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Analysis and mapping of the research landscape on occupational musculoskeletal disorders with an emphasis on risk factors and preventive approaches (1993-2022)

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ABSTRACT

Objective: The current study aims to provide a comprehensive overview of the research landscape on the risk factors and preventive approaches to occupational musculoskeletal disorders (MSDs).

Methods: A comprehensive search strategy was developed and used in the Scopus Database for the study period from 1993 to 2022.

Results: A total of 1,132 articles underwent analysis and mapping. Scholars from the United States made the largest contribution, while the Danish institution "*National Research Center for the Working Environment*" ranked first in the field. The map showed that the nursing profession was the most researched profession with regard to occupational MSDs. The top-100 cited articles included research themes focusing on risk factors, interventions and preventive strategies, and specific body regions affected.

Conclusions: More longitudinal research is needed to identify and confirm the causal relationship between different risk factors and occupational MSDs and more research is needed regarding the effectiveness of various interventional methods on occupational MSDs.

Keywords: musculoskeletal disorders, occupational health, risk factors, preventive approaches, research landscape

INTRODUCTION

Occupational musculoskeletal disorders (MSDs) pose a significant health and economic concern across various occupational settings [1]. These disorders include a wide range of conditions that affect the muscles, bones, ligaments, tendons, and other supporting structures of the body. MSDs are characterized by pain, discomfort, and dysfunction in the musculoskeletal system resulting from work-related activities and conditions. MSDs can manifest in various forms, such as low back pain, neck and shoulder pain, carpal tunnel syndrome, tendonitis, and muscle strain [2-5]. Understanding the risks and preventive strategies in the context of occupational MSDs is crucial for promoting workers' health, well-being, and organizational productivity. The prevalence of occupational MSDs is significant across different occupations, especially those involving repetitive tasks, heavy lifting, awkward postures, prolonged sitting or standing, and exposure to vibration [3, 5-7]. Workers in physically demanding industries, such as construction, manufacturing, healthcare, agriculture, and transportation are particularly susceptible to occupational MSDs. For instance, construction workers often experience back injuries and joint strains due to heavy lifting and repetitive motion [8, 9]. Office workers may develop musculoskeletal issues such as carpal tunnel syndrome from prolonged computer use and poor ergonomics [10-12].

MSDs are a leading cause of disability worldwide [13, 14]. The impact of occupational MSDs extends beyond physical discomfort, leading to reduced productivity, increased healthcare costs, and diminished quality of life of affected individuals [15, 16]. The negative impact of occupational MSDs affects both individuals and organizations. The chronic pain produced by MSD leads to frequent sick leave, absenteeism, and work disability [17-19]. To mitigate the negative impact of occupational MSDs, the identification of risk factors, implementation of preventive strategies, and adoption of appropriate management are essential. Examples of preventive measures include ergonomic assessment and modifications, training programs, proper lifting techniques and body mechanics, implementation of work/rest schedules, provision of personal equipment, and organizational policies promoting a culture of safety and well-being [20-22].

Given the prevalence of occupational MSDs in various occupations, and the negative health and economic consequences of occupational MSD on individuals and organizations, a comprehensive understanding of the research landscape in this field is crucial. Research plays a vital role in advancing knowledge about the causes, prevention, and management of occupational MSDs. It helps identify effective

