

11th ASIAN Conference on Environment-Behaviour Studies

Primula Beach Hotel, Kuala Terengganu, Malaysia, 14-16 Jul 2023

Ergonomic Intervention Practice at the Workplace in Asian boundary: A systematic review

**Mohamad Amirul Nizam Mohamed Thari¹, Naffisah Mohd Hassan^{2*},
Mohd Zulkifli Abdullah², Hairil Rashmizal Abdul Razak³**

** Corresponding Author*

¹ Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Shah Alam, Selangor, Malaysia

² Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Kampus Puncak Alam, Selangor, Malaysia

³ Medical Imaging Programme, Department of Health and Care Professions, Faculty of Health and Life Sciences,
University of Exeter, United Kingdom

2022641494@student.uitm.edu.my, naffi885@uitm.edu.my*, m_zulkifli@uitm.edu.my, h.abdul-razak@exeter.ac.uk

Abstract

Work-related musculoskeletal disorders (WRMSDs) are considered occupational diseases that can cause extreme discomfort and impairment. Due to the high prevalence of WRMSDs in Asia, ergonomic intervention has become particularly important and received growing interest among scholars. This review aims to classify ergonomic intervention practices for better musculoskeletal health at workplaces in Asian countries. PRISMA was chosen to review 22 recently published ergonomic intervention studies obtained from the Scopus and WoS databases. The findings revealed three main approaches for ergonomic intervention: application of devices or tools (seven articles), administrative approach (seven articles), and a combination of both (eight articles).

Keywords: Ergonomic Intervention; Work-Related Musculoskeletal Disorders; PRISMA; workplace

eISSN: 2398-4287 © 2023. The Authors. Published for AMER & cE-Bs by e-International Publishing House, Ltd., UK. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). Peer-review under responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers), and cE-Bs (Centre for Environment-Behaviour Studies), College of Built Environment, Universiti Teknologi MARA, Malaysia.
DOI: <https://doi.org/10.21834/e-bpj.v8i25.4842>

1.0 Introduction

Work-related occupational musculoskeletal disorders, or WRMSDs, are a type of occupational disease caused by injuries involving muscles, nerves, tendons, joints, cartilage, and spinal discs (Minniti et al., 2020). WRMSDs are commonly associated with exposure to workplace risk factors, including the environment and nature of work (Ngatcha Tchounga et al., 2022). According to the World Health Organization (WHO), WRMSDs rank second among the top-priority occupational diseases in the world. It is also reported to have a significant prevalence across many Asian countries. Table 1 shows a list of articles advocating the prevalence of WRMSDs in Asian countries as evaluated from the point of eligibility in PRISMA, along with a number of proposed ergonomic interventions, some of which have already been implemented.

Past studies showed that WRMSDs have been a prominent cause of discomfort and stages of pain among workers in various industries such as manufacturing, agriculture, medical centers, banks, and offices (Esmaeili et al., 2023). Some work tasks can highly affect the neck (Anshasi et al., 2022), shoulder (Gurnani et al., 2022), back (Wan-Nor-Asyikeen et al., 2022), upper extremities (Kong et al., 2023), and lower extremities (Sain & Meena, 2019) areas of the body, subsequently contributing to WRMSDs. The majority of previous review papers are focused on the job sector, specifically on the prevalence of issues and the proposed or implemented

eISSN: 2398-4287 © 2023. The Authors. Published for AMER & cE-Bs by e-International Publishing House, Ltd., UK. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). Peer-review under responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers), and cE-Bs (Centre for Environment-Behaviour Studies), College of Built Environment, Universiti Teknologi MARA, Malaysia.
DOI: <https://doi.org/10.21834/e-bpj.v8i25.4842>

interventions. For instance, Sen et al. (2020) examined the mining sector while Varghese and Panicker (2022) focused on the rubber processing sector. Additionally, a review by Rodrigues Ferreira Faisting and de Oliveira Sato (2019) examined the implementation of a specific type of intervention, such as assessing the efficacy of ergonomic training in mitigating musculoskeletal symptoms. However, this review encompasses a broader spectrum of interventions across various job sectors, focusing primarily on Asian countries.

