identification and risk assessment procedures are employed to identify hazards and evaluate their likelihood and severity, enabling workplaces to implement risk control measures to reduce or eliminate potential hazards (Elenge and Brouwer, 2011; Huang and Wu, 2019). Safety audits are also conducted to assess compliance with safety regulations, identify areas for improvement, and ensure the effectiveness of safety measures (Gray et al., 2016; van Gelderen et al., 2017).

The objective of this study is to use bibliometric methods to analyse and evaluate published literature on workplace safety. Specifically, the study aims to identify major themes, authors, and publications in the field, and assess the impact and influence of research in this area. Additionally, the study will uncover any gaps or areas requiring further research in workplace safety. Table 1 contains the research questions derived from the current research objective:

Table 1. Research questions

	Research question	Motivation
RQ1	What are the pattern growth trends of publication of workplace safety over the past decade?	To gain a better understanding of the current state of research on workplace safety
RQ2	What are the key scientific journals and research areas that have contributed to the field of workplace safety?	To provide insights into the progress made in this area and the areas that require further research
RQ3	What are the top publications in the field of workplace safety?	To identify the most highly cited publications
RQ4	What are the most productive institutions that published research on workplace safety?	To identify the most productive institutions
RQ5	What are the major themes and research gaps requiring further investigation in workplace safety?	To identify the significant themes in the literature and to provide possible future research on workplace safety

Materials and methods

Bibliometric analysis

Bibliometric analysis is a quantitative research method used to analyse and measure the bibliographic features of a body of literature. This method often evaluates scientific research's impact and identifies the most influential authors, journals, or publications in a particular field (Abdullah and Sofyan, 2023; Agarwal et al., 2016; Zupic and Čater, 2015). Bibliometric analysis typically involves collecting data on the number of publications, citations, and co-citations in a specific field, and using statistical methods to analyse and interpret the data (Donthu et al., 2021; Silveira and Zilber, 2017).

Datasets retrieval and analysis

This study's dataset retrieval process involves gathering relevant data from two bibliographic databases, Scopus and Web of Science (WoS). These databases are commonly used in bibliometric analyses, providing access to vast scholarly literature across multiple disciplines (Prancutė, 2021; Thompson and

Walker, 2015). The search query included multiple keywords related to workplace safety, including "Workplace safety", "Occupational safety", "Health and safety", "Industrial safety", "Employee safety", "Workplace risk management", "Workplace injury prevention", "Workplace accident prevention", "Workplace hazard control", "Workplace emergency preparedness", and "Safety at work". The researchers searched for these keywords within the title field of publications on April 7, 2023. Title-based dataset retrieval is crucial for highlighting the content-related and structural development of specific research topics (Tullu, 2019). After retrieving the Scopus and WoS datasets, the next step in the bibliometric study would be to analyse the data using ScientoPy and VOSviewer software.

Combining and cleaning duplicates

One common issue with bibliometric studies is the presence of duplicates in the dataset. Duplicates can arise for various reasons, such as multiple indexing of the same publication, author name variations, and publication metadata differences. Identifying and removing duplicates is essential to ensure the analysis is based on a clean and reliable dataset. In this biblio-

metric study, the researchers used ScientoPy to combine and clean duplicates from the retrieved datasets.

Results

General overview of the preprocessed bibliographic datasets

The ScientoPy module enables more effective preliminary analysis of workplace safety research in Scopus and WoS databases by merging datasets and eliminating duplicates. The datasets

obtained from both databases contained 17,294 publications, with the earliest paper found in 1914 and authored by Hamor (1914), indexed by Scopus. The inclusion criteria focused on document types such as articles, reviews, proceedings, book chapters, and conference papers, resulting in 13,879 publications to be examined, with 8,643 in Scopus and 5,236 in WoS. The removal of duplicates resulted in 9,712 datasets, with 4,519 from Scopus and 5,193 from WoS. With respect to this, 4,167 duplicate papers were eliminated from the analysis. The structure of database and registry searches in the current study is illustrated in Diagram 1, following the steps proposed by Page et al. (2021).

