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From Smart Workplaces to Human-Centered AI: A Comprehensive Review of Artificial Intelligence and Ergonomics Integration

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ABSTRACT

The increasing integration of artificial intelligence (AI) into workplace systems presents both opportunities and challenges for advancing ergonomics. The literature address how AI can be harmonized with ergonomic principles to enhance workplace design, safety, and human well-being. This gap underscores the need for a systematic synthesis of research on AI-driven ergonomic applications. The study aims to (i) analyze the existing body of research on AI-driven ergonomic applications, (ii) construct a conceptual map capturing the intersections of human, technological, and organizational factors, (iii) identify the contributions of key topic experts, and (iv) synthesize emerging themes that define future directions.

A comprehensive review was conducted using Scopus AI (25 September 2025). The method involved retrieving and analyzing relevant documents through search strings incorporating terms related to AI, ergonomics, workplace design, and integration. Scopus AI tools such as Summary, Expanded Summary, Concept Map, Topic Experts, and Emerging Themes were applied to identify patterns in research productivity, thematic structures, and knowledge gaps.

The findings reveal that AI integration with ergonomics has yielded applications across diverse sectors, including workplace health and safety, smart manufacturing, automotive design, and fashion manufacturing. Consistent themes such as AI in smart manufacturing, human-AI collaboration, and AI in human resource management highlight ongoing advancements, while rising themes such as AI-powered wearable technology, occupational health and safety, and smart building systems indicate new frontiers. Challenges related to ethics, data privacy, workforce readiness, and organizational resistance were also identified.

The study provides both theoretical and practical implications. Theoretically, it expands ergonomic discourse by situating it within human-centered AI frameworks, while practically, it offers insights for organizations seeking to implement AI solutions responsibly. These findings highlight the transformative potential of AI-driven ergonomics while emphasizing the need for ethical, sustainable, and user-centered integration.

Keywords: Artificial Intelligence (AI), Ergonomics, Human-Centered Design, Smart Workplace, Occupational Health and Safety

INTRODUCTION

The rapid advancement of digital technologies is reshaping the modern workplace, ushering in a new era where artificial intelligence (AI) is increasingly intertwined with human factors and ergonomics. Smart workplaces are leveraging AI-driven tools, such as machine learning, wearable devices, and real-time monitoring systems to enhance operational efficiency, optimize workplace design, and safeguard employee well-being (Balaji, 2025; Somaraju et al., 2024). Within this evolving landscape, ergonomics is no longer confined to static assessments of posture and physical design but is expanding toward dynamic, data-driven, and adaptive solutions that align with human cognitive, physical, and emotional needs.

Several studies have investigated the role of AI in occupational health and safety, ergonomics, and workplace design (Puertas & Galhardi, 2024; Pluchino et al., 2025). These contributions underscore the promise of AI in enhancing productivity and safety while highlighting the pressing need to address employee emotional well-being, workplace spirituality, and the cognitive demands of human-AI interaction (Deswal & Arora, 2024; Bisht & Uniyal, 2024). However, existing literature tends to be fragmented, focusing either on isolated ergonomic applications or on AI technologies in industrial contexts, with limited effort to synthesize insights into a cohesive framework.

This review addresses this gap by providing a comprehensive analysis of the integration of AI and ergonomics, framed within the broader context of smart workplaces and human-centered AI. Specifically, the study aims to (i) analyze the existing body of research on AI-driven ergonomic applications, (ii) construct a conceptual map that captures the intersections of human, technological, and organizational factors, (iii) identify the contributions of topic experts in this domain, and (iv) synthesize emerging themes that define future directions. By doing so, this paper contributes to advancing a more balanced, human-centered perspective on AI–ergonomics integration, offering insights for researchers, practitioners, and policymakers.

The remainder of this paper is structured as follows. Section 2 outlines the methodological approach employed to identify and review relevant literature. Section 3 presents the key findings, organized around thematic areas such as AI-driven ergonomic solutions, human-centered AI in smart manufacturing, operational efficiency, and employee well-being. Section 4 discusses challenges and ethical considerations, with particular attention to technocentric biases and sustainability concerns. Finally, Section 5 concludes with implications for research and practice, as well as recommendations for future studies in AI-enabled ergonomics.