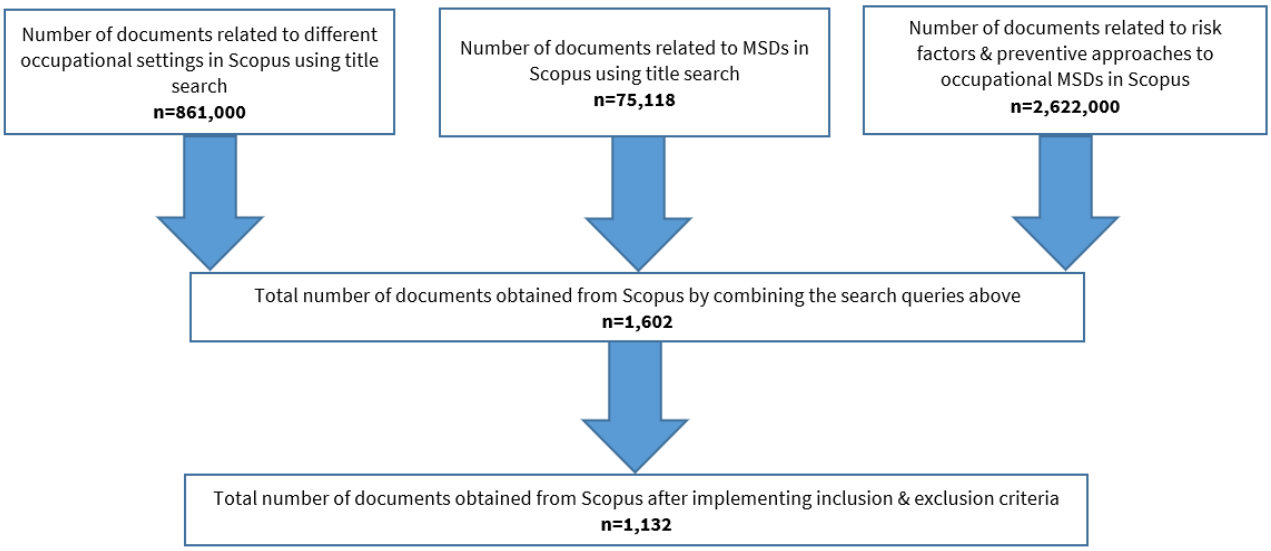

Figure 1. Number of retrieved documents (Source: Author's own elaboration)

strategies evaluate interventions and inform policy development to create a healthier and safer working environment and conditions. Based on the information given above, the aim of the current study is to provide a comprehensive overview of the research landscape on occupational MSDs with an emphasis on risks and preventive strategies. Risk factors refer to factors or conditions that increase the likelihood or possibility of developing occupational MSDs. The risk factors include physical factors (e.g., heavy lifting), poor ergonomic design, and psychosocial factors (e.g., low job control). The strategies refer to approaches, methods, or interventions employed to prevent, mitigate, and manage occupational MSDs. Preventive strategies include ergonomics, training, policies, and other measures implemented to decrease the incidence of occupational MSDs. The current study will provide a deeper understanding of the risk factors and preventive strategies in the field of occupational MSDs by identifying key players, research hotspots, major research themes addressed, research gaps, and future research expectations in the context of occupational MSDs. The current study is not meant to perform a critical appraisal of scientific publications on occupational MSDS nor to synthesize knowledge to answer a specific research question as in systematic or scoping reviews [23-26].

MATERIALS AND METHODS

The search strategy was developed to effectively retrieve relevant literature from the Scopus Database. Keywords related to occupational settings. MSDs, risk factors and preventive approaches were listed in **Appendix A**. To validate the search strategy, a title search approach was employed for all relevant keywords, aiming to minimize the risk of false-positive results. The use of title search methodology ensured that most retrieved articles were within the field of occupational MSDs. The list of active journals and most frequent keywords were related to occupational MSDs. For the comprehensiveness of the search strategy, a quick test was carried out to confirm the ability of the search string to retrieve well-known articles in the field. The well-known articles in the field were defined as ones with high citations and found either in PubMed or Google School. The well-known articles in the field were identified by using the advanced search in Google Scholar to retrieve articles with specific keywords in the title. Articles with the highest number of citations as indicated by Google Scholar were considered the well-known articles in the field and cross-referenced with the search string in Scopus. The search string was successful in retrieving the test articles (well-known articles) confirming the comprehensiveness of the search strategy.

For identification of key contributors in the field, data regarding journal names, country names, author names, and institution names were exported to Microsoft Excel, sorted, and tabulated for the top-10 active ones. For visualizing the most frequent author keywords and author-author research collaboration, the retrieved articles were exported from Scopus to the VOSviewer program for mapping and visualization. In visualization maps, the node size is proportional to the frequency of occurrence of keywords. For research collaboration, a research cluster with more than five authors indicates the presence of a good author-author collaboration. Regarding the most frequently addressed research topics in the top-100 cited articles, the articles were first exported from Scopus to Microsoft Excel and then grouped based on the research theme addressed. For counting the number of articles investigating the risk factors and preventive strategies, the search string modified by using the appropriate keywords for each topic to generate the numbers. Finally, the content of the most impactful (top-100 cited articles) was analyzed to give an insight into research themes present in the most impactful articles. The top-100 cited articles were identified by sorting the retrieved articles in Scopus by the number of citations. Then the top-100 were selected and exported to Microsoft Excel for further analysis.