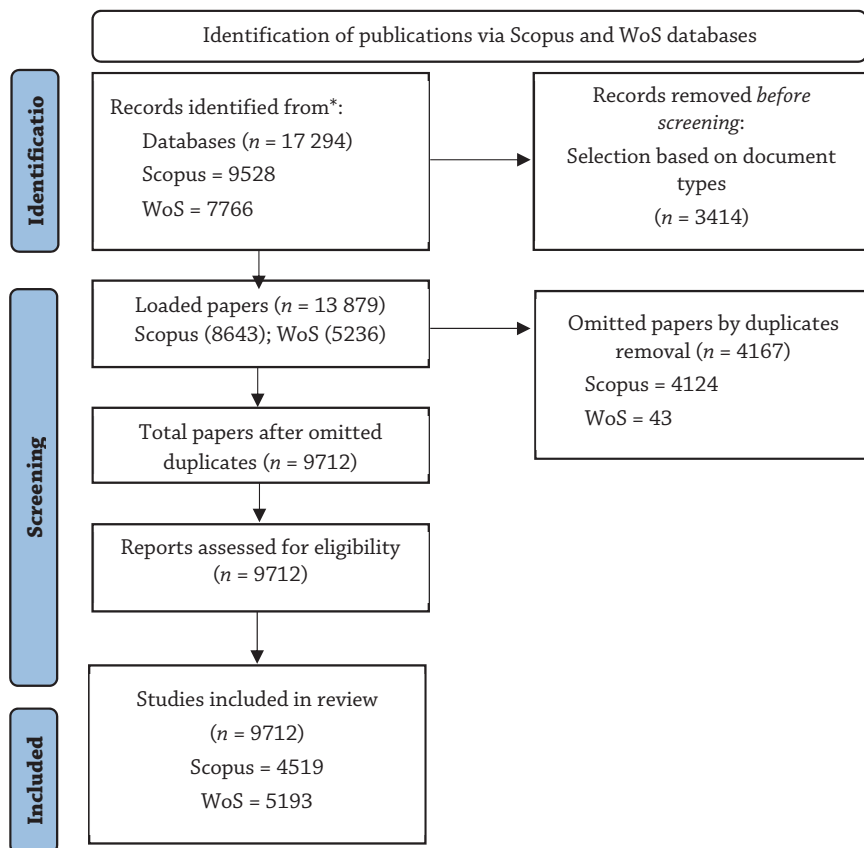


Diagram 1. Flow diagram of searches of databases and registers

Publication growth trends

Chart 1 illustrates the outcome of publication development, which has been categorised into five distinct time frames: from 1914 to 1965, from 1966 to 1980, from 1981 to 1995, from 1996 to 2010, and from 2011 to 2022. Based on Chart 1, from 1914 to 1965 there were very few publications in both WoS and Scopus databases, with no publications at all in WoS until 1970. Commencing in the 1970s, there was a notable surge in publications, culminating in a peak in 2019.

Key scientific journals and research areas

Chart 2 depicts the top ten scientific journals that published papers on workplace safety. At the top of the list is “Safety Science”, with a total of 258 publications, followed closely by “Bezopasnost’ Truda v Promyshlennosti”, with 253 publications. Both journals are focused on occupational safety research and are highly regarded in the field.

Regarding research areas, “Public, Environmental & Occupational Health” is the top-ranked subject, with 1,669 publications, as shown in Chart 3. This indicates a strong interest in studying health and safety in the workplace and environmental health. Data in Chart 3 also show the percentage of documents published in the last two years (2021 to 2022) for each subject. The subject with the highest percentage of documents published in the last two years is Environmental Sciences & Ecology at 23%, followed by Science & Technology – Other Topics at 24%.

