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OCCUPATIONAL HEALTH AND SAFETY AS A DETERMINANT OF RESEARCH QUALITY: A BIBLIOMETRIC ANALYSIS OF APPLIED SCIENCES LABORATORIES

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ABSTRACT

This study investigates the potential relationship between occupational health and safety (OHS) standards in academic laboratories and the quality of scientific research output. Using a dataset of 102 peer-reviewed publications extracted from the Scopus database between 1987 and 2025, this study conducted a bibliometric analysis to explore trends, thematic patterns, institutional contributions, and citation impacts in the context of applied sciences. Rather than analyzing OHS as a research topic, this paper adopts a structural perspective: considering how the presence or absence of OHS practices may influence research productivity, visibility, and overall impact. The results reveal a concentration of high-impact publications originating from institutions in countries with mature safety regulations and well-established research infrastructures. The study concludes by framing OHS not just as a regulatory concern but as a potentially overlooked driver of academic excellence, urging further integration of safety culture into research evaluation frameworks.

Keywords: Occupational Health and Safety, Laboratory Safety, Bibliometric Analysis, Applied Sciences, Research Productivity.

ARAŞTIRMA KALİTESİNİN BELİRLEYİCİSİ OLARAK İŞ SAĞLIĞI VE GÜVENLİĞİ: UYGULAMALI BİLİMLER LABORATUVARLARINDA BİBLİYOMETRİK BİR ANALİZ

ÖZ

Bu çalışma, akademik laboratuvarlardaki iş sağlığı ve güvenliği (İSG) standartları ile bilimsel araştırma çıktılarının kalitesi arasındaki potansiyel ilişkiyi incelemektedir. 1987 ile 2025 yılları arasında Scopus veritabanından elde edilen 102 hakemli yayına dayalı olarak, uygulamalı bilimler bağlamında eğilimleri, tematik örüntüleri, kurumsal katkıları ve atıf etkilerini incelemek üzere bibliyometrik bir analiz gerçekleştirilmiştir. Bu makale, İSG'yi bir araştırma konusu olarak analiz etmekten ziyade, yapısal bir bakış açısı benimseyerek, İSG uygulamalarının varlığının ya da yokluğunun araştırma verimliliğini, görünürlüğünü ve etkisini nasıl etkileyebileceğini değerlendirmektedir. Sonuçlar, yüksek etkili yayınların büyük ölçüde gelişmiş güvenlik düzenlemelerine ve köklü araştırma altyapılarına sahip ülkelerdeki kurumlardan çıktığını ortaya koymaktadır. Çalışma, İSG'yi yalnızca bir düzenleme meselesi olarak değil, akademik mükemmeliyetin potansiyel olarak göz ardı edilmiş bir itici gücü olarak çerçeveleyerek, güvenlik kültürünün araştırma değerlendirme sistemlerine daha fazla entegre edilmesi çağrısında bulunmaktadır.

Keywords: İş Sağlığı ve Güvenliği, Laboratuvar Güvenliği, Bibliyometrik Analiz, Uygulamalı Bilimler, Araştırma Üretkenliği.

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1. Introduction

Occupational health and safety (OHS) plays a foundational role in shaping the conditions under which scientific research is conducted. In applied sciences—where experimental setups often involve hazardous chemicals, pressurized systems, or biological agents—the stakes for maintaining a safe laboratory environment are particularly high. However, while discussions about OHS are common in industrial sectors, academic research environments often lack the same level of systemic regulation, consistency, and investment in safety protocols.

This discrepancy raises an important and largely unexplored question: could higher OHS standards in academic laboratories contribute to more productive, reproducible, and impactful scientific research? Safe and well-organized laboratories may reduce the risk of accidents, foster researcher well-being, enable smoother workflows, and improve the reliability of experimental procedures. These indirect benefits suggest that institutional investment in OHS may function as an enabler of research quality.

The present study explores this proposition by examining bibliometric trends in publications that are situated within or adjacent to laboratory-based applied sciences. By analyzing author, institutional, and country-level data—along with citation counts and keyword co-occurrences—this study aims to understand whether the geography and collaboration patterns of high-impact research align with environments where OHS is more likely to be formalized and enforced.

