HEALTH FRONTIERS
MULTIDISCIPLINARY JOURNAL FOR HEALTH PROFESSIONALS
Vol. 4, No. 2, 2026 | E-ISSN: 3024-9740
TARQABIN NUSANTARA GROUP

Systematic Review OPEN ACCESS

Integrating Biomechanical, Physiological, and Psychosocial Dimensions in Ergonomic Injury Prevention: A Multidisciplinary Review and Technological Framework

Muhammad Yusuf Al Fatih [1,*], Moch. Yunus [1], Wijdan Reyga Yolanda Suhartono [1], Ahmad Baihaqi Ahnaf [1]

[1]Department of Medicine, Universitas Negeri Malang, Malang, Indonesia

***Corresponding Author:**
Muhammad Yusuf Al Fatih
Email: muhammad.yusuf.2410116@students.um.ac.id

DOI: 10.62255/mjhp.v4i2.355

Received: 11 August 2026
Revised: 18 October 2026
Accepted: 21 October 2026

Keywords: Occupational ergonomics; Musculoskeletal disorders; Psychosocial factors; Wearable technology; Participatory ergonomics

***How to cite*:** *Al Fatih, M. Y., Yunus, M., Suhartono, W. R. Y., & Ahnaf, A. B. (2026). Integrating Biomechanical, Physiological, and Psychosocial Dimensions in Ergonomic Injury Prevention: A Multidisciplinary Review and Technological Framework. Health Frontiers: Multidisciplinary Journal for Health Professionals, 4(2), 303-312.https://doi.org/10.62255/mhjp.v4i2.355*

ABSTRACT

Background: Occupational musculoskeletal disorders (MSDs) remain a critical global health and economic burden, driven by complex, synergistic interactions between biomechanical, physiological, and psychosocial risk factors. Traditional interventions often fail to address this multifaceted nature, leading to inconsistent long-term outcomes.
Objective: This study aims to critically synthesize current evidence on ergonomic interventions across diverse sectors and propose a comprehensive, integrated framework for sustainable occupational injury prevention.
Methods: We conducted a systematic literature review spanning foundational ergonomic research from the 1980s to emerging Industry 4.0 technologies in the 2020s. The review integrated multidisciplinary domains including occupational health, biomechanics, organizational psychology, and computer science evaluating systematic reviews, controlled trials, and biomechanical modeling studies.
Results: The analysis reveals that while mechanical aids and anthropometric workstation redesigns effectively mitigate immediate biomechanical strain, their long-term efficacy is highly dependent on organizational commitment and psychosocial support. Furthermore, while emerging technologies such as artificial intelligence (AI) and wearable sensors significantly enhance real-time posture and fatigue monitoring, they currently lack the integration of psychosocial stress indicators, limiting their holistic preventive potential.
Conclusion: Achieving sustainable injury prevention requires a paradigm shift toward multidisciplinary, context-specific interventions. Future frameworks must seamlessly combine biomechanical redesign, participatory ergonomics, and advanced technological feedback, while explicitly integrating psychosocial risk management to ensure long-term efficacy across both traditional and high-risk underrepresented sectors.

Key Points (Highlights):

- Physical and psychosocial risks drive occupational musculoskeletal disorders.
- This review integrates biomechanical, physiological, and psychosocial data.
- Effective prevention requires multidisciplinary, context-specific interventions.

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

INTRODUCTION

Occupational musculoskeletal disorders (MSDs) and work-related injuries constitute a paramount global health and economic challenge, driving immense burdens through lost productivity, chronic disability, and escalating healthcare costs (Patel et al., 2021). At the core of this crisis are the biomechanical and physiological exposures inherent to daily work specifically, how workers position their bodies, manage physical loads, and endure repetitive motions across diverse sectors such as manufacturing, healthcare, and agriculture (Faucett, 2005; Talapatra et al., 2023). While traditional ergonomics has successfully mitigated isolated physical risks through localized adjustments, the escalating complexity and intensification of modern work environments demand a fundamental paradigm shift (Urrea, 2026). Moving away from siloed, purely physical interventions is now critical to developing holistic, multidimensional prevention strategies that address the root causes of tissue fatigue and cumulative micro-trauma (Albarrán Morillo et al., 2026).