METHODOLOGY

This study employed **Scopus AI** as the primary bibliometric and content exploration tool to conduct a comprehensive review of literature on the integration of artificial intelligence (AI) and ergonomics. The search was conducted on **25 September 2025**, ensuring that the dataset captured the most recent scholarly developments in the field. The study was guided by the following aims: (i) to analyze the existing body of research on AI-driven ergonomic applications, (ii) to construct a conceptual map that illustrates the intersections of human, technological, and organizational factors, (iii) to identify the contributions of topic experts advancing this domain, and (iv) to synthesize emerging themes that define future research directions.

The search strategy was designed to ensure both precision and comprehensiveness. The following Boolean search string was applied: **("artificial intelligence" OR "ai" OR "machine learning" OR "deep learning") AND ("ergonomics" OR "human factors" OR "workplace design" OR "user experience") AND ("smart workplace" OR "intelligent workplace" OR "automated workplace" OR "digital workplace") AND ("integration" OR "implementation" OR "application" OR "utilization") AND ("productivity" OR "efficiency" OR "well-being" OR "safety")**. This string targeted studies at the intersection of AI applications, ergonomics, workplace design, and organizational performance. The inclusion of multiple synonyms within each construct helped maximize the retrieval of relevant documents, while the focus on integration and outcomes such as productivity, efficiency, well-being, and safety aligned directly with the review's objectives. After executing the search query, Scopus AI generated structured outputs across four key analytical sections (Refer to Figure 1).

Scopus AI's **Summary and Expanded Summary** features provided a structured synthesis of the retrieved literature, enabling a rapid overview of the research field as well as a more nuanced understanding of methodological approaches, technological applications, and human-centered outcomes (Elsevier, 2023). The summaries revealed a strong concentration of work in AI-enabled ergonomic risk prediction, posture monitoring, and cognitive ergonomics in smart manufacturing environments, while also highlighting emerging interest in well-being and emotional dimensions of workplace design.

The **Concept Map** tool in Scopus AI was used to visualize the relationships between core concepts, offering an analytical lens through which to identify intersections across human, technological, and organizational domains. The map illustrated prominent linkages between machine learning algorithms, ergonomic risk assessment, and occupational health, as well as less developed but critical pathways connecting AI adoption to employee emotional well-being and organizational resilience. This visualization supported the identification of both established research clusters and underexplored areas, thereby guiding the discussion of research gaps.

The **Topic Experts** function was utilized to identify leading scholars and contributors shaping the discourse on AI and ergonomics integration. This feature highlighted a diverse group of researchers from domains spanning human factors engineering, occupational health, computer science, and industrial systems, confirming the interdisciplinary nature of the field (Balaji, 2025; Somaraju et al., 2024). Recognizing these experts provided a foundation for mapping intellectual contributions and identifying influential networks driving scholarly progress.

Finally, the **Emerging Themes** function revealed new directions in AI–ergonomics integration. These included advancements in AI-driven wearables for continuous posture monitoring, the integration of cognitive ergonomics in smart manufacturing, ethical and legal implications of AI in workplace design, and the role of emotional intelligence and workplace spirituality in shaping employee well-being (Deswal & Arora, 2024; Malek & Kamil, 2025). By synthesizing these themes, the study provides a forward-looking perspective on how AI can be responsibly integrated into ergonomics to foster productivity, efficiency, safety, and well-being.

Overall, the methodological approach ensured that the review captured both the breadth and depth of scholarship in this interdisciplinary area. By leveraging Scopus AI's suite of analytical tools—summary, expanded summary, concept map, topic experts, and emerging themes—this study systematically addressed the stated aims and constructed a comprehensive foundation for analyzing the integration of AI and ergonomics in smart workplaces.