Publications with more than 300 citations

Table 2 shows a list of publications with more than 300 citations. The citation count measures the impact or influence of a publication in the scientific community (Lee et al., 2021). The higher the citation count, the more widely cited and influential the publication is considered to be (Sofian et al., 2023). The

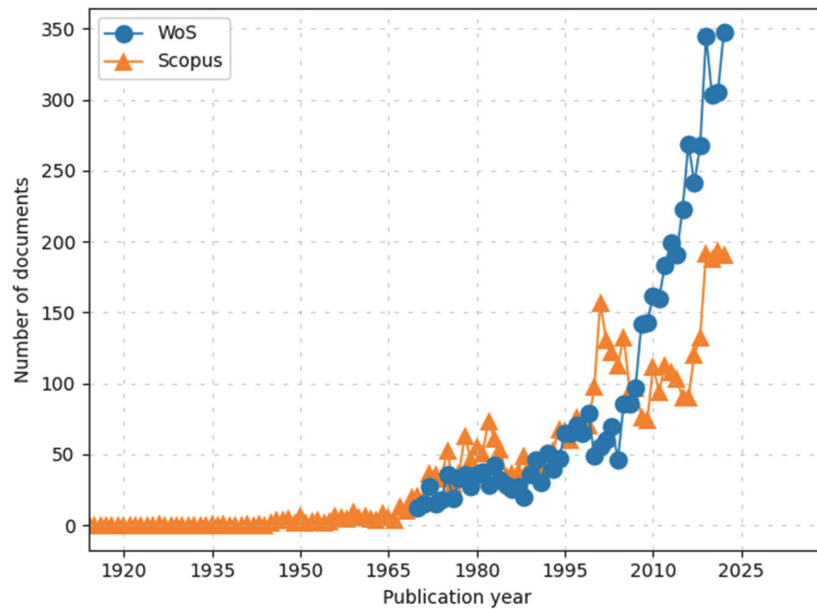


Chart 1. Publication growth trends in Scopus and WoS databases

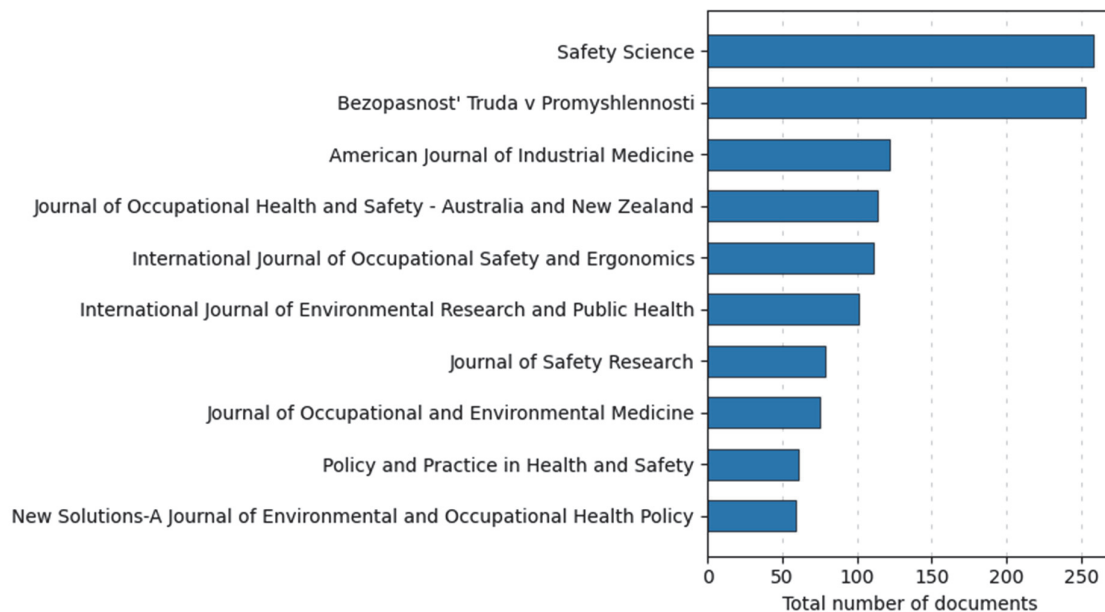


Chart 2. The top ten scientific journals

most highly cited publication on the list is “Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective” by Auffan et al. (2009), with 1,325 citations. This is followed by “Workplace safety: a meta-analysis of the roles of person and situation factors” by Christian et al. (2009) with 993 citations, and “Carbon nanotubes: a review of their properties in relation to pulmonary toxicology and workplace safety” by Donaldson et al. (2006) with 924 citations.