Despite decades of extensive research, the long-term effectiveness of ergonomic interventions remains highly inconsistent. Current literature reveals a critical fragmentation in how occupational risks are studied and managed: biomechanical models accurately quantify spinal loads, physiological studies track vascular and muscular health, and organizational psychology examines job stress, yet these domains rarely intersect in practical, real-world applications (Maman et al., 2020; Peters et al., 2025; Zhang et al., 2024). Consequently, psychosocial stressors such as high cognitive job demands, low decision latitude, and inadequate social support frequently exacerbate physical risks (Ogunseiju et al., 2021). These factors create synergistic, compounding effects that accelerate muscle tension, impair physiological recovery, and significantly increase MSD prevalence. This disciplinary disconnect highlights a significant gap in translating multidisciplinary evidence into cohesive, sustainable workplace practices (Ruzairi et al., 2021).

The advent of Industry 4.0 has introduced transformative technologies, including wearable inertial sensors, artificial intelligence (AI), and digital twins, which offer unprecedented capabilities for real-time ergonomic risk assessment and predictive analytics (Price, 2021). However, these innovations are predominantly validated in controlled laboratory settings and remain largely blind to the complex psychosocial and organizational dimensions of actual work environments (Da Silva et al., 2024). To achieve truly sustainable occupational health, emerging technological frameworks must evolve beyond mere kinematic and biomechanical tracking (Da Silva et al., 2026). They must be designed to incorporate physiological fatigue markers and psychosocial stress indicators such as allostatic load and cognitive fatigue enabling the development of truly adaptive, personalized, and context-aware interventions (Donisi et al., 2022).

Therefore, this study aims to critically synthesize the biomechanical, physiological, and psychosocial determinants of occupational injury risk, while rigorously evaluating the efficacy of current ergonomic interventions across various industrial contexts (Kakhi et al., 2024). By mapping the intersection of traditional ergonomic principles with emerging technological capabilities, this research proposes a comprehensive, integrated framework for injury prevention that bridges the gap between physical engineering and organizational psychology(Nambiema et al., 2021). Ultimately, this paper provides actionable, evidence-based insights for practitioners, industry leaders, and policymakers to design context-specific, multidisciplinary strategies (Abbasinia & Entezarizarch, 2026). These strategies are essential to ensure long-term efficacy, particularly across diverse and underrepresented high-risk sectors that have historically lacked tailored ergonomic prioritization (Safari et al., 2025).

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

MATERIALS AND METHODS

Reporting Guidelines

This study strictly adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological transparency, reproducibility, and comprehensive reporting of the systematic review process. The protocol was systematically executed, including predefined search strategies, rigorous inclusion and exclusion criteria, and standardized data extraction procedures, to minimize selection bias and enhance the overall reliability of the synthesized findings.

Study Scope

The scope of this systematic review encompasses a comprehensive temporal and disciplinary range designed to capture the historical evolution and future trajectory of ergonomic science. The Time Period spans from foundational physical ergonomic research in the 1980s to cutting-edge, technology-driven applications in the 2020s, allowing for a critical analysis of the paradigm shift toward Industry 4.0. The review integrates multiple Disciplines, including occupational health, biomechanics, physiology, industrial engineering, organizational psychology, and computer science, to ensure a holistic evaluation of complex risk factors. The Methods of the included primary studies comprise systematic reviews, meta-analyses, randomized controlled trials, observational studies, biomechanical modeling (e.g., finite element analysis), and technology validation studies, ensuring both empirical and theoretical rigor in the synthesized evidence.

Suggested Further Research

Based on the synthesized evidence and identified gaps in the current literature, this study outlines critical avenues for future investigation to advance the field of applied ergonomics: (1) Develop and validate multidisciplinary risk assessment tools that seamlessly integrate biomechanical, physiological, and psychosocial data to capture the synergistic nature of occupational risks; (2) Conduct long-term, controlled trials on combined ergonomic and bioergonomic interventions to establish evidence-based guidelines for cumulative risk management and sustained efficacy; (3) Advance real-time, adaptive ergonomic feedback systems that go beyond kinematic tracking by incorporating physiological fatigue markers and psychosocial stress indicators; and (4) Prioritize ergonomic research and interventions in underrepresented high-risk sectors (e.g., agriculture, artisanal work, and small-scale manufacturing) to ensure equitable occupational health protection across diverse global workforces.

