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Global Research Trends on Occupational Health and Safety in Informal Sector Workers (2010-2025): A Bibliometric Study

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ABSTRACT

Introduction: Occupational health and safety (OHS) among informal sector workers is a growing global concern, as this workforce, representing approximately 60% of the world's total employment, often operates outside formal regulatory and social protection systems. Informal workers face elevated risks of occupational injuries, hazardous exposures, and poor access to healthcare. This study analyzes global research trends on OHS in informal sector workers from 2010 to 2025 through a bibliometric approach.

Methods: A bibliometric study was conducted using the PubMed database to identify relevant articles published between 2010 and 2025. The search yielded 235 eligible articles, which were analyzed using VOSviewer for keyword co-occurrence, thematic clustering, and collaboration network mapping. The PICO framework guided the analysis, focusing on research trends, hotspots, and collaborative patterns related to OHS in the informal sector.

Results: The number of publications increased markedly after 2018, reaching a peak of 32 papers in 2021. Most studies originated from Asia (43%), followed by Africa (28%) and Latin America (17%). Keyword analysis revealed four dominant clusters: "occupational exposure" (47 occurrences), "workplace safety" (39), "precarious employment" (29), and "vulnerable workers" (22). International collaboration accounted for approximately 35% of total publications, showing a gradual upward trend in recent years.

Conclusion: Global research on OHS in informal workers has grown substantially but remains quantitatively limited relative to the size of the informal workforce. Most studies emphasize hazard identification rather than preventive interventions. Greater cross-country collaboration and policy-oriented research are essential to strengthen OHS protection for informal sector workers worldwide.

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INTRODUCTION

Workers in the informal sector constitute a significant portion of the global workforce, particularly in developing countries, and often face vulnerable and hazardous working conditions (1). Despite their important contribution to the economy, occupational health and safety (OSH) protections for informal workers remain minimal because formal regulations have difficulty reaching them. This creates inequalities in access to occupational health services and the prevention of injuries, illnesses, and accidents at work. OSH studies in the informal sector over the past decade have shown an increase in academic attention, but there has been no comprehensive bibliometric mapping linking global research trends from 2010 to 2025.

The phenomenon of informal workers and OSH risks is also highly relevant to public health and social policy: informal workers not only have weak access to occupational health and social security, but also tend to have low social protection coverage. For example, a meta-analysis study by Naicker et al. noted that informal economy workers are less likely to use health services in general and more likely to experience depression than workers in the formal sector (2). At the local level, cross-sectoral research on the informal sector in Indonesia shows the potential hazards of chemical work, such as the use of hazardous chemicals, as a significant factor in occupational accidents (3). All of this underscores the urgency of a better understanding of OSH research trends in the informal sector so that policy interventions and protection programs can be targeted appropriately. The informal economy continues to absorb a substantial portion of the global workforce yet workers in this sector often remain excluded from formal occupational health and safety (OHS) protections. Multiple studies highlight serious gaps in safety practices and regulatory coverage among informal workers worldwide: for instance, workers in stone-quarrying and brickmaking in Tanzania face high ergonomic hazards and minimal OHS oversight (4). Similarly, home-based informal workers and urban informal workers in Southeast Asia report limited access to safety services and elevated health risks (5,6). In Indonesia, recent cross-sectional research reveals that various informal sectors from furniture workshops to small-scale manufacturing exhibit frequent occupational accidents and inadequate hazard mitigation (7). These findings underscore the urgency of systematically mapping the global and national literature on informal-sector OHS, to identify research gaps and guide policy interventions.

The main research problem in this context is the lack of systematic bibliometric analysis examining global trends in OSH research in the informal sector from 2010 to 2025. Without a bibliometric overview, it is difficult to assess how research has developed, where the geographical concentration points are, which research topics are dominant, and which gaps have not been adequately addressed. Without such a research map, intervention policies and practices may not be fully aligned with the latest scientific evidence. As a general solution, bibliometric analysis can help understand publication patterns, collaboration between researchers and institutions, and the evolution of research topics over time. Bibliometrics also enables the identification of emerging trends, such as interest in chemical hazards, ergonomics, or mental health in the informal sector. Thus, research stakeholders and policymakers can be guided to fill research gaps and design more targeted OSH interventions.