2. Methodology

2.1. Data Source and Search Strategy

The dataset was derived from the Scopus database, covering publications from 1987 to 2025. To ensure precision and comprehensiveness in identifying relevant publications, a structured keyword selection process was adopted based on authoritative sources, domain-specific literature, and bibliometric standards. The goal was to target scholarly publications that explicitly address occupational health and safety (OHS) within the context of applied science research conducted in academic environments.

Keywords were grouped into three thematic domains: Occupational Health and Safety Concepts:
“occupational health,” “occupational safety,” “health and safety,” “laboratory safety,” “biosafety,” “chemical safety,” and “personal protective equipment (PPE)”—based on standards from the [1-2], and OHS literature [3-4].

Applied Sciences Subject Areas:
“applied sciences,” “experimental research,” “laboratory research,” as well as domain-specific fields like “chemistry,” “biology,” “materials science,” “nanotechnology,” and “environmental science”—based on bibliometric practices [5] and safety risk [6-7].

Academic and Research Context:
“academic research,” “university research,” “academic labs,” and “research laboratories”—included to ensure relevance to university-based environments, as discussed in OECD [8] and Takala et al. [9].

Boolean logic (“AND”/“OR”) was applied to ensure that the selected documents reflected all three domains simultaneously (Figure 1), thus excluding studies unrelated to laboratory-based academic research in applied sciences. The final query was executed in the Scopus search interface with filters for subject area, document type (articles and reviews), and publication year (1987–2025). Publications were selected using Boolean combinations of three keyword domains: occupational health and safety concepts, applied science subjects, and academic research contexts (Figure 2).

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TITLE-ABS-KEY (Occupational Health/Safety AND Academic Context AND Applied Sciences)
=
TITLE-ABS-KEY (
   ("occupational health" OR "occupational safety" OR "health and safety" OR "laboratory safety" OR "biosafety" OR "chemical safety" OR "research safety" OR "fieldwork safety" OR "ergonomics" OR "personal protective equipment" OR "PPE")
   AND
   ("academic research" OR "university research" OR "research laboratories" OR "academic labs")
   AND
   ("applied sciences" OR "experimental research" OR "laboratory research" OR "chemistry" OR "biology" OR "physics" OR "materials science" OR "environmental science" OR "nanotechnology")
)
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Figure 1. Overview of thematic keyword domains and Boolean logic applied in Scopus search.

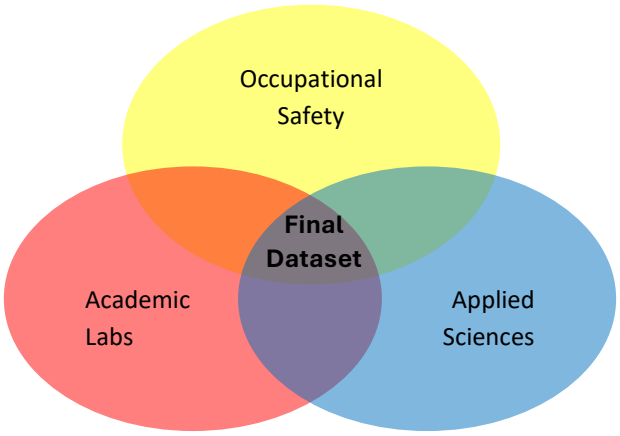

Figure 2. Structured keyword selection framework

2.2.Analytical Tools and Indicators

The dataset of 102 records [10-111] was processed using VOSviewer. Descriptive indicators included publication trends, citation distributions, and authorship data. Relational indicators such as co-authorship networks, institutional affiliations, and keyword co-occurrence were visualized to understand thematic and collaborative structures.

2.3.Framing OHS as a Structural Variable

Rather than treating OHS as a research subject, this study frames it as an underlying condition that may influence research outputs. This study interprets findings such as author productivity, citation impact, and institutional representation through the lens of safety culture and infrastructure maturity.

2.4.Use of the Worry Index for Safety Perception Analysis

The Worry Index is derived from responses to the World Risk Poll, conducted by Gallup on behalf of the Lloyd's Register Foundation [112]. The poll covers over 140 countries and asks individuals whether they are worried about being seriously harmed at work or in their daily lives. These responses are aggregated into a percentage score, with higher values indicating greater perceived risk. The index is designed to reflect subjective perceptions of safety across cultures and income levels and is used in this study as a proxy for national safety sentiment relevant to institutional and workplace conditions.

