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Global Trends and Emerging Challenges in Occupational Skin Disease Research: A Comprehensive Bibliometric and Science Mapping Analysis

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Abstract

Occupational Skin Diseases (OSDs) represent a significant global health issue. This study aims to analyze OSD research trends from 2014 to 2023 through a comprehensive bibliometric analysis. The search was carried out in the Scopus database using keywords: "occupational skin disease" OR "work-related skin disease" OR "occupational dermatosis". A total of 491 documents were analyzed using VOSviewer and Biblioshiny. The results show an increase in publications with a peak in 2021, dominated by developed countries such as Germany and the United States, but the contribution of developing countries is starting to be seen. The focus of research shifted from classic contact dermatitis to the issue of COVID-19 and the use of personal protective equipment. The University of Osnabrück and the journal Contact Dermatitis are the main contributors. The analysis uncovered gaps in longitudinal research, insufficient research on the informal sector, and limited interventions in developing countries. Future research is suggested to focus on innovative prevention strategies, climate change impacts, and the utilization of new technologies, with an emphasis on international collaboration. This study highlights the importance of OSD research's adaptation to new challenges in the workplace and the need for a more inclusive global approach.

Introduction

Occupational Skin Diseases (OSD) continue to be one of the most prominent health problems in the global world of work (Kurniawidjadja et al., 2019). These dermatological conditions caused or exacerbated by exposure to the work environment include a variety of skin diseases, with contact dermatitis being the most common manifestation (Febriana et al., 2023). OSD not only impacts workers' health, but also brings significant social and economic implications, including decreased productivity, increased health care costs, and career changes in some cases (Hendra et al., 2018).

As industrial growth and globalization increase, so too does the prevalence of OSD, especially in sectors with high exposure to chemicals, work equipment, and personal protective equipment (PPE) (Rauf et al., 2020). Although developed countries, such as the United States and European countries, are leading OSD-related research (John et al., 2016), the challenges for developing countries, including Indonesia, are becoming increasingly relevant. In these

countries, rapid industrial growth, lack of comprehensive reporting systems, and inadequate worker protection lead to a high risk of OSD without adequate treatment (Febriana et al., 2022).

Over the past decade, research in the field of OSD has undergone rapid development, covering aspects such as etiology, diagnosis, prevention, and management (Brans et al., 2016). What's more, global events such as the COVID-19 pandemic have changed the focus of research, with greater attention to skin problems resulting from the intensive use of PPE among healthcare and industrial workers (Lan et al., 2020). Nonetheless, major challenges remain, especially related to the development of more effective prevention strategies and management approaches adapted to local contexts (Johansen et al., 2010).

To address these challenges, bibliometric analysis and science mapping have proven to be valuable tools in understanding research trends, collaboration networks, and underexplored areas (Wittlich et al., 2016). This study aims to conduct a thorough analysis of publications in the field of OSD from 2014 to 2023, in order to: 1) Analyze publication trends and research directions in the last decade; 2) Identify key contributors in this field, including countries, institutions, and researchers; 3) Mapping international collaboration networks and topics that evolve over time (John et al., 2016); 4) Uncovering research gaps and opportunities for future study development, especially in developing countries such as Indonesia (Febriana et al., 2023).

With this approach, we hope to provide valuable guidance for researchers, occupational health practitioners, and policymakers in directing the future of research and policy in the field of OSD

Methods

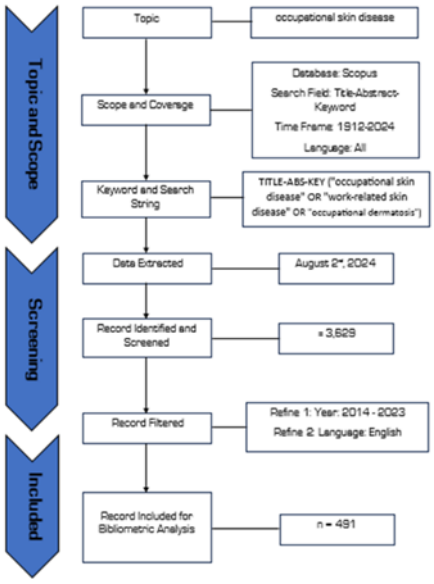

Figure 1. Methodological Flow Diagram for Bibliometric Analysis on Occupational Skin Diseases

Data Sources and Search Strategies

This study uses the Scopus database as the main data source due to its wide scope and reputation as one of the largest citation and abstract databases for peer-reviewed scientific literature (Wittlich et al., 2016). The search was carried out on August 2, 2024 using the keywords: "occupational skin disease" OR "work-related skin disease" OR "occupational dermatosis". In order to narrow the search results according to the purpose of the study, the "English" filter and publication time interval from 2014 to 2023 were applied in the search.

Inclusion criteria for selected articles include: a) Articles published between 2014 and 2023; b) Articles written in English; c) Different types of documents (research articles, reviews, conference papers, etc.) that focus on occupational skin diseases.