Productive institution

Productive institution research papers are the scholarly works that academic or research institutions produce that show high

productivity regarding the amount and quality of research work they make. Chart 4 illustrates the top ten productive publications concerning research work on workplace safety. NIOSH (National Institute for Occupational Safety and Health) in the United States is ranked first with 65 publications, followed by the University of Toronto and the Institute for Work and Health in Canada, with 54 and 48 publications, respectively. Monash University in Australia and the University of Minho in Portugal complete the top five, with 37 and 34 publications, respectively.

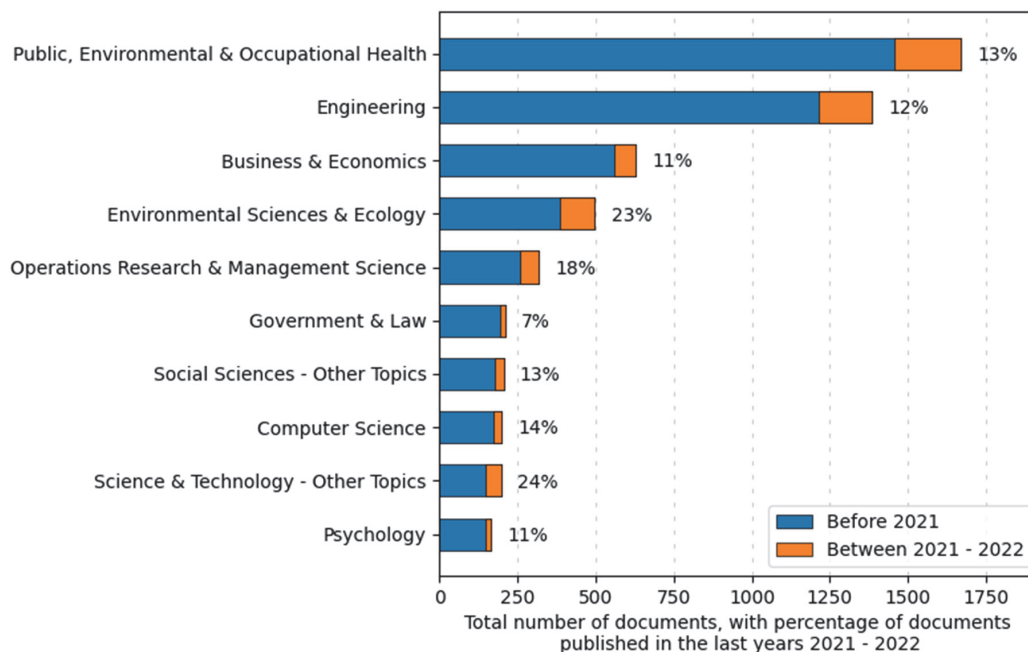


Chart 3. The top ten research areas

Table 2. List of publications with more than 300 citations

Source	Title	Citation count	Document type
Auffan et a. (2009)	Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective	1325	Review
Christian et al. (2009)	Workplace safety: a meta-analysis of the roles of person and situation factors	993	Review
Donaldson et al. (2006)	Carbon nanotubes: a review of their properties in relation to pulmonary toxicology and workplace safety	924	Review
Barling et al. (2002)	Development and test of a model linking safety-specific transformational leadership and occupational safety	672	Proceedings
Zacharatos et al. (2005)	High-performance work systems and occupational safety	547	Review
Lee et al. (2010)	Nanomaterials in the construction industry: a review of their applications and environmental health and safety considerations	525	Review
Chandler et al. (2009)	Treating drug abuse and addiction in the criminal justice system improving public health and safety	385	Article
Spurgeon et al. (1997)	Health and safety problems associated with long working hours: a review of the current position	357	Review
Craighead et al. (1982)	The pathology of asbestos-associated diseases of the lungs and pleural cavities – diagnostic-criteria and proposed grading schema – report of the pneumoconiosis committee of the college-of-american-pathologists and the national-institute-for-occupational-safety-and-health	330	Article
Taurozzi et al. (2011)	Ultrasonic dispersion of nanoparticles for environmental, health and safety assessment – issues and recommendations	324	Article
Robson et al. (2007)	The effectiveness of occupational health and safety management system interventions: a systematic review	321	Review
Komaki et al. (1978)	A behavioral approach to occupational safety: pinpointing and reinforcing safe performance in a food manufacturing plant	315	Article
Ilbahar et al. (2018)	A novel approach to risk assessment for occupational health and safety using pythagorean fuzzy ahp & fuzzy inference system	306	Article