According to Alipour et al. (2021), WRMSDs rank second in terms of frequency among disorders, following respiratory diseases. The severity of WRMSDs can vary from mild discomfort to significant disability (Ijaz et al., 2020) and can be accounted to several factors, like specific type of disorder as well as the duration and intensity of exposure to risk factors (Gurnani et al., 2022). Additionally, individuals' physical and psychological characteristics (Cheung et al., 2018) and the effectiveness of preventive measures (Esmaeili et al., 2023) further influence the severity of WRMSDs. Occasionally, WRMSDs can be mild and merely cause transitory discomfort or pain. However, such disorder may worsen if left untreated or if the individuals continue to be exposed to the risk factors. In extreme circumstances, WRMSDs can result in chronic pain, functional limitations, and disability (Snodgrass et al., 2022). It also has psychological and social effects such as decreased job satisfaction (Baek et al., 2018), decreased productivity (Susihono & Adiatmika, 2021), and increased absenteeism (Susihono & Gede, 2020), thus affecting the quality of life.

The rapid economic development in Asia has resulted in a rise in industrialization (Roxana Sierra-Hernández et al., 2019) and an increase in the labor force. Consequently, more employees are exposed to work-related risks, including WRMSDs. Due to the increasing prevalence of WRMSDs in the workplace, ergonomic intervention is particularly important as a preventive measure (Rostami et al., 2022). To reduce the effect of WRMSDs, several research employed administrative and engineering terms (Kee, 2022), physical and administrative interventions (Motamedzadeh et al., 2021), as well as engineering and training interventions (Esmaeili et al., 2023). These aspects are described in this review using the terms 'application of devices or tools' and 'administrative approach'. Therefore, this paper aims to classify ergonomic intervention practices for better musculoskeletal health at workplaces in Asian countries into three themes, namely, the application of devices or tools, administrative approach, and a combination of both.

Table 1: The prevalence of WRMSDs in Asian countries (articles from the point of eligibility in PRISMA)

Country	No. of Articles
Bangladesh	2
China	2
Hong Kong	2
India	9
Indonesia	3
Iran	5
Jordan	1
Korea	2
Malaysia	5
Pakistan	2
Saudi Arabia	3
Singapore	1

2.0 Methodology

A systematic review is a review of a well-defined subject that uses systematic and explicit procedures to find, select, and evaluate relevant research, as well as to gather and analyze data from the studies included in the review (Moher et al., 2009). This section describes the key terms used in the review: PRISMA, search database, systematic review process, and data abstraction and synthesis.

2.1 PRISMA

This review used "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) as guidance for the qualitative synthesis process. PRISMA is a reporting standard commonly used for systematic reviews and meta-analyses that has the capability of improving the clarity and quality of research reporting (Mohamed Shaffril et al., 2019). The reporting standard consists of four sections: identification, screening, eligibility, and included.

2.2 Search database

This review involved the use of two main databases, namely Web of Science (WoS) and Scopus. These databases were selected as it offers extensive databases for browsing and research. WoS is preferable due to its unique search engine, whereas Scopus has a reputation for reviewing documents frequently to maintain its standard (Patel et al., 2021).

2.3 The process of conducting a systematic review to choose relevant articles

The systematic review process was done to select suitable articles for the analysis. It entailed three phases, namely identification, screening, and eligibility.

2.3.1 Identification

The choice of keywords was crucial for the identification of appropriate articles. The keywords "ergonomic awareness" and "ergonomic training" did not yield more results than "ergonomic intervention". As a result, the articles were searched using a combination of these keywords (see Table 2) for both databases. "Ergonomic intervention" became an important keyword in this review. Past research suggests that ergonomic interventions have a favorable effect on musculoskeletal-related problems (Heidarimoghadam et al., 2020).

Relevant literature was identified using targeted keywords conducted through WoS and Scopus searches until 7 April 2023. The identification phase resulted in a total of 2043 articles identified from both databases

Table 2: The search strings used in the databases

Databases	Search string
Web of Science	Topic ("ergonomic awareness" OR "ergonomic intervention" OR "ergonomic training")
Scopus	TITLE-ABS-KEY ("ergonomic awareness" OR "ergonomic intervention" OR "ergonomic training")

2.3.2 Screening

All 2043 articles found in the identification phase underwent the screening phase, of which 11 articles were identified as duplicates from both databases and were excluded from the list of articles. The remaining 2032 articles were subjected to another screening by applying the inclusion and exclusion criteria outlined in Table 3. It resulted in a total of 58 articles that were selected for further analysis.