Exclusion criteria include: a) Articles that are not relevant to the topic of OSD; b) Articles that are not available in full or with limited access.

Data Extraction

Bibliometric data from articles that meet the inclusion criteria are extracted from Scopus in CSV and RIS formats. The extracted information includes publication metadata (title, author, affiliation, year of publication, journal), abstract, keywords, number of citations, and citations cited. Data extraction is carried out by utilizing the download function in Scopus.

Data Analysis

Bibliometric analysis was performed using a combination of software tools including VOSviewer (version 1.6.18) and Biblioshiny, an R module of the Bibliometrix package (Brans et al., 2016). The analysis methods carried out include: a) Annual publication trends: to capture shifts in the number of publications over time, which is valuable for identifying growth or decline in research on OSD;; b) Geographical distribution of publications: to identify the countries leading in OSD research; c) Contributions by institutions and authors: to analyze leading institutions and authors in the field; d) Journal analysis: to see which journals publish OSD-related articles most frequently; e) Keyword analysis: to map frequently occurring keywords and the main themes of the research; g) Co-citation analysis: to identify relationships between frequently cited articles together; h) Mapping of author and institution collaboration: to visualize the network of collaboration between researchers and institutions; i) Annual publication trends: Capture shifts in the number of publications over time, segmented into pre-pandemic, pandemic, and post-pandemic phases. This helps identify growth, decline, or disruptions in research output due to global events; External factor influences: Evaluate the impact of global health crises (e.g., COVID-19), changes in research funding, institutional research priorities, and occupational health policy on publication trends; Comparative domain analysis: Assess differences in research output across subdomains of occupational skin diseases, geographical regions, and the correlation between external factors and publication patterns.

Data Visualization

Data visualization was carried out using VOSviewer, which allows visual mapping of the author's collaborative network, the emergence of keywords, the evolution of research topics over time, and the concentration of research themes in various geographical regions (Febriana et al., 2023).

Trend Analysis and Research Gap Identification

Based on the results of bibliometric analysis and science mapping, a qualitative analysis was carried out to identify the main trends in OSD research, as well as existing research gaps and potential areas for future research, especially in developing countries such as Indonesia (Johansen et al., 2010). The study employed a multi-dimensional interpretation approach to enhance the bibliometric findings. Citation network analysis was used to evaluate not only the volume of publications but also the interconnectedness of research, identifying key influencer papers and analyzing citation patterns to understand their broader impact. Institutional contributions were assessed by considering research capacity, relative contributions to the field, and consistency of output over time to highlight nuanced contributions beyond publication counts. Additionally, the contextual citation impact was examined to determine whether high citation periods were driven by widespread research interest, the influence of key papers, or specific global events and shifting research priorities. This comprehensive approach provides

a deeper understanding of OSD research dynamics and helps to uncover trends relevant to both developed and developing contexts.

Validity and Reliability

To ensure the validity and reliability of the analysis, the following steps are implemented:

The use of the internationally recognized Scopus database (Wittlich et al., 2016). a) Implementation of a comprehensive and validated search strategy; b) Implementation of clear inclusion and exclusion criteria; c) Data verification by two independent researchers; d) Use of validated bibliometric analysis software.

Research Limitations

We acknowledge some limitations in our methodology: a) The use of a single database (Scopus) may exclude publications that are not indexed in Scopus; b) Restrictions on English-language articles may exclude significant literature in other languages; c) Bibliometric analysis has limitations in assessing the depth and quality of research content.

Result and Discussion

Annual Publication Trends

An analysis of 491 documents published between 2014 and 2023 showed a significant increase in the number of publications related to occupational skin disease (OSD). As seen in Figure 2, the number of publications increased from 35 articles in 2014 to a peak in 2021 with 87 articles. However, in 2022 there was a slight decrease in the number of publications to 48 articles.

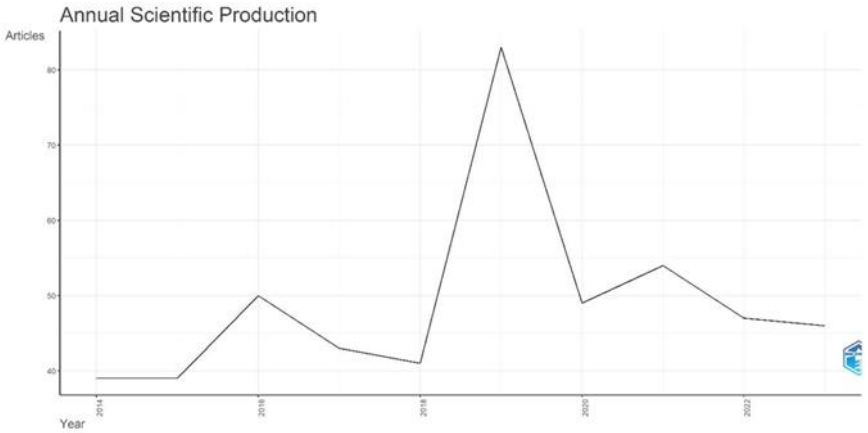

Figure 2. OSD-related annual publication trends from 2014 to 2023

Geographical Distribution of Publications

The study was dominated by developed countries, with Germany and the United States as the largest contributors. Figure 3. shows the 10 countries with the highest number of publications, with Germany leading with 115 publications (23.42%), followed by the United States with 81 publications (16.50%), and India with 49 publications (9.98%).