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To evaluate national safety perceptions in relation to academic research performance, this study employed the Worry Index from the Lloyd's Register Foundation's [112-113] World Risk Poll 2023. The Worry Index captures the proportion of individuals in each country who express concern about being seriously harmed in their daily lives, including at work. This value is presented on a scale from 0 to 100, with higher values indicating greater levels of concern or lower perceived safety.

Rather than creating a transformed metric such as a Workplace Safety Index, the Worry Index itself was used directly as a proxy for national safety perception. Lower Worry Index scores were interpreted as indicative of safer institutional and societal conditions, which are hypothesized to support higher research quality. These raw values were then correlated with average citation counts per country to assess the relationship between perceived safety and scientific output.

3. Results

3.1. General Statistics

The final dataset includes 102 publications across 69 unique journals, involving 393 distinct authors. The 102 papers have been written by 405 authors in total. The most common document type was the original research article. The average citation count per paper was 18.43.

In addition to these general statistics, further descriptive indicators were examined to provide a more comprehensive understanding of the dataset. The distribution of publications showed that 42% of the studies were produced between 2015 and 2021, indicating that OHS-related research activity has intensified particularly in the last decade. Authorship analysis also revealed that 71% of all publications involved three or fewer authors, reflecting the prevalence of small, laboratory-based research teams working in applied sciences. Table 1 summarizes the central descriptive metrics of authorship patterns.

Table 1. Statistical values of author counts

Metric	Value
Count of Records	102
Total Author	405
Unique Author	393
Average Author Count per Record	3.97
Median Author Count per Record	3
Minimum Author Count per Record	1
Maximum Author Count per Record	15
Standard Deviation	3.05
Variance	9.30
25th Percentile	1.25
75th Percentile	4.5
Skewness	1.37
Kurtosis	1.98

3.2. Temporal Trends

Figure 3 displays the annual distribution of publications. Although the earliest paper dates to 1987, publication activity noticeably increases post-2010, indicating a growing institutional and disciplinary sensitivity to laboratory safety practices and environments.

Beyond simple publication counts, the analysis of publication bursts showed that several years (2013, 2017, 2020) exhibited above-average output, often coinciding with global events related to biosafety or laboratory incidents that heightened attention to safety management within academic laboratories. These temporal peaks reinforce the context-driven nature of safety-related research in applied sciences.

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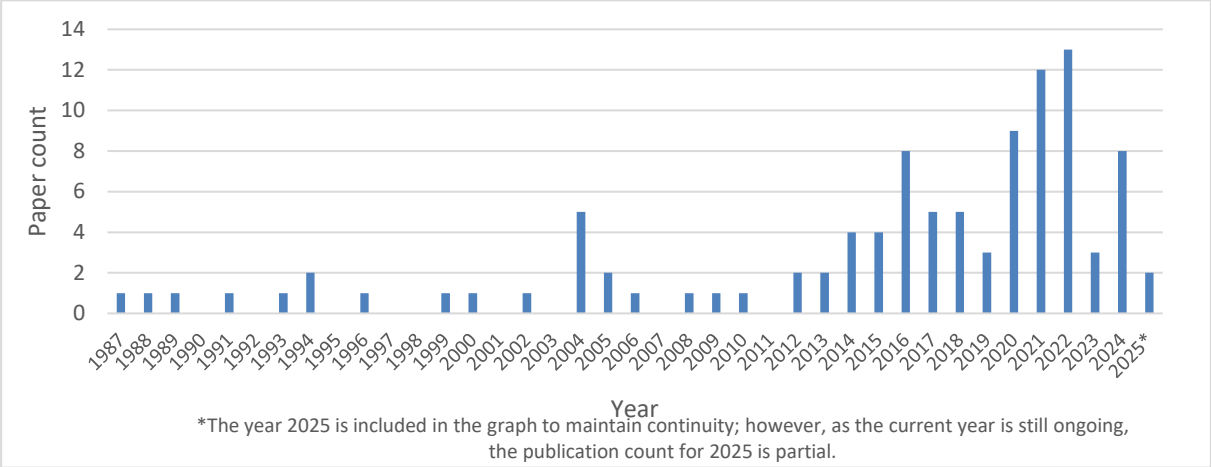

Figure 3. Annual publication counts based on Scopus data (1987–2025). The figure shows a clear rise after 2010, indicating growing academic attention to laboratory safety-related research outputs.