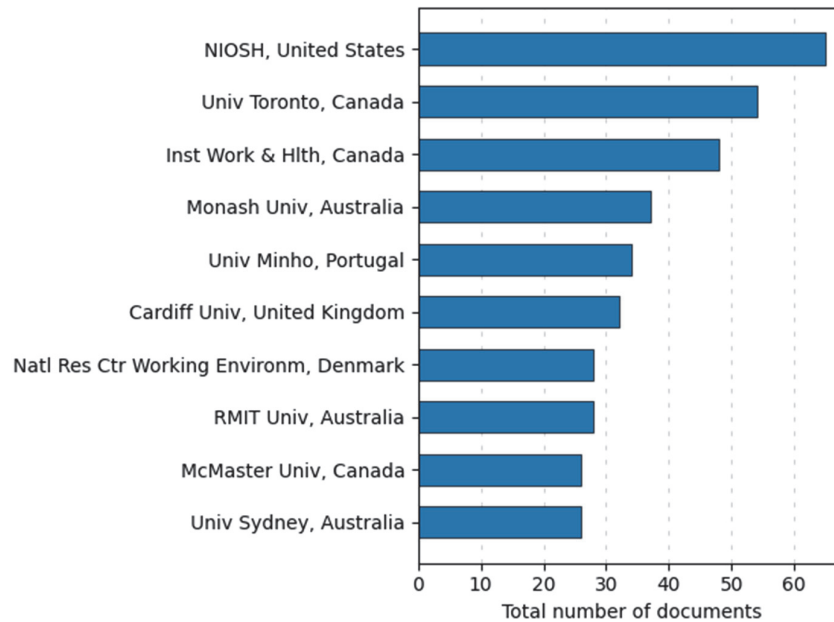


Chart 4. The top ten productive institutions

The major themes and research gaps

The significant themes in this study were derived from 20 authors' keywords used in previous research. Based on Chart 5, the results represent the author keywords and their corresponding totals, along with the percentage of documents published in the last two years (2021–2022) for each keyword. The top five author keywords are “occupational health and safety”, “health and safety”, “safety”, “occupational safety”, and “occupational health”. These keywords suggest that research in the field of workplace safety is focused on preventing occupa-

tional hazards and improving the health and safety of workers. Other notable authors' keywords include “construction”, “risk management”, “risk assessment”, “workplace safety”, and “COVID-19”. The high percentage of documents published in the last two years (PDLY) for “COVID-19” highlights the significant impact of the pandemic on workplace safety research. Notably, “COVID-19” is a keyword that has gained significant attention in the last two years, with 80.2% of publications containing this keyword during this time.



Chart 5. The top 20 authors' keywords

Diagram 2 is a network visualisation map of author keywords with a minimum frequency of 50 times. The map includes 27 keywords. The node size is proportional to the frequency of occurrence of the keyword. The keywords are ranked in descending order based on their occurrences. The most frequent keyword is “occupational health and safety”, with 508 occurrences and a total link strength of 277. Diagram 2 also shows that the keyword “safety” has a high total link

strength of 507, indicating that it is highly connected to other keywords in the dataset. The co-occurrence of keywords refers to how they are associated or appear together within the dataset. In this study, the co-occurrence map provides valuable insights into the most prevalent and essential workplace safety-related keywords in the bibliographic dataset, which can influence future research and exploration in the field.