Table 3: Inclusion and exclusion criteria for screening

Criterion	Inclusion	Exclusion
Document Type	Article	Review articles, conference papers, proceeding papers, book chapters, book reviews, editorial materials, early access, meeting abstracts, corrections, letters, reprints, notes, short surveys, erratum, undefined.
Language	English	Non-English
Years	2018 to 2023	Before 2018
Country/Territory	Asian Countries	Non-Asian countries
Open Access	All open access	Closed access

2.3.3 Eligibility

An extensive review process was conducted during the eligibility phase to ascertain that all 58 articles met the inclusion criteria as well as the objective of the review. A total of 36 articles were excluded because they disregarded ergonomic interventions, did not concentrate on the workplace or industry, or did not focus on Asian countries. Finally, 22 articles were included in the analysis stage (see Fig. 1).

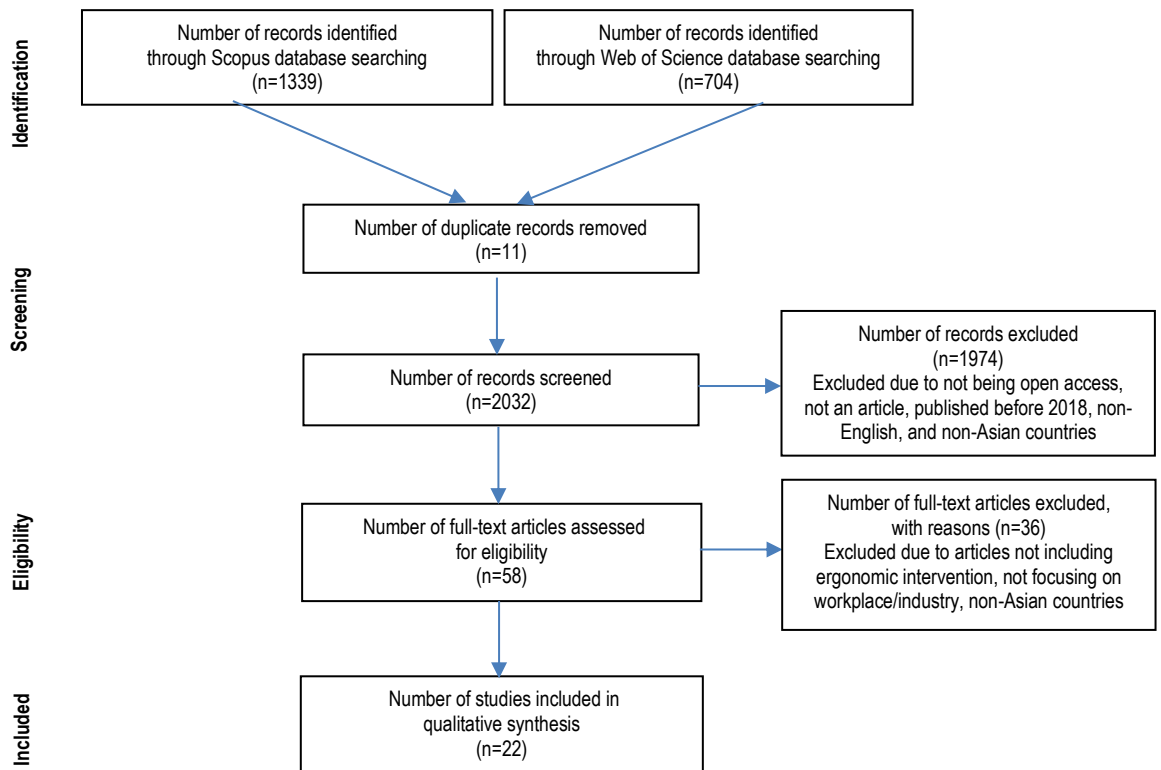


Fig. 1: Flow diagram showing the screening for qualitative synthesis (adapted from Mohamed Shaffril et al. (2019) and Moher et al. (2009)

3.0 Findings

Findings from the synthesis analysis indicated that ergonomic interventions have been frequently employed in Asian countries via three distinct approaches: device or tool-based interventions, administrative interventions, and a combination of both. As shown in Table 4, seven articles explored the utilization of devices or tools as a means of ergonomic intervention (Alipour et al., 2021; Antwi-Afari et al., 2021; Arunkumar et al., 2019; Darliana et al., 2020; Kong et al., 2023; Mohammad Yusof et al., 2021; Ramdan & Candra, 2021), seven articles focused on the use of administration (Alghadir et al., 2021; Anshasi et al., 2022; Dhole et al., 2021; Heidarimoghadam et al.,

2020; Hijam et al., 2020; Lin et al., 2022; Rahman et al., 2019), and eight articles used a combination of both approaches (Esmaeili et al., 2023; Kee, 2022; Motamedzadeh et al., 2021; Rostami et al., 2022; So et al., 2019; Susihono & Adiatmika, 2021; Susihono & Gede, 2020; Yang et al., 2021).