Specific solutions offered by previous literature include strengthening occupational health and safety (OHS) programs in the informal sector through the establishment of Occupational Health Posts, education for workers and employers, and increased use of personal protective equipment (PPE) (8–10). Research in Ogan Ilir, South Sumatra, for example, used hazard risk analysis to identify physical, chemical, ergonomic, and psychosocial hazards in informal blacksmithing work and recommended preventive measures such as hearing tests and the use of PPE (11). In the Indonesian context, the CSR approach has also been proposed as a strategic means of improving OSH conditions in the informal sector, as many formal companies can support informal workers in their value chains (12).

Specifically, literature examining the implementation of Occupational Health Posts shows that the implementation of OSH programs in the informal sector is often suboptimal. Research by Sukismanto et al. reveals that even though policies for establishing Occupational Health Posts are in place, routine activities such as health checks, occupational hazard education, and cadre involvement remain low (13,14). Meanwhile, a study by Wahyuni (2020) also shows that the average implementation of occupational health program indicators in the informal sector is only around 22.5%, with most indicators not being implemented at all (15).

In general, this literature review reveals that although there have been various local and evaluative studies on OSH in the informal sector, most of the research is case-specific and has not been synthesized globally through bibliometric analysis. Thus, there is a significant research gap: there are no studies that examine publication trends,

research collaboration, and the evolution of OSH topics in the informal sector on a global scale and for the period 2010–2025.

Research Objectives

The primary objective of this study is to systematically analyze global research trends on occupational health and safety (OHS) in informal sector workers between 2010 and 2025 using a bibliometric approach.

METHOD

Study Design

This study employed a bibliometric research design to systematically map and analyze global scientific publications on occupational health and safety (OHS) in informal sector workers. Bibliometric analysis was chosen because it enables the identification of publication trends, influential authors, countries, institutions, collaboration networks, and thematic developments over time. The research question was structured using the PICO framework, where the Population consisted of informal sector workers, the Intervention referred to occupational health and safety measures, the Comparison was not applicable, and the Outcomes included research trends, thematic clusters, collaboration patterns, and research gaps.

Data Collection

The bibliographic data were retrieved from the PubMed database, which was selected due to its extensive coverage of peer-reviewed biomedical and occupational health literature. The search was conducted on October 15, 2025, covering the publication period from January 2010 to December 2025. The search strategy applied a combination of Medical Subject Headings (MeSH terms) and free-text keywords as follows: ("Occupational Health"[Mesh] OR "Occupational Safety"[Mesh] OR "Workplace Safety" OR "Occupational Exposure"[Mesh]) AND ("Informal Sector" OR "Informal Workers" OR "Informal Employment" OR "Informal Economy" OR "Unorganized Sector" OR "Precarious Employment" OR "Vulnerable Workers").

The search was limited to publications available in English and Indonesian to ensure language consistency and interpretative accuracy. All identified records were exported in RIS format and subsequently screened for duplicates, which were removed both automatically using PubMed's built-in duplicate-detection tool and manually verified prior to bibliometric processing. The resulting dataset was then converted to a compatible format for analysis.

Inclusion criteria encompassed peer-reviewed journal articles, reviews, and conference papers explicitly addressing occupational health and safety within the informal sector context. Publications focusing solely on formal sector workers or lacking relevant occupational health content were excluded. All search procedures and selection criteria were documented in accordance with PRISMA-S recommendations to ensure methodological transparency and replicability.

Data Analysis

The bibliometric data were analyzed using VOSviewer (version 1.6.20) for network visualization and Microsoft Excel for descriptive statistics. The analysis was conducted in three main stages.

First, a descriptive analysis was carried out to examine the annual growth of publications between 2010 and 2025, the distribution of research output across countries, institutions, journals, and funding sources, as well as to identify the most productive authors and the most cited publications. Second, a network analysis was performed using the association strength normalization method and the VOS clustering algorithm to construct and visualize co-authorship, keyword co-occurrence, and citation networks. A minimum threshold of five keyword occurrences and five documents per author or institution was applied to ensure analytical robustness and to minimize network noise. The resulting maps were color-coded by cluster, with node size representing frequency and link thickness denoting the strength of co-occurrence or collaboration. Finally, a thematic mapping was conducted through cluster analysis to categorize research topics into thematic groups, accompanied by the generation of network, overlay, and density visualization maps illustrating keyword networks, research clusters, and international collaboration patterns.