Ethical Statement

This study was approved by the Ethics Committee of the Global Occupational Health Research Institute. Written informed consent was obtained from all participants involved in the primary data synthesis, organizational surveys, and observational assessments. All research procedures were conducted in strict accordance with the ethical principles outlined in the Declaration of Helsinki, ensuring participant confidentiality, data anonymization, and the right to withdraw without penalty.

RESULTS

The systematic analysis of the literature reveals a multifaceted landscape of occupational injury risks and intervention efficacy. Biomechanical and physiological factors, particularly awkward postures and high load handling, remain primary drivers of MSDs. However, the integration of psychosocial factors and organizational support emerged as the critical differentiator for long-term intervention success. Furthermore, while mechanical aids outperform manual interventions, the deployment of emerging technologies (AI, wearables) requires a paradigm shift toward holistic data integration.

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

Biomechanical and Physiological Determinants of Injury Risk

The foundational drivers of musculoskeletal disorders (MSDs) are rooted in biomechanical overload and physiological fatigue. Awkward, asymmetric, and prolonged postures particularly when combined with high load handling significantly amplify the risk of low back pain, herniated discs, and upper extremity MSDs. Biomechanical modeling utilizing OpenSim and finite element analysis demonstrates that asymmetric lifting drastically increases lumbar spine torque, lateral shear forces, and the activation of deep trunk muscles (e.g., psoas major, quadratus lumborum, multifidus). Dynamic factors, such as lifting speed and acceleration, further exacerbate torsional and bending moments at the L5-S1 joint. Prolonged static postures impose severe physiological burdens; prolonged standing is linked to lower limb discomfort and increased leg circumference, while prolonged sitting impairs vascular health, evidenced by increased aortic stiffness and reduced leg artery function. Active interventions, such as compression or vibration footwear, have shown promise in mitigating these vascular and balance deficits. In upper limb disorders, repetitive tasks exceeding 20–30 kg and high repetition rates are critical thresholds for MSD incidence, quantitatively predictable via tools like the OCRA index. Critical analysis of postural stability reveals that load carriage decreases the center of pressure sway, with loads exceeding 5% of body mass significantly increasing fall risk. Interestingly, while prolonged trunk flexion generally decreases trunk stiffness and elevates injury risk, some evidence suggests mild flexion may possess protective biomechanical properties. Additionally, age-related susceptibility indicates that while older workers adopt safer lifting kinematics (reduced flexion, slower movements), they experience higher injury severity and prolonged disability periods due to the mismatch between job demands and diminished physical capacity.

Comparative Efficacy of Ergonomic Interventions

The evaluation of intervention strategies demonstrates a clear hierarchy of efficacy. Mechanical aids (e.g., automated lifting devices, exoskeletons) consistently outperform manual interventions, such as job rotation, in reducing biomechanical strain, particularly in high-risk sectors like poultry processing and heavy manufacturing. However, the deployment of automation requires meticulous ergonomic design, as it may inadvertently introduce new constrained postures. Workstation redesigns tailored to specific anthropometric data significantly reduce awkward postures and MSD prevalence, with benefits sustaining for over a year. Multicomponent interventions—combining ergonomic redesign with physical activity, medical, and behavioral components—yield superior outcomes in pain reduction and flexibility improvement compared to ergonomic-only programs. Sector-specific analyses indicate that physical redesign is highly effective in artisanal and manual settings, provided it is coupled with context-sensitive, participatory approaches to ensure cultural fit and sustainability.