Iran was found to have the highest number of contributions in the field of ergonomic intervention, with a total of four articles. It was followed by India, Indonesia, and Malaysia (each contributing three articles), China, Hong Kong, and Korea (each contributing two articles), and Saudi Arabia, Jordan, and Pakistan (each contributing one article). From the industrial aspect, this review identified six primary industries engaged in ergonomic intervention: manufacturing, healthcare, construction, agriculture, the office environment, and civil service. The majority of industries analyzed in this study were associated with the manufacturing sector, accounting for a total of ten articles. It was followed by the healthcare sector with seven articles, the office environment with two articles, whereas the construction, agriculture, and civil service sectors each contributed one article to the analysis.

Regarding the timeframe for ergonomic interventions, our analysis revealed that the maximum duration can extend beyond two years. Nonetheless, several scholarly articles have underscored the importance of periodic follow-up assessments to ensure their efficiency and sustainability (Esmaeili et al., 2023; Heidarimoghadam et al., 2020; Lin et al., 2022; Ramdan & Candra, 2021; Susihono & Adiatmika, 2021; Susihono & Gede, 2020; Yang et al., 2021). In terms of sample size or participant selection, certain articles employed mathematical formula to ascertain sample size (Dhole et al., 2021; Heidarimoghadam et al., 2020; Hijam et al., 2020; Lin et al., 2022; Mohammad Yusof et al., 2021; Rostami et al., 2022; So et al., 2019) while others either utilized the inclusion and exclusion criteria (Alghadir et al., 2021; Alipour et al., 2021; Antwi-Afari et al., 2021; Esmaeili et al., 2023; Kee, 2022; Kong et al., 2023; Motamedzadeh et al., 2021; Rahman et al., 2019; Ramdan & Candra, 2021; Susihono & Adiatmika, 2021; Susihono & Gede, 2020; Yang et al., 2021) or did not explicitly specify their sampling approach (Anshasi et al., 2022; Arunkumar et al., 2019; Darliana et al., 2020). Further analysis of the years of publication showed that a total of nine articles were published in 2021, which was the highest between 2018 to 2023. It was followed by four articles in 2022 and 2020, three articles in 2019, and two articles in 2023.

Table 4: Classification of ergonomic intervention and breakdown by country, industry, and period of intervention

Author	Country	Period	Industry	Application of devices or tools	Administrative approach
Alipour et al. (2021)	Iran	-	Electronics (Manufacturing)	√	
Alghadir et al. (2021)	Saudi Arabia	6 months	Nursing (Healthcare)		√
Anshasi et al. (2022)	Jordan	6 months	Dental (Healthcare)		√
Antwi-Afari et al. (2021)	Hong Kong	2.7 hours	Construction	√	
Arunkumar et al. (2019)	India	-	Automotive parts (Manufacturing)	√	
Darliana et al. (2020)	Malaysia	-	Batik stamping (Manufacturing)	√	
Dhole et al. (2021).	India	2 months	Nursing (Healthcare)		√
Esmaeili et al. (2023)	Pakistan	6, 12 months	Foundry (Manufacturing)	√	√
Heidarimoghadam et al. (2020)	Iran	1,3 & 6 months	Knowledge-based companies (Office Environment)		√
Hijam et al. (2020)	India	15 days	Nursing (Healthcare)		√
Kee (2022)	Korea	4 weeks	Agriculture	√	√
Kong et al. (2023).	Korea	2 days	Overhead works (Manufacturing)	√	
Lin et al. (2022).	China	3, 6, 9, & 12 months	Dental (Healthcare)		√
Mohammad Yusof et al. (2021)	Malaysia	1 week	Police rider (Civil Service)	√	
Motamedzadeh et al. (2021)	Iran	9 months	Bank (Office Environment)	√	√
Rahman et al. (2019)	Malaysia	-	Electronic (Manufacturing)		√
Ramdan & Candra (2021)	Indonesia	3 & 6 months	Weaving (Manufacturing)	√	
Rostami et al. (2022)	Iran	Over 2 years	Steel (Manufacturing)	√	√
So et al. (2019)	Hong Kong	1 year	Hospital (Healthcare)	√	√
Susihono & Adiatmika (2021)	Indonesia	1 & 8 months	Metal casting (Manufacturing)	√	√
Susihono & Gede (2020)	Indonesia	1 & 10 months	Metal casting (Manufacturing)	√	√
Yang et al. (2021)	China	3 & 6 months	Nursing (Healthcare)	√	√