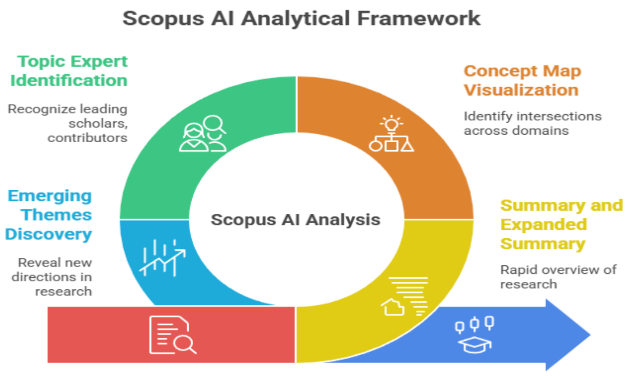

Figure 1: 4 core elements of scopus AI

RESULTS AND DISCUSSION

The analysis conducted using Scopus AI on 25 September 2025 yielded a comprehensive overview of the scholarly discourse on the integration of artificial intelligence (AI) and ergonomics. The findings are presented and discussed in alignment with four key outputs from Scopus AI: (i) Summary and Expanded Summary, (ii) Concept Map, (iii) Topic Experts, and (iv) Emerging Themes. Together, these elements provide a structured foundation for understanding the current state of research, the intellectual landscape, and future trajectories in this evolving field.

Summary and Expanded Summary

Integration of AI and Ergonomics in Workplace Environments

The results derived from the Scopus AI **Summary and Expanded Summary (25 September 2025)** reveal that the integration of artificial intelligence (AI) and ergonomics is reshaping workplace environments by emphasizing worker well-being, operational efficiency, and adaptive design. Studies indicate that AI-driven ergonomic applications leverage data analytics, machine learning, and real-time monitoring to assess human factors, task demands, and environmental conditions, enabling a data-driven and predictive approach to workplace safety and health (Somaraju et al., 2024; Balaji, 2025). This integration not only reduces risks of musculoskeletal disorders (MSDs) and repetitive strain injuries (RSIs) but also lowers injury-related costs through early risk detection.

AI-Enabled Customization and Worker-Centered Design

A significant contribution of AI in ergonomics lies in its ability to customize ergonomic solutions. Adaptive workplace designs, such as adjustable chairs and smart desks, can now be tailored to the physical dimensions and preferences of individual workers, thereby enhancing comfort and productivity (Priyanka & Subashini, 2024). Wearables and AI-enabled motion sensors provide continuous feedback on posture and movement, facilitating proactive interventions and personalized recommendations (Donisi et al., 2022). This reflects a paradigm shift from static ergonomic interventions to dynamic, personalized, and responsive solutions.

Enhancing Safety and Training Through AI

The integration of AI further enhances workplace safety by enabling advanced hazard detection and immersive training tools. For example, AI-driven immersive simulations help workers practice safe behaviors and decision-making in high-risk environments, thereby reducing accident likelihood (Fiegler-Rudol et al., 2025). Moreover, real-time hazard detection supports proactive measures to prevent workplace injuries, fostering safer and more resilient environments. These results underscore the potential of AI to go beyond reactive safety protocols toward predictive and preventive ergonomics.

Employee Well-Being and Organizational Outcomes

Beyond physical ergonomics, AI adoption also impacts broader dimensions of employee well-being. Research demonstrates that AI influences task optimization and workplace safety, which in turn contribute to employee satisfaction and emotional well-being (Valtonen et al., 2025). However, findings also suggest that these benefits depend on the strategic implementation of AI. Misalignment between AI tools and employee needs can generate stress or resistance, highlighting the necessity of human-centered integration strategies.

Challenges and Ethical Considerations

Despite its transformative potential, the integration of AI and ergonomics faces several challenges. Ethical concerns around data privacy, algorithmic bias, and potential job displacement remain critical issues that must be addressed (Puertas & Galhardi, 2024; Leão et al., 2024). Additionally, methodological challenges, such as sampling bias in studies and limitations in data representativeness, can affect the generalizability of findings (Anacleto Filho et al., 2024). These challenges underscore the need for responsible AI deployment grounded in transparency, fairness, and accountability.