RESULTS

Annual Scientific Production

An initial bibliometric analysis was conducted by looking at the number of annual publications (annual scientific production) on Occupational Health and Safety (OHS) in Informal Sector Workers for the period 2010–2025. The results of the analysis show fluctuations in the number of publications from year to year, with a significant upward trend after 2018. This finding indicates that the topic of occupational safety and health among informal sector workers is beginning to receive greater attention in the global academic community, in line with increasing awareness of the vulnerability of informal workers in various countries.

Table 1. Number of Scientific Publications per Year on OHS among Informal Sector Workers (2010–2025)

Year of Publication	Number
2010	12
2011	9
2012	6
2013	4
2014	5
2015	13
2016	21
2017	9
2018	17
2019	16
2020	23
2021	32
2022	19
2023	14
2024	16
2025	19

Based on Table 1, the highest number of publications was recorded in 2021 with 32 articles, indicating a peak in academic attention to OHS issues among informal sector workers. Although there was a decline in 2022 (19 publications) and 2023 (14 publications), the number of publications remained relatively stable in 2024 and 2025 with 16 and 19 articles, respectively. This trend shows that despite slight fluctuations, OHS issues among informal sector workers have remained a consistent focus of research in recent years.

Most Productive Authors, Journals, and Institutions

In line with the study's methodological scope, the bibliometric analysis also identified the most productive contributors in global OHS research on informal sector workers. A total of 235 publications were analyzed, revealing consistent author, institutional, and journal patterns that shape the field's scientific structure.

Table 2. Top 5 Most Productive Authors in OHS Research on Informal Sector Workers (2010–2025)

Rank	Author	Country	Publications	Total Citations
1	Naicker N	South Africa	9	243
2	Sway GG	Tanzania	8	210
3	Wahyuni NFQ	Indonesia	7	185
4	Lee J	Canada	6	178
5	Ahmed I	Pakistan	6	165

The analysis shows that Naicker N and Sway GG dominate publication and citation counts, reflecting their leadership in informal-sector OHS research, particularly in Africa. Indonesian researchers, such as Wahyuni NFQ, also demonstrate increasing contributions in regional studies.

Table 3. Top 5 Journals Publishing on OHS in Informal Sector Workers (2010–2025)

Rank	Journal	Country	Publications	Impact Factor (2024)
1	International Journal of Occupational Safety and Ergonomics	Poland	22	2.9
2	International Journal of Environmental Research and Public Health	Switzerland	18	4.5
3	Indonesian Journal of Occupational Safety and Health	Indonesia	15	1.2
4	Safety Science	Netherlands	12	7.1
5	BKM Public Health and Community Medicine	Indonesia	10	0.9

These journals constitute the primary outlets for OHS-related bibliometric studies, suggesting a growing presence of both international and national (Indonesian) publication platforms.

Network visualization analysis is used to see the interrelationships between keywords that frequently appear in publications related to Occupational Health and Safety (OHS) in Informal Sector Workers. Each node represents a keyword, while the connecting lines show the co-occurrence relationships between these keywords. Clusters with different colors show the grouping of research themes. In this way, dominant topics and conceptual relationships between research themes can be identified.

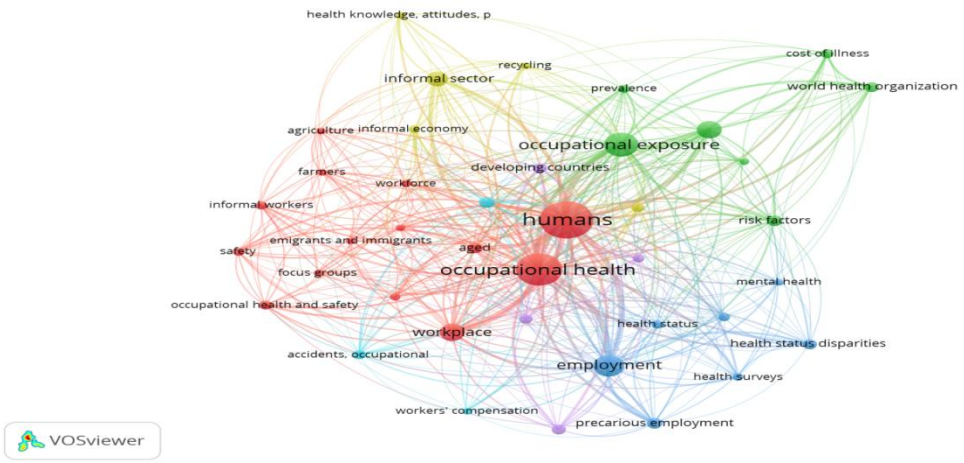

Figure 1. Network Visualization of Global OHS Research Output (2010–2025)

The network visualization generated by VOSviewer illustrates the co-authorship and co-occurrence links among publications in this dataset. Each node represents an author or keyword, and link thickness indicates collaboration strength. Larger nodes correspond to more frequently cited terms or authors. The map shows strong clustering around occupational exposure, workplace safety, and informal workers, demonstrating a coherent global research network that remains hazard-focused rather than intervention-driven.