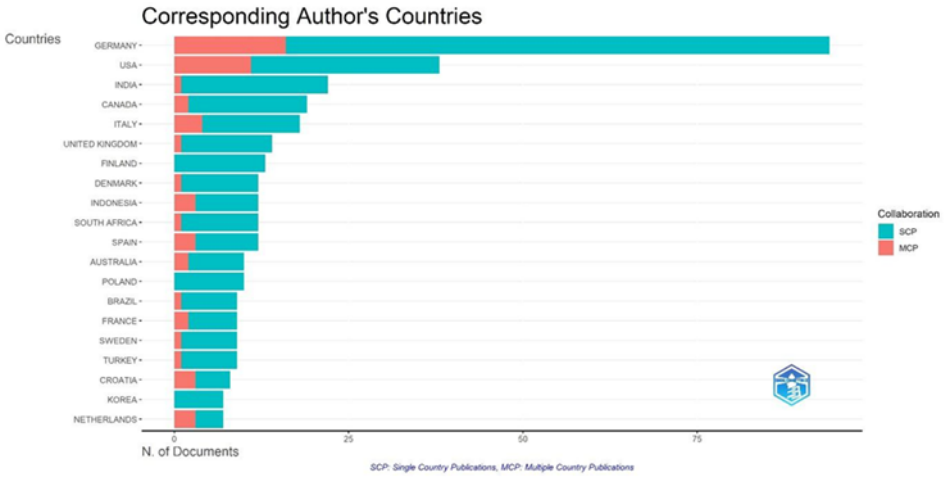

Figure 3. Geographical distribution of OSD publications.

Contributions by Institutions and Authors

In terms of institutional contributions, the University of Osnabrück of Germany leads the way with 81 publications, followed by the University of Toronto of Canada with 41 publications. Figure 4. shows the top 10 institutions by number of publications.

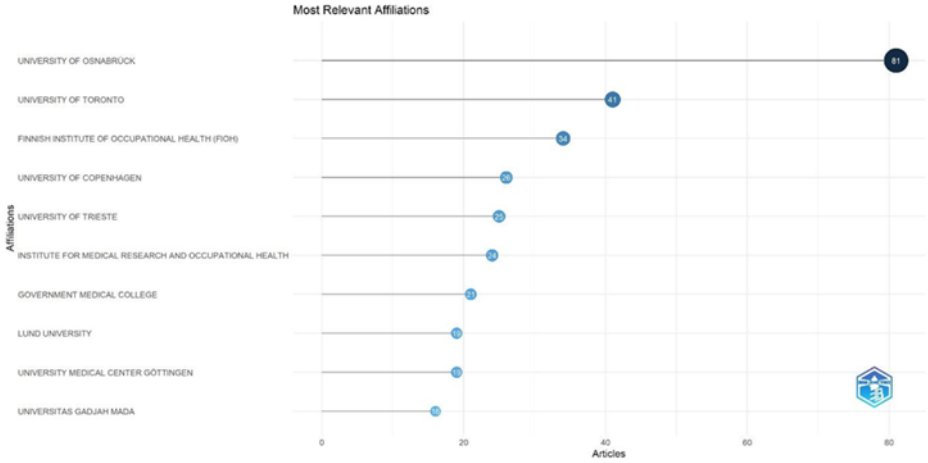

Figure 4. Institutions with the most publication contributions

Keyword Analysis and Thematic Clustering

Figures 5 and 6 show an analysis of the occurrence of the keywords that most frequently appeared in OSD-related literature over the past decade. The main keywords that often appear include "contact dermatitis", "occupational skin disease", and "hand eczema". From this analysis, five main clusters can be identified: a) Occupational contact dermatitis; b) Skin diseases are related to PPE, especially in the context of the COVID-19 pandemic; c) OSD prevention and management; d) Faktor risiko spesifik pekerjaan; e) Epidemiologi OSD.

From the VOSviewer methodology we used (Figure 5.), several keyword trends were identified that can attract the attention of readers, which are highlighted by the brightest and largest words in the image, including "occupational skin disease," "contact dermatitis," "occupational," and "occupational dermatoses." For research and publication keywords involving "patch testing," "contact urticaria," "quality of life," "intervention tobacco smoking," "asthma," "allergen," and others, as shown in the image, can serve as ideas for future publications in the field of OSD. Despite their limited number, these topics remain of interest in relation to OSD, presenting opportunities for further exploration.