Future Research and Implications

The Expanded Summary highlights that future research should prioritize understanding the long-term impacts of AI on organizational culture, workplace satisfaction, and sustainable ergonomics. Emerging areas include refining AI-based signal detection methods for ergonomic analysis and embedding human-centered design principles in future AI applications (Taslim et al., 2025; Donisi et al., 2022). Ultimately, the results suggest that the full potential of AI in ergonomics can only be realized when technological innovation is coupled with human-centered approaches, ensuring that efficiency gains align with worker well-being.

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Concept Map

The concept map presented in Figure 2 is generated by Scopus AI (25 September 2025) provides a structured visualization of the key themes and research directions related to the **integration of artificial intelligence (AI) and ergonomics**. The map identifies four primary thematic clusters—**Assessment Methods, Innovations, Challenges, and Applications**—each of which is linked to more specific subdomains.

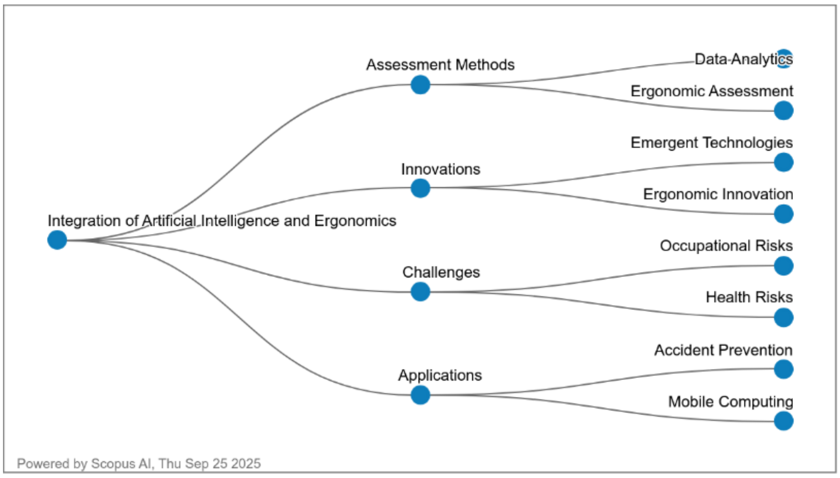

Figure 2: Concept map of integration of artificial intelligence and ergonomics

- **Assessment Methods** highlight the central role of **data analytics** and **ergonomic assessment**, reflecting the growing reliance on AI-driven tools to capture, process, and interpret workplace data for optimizing human performance and safety.
- **Innovations** focus on the development of **emergent technologies** and **ergonomic innovations**, emphasizing how AI is advancing adaptive solutions and reshaping ergonomic design practices.
- **Challenges** underscore critical issues such as **occupational risks** and **health risks**, pointing to the dual impact of AI adoption—while it can enhance safety, it also raises ethical, physiological, and psychological concerns.
- **Applications** illustrate practical domains where AI and ergonomics intersect, particularly in **accident prevention** and **mobile computing**, showing how AI-enabled technologies are being integrated into everyday workplace tools and systems.

The Relationship Between Integration of Artificial Intelligence and Ergonomics

The integration of artificial intelligence (AI) and ergonomics is redefining how industries address employee well-being, workplace safety, and operational efficiency. In workplace ergonomics, AI-powered solutions leverage data analytics, machine learning, and real-time monitoring to identify ergonomic risks and predict potential injuries. Wearables and motion sensors provide continuous tracking of posture, movement, and environmental conditions, enabling tailored interventions that minimize musculoskeletal disorders and enhance overall productivity. These AI-driven approaches allow organizations to move from reactive to proactive ergonomics, reducing injury-related costs while fostering healthier and more adaptive work environments (Balaji, 2025; Somaraju et al., 2024).