RESULTS

Characteristics and Key Contributors

In **Figure 1**, the number of retrieved documents is depicted for each step in the search strategy. The net number of articles, which underwent subsequent analysis and mapping was 1,132. The retrieved articles had a Hirsch index of 87.

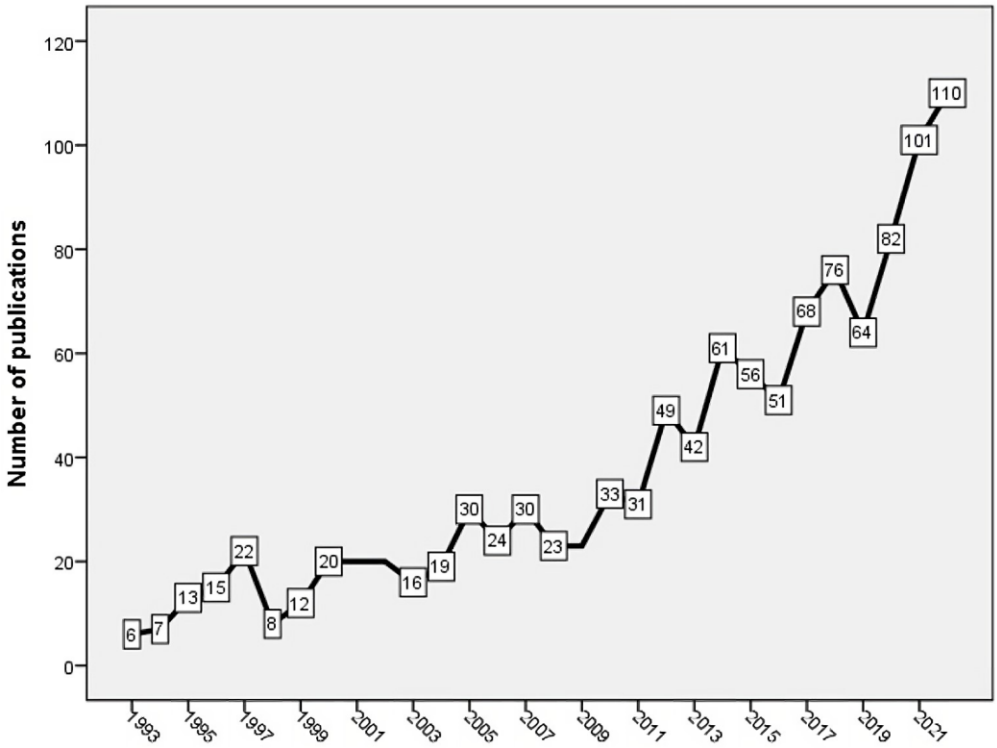

Figure 2. Growth pattern of the publications (Source: Author's own elaboration)

Table 1. Key contributors to research on risk factors & preventive approaches in context of occupational MSDs (1993-2022)

Top-5 journal			
Rank	**Journal name**	**Number of publications**	**% (n=1,132)**
1	Work	64	5.7
2	Occupational and Environmental Medicine	44	3.9
3	American Journal of Industrial Medicine	37	3.3
3	BMC Musculoskeletal Disorders	37	3.3
5	International Journal of Occupational Safety and Ergonomics	33	2.9
5	Scandinavian Journal of Work Environment and Health	33	2.9
Top-5 active countries			
Rank	**Country**	**Number of publications**	**% (n=)**
1	United States	219	19.3
2	Australia	80	7.1
3	United Kingdom	74	6.5
4	Canada	66	5.8
5	Iran	59	5.2
Top-5 active researchers			
Rank	**Researcher name**	**Number of publications**	**% (n=)**
1	Andersen LL	21	1.9
2	Janwantanakul P	18	1.6
3	Holtermann A	16	1.4
4	Coggon D	15	1.3
5	Roquelaure Y	13	1.1
Top-5 active institution			
Rank	**Institution name**	**Number of publications**	**% (n=)**
1	Det Nationale Forskningscenter for Arbejdsmiljø	37	3.3
2	Työterveyslaitos	28	2.5
2	Vrije Universiteit Amsterdam	28	2.5
4	Universiteit van Amsterdam	25	2.2
5	Karolinska Institutet	22	1.9

The growth pattern of the publications exhibited an upward trend with intermittent fluctuations. The final two years of the study showed a growth surge with 101 publications in 2021, followed by a further increase to 110 publications in 2022 (**Figure 2**).