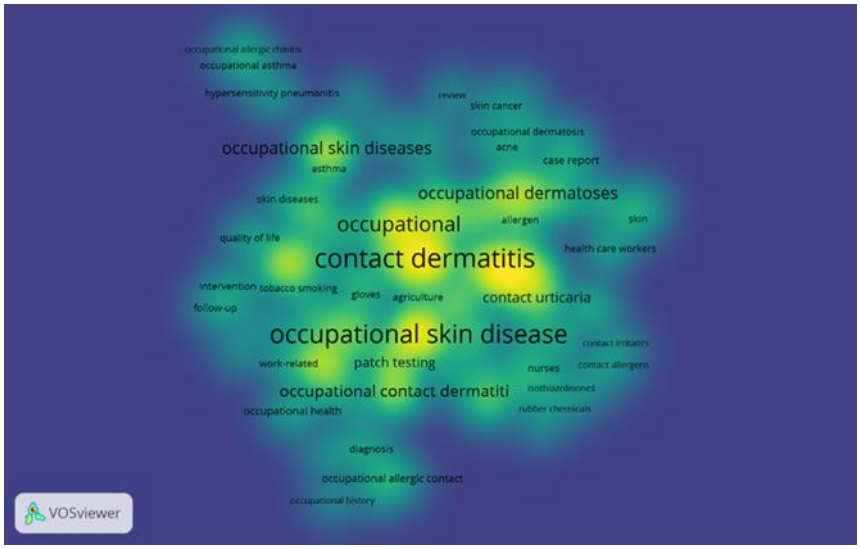

Figure 5. Visualization of Keyword Density in Bibliometric Analysis of Occupational Skin Diseases

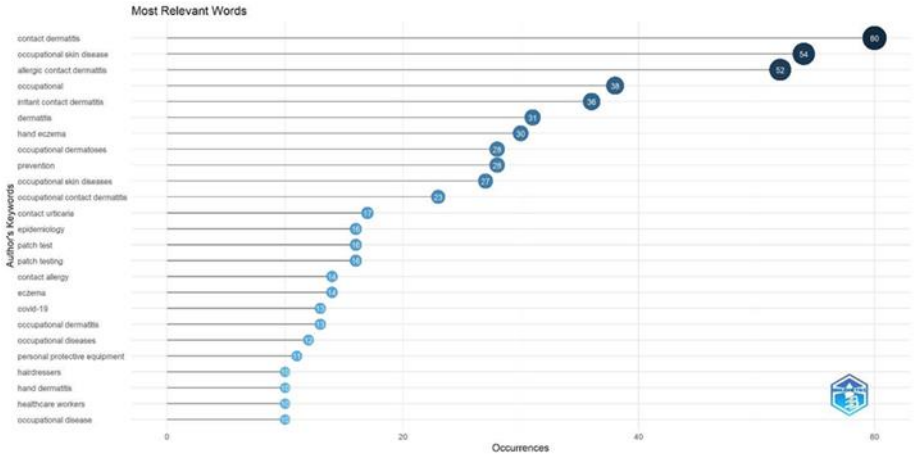

Figure 6. Keyword emergence visualization map

Evolution of Research Topics Over Time

Figure 7. shows a temporal overlay map that visualizes the evolution of the research topic from 2014 to 2023. In the early period (2014-2017), research focused on topics such as "hypersensitivity pneumonitis" and "epidemiology". Meanwhile, in the 2018-2020 period, topics related to "skin cancer" and "contact dermatitis" began to dominate. In recent years (2021-2023), a lot of research has been related to the impact of COVID-19 on workers, especially skin problems due to the use of PPE.

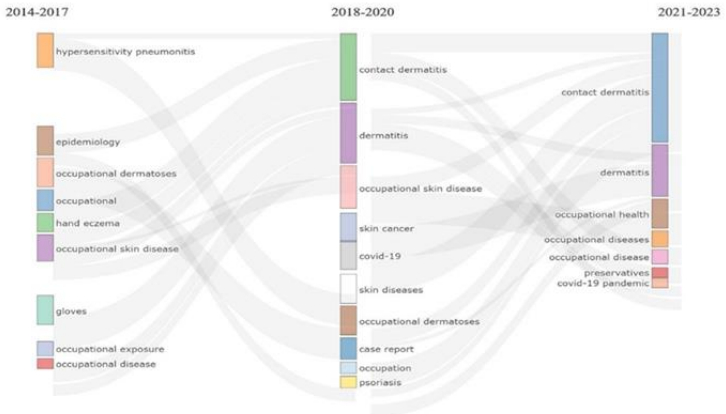

Figure 7. Temporal overlay map of the evolution of OSD research topics

Most Influential Authors and Articles

An analysis of the most prolific authors showed that John S.M. of the University of Osnabrück was the most prolific author with 43 publications, followed by Lan J., who had the article with the highest number of citations (391 citations) for a single article published in 2020, regarding the impact of COVID-19 on health workers. Table 1 shows the authors with the most publications and citations. The most influential articles that discuss OSD along with the types of diseases discussed and the main topics can be seen in Table 2.