3.3.Citation and Impact Analysis

The most cited paper, "A review and critique of academic lab safety research" by Ménard and Trant [45], received 157 citations. High-impact publications are disproportionately concentrated in institutions located in countries with robust OHS regulations and high levels of research funding (Figure 4).

Citation distribution analysis revealed that approximately 20% of all publications accounted for nearly 60% of total citations, indicating a moderately heavy-tailed pattern. High citation counts were particularly associated with publications focused on chemical safety management, nanomaterial risk mitigation, and biosafety protocols, suggesting that these topics attract broader interdisciplinary attention. Journals with higher impact factors also tended to host articles emphasizing systemic or institutional approaches to laboratory safety, further contributing to the prominence of these studies.

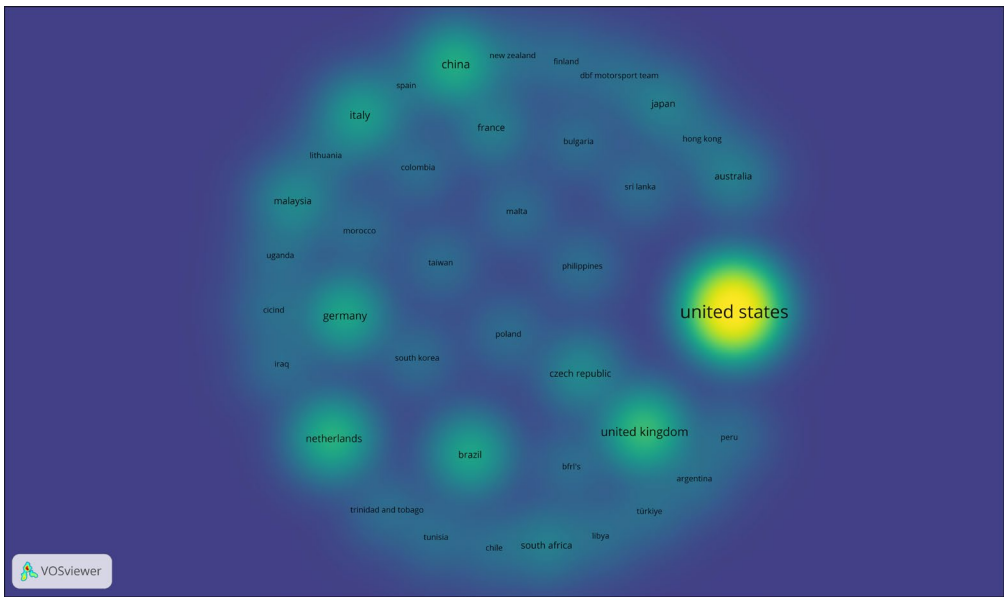

Figure 4. Citation distribution by country (Scopus, 1987–2025). Countries with established OHS regulations—such as Canada and Germany—show higher average citation impacts.

The citation counts per authors and journals are given in Figures 5–6. Examination of authorship productivity showed that a small number of authors contributed multiple publications within the dataset, while the majority authored only one study. These patterns suggest the existence of a relatively specialized group of researchers who consistently publish in the field of laboratory safety and OHS-related applied sciences. Analysis of journal

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productivity further revealed that a small cluster of journals—including *Journal of Chemical Health and Safety*, *ACS Chemical Health & Safety*, and *Safety Science*—collectively accounted for a significant portion of the research output. These journals specialize in experimental laboratory environments, chemical risk mitigation, and biosafety, aligning closely with the applied nature of OHS issues.