The journal with the highest number of publications was "Work", which has published 64 (5.6%) of the total retrieved articles (**Table 1**). Following closely were the "Occupational and Environmental Medicine" and the "American Journal of Industrial Medicine".

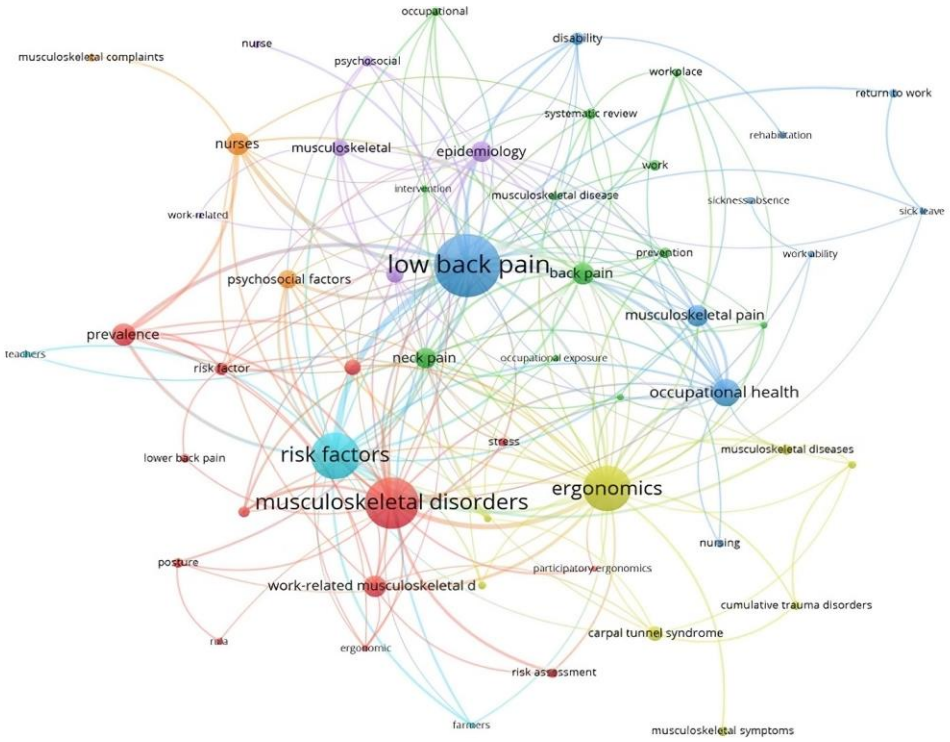

Figure 3. Network visualization map of author keywords with minimum occurrences of 10 times (node size is proportional to frequency of occurrence of keyword) (Source: Author's own elaboration, using VOSviewer)

Analysis showed that the United States emerged as the leading country in terms of the number of publications with 219 (19.3%) publications. Australia and the United Kingdom showcased a substantial contribution, followed by Canada and Iran with comparable levels of research activity. Analysis showed that Anderson LL (Denmark) has emerged as the most prolific author (n=21, 1.9%) followed Janwantanakul P (Thailand) and Holtermann A (Denmark). Analysis also showed the institutions that contributed most to the topic. The National Research Center for the Working Environment (Denmark) (n=37, 3.3%) has emerged as the most active institution, followed by the Finnish Institute of Occupational Health and the Amsterdam UMC–Vrije Universiteit Amsterdam.

Frequent Keywords and Research Collaboration

Visualization techniques were applied to analyze frequent author keywords and frequent terms in the titles and abstracts of the retrieved articles. The map of author keywords with a minimum occurrence of 10 included 55 keywords (**Figure 3**). Of the 55 most frequent author keywords, four stood out in the center of map with the largest node sizes indicative of high importance in retrieved literature: MSDs, low back pain, risk factors, and ergonomics. Other important keywords with large node size included neck pain, psychosocial factors, nurses, prevalence/epidemiology, and carpal tunnel syndrome.