Table 1. Authors with the most publications and citations

Author	Institution	Number of Publications	Highest Citations
John S.M.	Universitas Osnabrück	43	320
Lan J.	Universitas Fudan	35	391
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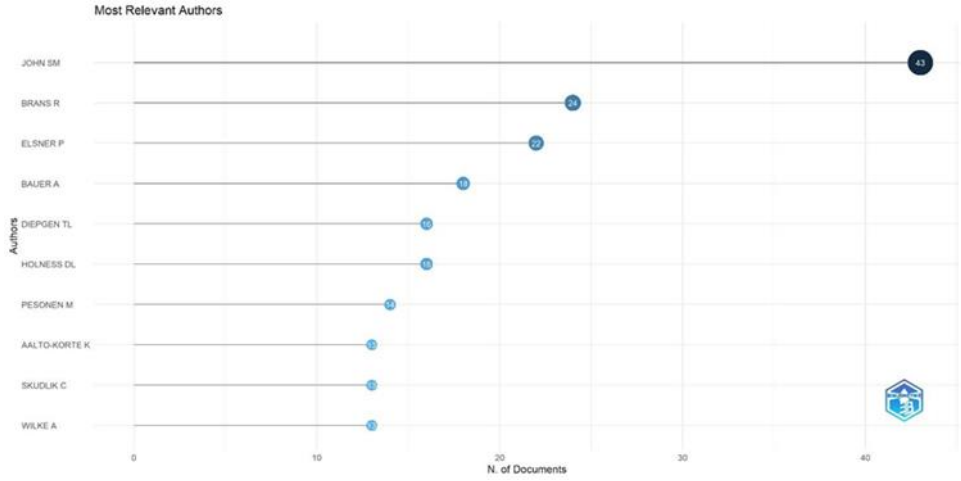

Table 2. Publications on OSDs based on the most citations

Author	Title of study	Year	Total citations	Journal	Diseases analyzed (or main topics)	References
Lan J, et al	Skin damage among health care workers managing coronavirus disease-2019	2020	391	Journal of the American Academy of Dermatology	Skin damage due to prolonged use of protective equipment during COVID-19	(Lan et al., 2020)
Bains SN, et al	Irritant Contact Dermatitis	2019	104	Clinical Reviews in Allergy & Immunology	Irritant contact dermatitis caused by occupational exposure to irritants	(Bains et al., 2018)
Elston DM, et al	Occupational skin disease among health care workers during the coronavirus (COVID-19) epidemic	2020	94	Journal of the American Academy of Dermatology (JAAD)	Occupational skin diseases related to COVID-19 prevention measures in healthcare workers.	(Elston, 2020)

The Most Productive Journals

The Journal of Contact Dermatitis was the most published OSD-related articles during the study period, with 73 publications. This journal is followed by Kanerva's Occupational

Dermatology with 48 publications. Figure 8. shows the top 10 journals in OSD-related publications.

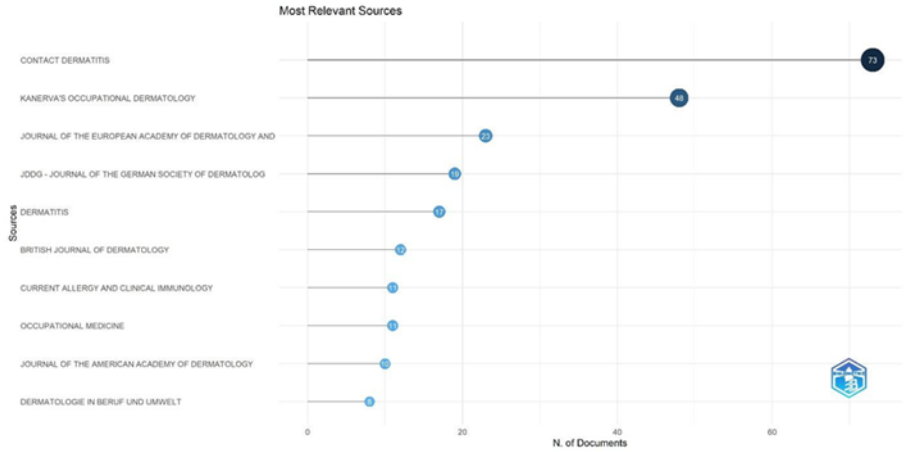

Figure 8. Journals with the highest number of publications

Joint Citation Analysis

Joint citation analysis was carried out to identify articles that are often cited together in OSD-related literature. The results showed that the article from Lan J. (2020) on skin damage to health workers during the COVID-19 pandemic was often cited along with an article from John S.M. (2016) on occupational skin cancer.