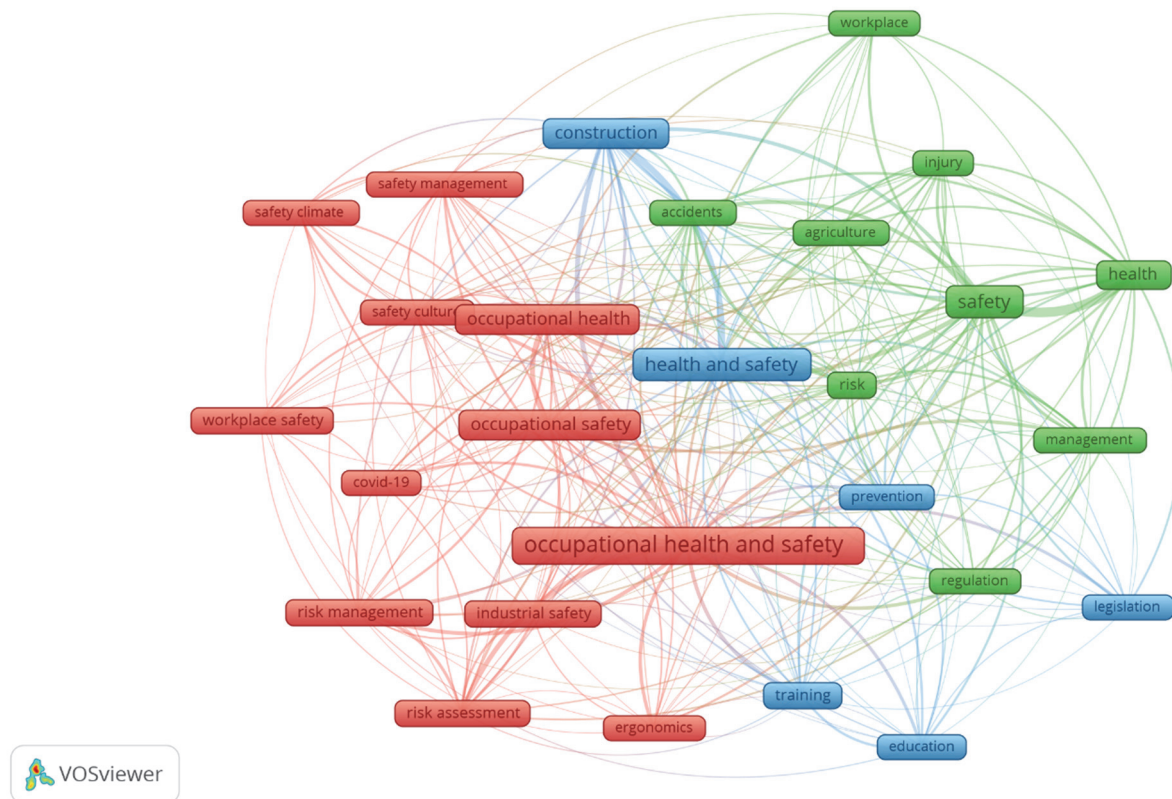


Diagram 2. A keyword co-occurrence map

Discussion

Researchers have been studying workplace safety for a considerable time, as indicated by the steady rise in publications from 1914 to 1996 and the subsequent increase from 1996 to 2010. This finding supports the statement made by Burke and Signal (2010) that workplace safety aims to address a theoretical gap in our comprehension of how individual differences and situational factors interact over time to affect safety behaviours at the individual level. Additionally, Khosravi et al. (2013) found that workplace safety plays a crucial mediating role in linking safety climate to the engagement of construction workers in safe or unsafe behaviour.

The reduced growth rate from 1996 to 2010 could be attributed to a plateau in research or a shift in focus to other topics. Researchers may have already investigated critical research questions, leading to a plateau in the research domain. However, there is still potential to improve overall safety performance by exploring a more comprehensive range of factors beyond physical safety, such as organisational and culture-related factors, as suggested by Newaz et al. (2021). The decrease

in workplace safety research from 1996 to 2010 might also be explained by researchers shifting their attention towards other emerging research fields considered more relevant to contemporary social or economic challenges.

The increase in publications from 2011 to 2022 indicates that researchers have regained their interest in workplace safety research. Several studies support the idea that there has been an increase in publications related to workplace safety research from 2011 to 2022. For instance, with the COVID-19 pandemic, workplace safety has become a critical area of concern, leading to increased research interest (Willis et al., 2021). Another reason for the increase in publications could be advancements in research methods and technologies. Researchers may have developed new research tools and techniques that have made it easier to investigate workplace safety issues, increasing research output (Baby et al., 2021).