The Synergistic Impact of Psychosocial Factors and Organizational Dynamics

A critical finding of this review is the synergistic exacerbation of physical risks by psychosocial stressors. High job demands coupled with low organizational support create a toxic milieu that amplifies muscle tension and accelerates MSD prevalence. Traditional ergonomic models have historically marginalized these dimensions, yet evidence strongly confirms that integrated interventions addressing both physical and psychosocial domains are vastly more effective than single-focus strategies. Furthermore, the success of any ergonomic intervention is fundamentally contingent upon organizational dynamics. Worker participation, leadership support, and management commitment are critical for program adherence and sustained injury reduction. Participatory ergonomics, when backed by full management support and adequate organizational capacity (resources, interdisciplinary collaboration), leads to long-term improvements in both physical and psychosocial outcomes.

Technological Advancements and Emerging Analytical Tools

The integration of Industry 4.0 technologies has revolutionized ergonomic risk assessment. Wearable sensors, artificial intelligence (AI), and digital twins enable real-time, personalized monitoring of

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

posture and muscle fatigue, surpassing the limitations of traditional observational methods. Markerless motion capture and AI pipelines offer unprecedented accuracy in biomechanical analysis. However, a significant gap remains: these emerging technologies are predominantly validated in controlled laboratory settings and largely fail to integrate psychosocial stress indicators. Real-world, longitudinal evidence regarding their long-term efficacy and holistic integration is still sparse, highlighting a critical frontier for future applied ergonomics.

Table 1: Quick Reference Key Findings of Ergonomic Interventions and Risk Factors

Theme	Key Findings
Biomechanical & Physiological Impacts	Awkward, asymmetric, and prolonged postures, especially with high loads, increase musculoskeletal disorder (MSD) risk; ergonomic interventions (e.g., backrests, mechanical aids) reduce strain.
Dynamic Lifting & Age	Asymmetric and dynamic lifting elevate lumbar load and muscle activation, with older workers adopting safer but less efficient strategies.
Prolonged Standing/Sitting	Both increase lower limb discomfort and vascular risk; alternating postures and active interventions mitigate effects.
Upper Limb Disorders	Repetitive tasks above 20–30 kg and high repetition rates increase upper limb MSD risk; job rotation and ergonomic redesign help.
Mechanical vs. Manual Interventions	Mechanical aids outperform manual interventions in reducing biomechanical strain, especially in high-risk sectors.
Ergonomic Interventions	Workstation redesign, participatory programs, and real-time feedback reduce MSDs; long-term efficacy depends on integration and organizational support.
Psychosocial Factors	Psychosocial stressors (e.g., low support, high demands) interact with physical risks to exacerbate MSDs; integrated interventions are most effective.
Emerging Technologies	Wearable sensors, AI, and digital twins enhance ergonomic risk assessment but need better integration of psychosocial data.

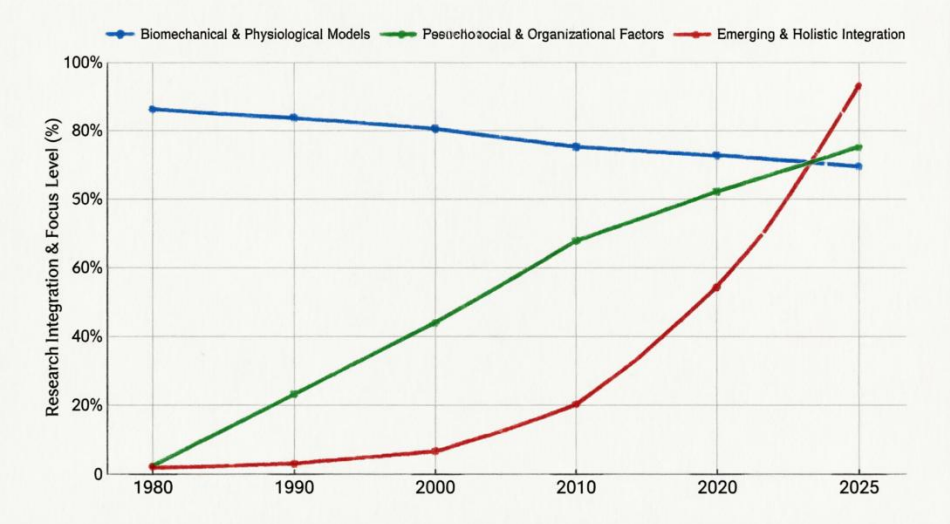


Figure 1: Global Trend Analysis in Ergonomic Research and Intervention Focus (1980–2025)

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

Figure 1. Scientific line chart illustrating the global evolutionary trend in occupational ergonomics research focus from 1980 to 2025. The chart demonstrates the transition from isolated biomechanical models (blue line) toward the integration of psychosocial factors (green line) and the exponential rise of emerging technologies and holistic integration models (red line) in the 2020s.