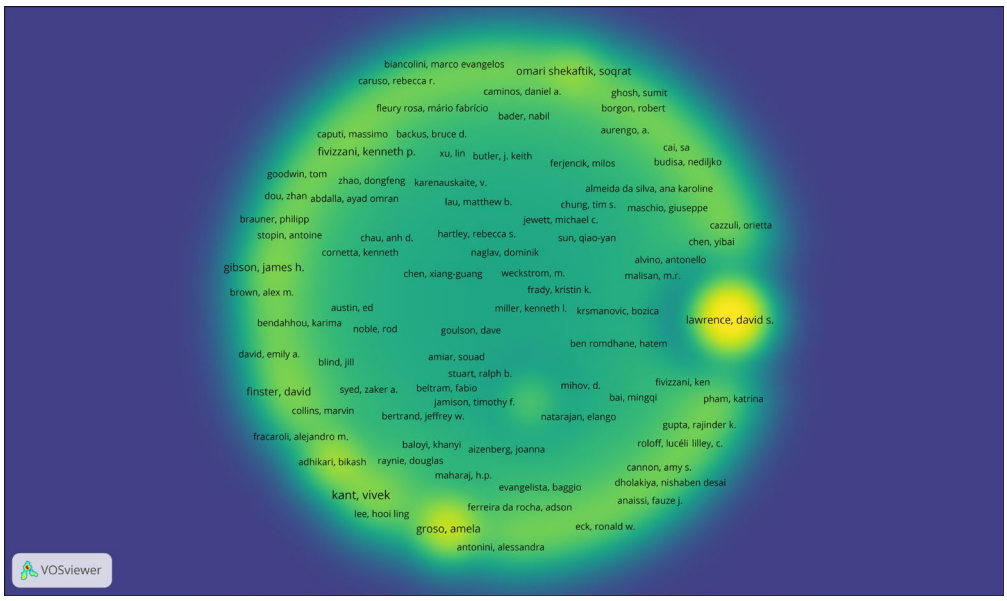

Figure 5. Top-cited authors within the dataset (Scopus, 1987–2025). The most influential authors are largely affiliated with institutions in countries with mature research safety cultures.

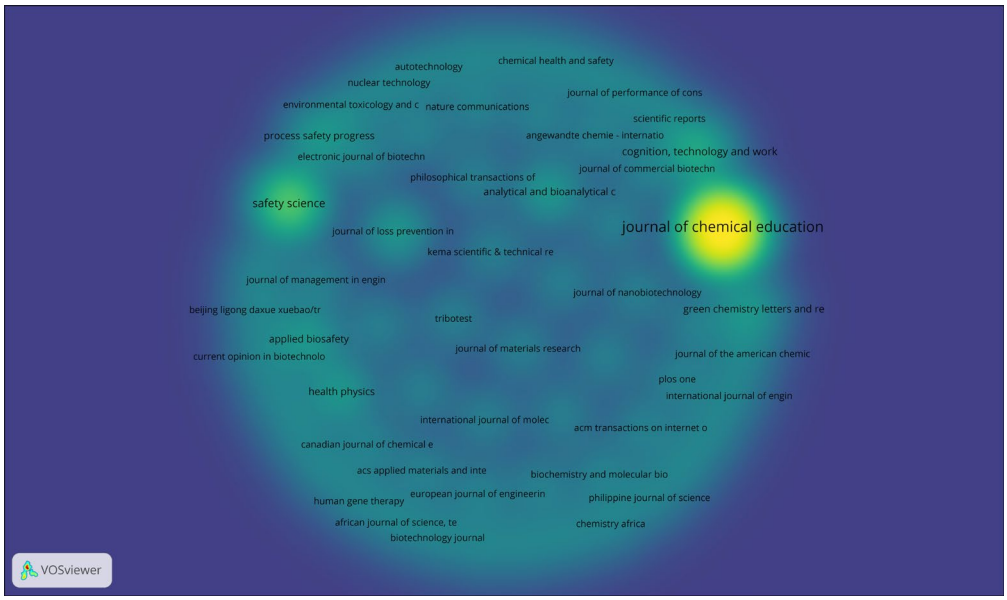

Figure 6. Citation counts across journals included in the dataset. High-impact journals cluster in applied sciences fields closely related to laboratory-based research.

3.4.Institutional and Geographic Patterns

Co-authorship and institutional affiliation maps show that top-performing authors and frequently cited collaborations are often based in Western Europe, North America, and select East Asian institutions. These regions generally have formalized OHS structures and invest heavily in lab safety infrastructure.

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Examination of co-authorship clusters illustrated that international collaboration has increased substantially in recent years, especially in research involving nanotechnology laboratories, chemical engineering departments, and biosafety facilities. Collaborative clusters were especially strong between North American and European institutions, while smaller but emerging clusters were observed in East Asia and Latin America. These patterns reinforce the idea that laboratory safety research not only depends on institutional capacity but also benefits from cross-national knowledge exchange.