International Collaboration Network

The international collaboration map shows that OSD-related research is largely dominated by collaborations between developed countries, especially between Germany, the United States, and the United Kingdom. However, the emergence of contributions from developing countries, such as Indonesia and India, indicates a global expansion in OSD research. Figure 9. visualize the network of international collaboration between institutions active in this field.

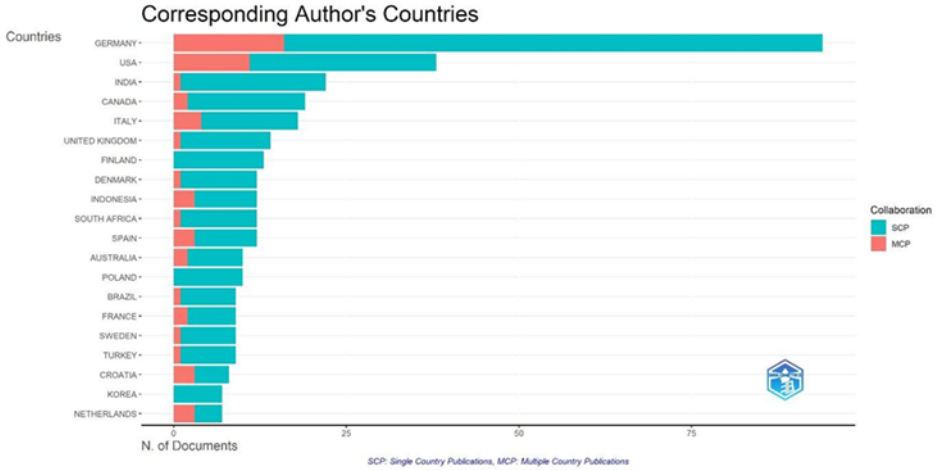

Figure 9. International collaborative network in OSD research

Occupational Skin Diseases (OSDs) remain a major concern in global health, especially in sectors where workers are exposed to hazardous substances. OSD, including contact dermatitis, is often caused or exacerbated by environmental factors in the workplace. This condition not only affects workers' health, but also brings significant social and economic consequences, such as decreased productivity and increased healthcare costs (Srinivas & Sethy, 2023) Rapid industrialization and global economic expansion have increased the prevalence of OSD, especially in industries with high exposure to chemicals, the use of certain work tools, and inadequate personal protective equipment (Wang et al., 2024) Despite progress in developed

countries, countries like Indonesia face challenges due to rapid industrial growth and a lack of adequate occupational health systems, putting workers at high risk without proper treatment or prevention. Given the wide health and economic impacts, reviewing OSD is critical. A deeper understanding of OSD is not only helpful in disease prevention, but also in developing more targeted treatment strategies, especially in new industries and developing countries. The long-term goal is to reduce the incidence of OSD and improve the quality of life of affected workers, as well as ensure a safer and healthier work environment (Sawada, 2023).

Publication Trends and Research Growth

The increase in publications related to occupational skin disease (OSD) over the past decade, peaking in 2021, highlights growing interest in this area. This surge can be attributed to the COVID-19 pandemic, which heightened awareness of worker health, particularly among healthcare workers frequently using personal protective equipment (PPE) such as gloves, N95 masks, goggles, or face shields, alongside rigorous handwashing protocols (Elston, 2020; Lan et al., 2020; O'Neill et al., 2020). The pandemic led to an increase in cases of irritant and allergic contact dermatitis, with common triggers including soaps, alcohol sanitizers, and synthetic detergents (Rundle et al., 2020).

This trend demonstrates how global events can significantly influence publication rates. During the pandemic, many research projects were delayed, non-COVID-related research funding was redirected, and research priorities shifted to focus on COVID-19 (Santos et al., 2021; Yanow & Good, 2020). Past outbreaks, such as SARS (2002/03) and MERS (2012/13), also drove research on coronaviruses, with studies noting that COVID-19 manuscripts were accepted faster than those on other topics (Kun, 2020; Schonhaut et al., 2022). Journals prioritizing COVID-19 research may experience long-term increases in visibility and impact factors (Uddin et al., 2023).

A decline in OSD-related publications in 2022 could reflect stabilization of research interest and improved workplace skin protection practices. However, ongoing monitoring is necessary to confirm this trend (Tang et al., 2023). Despite the decline, research on OSD remains critical due to its high prevalence, particularly contact dermatitis, which constitutes a significant portion of occupational health issues worldwide. Many OSD cases are underreported or misdiagnosed, leading to a lack of accurate data (Milam et al., 2020). Investigations into irritant and allergic contact dermatitis across various professions have analyzed causative agents and prevalence rates (Jacobsen et al., 2022; Srinivas & Sethy, 2022).