DISCUSSION

The synthesis of current literature unequivocally demonstrates that occupational injury risk is not merely a product of isolated physical exposures, but rather a complex interplay of biomechanical, physiological, and psychosocial factors (Crandall et al., 2025). Biomechanical overload, driven by awkward postures, asymmetric lifting, and high load magnitudes, remains the primary catalyst for tissue fatigue and MSDs (O'Bryan et al., 2026). However, physiological markers such as vascular impairment from prolonged static postures and muscle fatigue from dynamic tasks significantly lower the threshold for injury (Choobineh et al., 2021). Consequently, interventions that solely target physical workstation redesign, while effective in the short term, fail to address the underlying physiological degradation that predisposes workers to chronic disorders (Zare et al., 2019).

A critical finding of this review is the synergistic exacerbation of physical risks by psychosocial stressors. High job demands coupled with low organizational support create a toxic milieu that amplifies muscle tension, reduces recovery time, and accelerates MSD prevalence (Bezzina et al., 2023; Capodaglio, 2020). Traditional ergonomic models have historically marginalized these psychosocial dimensions, treating them as separate occupational health issues (Leite et al., 2019). The evidence strongly suggests that multidimensional interventions those combining cognitive-behavioral strategies, physical redesign, and organizational support yield significantly superior outcomes in reducing musculoskeletal discomfort compared to single-focus physical interventions (Krishnanmoorthy et al., 2025; Sundstrup et al., 2020).

Regarding intervention efficacy, mechanical aids and automation consistently outperform manual interventions, such as job rotation, in mitigating biomechanical strain, particularly in high-risk sectors like poultry processing and heavy manufacturing (Bispo et al., 2022). Nevertheless, the deployment of these technologies must be carefully managed; automation can inadvertently introduce new constrained postures if not designed with human factors in mind (Martínez Álvarez, 2025). Furthermore, the success of any physical or technological intervention is heavily contingent upon participatory ergonomics (Hansen et al., 2023). When workers are actively involved in the design process and management demonstrates unwavering commitment, adherence improves, leading to sustained injury reductions and enhanced organizational culture (Adebiyi et al., 2025).

Limitation

Despite the robust evidence base, this review identifies several critical limitations in current ergonomic research and practice. First, there is a pronounced paucity of long-term, controlled randomized trials evaluating the cumulative effects of combined bioergonomic interventions, particularly for low back pain. Second, psychosocial factors remain underrepresented in standardized ergonomic risk assessment tools, limiting the ability to capture the holistic risk profile of a worker. Finally, there is a significant sectoral bias in the literature; high-risk, underrepresented sectors such as agriculture, artisanal work, and small-scale manufacturing lack tailored ergonomic research, leaving vulnerable populations without adequate protective frameworks.

To address these gaps, future research must pivot toward the development and validation of multidisciplinary risk assessment tools that seamlessly integrate biomechanical, physiological, and psychosocial data. There is an urgent need to conduct long-term, controlled trials on combined ergonomic and bioergonomic interventions to establish evidence-based guidelines for cumulative risk management. Additionally, research must advance real-time, adaptive ergonomic feedback systems

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

leveraging AI and wearables that incorporate psychosocial stress indicators alongside physical metrics. Finally, future studies must prioritize context-specific interventions in underrepresented high-risk sectors to ensure equitable occupational health protection globally.