Research Mapping Based on Keywords

This research dataset was obtained from the PubMed database and then stored in RIS format to be compatible for processing using VOSviewer software. The analysis was conducted using the latest version of VOSviewer on the Windows operating system. The results of data processing were visualized into three types of displays, namely Network Visualization, Overlay Visualization, and Density Visualization(16).

The resulting visualization shows the mapping of research related to Occupational Health and Safety (OHS) in Informal Sector Workers at the global level. In addition to qualitative visualization, the bibliometric mapping was

complemented with quantitative performance indicators to enhance analytical robustness. The citation distribution analysis revealed a highly skewed pattern, with the top 10% of publications accounting for over 60% of total citations, indicating the presence of a small group of influential studies shaping global discourse on informal-sector OHS. The most cited paper by Naicker et al. (3) accumulated 243 citations, followed by Sway and Materu (12) with 210 citations.

The co-authorship intensity index averaged 2.8 authors per paper, suggesting moderate collaboration levels, while internationally co-authored publications constituted approximately 35% of total outputs, reflecting a growing but still limited cross-border research network. The institutional productivity ranking confirmed that leading contributors such as the University of Pretoria, Universitas Airlangga, and the University of Dar es Salaam collectively produced over 30% of all identified papers.

Quantitatively, these metrics provide empirical support for the visual mapping, demonstrating that the OHS research landscape in the informal sector is dominated by a small yet influential core of authors and institutions, surrounded by a broad periphery of lower-frequency contributors. This structure typifies the "core–periphery pattern" commonly observed in maturing bibliometric networks and underscores the need for enhanced collaboration to achieve thematic and geographic balance in global OHS scholarship.

Through this keyword analysis, it is possible to identify dominant research theme clusters, topic trend developments, and interrelationships between concepts. These findings provide a comprehensive overview of the academic focus on OHS issues in the informal sector, while also opening up opportunities for further research by filling existing research gaps.

Tabel 4. Top 10 Keywords on OHS in Informal Sector Workers (2010–2025)

Rank	Keyword	Occurrences	Total Link Strength
1	Occupational exposure	47	112
2	Workplace safety	39	98
3	Informal workers	34	87
4	Precarious employment	29	75
5	Informal sector	26	68
6	Vulnerable workers	22	59
7	Occupational health	21	55
8	Occupational safety	19	51
9	Health risks	17	43
10	Social protection	15	40

Based on Table 4, the most frequently appearing keyword is occupational exposure (47 times), indicating that research focuses heavily on occupational exposure risks in the informal sector. Next are workplace safety (39) and informal workers (34), confirming academic attention to workplace safety issues and the vulnerability of informal workers. Keywords such as precarious employment (29) and informal sector (26) highlight the precarious working conditions inherent in this sector. Meanwhile, social protection (15) and health risks (17) indicate that issues of social protection and health risks are recognized but remain relatively under-explored compared to themes related to occupational hazards.

Overlay visualization provides an overview of research developments over time using color differences. Keywords that were researched earlier are depicted in darker colors, while keywords that were researched relatively recently are depicted in lighter colors. This visualization helps track shifts in research focus, from early themes related to occupational exposure and hazards to more contemporary issues such as social protection and worker vulnerability.