Additionally, outdoor workers face increased risks of non-melanoma skin cancers due to solar ultraviolet radiation exposure, exacerbated by climate change (Symanzik & John, 2024; Watson et al., 2024). Novel workplace hazards, such as nanomaterials and disinfectants, also present emerging risks for skin sensitization or irritation (Lechuga et al., 2023). Even post-pandemic, healthcare and industrial workers continue to rely on PPE, which can cause pressure sores, contact dermatitis, and other skin issues (Setyowati et al., 2024).

Geographical Domination by Developed Countries and the Emergence of Developing Countries

OSD-related research is dominated by developed countries such as Germany and the United States, which reflects a strong research infrastructure and policy focus on occupational health. The prominence of Germany and the United States in the OSD research space is likely influenced by several interrelated factors, including greater access to research funding, advanced healthcare systems, and a stronger policy emphasis on occupational health. These nations typically have well-established research infrastructures, with significant government and private investments in public health research (Ogugua et al., 2024). For example, the U.S. National Institutes of Health (NIH) and Germany's Federal Ministry of Education and Research (BMBF) fund large-scale studies on occupational health, enabling comprehensive and long-

term studies, leading to higher publication outputs (NIOSH, 2023; BMBF, 2023). These resources contribute to the quantity and quality of research output, offering a more thorough understanding of the factors influencing the geographical disparities in OSD research.

As industries expand globally, research has increasingly considered how OSDs affect workers in developing countries, where industrialization is often rapid, and workplace protections may be weaker. The emergence of contributions from developing countries, such as Indonesia and India, indicates a global expansion in OSD research. This is especially important because developing countries face unique occupational health challenges, with exposures that are often not recorded or properly addressed (Febriana et al., 2022, 2023). Structural and systemic barriers often limit research output in these regions, differentiating them from developed countries. Developing countries often face significant challenges in occupational health, such as underreporting of OSD cases, lack of standardized data collection methods, and limited funding for research initiatives (Milam et al., 2020). Government or private sector support for health-related research, including OSD, is often minimal, which impacts access to advanced technology, data collection, and research facilities (Ogugua et al., 2024). The lack of comprehensive health surveillance systems and insufficient focus on occupational health issues may result in underreported cases, ultimately affecting the volume of research. Furthermore, in countries like Indonesia and India, occupational health policies are often not as developed or enforced as in developed countries, leading to a lack of prioritization for OSD research.

International Collaboration Network and Influential Authors

The analysis of the collaboration shows that John S.M. and his research group at the University of Osnabrück form the largest research network in the field of OSD. Strong international collaboration, especially between developed countries, is essential in sharing knowledge and resources, but there is still room to improve collaboration between developed and developing countries to bridge knowledge gaps and practical applications, as well as creating more effective and globally applicable prevention measures and policies.

This is closely related to the healthcare infrastructure in developing countries compared to that of developed nations. In many low- and middle-income countries, healthcare systems are often strained and under-resourced, which affects the capacity for robust research on occupational diseases (Ogugua et al., 2024). Limited access to specialized dermatological care and occupational health expertise further compounds the problem. This results in missed opportunities for research and intervention, as workers suffering from occupational skin diseases (OSDs) may not receive timely diagnoses or treatment (Nuwayhid, 2004). Additionally, the economic constraints in these countries could lead to fewer opportunities for researchers to engage in longitudinal studies or experimental research, further limiting the scope of OSD publications (Nchinda, 2002). Disparities in research capacity are exacerbated by challenges such as limited research infrastructure and lack of coordinated health programs, which are prevalent in many developing nations (Kitua et al., 2000). According to the disparities in research capacity, it would be beneficial for future studies to examine the specific challenges and barriers faced by researchers in developing countries, such as political instability, limited research funding, or cultural factors that affect the prioritization of occupational health. Moreover, it could explore how international collaborations or global health initiatives might help bridge the gap, ensuring that OSD research in developing countries receives the support and attention it deserves (Coleman et al., 2020).

Changes in Research Focus Over Time

Several factors have contributed to the shift in research focus on occupational skin diseases (OSD), including emerging global health challenges (e.g., COVID-19), technological advancements, broader occupational health trends (e.g., holistic health approaches), cross-

sectoral influences, evolving understandings of OSD etiology, and increased awareness and advocacy efforts.

Over time, the research focus on OSD has evolved to reflect a deeper understanding of the condition and its associated challenges. Earlier studies concentrated on classic manifestations like contact dermatitis and hand eczema (Rauf et al., 2020). However, the COVID-19 pandemic expanded research to include skin conditions linked to the intensive use of personal protective equipment (PPE), such as contact dermatitis, pressure ulcers, and skin irritation (Lan et al., 2020).As work environments evolve, so do the materials and technologies used in PPE and workplace equipment. Recent research examines the interaction between these new materials and the skin, focusing on potential risks such as irritation or allergenic reactions. The development of advanced yet potentially irritating materials underscores the need for targeted studies on these interactions.