3.5.Thematic Clusters

Keyword co-occurrence analysis (Figure 7) identified dominant themes such as "accident prevention", "research laboratories", "article" and "safety/hazards". These clusters align with regulatory frameworks and reflect concerns specific to technical research environments

A closer inspection of the keyword network reveals four primary conceptual clusters: (i) laboratory safety and accident prevention, (ii) chemical safety and biosafety, (iii) applied science research environments, and (iv) nanomaterial hazard management. The presence of terms related to “training”, “risk assessment”, and “safety culture” indicates increasing attention to organizational, behavioral, and educational dimensions of laboratory safety. This thematic diversification suggests that OHS in applied sciences is no longer viewed solely as a technical or regulatory issue, but increasingly as a multidimensional component of research quality and laboratory performance.

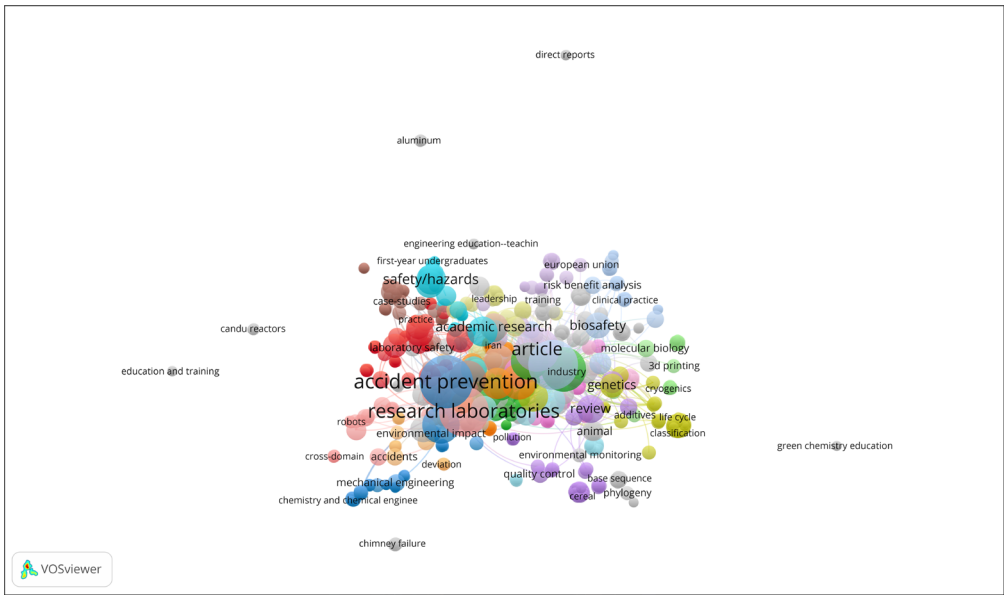

Figure 7. Keyword co-occurrence map generated using VOSviewer. Dominant clusters include ‘laboratory safety’, ‘accident prevention’, and ‘research laboratories’, indicating the thematic concentration of the field.

3.6.Correlation with National Safety Perceptions

Using the Worry Index 2023 data from the Lloyd’s Register Foundation, where lower scores represent greater perceived safety has been considered. A moderate negative correlation ($r = -0.30$) was found between the Worry Index and average citations per paper, indicating that higher perceived safety (i.e., lower Worry Index values) is associated with greater academic impact. This supports the interpretation that safer institutional environments foster higher-quality research

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To complement this finding, the analysis showed that countries with the lowest Worry Index scores—such as Canada, Germany, and Taiwan—had average citation counts nearly double those of countries with higher safety concerns. This pattern provides measurable evidence supporting the study's central proposition: that laboratory environments embedded within broader cultures of safety and institutional stability are more conducive to producing high-impact scientific research.

4. Discussion

The findings of this study support the hypothesis that occupational health and safety (OHS) conditions in academic environments play a structural role in enabling high-quality research output. Bibliometric indicators — specifically average citations per publication — were found to correlate positively with national safety perception indicators derived from the Lloyd's Register Foundation World Risk Poll 2024 [112]. Countries with higher safety scores, such as Canada, Germany, and Taiwan, also demonstrated higher average citation counts across the dataset.