4.0 Discussion

This paper systematically reviewed 22 articles that looked on ergonomic intervention practices for better musculoskeletal health at workplaces in Asian countries. From the figure, seven articles were classified as the application of devices or tools, another seven articles were focused on the administrative approach, and the remaining eight articles involved the combination of both approaches. The investigation in these articles extended across the manufacturing, healthcare, construction, agriculture, office environment, and civil service industries. A number of studies employed the engineering and administrative control terminology to reduce the impact of WRMSDs within the working environments (Kee, 2022). Other studies, on the other hand, utilized the terminology of physical and administrative interventions to mitigate WRMSDs (Motamedzadeh et al., 2021). Additionally, one study used the terminology of engineering and training interventions (Esmaeili et al., 2023).

Engineering methods often include four approaches: tool modification, workspace redesign, powered equipment, and automation (Darliana et al., 2020). This review changes the term 'engineering methods' into the 'application of devices or tools'. In contrast, the administrative approach was used as a substitute for administrative control, which involved awareness, training, break and work duration, and physical activity (Motamedzadeh et al., 2021). This review also identified eight articles that employed a combination of both approaches, while the application of devices or tools and the administrative approach consisted of seven articles respectively. This implies that there is no superior approach compared to the others.

When analyzing these 22 articles, it would be unjust to draw comparisons between the application of devices or tools and the administrative approach. Despite the successful implementation of devices or tools interventions in the workplace (Darliana et al., 2020) and there is contradictory evidence regarding the effectiveness of ergonomic training in reducing physical effort and alleviating musculoskeletal discomfort among employees (Rodrigues Ferreira Faisting & de Oliveira Sato, 2019), workplaces that face challenges in implementing devices or tools may resort to administrative control as a cost-effective option for managing WRMSDs (Kee, 2022). The author further stated that applying the administrative approach can also yield similar efficacy in the application of devices or tools. This suggests that both approaches have the potential to give superior outcomes in mitigating or diminishing the impact of WRMSDs.

The 22 articles were also systematically categorized according to their respective industries, which resulted in the identification of six primary industries: manufacturing, healthcare, construction, agriculture, office environment, and public service. This classification provides a comprehensive overview of the industries covered within the literature, ensuring a thorough examination of ergonomic interventions across diverse sectors. The manufacturing industry emerged as the primary sector for implementing ergonomic interventions owing to numerous deficiencies in the workplace environment, tools, and equipment that threaten employees' health and safety at the workplace (Arunkumar et al., 2019). This indicates that the manufacturing sector represents a higher degree of risk in comparison to other industries. Other articles were focused on the manufacturing and healthcare industries, and there appear to be not many article contributions in other sectors.

Our results also found several high-impact articles that employed the quasi-experimental method to compare the control group with the main group or other relevant groups (Dhole et al., 2021; Esmaeili et al., 2023; Heidarimoghadam et al., 2020; Hijam et al., 2020; Lin et al., 2022; Mohammad Yusof et al., 2021; Motamedzadeh et al., 2021; So et al., 2019; Yang et al., 2021). Such an approach allows for a rigorous examination of the effects of interventions and facilitates a comprehensive analysis of the research findings. Nevertheless, it is worth noting that certain articles demonstrated that the implementation of ergonomic interventions, particularly those involving the application of devices or tools, may not demand an extended duration and can be accomplished within a relatively short period of time (Alipour et al., 2021; Antwi-Afari et al., 2021; Arunkumar et al., 2019; Darliana et al., 2020; Rahman et al., 2019). It subsequently suggests that the timeframe for implementing ergonomic interventions is not rigidly defined and can vary depending on the specific approach and context.