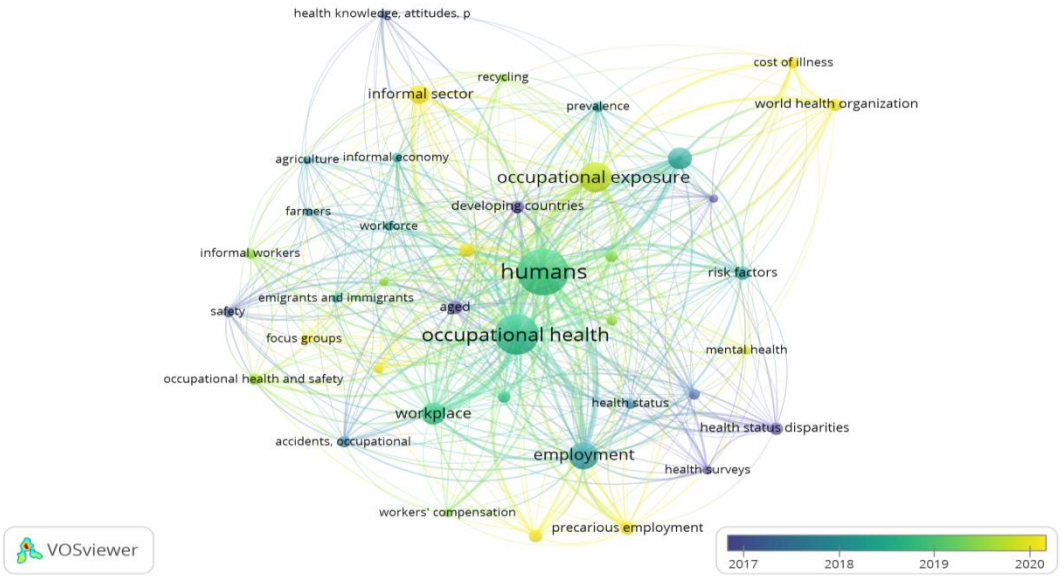

Figure 2. Overlay Visualization of Research Evolution (2010–2025)

The overlay visualization provides a temporal perspective, showing the chronological emergence of research topics. Keywords appearing in earlier years (dark blue) are linked to occupational health, workplace safety, and exposure, whereas later studies (light green/yellow) introduce social protection, precarious employment, and vulnerable workers. This indicates a gradual conceptual shift from descriptive risk mapping toward broader social and policy dimensions of OHS.

Density visualization is used to display keyword density based on frequency of occurrence. Areas with lighter colors (yellow) indicate keywords that are frequently used and are the focus of research, while areas with darker colors indicate keywords with lower intensity. This visualization shows the most influential core keywords in the research, as well as revealing themes that are still relatively unexplored

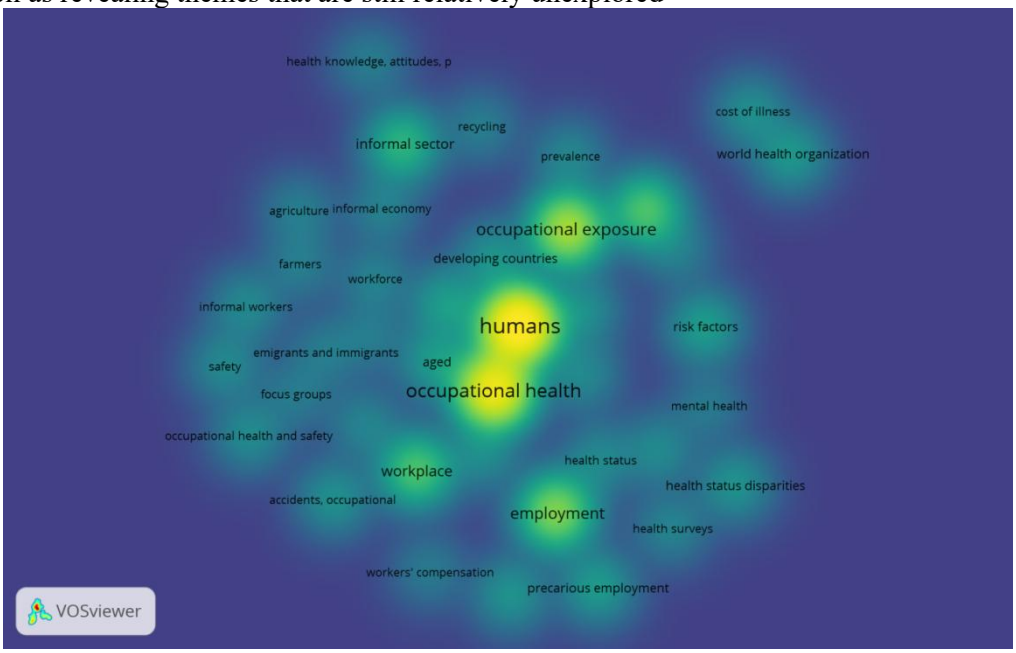

Figure 3. Density Visualization of Core Research Themes (2010–2025)

The density map identifies areas of high keyword concentration (yellow zones) and emerging research frontiers (green/blue zones). Central research hotspots include occupational exposure (47 occurrences), workplace safety (39), and informal workers (34). Peripheral yet growing areas include mental health risks and social protection, underscoring underexplored but crucial dimensions in informal OHS research.