In the automotive industry, the integration of AI and ergonomics has been particularly impactful in enhancing vehicle design, manufacturing processes, and driver safety. AI enables the optimization of interior layouts and driver interfaces to align with ergonomic principles, improving user comfort and reducing fatigue. Furthermore, AI systems enhance safety features through real-time hazard detection and adaptive assistance technologies. However, these advancements also raise challenges related to ethical and legal concerns, including data privacy, liability in autonomous systems, and employment implications in increasingly automated production environments. Addressing these issues remains critical to ensuring a balanced and sustainable adoption of AI-driven ergonomic solutions in the automotive sector (Puertas & Galhardi, 2024).

The fashion manufacturing industry has also experienced a shift through the integration of AI and ergonomics. Predictive analytics and automated design processes are being applied to enhance production efficiency while aligning with ergonomic considerations. For example, AI assists in inventory forecasting and workflow optimization, which not only streamlines supply chains but also reduces physical strain on workers. Additionally, AI-driven design platforms promote sustainable ergonomic practices by integrating data on worker well-being, production cycles, and resource allocation. These developments highlight how AI can simultaneously support productivity, sustainability, and the health of employees in labor-intensive industries such as fashion manufacturing (Zhang et al., 2024).

Despite these promising applications, significant challenges accompany the integration of AI and ergonomics. Ethical considerations, particularly related to worker surveillance, privacy, and the potential deskilling of employees, continue to spark debate. Legal frameworks for liability in AI-driven ergonomic systems remain underdeveloped, creating uncertainty in cases of workplace accidents or system errors. Moreover, while AI has the potential to reduce occupational risks, its misuse or over-reliance could also exacerbate psychosocial risks, including stress and job insecurity. Nevertheless, these challenges present opportunities for policymakers, researchers, and industry leaders to develop regulatory standards and best practices that balance innovation with human-centered values (Puertas & Galhardi, 2024; Zhang et al., 2024).

Overall, the integration of AI and ergonomics demonstrates immense potential to revolutionize industries by enhancing workplace safety, improving product design, and fostering sustainable manufacturing practices. By bridging technological innovation with human-centered design, AI-driven ergonomic solutions can create safer, more efficient, and more inclusive environments. However, achieving this vision requires a balanced approach that addresses ethical and legal implications while ensuring that workers remain at the center of technological transformation. Future research should therefore continue exploring how AI can be responsibly integrated into ergonomics to maximize benefits while safeguarding worker rights and well-being (Balaji, 2025; Somaraju et al., 2024).

Integration of Artificial Intelligence and Ergonomics with Assessment Methods

The integration of artificial intelligence (AI) and ergonomics has revolutionized assessment methods by introducing intelligent, data-driven approaches to risk identification and workplace optimization. Traditional ergonomic assessments often relied on observational checklists or subjective evaluations, which were time-consuming and prone to human error. By contrast, AI-powered ergonomic solutions utilize advanced data analytics, machine learning algorithms, and real-time monitoring to create adaptive assessments that can predict risks and recommend preventive strategies. These tools enhance workplace design and reduce injury-related costs by shifting from reactive assessments to proactive and continuous evaluation processes (Balaji, 2025).

One of the most transformative contributions of AI to ergonomics is its ability to conduct real-time evaluations and automate risk assessment. Through the use of computer vision algorithms, AI can capture and analyze worker movements instantly, drastically reducing the time required for traditional assessment methods. For instance, automated assessment frameworks such as METEO, based on AI and computer vision, provide rapid and accurate detection of improper postures, thereby minimizing the risk of musculoskeletal disorders (MSDs). This automation not only accelerates assessment but also improves workplace conditions by ensuring consistent and objective evaluation standards (El Hassani et al., 2023).

Wearable sensor technology further strengthens the integration of AI and ergonomics, offering enhanced assessment methods that go beyond simple observation. By embedding sensors into wearable devices, researchers and practitioners can collect continuous streams of data on posture, movement, and physical strain. AI systems then analyze this data to provide diagnostic, prognostic, and preventive insights into ergonomic risks. This capability is especially valuable in physical ergonomics, where early detection of strain or fatigue can prevent long-term injuries and optimize worker health and productivity (Donisi et al., 2022).