5.0 Conclusion and Recommendation

The present review encompassed a total of 22 articles focusing on device or tool-based interventions (seven articles), administrative approach (seven articles), and a combination of both approaches (eight articles). The search was limited to articles available in the Scopus and Web of Science databases. This review investigated all of Asia's job sectors, including manufacturing, healthcare, construction, agriculture, office environments, and civil service, using a variety of interventions rather than focusing on a single industry or type of intervention. The majority of studies highlighted the effectiveness of the ergonomic interventions employed. Notably, no single approach demonstrated inherent superiority over the others, as there were instances of interdependence between device-based and administrative interventions. This review suggests that workplaces encountering difficulties to implement devices or tools should consider implementing an administrative approach to manage initial measures for managing WRMSDs, particularly for small and medium enterprises (SMEs).

It should be noted that this review was confined to Asian countries, and it is worthwhile to conduct more comparative reviews involving other regions. Furthermore, the present review only looked at the prevalence of work-related musculoskeletal disorders (WRMSDs) and recommended the implementation of ergonomic interventions at the workplace across 12 Asian countries, which is merely a quarter of the region. Therefore, future research can focus on more countries in the Asian region to explore the prevalence of WRMSDs across a wider range of occupational sectors, subsequently enabling the implementation of diverse ergonomic intervention

methods and facilitating the comparison of their effectiveness. This will further expand the body of knowledge regarding WRMSDs and enhance the application of intervention strategies across the region.

Acknowledgments

The authors wish to express their gratitude to Universiti Teknologi MARA (UiTM), Malaysia, the Department of Occupational Safety and Health Malaysia, and the Public Service Department (JPA) for the provision of support and funding throughout the completion of this review.

Paper Contribution to Related Field of Study

Contribution to Researchers:

This paper provides an overview of ergonomic interventions implemented across Asia along with the extent of their efficacies, which can be of great value for researchers and practitioners in the respective field to evaluate the effectiveness of current interventions and initiatives aimed at mitigating WRMSDs, mainly in the Asian region. By assessing the results of these interventions, relevant stakeholders can pinpoint any domains that require enhancement, explore ways to optimize the current strategies and provide evidence-based suggestions for forthcoming interventions.

More comparative studies can be conducted across Asian countries to ascertain the similarities and differences in the prevalence of WRMSDs, risk factors, and interventions. Research in this area can offer significant contributions to understand the influence of cultural, organizational, and regional variables of WRMSDs, which can benefit the development of targeted interventions.

This review also offers researchers the capacity to conduct further investigation to identify specific risk factors that are linked to WRMSDs within the Asian demographics. This process entails an analysis of various aspects, such as the nature of industries, job responsibilities, ergonomic issues, and cultural or socio-economic determinants that play a role in the emergence of WRMSDs. Comprehending these risk factors may facilitate the development of focused interventions and preventive measures.

Contribution to Practitioners:

This review will enable health and safety practitioners to decide and employ suitable WRMSDs prevention and management strategies based on the industry, costs, work environment, time allocation, and the efficacy of ergonomic interventions. This has the potential to bring about positive results like a decrease in pain, enhanced functionality, improved productivity, and a reduction in absenteeism. Moreover, adopting evidence-based interventions can lead to financial benefits, mainly for employers. Additionally, findings from this review can provide professionals with valuable insights gained from others' experiences and offer valuable contributions toward the progression of optimal approaches.

Furthermore, this review intends to provide practitioners with a proper understanding of the variations among industries related to WRMSDs, including, but not limited to, manufacturing industries and healthcare services. Such knowledge will enable them to create and execute interventions that are highly suited with the organizational culture and surrounding. Customized interventions are believed to have a higher probability of being efficacious and connecting with the intended demographic. It also can potentially be incorporated into professional growth programs, particularly for practitioners, to assure that they remain informed about the most recent findings and evidence-supported approaches to effectively address and mitigate WRMSDs.