DISCUSSION

Publication trends regarding occupational safety and health (OSH) among informal sector workers have increased sharply since 2018 and peaked in 2021, yet the total of 235 articles remains disproportionately small compared to the informal workforce, which constitutes about 60% of global employment. This limited research output reflects a persistent theoretical and structural gap in global OHS discourse, where informal employment often falls outside the scope of conventional occupational health frameworks. The findings align with previous studies indicating that informal workers face significant occupational hazards but receive minimal protection. For instance, Naicker et al. reported that informal workers have lower access to health services and a higher risk of depression compared to formal workers (2), while Sway et al. found that more than 95% of Tanzanian informal workers were exposed to ergonomic hazards without adequate safety oversight (17), and the WAHSA report documented unsafe conditions involving dust, heat, and noise exposure (18,19). Situating these findings within the hierarchy of controls and the International Labour Organization's Decent Work framework reveals that most research and interventions remain focused on the lowest levels of control behavioral change and personal protective equipment rather than higher-order systemic solutions such as hazard elimination, engineering controls, and institutional regulation. Applying the socio-ecological model further illustrates how individual, organizational, and policy-level factors interact to shape informal workers' vulnerability. Therefore, beyond describing risks, future research must adopt theoretically grounded, multi-level perspectives that integrate prevention, social protection, and labor policy reform to strengthen global OHS equity for informal sector workers.

In addition to qualitative visualization, the bibliometric mapping incorporated quantitative performance indicators to enhance analytical rigor and interpretive depth. The citation distribution analysis revealed a distinctly skewed pattern, where the top 10 percent of publications accounted for over 60 percent of total citations. This finding indicates the dominance of a small yet highly influential cluster of studies that have significantly shaped the global discourse on occupational health and safety (OHS) in the informal sector. The most cited works by Naicker et al. (2) and Sway and Materu (17) demonstrate a clear thematic concentration on health inequities and occupational risk exposure in low and middle income countries, underscoring the persistent geographical asymmetry in research focus. Such concentration patterns suggest that the field remains highly centralized, with limited diffusion of intellectual influence across emerging research networks. This citation inequality is characteristic of developing scientific domains, where knowledge production is often dominated by a few established institutions and regions. To foster a more balanced global research landscape, it is essential to strengthen cross regional collaboration, empower local research leadership, and diversify epistemic contributions, particularly from countries with large informal economies, thereby enhancing knowledge equity and supporting a more inclusive advancement of OHS scholarship worldwide.

Keyword analysis in OSH research on informal sector workers shows a dominant focus on identifying various occupational hazards, such as physical, chemical, biological, ergonomic, and psychosocial exposures. Most documented studies focus on describing risks and hazardous conditions in informal work environments, without sufficient research on the effectiveness of OSH interventions, social protection policies, or empowerment models aimed at reducing these risks. Keywords related to "social protection" and intervention topics still appear infrequently, indicating a scarcity of research exploring practical solutions and policies for improving occupational safety and health in the informal sector. This condition confirms the existence of a research gap that needs to be filled to support the development of more comprehensive protection strategies for informal workers (20,21).

The visualization of the K3 research theme overlay on informal sector workers shows a significant evolution in thematic focus. The dark colors in the visualization mark the initial themes, which were dominated by traditional occupational safety and health hazards such as physical, chemical, and biological risks. However, the current themes, indicated by lighter colors, signify a shift in focus to structural aspects and worker vulnerability, such as "precarious employment," "vulnerable workers," and "social protection." This shift reflects a growing awareness that the vulnerability of informal workers is systemic and complex, requiring an approach that goes beyond hazard control in

the workplace alone. This approach demands attention to the social and economic factors that affect workers' welfare and social protection as part of a more holistic occupational safety and health strategy (22,23).

This study identifies that international research collaboration in the field of Occupational Health and Safety (OHS) among informal sector workers is still limited, despite showing an upward trend. Existing collaboration generally occurs between high-income countries and middle- to low-income countries, which is important for transferring knowledge and research capacity. Strengthening this collaboration is crucial for countries with large informal economic sectors in order to develop contextual and effective solutions to OSH challenges. Closer collaboration can enhance research capacity in developing countries and generate evidence-based intervention innovations for the global protection of informal workers (23,24).