The results presented in the study highlight the critical scientific journals and research areas in the field of workplace safety. The journal “Safety Science” and “Bezopasnost’ Truda v Promyshlennosti” are the top two journals with the most publications that focus on occupational safety research and have a solid reputation in the field (Merigó et al., 2019). The

subject with the highest percentage of documents published in the last two years is Environmental Sciences & Ecology at 23%, followed by Science & Technology – Other Topics at 24%. This suggests these subjects may be experiencing rapid growth or advancements (Ruiz-Rosero et al., 2019).

Table 2 presents a list of highly cited publications, with over 300 citations, that have significantly contributed to advancing knowledge and practices in various fields. The high citation counts indicate the impact and influence of these publications on their respective fields (Lee et al., 2021; Sofian et al., 2023). The publications cover various topics related to environmental health and safety, workplace safety, drug abuse and addiction, and occupational health and safety management. The most highly cited publication on the list is written by Auffan et al. (2009): “Towards a definition of inorganic nanoparticles from an environmental, health and safety perspective”, which has been cited 1325 times. This publication has contributed significantly to defining and understanding the environmental, health, and safety impacts of inorganic nanoparticles.

The ranking of institutions based on their publications related to occupational safety and health is an essential indicator of the research productivity of these institutions. As the leading institution in the field, NIOSH has a strong reputation for its research on occupational safety and health in the United States (Neu-Baker et al., 2022). Its publications have contributed significantly to developing knowledge and practices in occupational safety and health and have influenced policy decisions in the United States and worldwide (Tamers et al., 2019).

The results highlight the major research themes and areas of focus in workplace safety. The prominence of keywords such as “occupational health and safety”, “health and safety”, and “safety,” underscores the importance of preventing occupational hazards and improving worker safety and health. The emergence of “COVID-19” as an essential keyword with a high PDLY underscores the pandemic’s impact on workplace safety research and the need for studies to examine the challenges and strategies for ensuring worker safety during the pandemic. The findings of this study corroborate the assertion made by Willis et al. (2021) that the COVID-19 pandemic has brought to light pre-existing concerns regarding occupational health and safety, which carry significant ramifications for job contentment, healthcare personnel retention and, ultimately, the quality of patient care.

The investigation highlights various areas of research that require further exploration in the realm of occupational safety, such as “regulation”, “safety culture”, and “safety climate”. Li et al. (2022) observed that the predominant emphasis in safety climate research is on creating and authenticating questionnaires and surveys tailored to particular organisational settings. On the other hand, research on safety culture establishes a connection between these metrics and more comprehensive organisational attributes and managerial methodologies. The keywords mentioned above underscore the necessity for further investigation in said domains. Additional research in these areas may fill the existing gaps in comprehension and facilitate the creation of efficacious policies and tactics to enhance workplace safety.

The network visualisation map of author keywords provides additional insights into the most frequent and essential keywords related to workplace safety. The map highlights the interconnections between different keywords and their relative importance in the field. For instance, “safety” is highly connected to other keywords, indicating its significance in the workplace safety discourse. The map can help researchers

identify the most relevant and essential keywords for their research and guide future studies. The study’s findings have significant implications for advancing knowledge and practices in workplace safety. The study highlights the importance of ongoing research to address emerging challenges, such as the COVID-19 pandemic, and identifies areas for future research to address gaps in current knowledge.

Conclusion

The bibliometric analysis shows that workplace safety research is the subject of consistent and growing interest among researchers. The publication growth trends indicate that there has been a recent surge in research interest in this field. The study has identified critical scientific journals, research areas, highly cited publications, and institutions that have significantly contributed to advancing knowledge and practices in occupational safety and health. However, the publication rates alone do not necessarily indicate the quality or impact of research in a given field. Therefore, further evaluation and analysis of the content and impact of research publications in each field are necessary.

The current bibliometric analysis on workplace safety has significantly contributed to the body of knowledge and practices in this field. By utilising bibliometric techniques, this study has identified the main topics, authors, and publications related to workplace safety and has determined the impact and influence of research in this domain. The study’s findings indicate that workplace safety research is a growing interest among researchers, and the field is likely to continue to grow.