In addition, occupational health research has increasingly adopted a holistic approach, extending beyond physical health to consider mental and social health. This perspective has drawn attention to how stress can exacerbate skin conditions like eczema and psoriasis, as well as the broader impact of OSD on workers' quality of life. As industries such as healthcare, construction, manufacturing, and agriculture advance at different rates, research must adapt to address their unique challenges.The definition of OSD has also broadened to encompass a wider range of conditions. Beyond traditional contact dermatitis, it now includes occupational acne, urticaria, and rare conditions influenced by environmental factors. This expanded scope has prompted researchers to investigate the links between OSD and systemic diseases such as asthma, allergies, and autoimmune conditions, adopting a more integrated approach to occupational health.

Additionally, increased awareness and advocacy for workers' rights have contributed to changes in research priorities. Greater attention is being given to lesser-studied conditions that disproportionately affect certain industries or demographics, particularly those in low-wage or high-risk sectors. These developments emphasize the need for flexibility and adaptation in OSD research to address evolving workplace challenges.

Implications for Practice and Policy

These findings have several practical implications: a) The need for more effective prevention strategies: The frequency of occurrence of prevention-related keywords shows the importance of developing and implementing better prevention strategies for OSDs; b) Industry-specific approaches: The emergence of research on OSD in the health sector during the COVID-19 pandemic demonstrates the need for tailored approaches for high-risk sectors; c) Technology integration: Increased research on the use of technology in diagnosing and managing OSD opens up opportunities to improve early detection and treatment, especially in developing countries.

Research Gaps and Potential Areas for Future Research

This bibliometric analysis reveals several significant research gaps, especially in the context of developing countries such as Indonesia: a) Lack of studies from developing countries: Despite contributions from countries like India, there is still a large gap in the number of publications from developing countries, including Indonesia. This indicates the need to increase research capacity in these countries; b) Focus on the informal sector: Research on OSD in the informal sector, which is a significant part of emerging economies, especially in developing countries, is still very limited, which have a high risk of OSD but are rarely researched. (Hendra et al., 2018) There is a need for studies that focus on workers in the agriculture, small-scale manufacturing, and home industry sectors; c) Evidence-based interventions: There are shortcomings in studies that develop and evaluate OSD prevention and management interventions tailored to the local context of developing countries. More evidence-based

interventions are needed for OSD prevention and management in developing countries; d) Longitudinal studies: Lack of long-term studies evaluating the cumulative impact of occupational exposure on skin health, especially in work environments typical of developing countries; e) Economic impact analysis: Research quantifying the economic impact of OSD at the individual, industry, and national levels in developing countries is still rare, although the economic effects of the disease are significant; f) Technology in diagnosis and management: Opportunities to explore the use of affordable technologies in OSD diagnosis and management in areas with limited resources; g) Specific risk factors: There is a lack of research on OSD risk factors specific to tropical and sub-tropical climatic conditions, which are common in many developing countries including Indonesia; h) Policy and regulation: Analysis of the effectiveness of OSD-related policies and regulations in developing countries is still minimal, indicating the need for more robust policy research.

Future study development opportunities include several important aspects. First, there is a need to increase international collaboration between researchers from developed and developing countries to facilitate knowledge transfer and capacity building. This would be key in expanding the reach of research and practical applications. Second, interdisciplinary research that integrates the health, economic, and social aspects of OSD needs to be prioritized. Third, the development of appropriate screening and diagnosis methods for environments with limited resources is urgently needed. Fourth, intervention studies focusing on OSD prevention and management in the informal sector should be improved, especially by utilizing new technologies such as artificial intelligence in OSD management. Finally, research on the impact of climate change on the prevalence and characteristics of OSD in tropical countries such as Indonesia needs special attention. By addressing these aspects, it is hoped that the understanding and handling of OSD in developing countries can be significantly improved.

Limitations and Strengths of Research

This bibliometric analysis only gives a glimpse of what has been published to date, and this review comes from only one database used for data retrieval. Nonetheless, the Scopus platform is a data collection source that has a comprehensive collection that has been curated and consists of publications of high-quality scientific journals reviewed by many peers around the world. It is recommended to use multiple search databases for future research

Conclusion

This bibliometric analysis revealed significant developments in occupational skin disease (OSD) research from 2014 to 2023. There has been an increase in publications, especially during the COVID-19 pandemic, with the dominance of developed countries but the beginning of contributions from developing countries. The focus of research shifted from contact dermatitis and hand eczema to issues related to COVID-19 and the use of PPE. Research gaps were identified in longitudinal studies, the informal sector, and interventions in developing countries. Further research needs to focus on innovative prevention strategies, the use of new technologies, and increased international collaboration. Exploration of the impact of climate change on OSD is also important. With this understanding, it is hoped that future research can contribute more significantly to the prevention and management of OSD, especially in developing countries that face unique challenges in occupational health.

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