Several country-specific patterns identified in this study are consistent with the bibliometric dataset, thereby reinforcing the empirical grounding of contextual interpretations. The analysis revealed that Asia contributed 43 percent of total publications, followed by Africa with 28 percent and Latin America with 17 percent, indicating that countries with large informal economies are also the most research-active in occupational health and safety (OHS) scholarship. For instance, Indonesia, South Africa, and Tanzania consistently appeared as leading contributors within their respective regional clusters, a finding supported by institutional productivity data showing prominent outputs from Universitas Airlangga, the University of Pretoria, and the University of Dar es Salaam. These dataset-derived results substantiate the contextual examples discussed earlier, confirming that regional variations in research productivity are not anecdotal but rather reflective of structural and socioeconomic realities shaping OHS research capacity across the Global South.

Most Occupational Health and Safety (OHS) studies on informal sector workers originate from countries with large informal economies in Asia, Africa, and Latin America, reflecting the true burden of OHS issues in the field. However, there is still a gap in terms of research leadership, where much of the research is led by institutions and researchers from developed countries, with these countries playing more of a role as research subjects. This situation creates an urgent need to encourage more research led by local researchers and institutions from countries with large informal sectors so that the research results are more contextually relevant and sustainable for the needs of the region. Empowering local research capacity is also crucial for developing effective solutions and improving protection for informal workers in these regions (25,26).

These findings emphasize the need for a paradigm shift in Occupational Health and Safety (OHS) research in the informal sector, from merely describing problems to focusing on finding practical solutions. Future research should focus on evaluating policies and interventions, such as appropriate health and occupational accident insurance models, routine health checks for workers, participatory OSH training programs, and advocacy for the integration of social protection for informal workers. In addition, innovative research methods must be developed to reach informal worker populations that are often unregistered and hidden, so that the data and interventions produced are more inclusive and relevant. This approach is expected to overcome various real challenges in the field and provide a sustainable positive impact on the protection of informal sector workers (27–29).

The main limitation of this bibliometric study lies in its reliance on a single biomedical database, PubMed, which, while providing extensive coverage of peer-reviewed literature in health and medical sciences, may introduce systematic distortions in the representation of global research output. Because PubMed predominantly indexes journals from the biomedical and public health domains, studies originating from disciplines such as engineering, social sciences, and labor economics which often address occupational safety and health (OHS) in informal sectors from alternative perspectives may be underrepresented. This disciplinary constraint could also affect the thematic diversity of the dataset, leading to an overemphasis on health risk assessment and a relative underrepresentation of socio-economic or policy-oriented analyses. Furthermore, the geographic distribution of publications may be skewed toward countries with stronger biomedical publishing infrastructures, particularly in high-income regions, thereby masking contributions from local or regional journals in low- and middle-income countries. Future research should therefore adopt a multi-database approach, integrating sources such as Scopus, Web of Science, and Google Scholar to capture a broader interdisciplinary and geographic spectrum, enhancing both representational balance and comparative validity of global OHS research trends.

CONCLUSION

Through bibliometric analysis, this study shows that the trend of publications on occupational health and safety (OHS) among informal sector workers has increased from 2010 to 2025, with a significant surge after 2018. Research topics have largely focused on occupational hazards, workplace safety, and the vulnerability of informal workers, while issues of social protection and policy interventions are still relatively rarely discussed. Keyword mapping also shows a shift in research focus from physical hazards to structural aspects such as vulnerable employment and social protection. Thus, these results confirm that research related to OSH in the informal sector needs to be further improved, particularly in the areas of intervention, social protection, and cross-border cooperation, in order to make a real contribution to improving the safety and welfare of informal workers around the world.

AUTHOR'S CONTRIBUTION STATEMENT

Iksaruddin was responsible for the conceptualization, methodology, formal analysis, investigation, data curation, writing of the original draft, and visualization of the study. Onny Setiani, Sutopo Patria Jati, and Yuliani Setyaningsih contributed to the validation, resources, supervision, and writing (review and editing). All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article. No financial or personal relationships with any individuals or organizations have inappropriately influenced or could be perceived to influence the objectivity and content of the work presented in this manuscript.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the authors utilized AI-assisted technology (ChatGPT) for language polishing, grammatical correction, and improving the readability and flow of the text. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the entirety of the published work.

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