Visualization techniques were also applied to explore research collaboration. **Figure 4** shows the cross-country collaboration among countries with a minimum contribution of 10 publications. In the current study, the cutoff point of 10 publications was used to map international research collaboration because of the limited number and limited research contribution made by countries contributing less than 10 publications. In the collaboration map, the thickness of connecting lines indicated limited cross-country research collaboration. Research collaboration among researchers with a minimum contribution of five publications was visualized. The map included 64 authors. Less than half of the authors (n=30) on the map existed in large collaborative research networks while the remaining authors (n=34) existed in small collaborative research networks or alone indicating poor author-author research collaboration.

Volume of Research on Risk Factors and Preventive Approaches

Among the retrieved articles, there were 870 (76.9%) focused on risk factors of occupational MSDs. The most cited article on the risk factors for occupational MSDs was a systematic review published in 2009. The study summarized 63 research articles and concluded that work-related MSDs were mainly physical work, smoking, high body mass index, high psychosocial work demands, and the presence of comorbidities were the main causal factors for occupational MSDs [27]. The article about causal risk factors for the occupational shoulder pain that ranked second in the number of citations was also a systematic review published in 2004 [28]. The authors of the article concluded that heavy workloads, awkward postures, repetitive movements, vibrations, and duration of employment.

Among the retrieved articles, 298 (26.3%) articles were on interventional strategies and preventive approaches for occupational MSDs. One of the highly cited articles related to preventive approaches was an article on work-related MSDs among construction workers [29]. This study developed a real-time motion warning personal protective equipment that enables workers' self-awareness and self-management of ergonomically hazardous operational patterns for the prevention of occupational MSDs. Another highly cited article on preventive approaches was a systematic review of the evidence available for 30 interventional strategies [30]. The study concluded that a workplace-based resistance training exercise program can help prevent and manage occupational MSDs and symptoms.

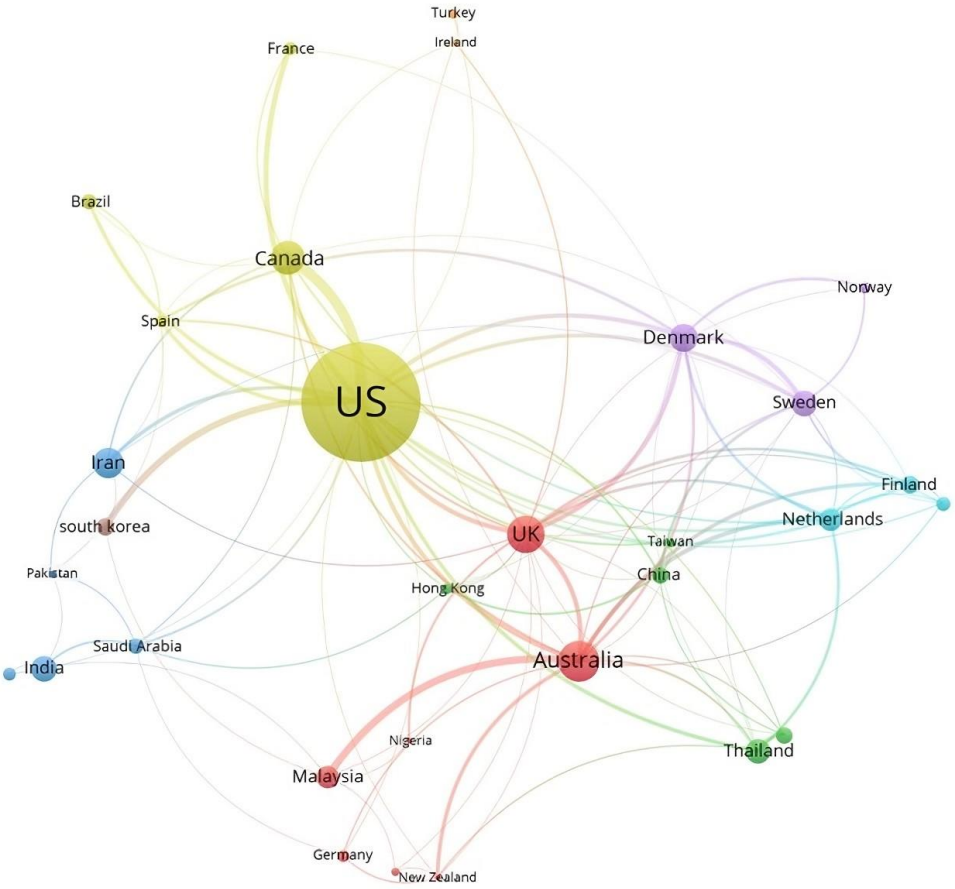

Figure 4. Network visualization map of countries with minimum contribution of at least 10 articles (thickness of connecting lines & distance between nodes are proportional to strength of international research collaboration) (Source: Author's own elaboration, using VOSviewer)