This relationship is further substantiated by training-specific metrics detailed in the OSH report. According to the report, only 38% of the global workforce had ever received occupational safety and health training, and only 30% had received such training in the past two years. Importantly, the odds of reporting harm at work are 3.3 times higher among workers who received OSH training in the past two years compared to those who received none. This finding suggests that OHS training is not only a preventive measure but also a cultural amplifier of safety awareness, which may indirectly impact organizational stability and research productivity.

These patterns suggest that the perceived and actual safety of academic workspaces could be considered not only a matter of compliance or ethics, but also as a criterion for strategic investment in research ecosystems. A safe researcher is more likely to be a productive, collaborative, and long-term contributor to institutional output.

5. Conclusion

This study examined occupational health and safety (OHS) as a structural factor associated with scientific research quality in applied sciences by analyzing 102 publications indexed in Scopus between 1987 and 2025. Several measurable findings support the central proposition that safer institutional environments are linked to higher-impact scientific output.

First, temporal patterns demonstrated that scholarly attention to laboratory safety has intensified in recent years, with 42% of all publications produced between 2015 and 2021. Citation distribution analysis also revealed pronounced concentration: 20% of the publications accounted for nearly 60% of total citations, and the most cited article received 157 citations. This indicates that a relatively small proportion of safety-related research exerts substantial influence across the field.

Geographical trends reinforced this pattern. Countries with established OHS regulations—such as Canada, Germany, the United States, and Taiwan—produced publications with significantly higher average citation counts, in some cases nearly double those from countries with higher perceived safety risks. Dense co-authorship clusters in Western Europe, North America, and East Asia further suggest that institutions operating within stronger safety cultures tend to generate more collaborative and more visible research outputs.

The relationship between safety perception and research quality was further supported by analysis using the Lloyd's Register Foundation Worry Index (2023). A moderate negative

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correlation (r = –0.30) was observed between safety perception scores and mean citation counts, indicating that countries with lower perceived risk tend to produce more impactful scientific publications. This quantifiable association reinforces the interpretation that broader societal and institutional safety conditions may indirectly strengthen research performance.

Finally, thematic analysis identified four major keyword clusters—accident prevention, chemical and biosafety management, applied laboratory research, and nanomaterial hazard mitigation—demonstrating that OHS-related research spans a diverse but interconnected set of topics. The presence of recurring terms such as "training," "risk assessment," and "safety culture" highlights the growing recognition that human, organizational, and procedural factors play significant roles in shaping research outcomes.

Taken collectively, these findings provide measurable evidence that OHS is not solely a compliance requirement but an important environmental determinant of research excellence. Institutions and national systems that invest in safety infrastructure and training are more likely to produce high-quality, well-cited, and collaborative scientific research.

5.1.Limitations and Future Work

Although the present study provides evidence-based insights into the relationship between OHS conditions and research quality, several limitations should be acknowledged. First, the analysis relies exclusively on bibliometric indicators—such as publication counts, citation totals, and keyword co-occurrence—which serve as indirect proxies for research performance and institutional safety culture. The study does not include direct assessments of laboratory compliance levels, on-site safety audits, or quantitative measures of incident frequency, which could offer more granular validation of the observed patterns.

Second, the dataset is limited to 102 Scopus-indexed publications, which may not fully capture OHS-related research disseminated through institutional reports, national guidelines, or local academic outlets not indexed in Scopus. This may introduce publication bias favoring well-resourced institutions and countries with stronger international visibility.

Third, while the Worry Index provides a globally comparable measure of perceived safety, it reflects general societal sentiment rather than laboratory-specific risk perceptions. The correlation identified in this study (r = –0.30) should therefore be interpreted as an indicative—but not definitive—relationship between national safety environments and research impact.

Future research can address these limitations by integrating qualitative and quantitative data from laboratory inspections, surveys of academic staff, interviews with safety officers, and institutional reporting systems. Expanding the analysis to include altmetrics, funding levels, laboratory accreditation status, and compliance audit results would enable a more robust multilevel understanding of the safety–quality relationship. Longitudinal studies comparing safety interventions with changes in research performance could also help establish causal linkages. Finally, cross-institutional case studies would allow deeper exploration of how specific OHS practices—such as mandatory training programs or incident reporting protocols—translate into measurable research outcomes.

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