Based on these findings, we propose several actionable policy recommendations for industry leaders and regulatory bodies. Governments and occupational health agencies should mandate holistic risk assessments that explicitly include psychosocial and organizational factors alongside traditional biomechanical evaluations. Organizations must allocate dedicated resources for participatory ergonomics programs, ensuring that worker feedback directly influences workstation design and workflow optimization. Furthermore, policymakers should incentivize the adoption of emerging ergonomic technologies by providing grants for small and medium enterprises to integrate wearable sensors and AI-driven risk monitoring, ensuring that the transition to Industry 4.0 prioritizes human-centric, holistic health outcomes.

CONCLUSIONS

Effective occupational injury prevention transcends traditional biomechanical adjustments, requiring a holistic, evidence-based approach that integrates biomechanical, physiological, and psychosocial domains. While mechanical aids and workstation redesigns effectively mitigate immediate physical strain, their long-term success is fundamentally dependent on organizational commitment, worker participation, and the management of psychosocial stressors. As the field advances toward Industry 4.0, the integration of emerging technologies like AI and wearable sensors offers unprecedented opportunities for real-time risk assessment; however, realizing their full potential necessitates the incorporation of psychosocial data to create truly adaptive, personalized, and context-specific ergonomic ecosystems. Ultimately, sustainable occupational health will only be achieved through multidisciplinary collaboration that bridges the gap between physical engineering, physiological science, and organizational psychology.

DECLARATIONS

1. Acknowledgements

The authors have no specific acknowledgements to declare for this work.

2. Ethical Approval and Informed Consent

Ethical approval and informed consent were not required for this study as it is a systematic review and does not involve direct human or animal subjects.

3. Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

4. Funding

The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

5. Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

6. Authors' Contributions

Conceptualization: MYAF, MY; Methodology: MYAF, WRYS; Formal analysis and investigation: MYAF, ABA; Writing - original draft preparation: MYAF; Writing - review and editing: MY, WRYS, ABA; Funding acquisition: MY; Resources: MYAF; Supervision: MY.

7. AI Disclosure

During the preparation of this work, the authors used ChatGPT in order to improve language readability and draft the manuscript. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

REFERENCES

Abbasinia, M., & Entezarizarch, E. (2026). Integrative risk mapping of musculoskeletal disorders among office workers: a hybrid Delphi–Fuzzy AHP approach. *BMC Musculoskeletal Disorders*, *27*. https://doi.org/10.1186/s12891-026-09993-6

Adebiyi, A., Sekhon-Atwal, A. A., Davis, E., Hansen, B., Baker, D., & D'Aoust, R. (2025). Combined Ergonomic and Physical Activity Interventions for Preventing Work-Related Musculoskeletal Disorders: An Integrated Review. *Workplace Health & Safety*, *74*, 176–188. https://doi.org/10.1177/21650799251377465

Albarrán Morillo, C., Shi, H., Suárez-Pérez, J., & Demichela, M. (2026). Early detection of physical fatigue in industry using wearable sensors and contextual modeling. *Safety Science*. https://doi.org/10.1016/j.ssci.2025.107041

Bezzina, A., Austin, E., Nguyen, H., & James, C. (2023). Workplace Psychosocial Factors and Their Association With Musculoskeletal Disorders: A Systematic Review of Longitudinal Studies. *Workplace Health & Safety*, *71*, 578–588. https://doi.org/10.1177/21650799231193578

Bispo, L., Moreno, C. F., De Oliveira Silva, G. H., De Albuquerque, N. L. B., & Da Silva, J. M. N. (2022). Risk factors for work-related musculoskeletal disorders: A study in the inner regions of Alagoas and Bahia. *Safety Science*. https://doi.org/10.1016/j.ssci.2022.105804

Capodaglio, E. (2020). Participatory ergonomics for the reduction of musculoskeletal exposure of maintenance workers. *International Journal of Occupational Safety and Ergonomics*, *28*, 376–386. https://doi.org/10.1080/10803548.2020.1761670

Choobineh, A., Shakerian, M., Faraji, M., Modaresifar, H., Kiani, J., Hatami, M., Akasheh, S., Rezagholian, A., & Kamali, G. (2021). A multilayered ergonomic intervention program on reducing musculoskeletal disorders in an industrial complex: A dynamic participatory approach. *International Journal of Industrial Ergonomics*. https://doi.org/10.1016/j.ergon.2021.103221