The study has also identified critical scientific journals and research areas in workplace safety. This information is crucial for researchers and practitioners to stay up-to-date with the latest research trends and to identify areas where further research is necessary. Additionally, the study has provided a list of highly cited publications that have significantly contributed to advancing knowledge and practices in various fields related to workplace safety.

Furthermore, the study’s evaluation of the research productivity of institutions in occupational safety and health is essential for identifying institutions that have made significant contributions to the field. This information is helpful for policymakers, funders, and researchers to determine where to direct resources and funding to maximise impact.

The current bibliometric analysis on workplace safety has provided valuable insights into the research trends, critical scientific journals and research areas, highly cited publications and institutions’ research productivity. These findings can help guide future research directions, policy decisions, and practical interventions to improve workplace safety and protect workers’ health and well-being.

A limitation of the study is that it used only two databases, Scopus and WoS, which may not cover all occupational safety and health publications. Future research directions could explore the intersection between workplace safety, the economy, and the environment, and evaluate the effectiveness of interventions for improving occupational safety and health. It could also examine the impact of emerging technologies on workplace safety and health, such as artificial intelligence and the Internet of Things. The study can also be expanded to cover more databases and utilise other bibliometric software, such as SciMAT, BibExcel, and CiteSpace, for a comprehensive view of the research landscape in occupational safety and health.

Credit authorship contribution statement

Khairul Hafezad Abdullah: Visualisation, Software, Methodology, Formal Analysis, Conceptualisation, Project Administration, Validation, Writing, Reviewing, and Editing. *Mohd Firdaus Roslan*: Data retrieval, Visualisation, Software, and Methodology. *Noor Syazwani Ishak*: Formal Analysis and Conceptualisation. *Noor Syamimi Ishak*: Formal Analysis and

Conceptualisation. *Mohamad Afifi Yahya*: Validation, Writing, Reviewing, and Editing. *Haniff Riza Abdul Hadi*: Validation, Writing, Reviewing, and Editing. *Mohamad Shahrul Nizam Mohd Rosaai*: Validation, Writing, Reviewing, and Editing.

Ethical aspects and conflict of interest

The authors have no conflict of interest to declare.

Odhalení neviditelného: bibliometrická analýza bezpečnosti na pracovišti

Souhrn

Zajištění bezpečnosti na pracovišti je prvořadě pro organizace působící ve zdravotnictví nebo průmyslu, protože snižuje riziko nehod, zranění a nemocí, které mohou nastat při činnostech souvisejících s prací. Tato studie využívá bibliometrické metody k analýze a hodnocení publikované literatury o bezpečnosti na pracovišti, identifikaci hlavních témat, autorů a publikací v oboru a hodnocení dopadu a vlivu výzkumu v této oblasti. Výzkum využívá datové sady ze Scopusu a Web of Science (WoS). K analýze datových souborů byly použity softwary ScientoPy a VOSviewer. Zjištění naznačují stálý nárůst literatury o bezpečnosti na pracovišti od sedmdesátých let 20. století. V roce 2019 bylo zdokumentováno značné množství publikací (537) napříč oběma databázemi. Nejvyššího hodnocení dosáhl předmět „Veřejné, environmentální a pracovní zdraví“ s 1 669 publikacemi. Pět hlavních klíčových slov autorů spojených s tímto tématem jsou „bezpečnost a ochrana zdraví při práci“, „bezpečnost a ochrana“, „bezpečnost“, „bezpečnost práce“ a „ochrana zdraví při práci“. Termín „COVID-19“ si v poslední době získal významnou pozornost, zejména v letech 2021 a 2022. Bibliometrická analýza ukazuje, že výzkum bezpečnosti na pracovišti je konzistentním a rostoucím tématem vědeckého zájmu. Zjištění mohou být vodítkem pro budoucí výzkumné podniky, rozhodovací procesy při formulování politiky a praktická opatření zaměřená na zvýšení bezpečnosti práce a zachování obecného pracovního blahobytu.

Klíčová slova: bibliometrický; bezpečnost a ochrana zdraví při práci; bezpečnost na pracovišti; COVID-19

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