Table 2. Most frequently encountered occupational MSDs, risk factors, & preventive methods in the retrieved literature

Category	Keywords
MSDs	Acute low back pain, chronic back pain, chronic low back pain, chronic pain, de Quervain's disease, neck pain, osteoarthritis, sciatica, shoulder pain, tendinitis, tendonitis, tenosynovitis, upper extremity MSDs, & widespread pain
Risks of MSDs	Age, agricultural work, anxiety, awkward postures, biomechanical exposure, body mass index, computer use, ergonomic risk factors, heavy lifting, manual handling, type of occupation, occupational exposure, physical demands, psychosocial factors, repetitive movements, sedentary work, vibration, & work-related stress
Prevention methods	Ergonomic interventions, exercise therapy, health promotion, physical fitness, physical therapy, & workplace intervention

Table 2 shows the most frequently encountered occupational MSDs, risk factors, and preventive methods. **Table 2** was on network visualization map of author keywords.

Research Themes in the Top-100 Cited Articles

The top-100 cited articles represent the influential articles that shaped the topic of occupational MSDS in the context of risk factors and preventive approaches. Analysis indicated the presence of six major research themes that shaped the knowledge structure on the topic:

1. Risk factors and etiology of occupational MSDs (n=32; 32.0%). In this research theme, physical factors, individual factors, and psychosocial factors were addressed in various occupational settings.
2. Work-related interventions and preventive strategies (n=20, 20.0%). In this research theme, studies on ergonomic interventions, training programs, workplace modifications, and health promotion initiatives were investigated regarding their efficacy to reduce the incidence of occupational MSDs.
3. Occupational factors and specific body regions affected (n=18; 18.0%). In this research theme, occupational factors associated with MSDs in different body regions, mainly the back, neck, shoulder, and upper extremities. In this research theme, biomechanical factors and tasks that contribute to occupational MSDs were discussed.
4. Psychosocial factors and their association with occupational MSDs (n=10, 10%). In this research theme, psychosocial factors such as social support, job satisfaction, job stress, and work demands were investigated for their potential role in the development and progression of occupational MSDs.
5. Occupational factors, prevalence, and burden of occupational MSDs in various occupational settings (n=10, 10%). In this research theme, epidemiology, burden and cost of disability caused by occupational MSDs.

DISCUSSION

The current study aimed to analyze and map scientific literature on occupational MSDs with an emphasis on risk factors and preventive approaches. The importance of the study lies in the idea that understanding the current research characteristics, growth patterns, key contributors, research collaboration, and research themes enables policymakers to implement work-related strategies to reduce occupational MSDs and increased productivity.

The growth pattern of the research publications on occupational MSDs showed an increasing trend over time indicative of increasing interest in the field. This increased interest could be attributed to the increased recognition of occupational MSDs as a major national and global concern [9, 31-33]. Secondly, the recent emphasis on workplace safety to ensure the health and well-being of the workers [34-37]. Third, the emphasis of recent literature on the increased satisfaction of employees upon enhancing workplace safety [38-40]. Finally, the advancement of technology, modern diagnostic tools, and research collaboration helped in increasing research production in the field. The active journals involved in publishing articles on occupational MSDs are well known for their emphasis on occupational health and ergonomics. This indicates that the topic is popular in leading journals in the field of occupational health and ergonomics. Geographically, the distribution of publications worldwide indicates that there was a global contribution to occupational MSDs and that the topic is universal among different occupational settings and in different countries.

Analysis indicated that low back pain, neck, and shoulder pain were the most common body regions affected by occupational MSDs. Several reasons could explain this. Back pain is prevalent and has a significant negative impact on the individuals' ability to perform and produce [41-44]. Furthermore, workplace design interventions could mitigate occupational low back pain [45-48]. Other important but less frequent keywords related to occupational MSDs were neck pain, shoulder pain, and carpal tunnel syndrome. These disorders were also prevalent and occurred across different occupational settings [49-52]. MSDs in neck and shoulder body regions are common among workers with prolonged computer use and poor ergonomics [53, 54]. For carpal tunnel syndrome, it is a common MSD among workers with repetitive and awkward hand postures and uses such as typing or assembly line workers [55]. Ergonomics was a prominent keyword on the map of keywords since ergonomics is the science that deals with the optimization of interaction between workers and the work environment to enhance efficiency, safety, and production [56-59].