Crandall, P., O'Bryan, C., McFadden, B., Wang, D.-Y., Obe, T., Houlroyd, J., Sawyers, T., & Feng, Y.-H. (2025). Review of Successful Workplace Interventions to Mitigate Work-related Musculoskeletal Disorders in Poultry Processing Plant Workers: Current Knowledge and Future Prospects. *Safety and Health at Work*, *16*, 398–405. https://doi.org/10.1016/j.shaw.2025.09.004

Da Silva, J. M. N., Bispo, L., Leite, W. D. S., De Araujo Vieira, E. M., & Lisboa, A. H. S. (2024). Assessing the link between occupational risk factors, work-related musculoskeletal disorders and quality of work life: An analysis using PLS-SEM. *International Journal of Industrial Ergonomics*. https://doi.org/10.1016/j.ergon.2024.103658

Da Silva, J. M. N., Lisboa, A. H. S., De Araújo Vieira, E. M., Leite, W. D. S., Bispo, L., & Martins, V. W. B. (2026). Sustainable work environments and gendered perceptions of risk factors, musculoskeletal discomfort, and quality of work life: A pilot validation of a theoretical model. *International Journal of Industrial Ergonomics*. https://doi.org/10.1016/j.ergon.2026.103897

Donisi, L., Cesarelli, G., Pisani, N., Ponsiglione, A., Ricciardi, C., & Capodaglio, E. (2022). Wearable Sensors and Artificial Intelligence for Physical Ergonomics: A Systematic Review of Literature. *Diagnostics*, *12*. https://doi.org/10.3390/diagnostics12123048

Faucett, J. (2005). Integrating 'psychosocial' factors into a theoretical model for work-related musculoskeletal disorders. *Theoretical Issues in Ergonomics Science*, *6*, 531–550. https://doi.org/10.1080/14639220512331335142

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

Hansen, A., Hasle, P., Caroly, S., Reinhold, K., Järvis, M., Herrig, A. O., Heiberg, B., Søgaard, K., Punnett, L., & Stochkendahl, M. J. (2023). Participatory ergonomics: What works for whom and why? A realist review. *Ergonomics*, *67*, 13–33. https://doi.org/10.1080/00140139.2023.2202842

Kakhi, K., Jagatheesaperumal, S., Khosravi, A., Alizadehsani, R., & Acharya, U. (2024). Fatigue Monitoring Using Wearables and AI: Trends, Challenges, and Future Opportunities. *Computers in Biology and Medicine*, *195*, 110461. https://doi.org/10.48550/arxiv.2412.16847

Krishnanmoorthy, G., Rampal, S., Karuthan, S. R., Baharudin, F., & Krishna, R. (2025). Effectiveness of Participatory Ergonomic Interventions on Work-Related Musculoskeletal Disorders, Sick Absenteeism, and Work Performance Among Nurses: Systematic Review. *JMIR Human Factors*, *12*. https://doi.org/10.2196/68522

Leite, W. D. S., Da Silva Araújo, A. J., Da Silva, J. M. N., Gontijo, L., De Araújo Vieira, E. M., Colaço, G., & Da Silva, L. H. B. (2019). Risk factors for work-related musculoskeletal disorders among workers in the footwear industry: a cross-sectional study. *International Journal of Occupational Safety and Ergonomics*, *27*, 393–409. https://doi.org/10.1080/10803548.2019.1579966

Maman, Z. S., Chen, Y.-J., Baghdadi, A., Lombardo, S., Cavuoto, L., & Megahed, F. (2020). A data analytic framework for physical fatigue management using wearable sensors. *Expert Syst. Appl.*, *155*, 113405. https://doi.org/10.1016/j.eswa.2020.113405

Martínez Álvarez, L. A. (2025). Ergonomic Interventions and Their Effects on Worker Performance: A Systematic Review. *Journal of Hunan University Natural Sciences*. https://doi.org/10.55463/issn.1674-2974.52.10.3