References

- Alghadir, A. H., Al-Abbad, H., Buragadda, S., & Iqbal, A. (2021). Influence of work-related safety and health guidelines on knowledge and prevalence of occupational back pain among rehabilitation nurses in Saudi Arabia: A 6-month follow-up study. *International Journal of Environmental Research and Public Health*, 18(16). <https://doi.org/10.3390/ijerph18168711>
- Alipour, P., Daneshmandi, H., Fararuei, M., & Zamanian, Z. (2021). Ergonomic design of manual assembly workstation using digital human modeling. *Annals of Global Health*, 87(1), 1–12. <https://doi.org/10.5334/aogh.3256>
- Anshasi, R. J., Alsyuf, A., Alhazmi, F. N., & AbuZaitoun, A. T. (2022). A Change Management Approach to Promoting and Endorsing Ergonomics within a Dental Setting. *International Journal of Environmental Research and Public Health*, 19(20). <https://doi.org/10.3390/ijerph192013193>
- Antwi-Afari, M. F., Li, H., Anwer, S., Li, D., Yu, Y., Mi, H.-Y., & Wuni, I. Y. (2021). Assessment of a passive exoskeleton system on spinal biomechanics and subjective responses during manual repetitive handling tasks among construction workers. *Safety Science*, 142, 105382. <https://doi.org/10.1016/j.ssci.2021.105382>
- Arunkumar, D., Ramesh, V., & Skanda, M. G. (2019). Implementation of rapid upper limb assessment technique in automotive parts manufacturing industry. *International Journal of Recent Technology and Engineering*, 8(3), 1599–1602. <https://doi.org/10.35940/ijrte.C4421.098319>
- Dariana, M., Hanisa, H., Fadhli, K. A., Nurulhda, S., & Indah, D. D. D. (2020). Ergonomic engineering intervention of batik stamping work to reduce lifting load. *Malaysian Journal of Public Health Medicine*, 20(Special Issue 1), 124–127. <https://doi.org/10.37268/MJPHM/VOL.20/NO.SPECIAL1/ART.680>
- Dhole, R., Patil, D., & Kapoor, A. (2021). Impact of workstation exercise and ergonomic exercise on nursing population – A randomized clinical trial research protocol. *Indian Journal of Forensic Medicine and Toxicology*, 15(1), 622–627. <https://doi.org/10.37506/ijfimt.v15i1.13483>