The map of frequent author keywords indicated that the healthcare profession, especially nurses, was the most researched with regard to occupational MSDs. The nursing profession involves several risk factors that increase the risk of occupational MSDs [60-64]. Nurses are involved in several manual activities when handling, lifting, and transferring patients that increase the risk of MSDs. Nurses are involved in awkward postures, such as bending, when handling patients. Poorly designed nursing workstations create working and posture difficulties in nurses. Nurses are also exposed to long working hours and night shifts that lead to fatigue and increased risk of MSDs. Finally, poor psychosocial factors nursing contribute to the increased risk of MSDs. The findings in the current study that "nursing" as a profession was more investigated in the context of occupational MSD than other professions is considered a research gap. Several other professions involve heavy lifting and manual activities that impose musculoskeletal problems such as construction, agriculture, transportation, and office work. Therefore, it is crucial to conduct research on other professions to implement comprehensive preventive strategies for occupational MSDs.

Analysis of the retrieved articles revealed that the vast majority of the articles focused on causal and risk factors indicating the importance of identifying and understanding the factors that contribute to occupational MSDs. The importance of this was re-emphasized by the finding that articles on causal and risk factors received the highest number of citations. These highly cited articles happen to be systematic reviews that emphasize the significance of synthesizing existing knowledge to develop evidence-based preventive strategies for occupational MSDs. While the presence of a relatively large volume of literature addressing causal and risk factors provides an insight into the etiology, it also gives an indication of a research gap in the literature pertaining to preventive approaches. Therefore, more research is required to investigate the effectiveness of various preventive interventions to mitigate and eliminate identified risk factors in the workplace environment. To address these research gaps, future studies should focus on ergonomic modifications, training programs, the introduction of policies and guidelines that improve the occupational health, safety, and well-being of the workers [44, 65-67]. By assessing the effectiveness of various preventive interventional strategies, appropriate policies and practices can be recommended and applied.

Analysis of the top-100 cited articles showed that the largest research theme focused on the causal and risk factors while the smallest research theme focused on psychosocial factors, such as job demand, job satisfaction, social support, and stress in the development of occupational MSDs. These findings underscore the importance of continued research with emphasis on preventive interventions. Future research should focus on the effectiveness of various intervention in different occupational settings. Furthermore, future research should focus on dual solutions and interventions taking into consideration the ergonomic and psychosocial factors.

The current study like any other study has few limitations regarding the use of a single database and potential errors in the search strategy. Despite these limitations, the current study will advance the field of occupational MSDs and will direct future research and funding to reach evidence-based practices.

CONCLUSIONS

The current study aimed at analyzing and mapping the research landscape on occupational MSDs. The analysis identified the growth patterns, key contributors, frequent keywords, research areas, the volume of research on risk factors and preventive approaches, and finally the research themes in the 100 influential articles. The study found a substantial number of the retrieved articles focused on risk factors while research on preventive approaches was less presented. The analysis of the top-100 cited revealed the main research themes that constitute the current knowledge in the field and need to be continued in the future. The research

themes were occupational risk factors for MSDs, prevention and intervention strategies, low back pain, neck and shoulder pain, and psychosocial factors in developing occupational MSDs. Based on the analysis, recommendations for future research could be summarized, as follows:

(1) more longitudinal research is needed to identify and confirm the causal relationship between different risk factors and occupational MSDs in different occupational settings,

(2) more research on the effectiveness of various interventional methods on the occupational MSDs,

(3) interdisciplinary research involving psychology, ergonomic, rheumatology, and occupational health experts is recommended and needed since the topic is a multidisciplinary one,

(4) more future research should focus on the role of technology, such as wearable devices, in reducing occupational MSDSs, and finally

(5) efforts should be made at the managers' level to translate recommendations and research findings into practice and policies that ensure occupational safety and health.

In conclusion, the current study gave a comprehensive overview of research publications on the risk factors and preventive approaches of occupational MSDs hoping to contribute to the prevention and improvement of practice in the field of occupational MSDs.