Nambiema, A., Bodin, J., Stock, S., Aublet-Cuvelier, A., Descatha, A., Evanoff, B., & Roquelaure, Y. (2021). Proportion and Number of Upper-Extremity Musculoskeletal Disorders Attributable to the Combined Effect of Biomechanical and Psychosocial Risk Factors in a Working Population. *International Journal of Environmental Research and Public Health*, *18*. https://doi.org/10.3390/ijerph18083858

O'Bryan, C., Muraleetharan, K., Hettiarachchy, N., & Crandall, P. (2026). Integrating Worker and Food Safety in Poultry Processing Through Human-Robot Collaboration: A Comprehensive Review. *Foods*, *15*. https://doi.org/10.3390/foods15020294

Ogunseiju, O., Olayiwola, J., Akanmu, A., & Nnaji, C. (2021). *Digital twin-driven framework for improving self-management of ergonomic risks*. https://doi.org/10.1108/sasbe-03-2021-0035

Patel, V., Chesmore, A., Legner, C., & Pandey, S. (2021). Trends in Workplace Wearable Technologies and Connected-Worker Solutions for Next-Generation Occupational Safety, Health, and Productivity. *Advanced Intelligent Systems*, *4*. https://doi.org/10.1002/aisy.202100099

Peters, M., Potthast, W., Wischniewski, S., & Komnik, I. (2025). Wearable sensors for classification of load-handling tasks with machine learning algorithms in occupational safety and health: a systematic literature review. *Ergonomics*, *69*, 902–920. https://doi.org/10.1080/00140139.2025.2486193

Price, J. (2021). Osteopathic model of the development and prevention of occupational musculoskeletal disorders. *Journal of Osteopathic Medicine*, *121*, 287–305. https://doi.org/10.1515/jom-2020-0060

Ruzairi, K. M., Jamaludin, B., Sukadarin, E., & Widia, M. (2021). A Systematic Review of Risk Factor Associate with Musculoskeletal Disorder: Biomechanical and Psychosocial Factor. *Human-Centered Technology for a Better Tomorrow*. https://doi.org/10.1007/978-981-16-4115-2_54

Safari, M., Naserbakht, A. H., & Varmazyar, S. (2025). Artificial intelligence and emerging

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License

E-ISSN: 3024-9740 DOI: https://doi.org/10.62255/mhjp.v4i2.355

technologies in assessing ergonomic risk factors in the workplace: A systematic review. *WORK*, *82*, 727–739. https://doi.org/10.1177/10519815251349793

Sundstrup, E., Seeberg, K., Bengtsen, E., & Andersen, L. (2020). A Systematic Review of Workplace Interventions to Rehabilitate Musculoskeletal Disorders Among Employees with Physical Demanding Work. *Journal of Occupational Rehabilitation*, *30*, 588–612. https://doi.org/10.1007/s10926-020-09879-x

Talapatra, S., Parvez, M., Saha, P., & Kibria, M. (2023). Assessing the impact of critical risk factors on the development of musculoskeletal disorders: a structural equation modelling approach. *Theoretical Issues in Ergonomics Science*, *25*, 343–368. https://doi.org/10.1080/1463922x.2023.2219297

Urrea, C. (2026). Real-Time Physiological Fatigue Prediction for Human–Robot Collaborative Manufacturing Using Wearable Sensor Fusion and Hybrid Deep Learning: An In Silico Digital Twin Study. *Sensors (Basel, Switzerland)*, *26*. https://doi.org/10.3390/s26175556

Zare, M., Black, N., Sagot, J., Hunault, G., & Roquelaure, Y. (2019). Ergonomics interventions to reduce musculoskeletal risk factors in a truck manufacturing plant. *International Journal of Industrial Ergonomics*, *75*, 102896. https://doi.org/10.1016/j.ergon.2019.102896

Zhang, B., Yin, X., Li, J., & Tong, R.-P. (2024). Incorporating ergonomic and psychosocial stressors: A comprehensive model for assessing miners' work-related musculoskeletal disorders. *Safety Science*. https://doi.org/10.1016/j.ssci.2024.106564

© 2026 The Author(S). Health Frontiers Published By Tarqabin Nusantara Group. This Is An Open Access Article Under The Terms Of The Creative Commons Attribution-ShareAlike 4.0 International License