- Esmaeili, R., Shakerian, M., Esmaeili, S. V., Jalali, M., Pouya, A. B., & Karimi, A. (2023). A multicomponent quasi-experimental ergonomic interventional study: long-term parallel four-groups interventions. *BMC Musculoskeletal Disorders*, 24(1), 1–15. <https://doi.org/10.1186/s12891-023-06220-4>
- Heidarimoghadam, R., Mohammadfam, I., Babamiri, M., Soltanian, A. R., Khotanlou, H., & Sohrabi, M. S. (2020). Study protocol and baseline results for a quasi-randomized control trial: An investigation on the effects of ergonomic interventions on work-related musculoskeletal disorders, quality of work-life and productivity in knowledge-based companies. *International Journal of Industrial Ergonomics*, 80(April), 103030. <https://doi.org/10.1016/j.ergon.2020.103030>
- Hijam, S., Deaver, U., Kanika, & Sarin, J. (2020). Effectiveness of ergonomic training program on knowledge, self-efficacy and practice on prevention of work related low back pain among staff nurses. *Indian Journal of Forensic Medicine and Toxicology*, 14(4), 551–556. <https://doi.org/10.37506/ijfmt.v14i4.11540>
- Kee, D. (2022). Participatory Ergonomic Interventions for Improving Agricultural Work Environment: A Case Study in a Farming Organization of Korea. *Applied Sciences (Switzerland)*, 12(4). <https://doi.org/10.3390/app12042263>
- Kong, Y. K., Kim, J. H., Shim, H. H., Shim, J. W., Park, S. S., & Choi, K. H. (2023). Efficacy of passive upper-limb exoskeletons in reducing musculoskeletal load associated with overhead tasks. *Applied Ergonomics*, 109(December 2022), 103965. <https://doi.org/10.1016/j.apergo.2023.103965>
- Lin, S., Tsai, C. C., Liu, X., Wu, Z., & Zeng, X. (2022). Effectiveness of participatory ergonomic interventions on musculoskeletal disorders and work ability among young dental professionals: A cluster-randomized controlled trail. *Journal of Occupational Health*, 64(1), 1–11. <https://doi.org/10.1002/1348-9585.12330>
- Mohamed Shaffril, H. A., Samah, A. A., Samsuddin, S. F., & Ali, Z. (2019). Mirror-mirror on the wall, what climate change adaptation strategies are practiced by the Asian's fishermen of all? *Journal of Cleaner Production*, 232, 104–117. <https://doi.org/10.1016/j.jclepro.2019.05.262>
- Mohammad Yusof, N. A. D., Karupiah, K., Tamrin, S. B. M., Rasdi, I., How, V., Sambasivam, S., Jamil, P. A. S. M., Mani, K. K. C., Naeini, H. S., & Nata, D. H. M. S. (2021). Effectiveness of lumbar support with built-in massager system on spinal angle profiles among high-powered traffic police motorcycle riders: A randomised controlled trial. *PLoS ONE*, 16(10 October), 1–15. <https://doi.org/10.1371/journal.pone.0258796>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement. *Annals of Internal Medicine*, 151(4), 264–269.
- Motamedzadeh, M., Jalali, M., Golmohammadi, R., Faradmal, J., Zakeri, H. R., & Nasiri, I. (2021). Ergonomic risk factors and musculoskeletal disorders in bank staff: an interventional follow-up study in Iran. *Journal of the Egyptian Public Health Association*, 96(1). <https://doi.org/10.1186/s42506-021-00097-8>
- Rahman, I. A., Mohamad, N., Rohani, J. M., & Zein, R. M. (2019). The impact of work rest scheduling for prolonged standing activity. *Industrial Health*, 56(6), 492–499. <https://doi.org/10.2486/indhealth.2018-0043>
- Ramdan, I., & Candra, K. (2021). Evaluation and analysis of new design traditional handloom performance in reducing work musculoskeletal disorders among Sarong Samarinda female weavers: A quasi-experimental study. *International Journal of Critical Illness and Injury Science*, 11(4), 215. https://doi.org/10.4103/ijciis.ijciis_22_21
- Rodrigues Ferreira Faisting, A. L., & de Oliveira Sato, T. (2019). Effectiveness of ergonomic training to reduce physical demands and musculoskeletal symptoms - An overview of systematic reviews. *International Journal of Industrial Ergonomics*, 74(October), 102845. <https://doi.org/10.1016/j.ergon.2019.102845>
- Rostami, M., Choobineh, A., Shakerian, M., Faraji, M., & Modarresifar, H. (2022). Assessing the effectiveness of an ergonomics intervention program with a participatory approach: ergonomics settlement in an Iranian steel industry. *International Archives of Occupational and Environmental Health*, 95(5), 953–964. <https://doi.org/10.1007/s00420-021-01811-x>
- Sen, A., Sanjog, J., & Karmakar, S. (2020). A Comprehensive Review of Work-Related Musculoskeletal Disorders in the Mining Sector and Scope for Ergonomics Design Interventions. *IJSE Transactions on Occupational Ergonomics and Human Factors*, 8(3), 113–131. <https://doi.org/10.1080/24725838.2020.1843564>
- So, B. C. L., Szeto, G. P. Y., Lau, R. W. L., Dai, J., & Tsang, S. M. H. (2019). Effects of ergomotor intervention on improving occupational health in workers with work-related neck-shoulder pain. *International Journal of Environmental Research and Public Health*, 16(24), 1–13. <https://doi.org/10.3390/ijerph16245005>
- Susihono, W., & Adiatmika, I. P. G. (2021). The effects of ergonomic intervention on the musculoskeletal complaints and fatigue experienced by workers in the traditional metal casting industry. *Heliyon*, 7(2), e06171. <https://doi.org/10.1016/j.heliyon.2021.e06171>
- Susihono, W., & Gede, I. P. (2020). Assessment of inhaled dust by workers and suspended dust for pollution control change and ergonomic intervention in metal casting industry : A cross-sectional study. *Heliyon*, 6(February), e04067. <https://doi.org/10.1016/j.heliyon.2020.e04067>
- Varghese, A., & Panicker, V. V. (2022). Effect of MSDs and scope of ergonomic interventions among rubber processing workers: a systematic review. *Medicina Del Lavoro*, 113(4), 1–13. <https://doi.org/10.23749/mdl.v113i4.12826>
- Yang, S., Li, L., Wang, L., Zeng, J., Yan, B., & Li, Y. (2021). Effectiveness of a multidimensional intervention program in improving occupational musculoskeletal disorders among intensive care unit nurses: a cluster-controlled trial with follow-up at 3 and 6 months. *BMC Nursing*, 20(1), 1–14. <https://doi.org/10.1186/s12912-021-00561-y>