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Ethical statement: The author stated that the study does not require any ethical approval since it is a review of existing literature.

Declaration of interest: No conflict of interest is declared by the author.

Data sharing statement: All data present in this article can be retrieved from Scopus using keywords listed in the article.

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APPENDIX A: KEYWORDS USED TO RETRIEVE DOCUMENTS RELEVANT TO THE RISK FACTORS AND PREVENTIVE APPROACHES IN THE CONTEXT OF OCCUPATIONAL MUSCULOSKELETAL DISORDERS

Database: Scopus

Date: June 03, 2023

1. **Occupational settings**

(TITLE search)

occupational or "workplace" or "work-related" or "job-related" or "employment-related" or ("industr*" and worker*) or "workplace" or "workers" or "occupation*-related" or (construction and worker*) or (agricultural and worker*) or fishermen or "retail worker*" or farmers or janitor* or cleaner or "taxi driver*" or "truck driver*" or "occupational drivers" or "healthcare worker*" or nurses or physicians or pharmacists or doctors or teachers or "hairstylist" or "manufactur* worker*" or "physical therapist" or employee*

2. **Musculoskeletal disorders**

(TITLE search)

("upper extremit*" and pain) or "sprained ankle" or "musculoskeletal pain" or ("lower extremit*" and pain) or "carpal tunnel syndrome" or (musculoskeletal and disorder*) or "muscle pain" or "muscle strain" or "back pain" or "neck pain" or "shoulder pain" or "extrermit* pain" or "elbow pain" or "wrist pain" or "shoulder pain" or "musculoskeletal disease*" or "musculoskeletal complaint*" or "musculoskeletal symptom*" or "hand pain" or "hip pain" or "knee pain" or "ankle pain" or "foot pain" or "tendonitis" or "bursitis" or "repetitive strain injury" or "muscle strain" or "ligament sprain" or "herniated disc" or "sciatica" or "rotator cuff injury" or "frozen shoulder" or "tennis elbow" or "elbow pain" or "plantar fasciitis" or "shin splints" or "stress fracture" or "back injur*" or "neck injur*" or (musculoskeletal and symptom*)

3. **Risk factors**

(TITLE search)

risk or "contributing factor*" or "causal factor*" or "precipitating factor*" or "susceptibility factor*" or "work-related factor*" or "ergonomic factor*" or "occupational ergonomic*" or (ergonomic and factor) or "occupational stressor*" or "job related factor*" or risk or etiology or determinant or predictor or cause or "causative factor*" or "psychosocial factor*" or "physical factor*" or "occupational factor*" or (factor and predict) or (occupation* and "factor*") or (psychosocial and factor) or (physical and factor) or (workplace and factor*) or "factor* associated" or "associated factor*" or correlate* or "causal factor*"

4. **Preventive approaches**

(TITLE search)

"injury prevention" or "musculoskeletal disorder prevention" or "occupational safety" or "control measure*" or "mitigation" or mitigating or "preventive intervention" or (ergonomic* and assess*) or (ergonomic* and modification) or (ergonomic* and change) or (ergonomic* and improve*) or (ergonomic* and program*) or (ergonomic and participatory*) or ("ergonomic measure*") or (ergonomic* and prevent*) or (ergonomic and program) or (ergonomic* and consideration) or (ergonomic* and method*) or "ergonomic practice" or "health promotion" or "work initiative" or "workplace wellness" or training or "preventive measure*" or "protective measure*" or "protective strategies" or "protective factors" or "new approach" or "change approach" or "different approach" or "occupation* approach" or "protective factor*" or protection or "intervention*" or "mitigation" or mitigating or "intervention" or "occupational health practice" or "occupational health polic*" or "occupational health measure*" or "occupational health initiative*" or "occupational health intervention*" or "occupational health strateg*" or controlling*

Inclusion and Exclusion criteria

1. **Time:** 1993 to 2022
2. **Type of documents:** Journal research and review articles
3. **Language:** English
4. **Documents with the following keywords in the title were false-positive and were excluded:** Return or "nurse health study" or ("patient*" and physician) or "task force" or guideline or interventionalist* or "prognostic factor*" or "current technique*" or "assessing exposure" or "assessment method".

Note. Scopus Database allows for use of quotation marks and asterisk as tools to make search strategy comprehensive but still accurate.