The effectiveness of AI-driven assessment methods has been demonstrated across various industries. In agriculture, for example, AI has been applied to assess ergonomic risks by detecting forced postures more effectively than conventional approaches. These AI-powered methods not only provide faster evaluations but also improve accuracy, thereby supporting interventions that are both timely and evidence-based. Such sector-specific applications highlight the versatility of AI in addressing diverse ergonomic challenges, from industrial workplaces to labor-intensive fields like farming (Varas et al., 2024).

Despite these advancements, challenges remain in the integration of AI into ergonomic assessment methods. Issues such as data privacy, worker acceptance of monitoring technologies, and the need for standardized validation across industries continue to limit widespread adoption. Furthermore, while AI systems can enhance objectivity, they must be carefully designed to avoid biases in data interpretation and ensure equitable applications. Nevertheless, the ongoing convergence of AI and ergonomics offers substantial opportunities to redefine assessment methods, making them more efficient, precise, and adaptable to evolving workplace demands (Balaji, 2025; El Hassani et al., 2023).

Integration of Artificial Intelligence and Ergonomics with Innovations

The integration of artificial intelligence (AI) and ergonomics has stimulated significant innovations across industries, offering transformative possibilities for product design, workplace safety, and user experience. In the automotive sector, AI-driven ergonomic systems are being employed to optimize vehicle design, enhance driver comfort, and improve overall safety. These innovations range from adaptive seating and dashboard layouts to intelligent driver-assistance systems that reduce cognitive load. However, the adoption of such technologies also raises ethical and legal concerns, including data privacy, liability in case of failures, and potential impacts on employment. These challenges underscore the importance of balancing technological progress with regulatory and social considerations (Puertas & Galhardi, 2024).

Workplace ergonomics has also benefitted from AI-powered innovations, particularly through real-time monitoring and predictive analytics. Wearable technologies and sensor-based systems allow for continuous observation of employee postures and movements, enabling early detection of musculoskeletal strain and reducing repetitive stress injuries. By leveraging AI's ability to analyze vast datasets, these systems provide personalized recommendations to optimize workstation design and task allocation. The innovative application of AI in workplace ergonomics not only reduces injury-related costs but also enhances employee productivity, reflecting a paradigm shift toward proactive occupational health management (Balaji, 2025).

Fashion manufacturing presents another domain where the integration of AI and ergonomics has fostered innovation. AI-driven decision-support frameworks combine predictive analytics with ergonomic optimization to streamline production processes, improve demand forecasting, and minimize material waste. These innovations align with sustainable manufacturing practices, ensuring worker well-being while enhancing operational efficiency. By embedding ergonomics into AI-driven systems, fashion manufacturers can strike a balance between economic performance, environmental sustainability, and employee safety—an advancement particularly relevant in labor-intensive industries (Zhang et al., 2024).

Innovations have also extended into interior design, where AI-based hybrid recommendation models contribute to intelligent layout solutions from an ergonomic perspective. These models integrate user preferences with ergonomic criteria to generate optimized room configurations and furniture arrangements. By prioritizing comfort, functionality, and user well-being, AI-driven design tools offer scalable innovations for residential and commercial spaces. Such developments highlight the versatility of AI in applying ergonomic principles beyond industrial contexts, extending its impact to everyday environments (Wang, 2025).

Overall, AI-mediated ergonomic innovations demonstrate a growing capacity to enhance workplace safety, product design, and user-centered experiences. Nevertheless, while AI provides powerful tools for advancing ergonomic practices, it also presents challenges such as ensuring fairness, managing ethical implications, and overcoming resistance to adoption. Empirical evidence suggests that AI often acts as a mediator between ergonomics and the drivers of innovation, helping to bridge the gap between theory and practice (Priyanka & Subashini, 2024). Consequently, the future of ergonomic innovation will depend not only on technological advancements but also on the ability to integrate human-centered design, ethical considerations, and sustainable practices.

Integration of Artificial Intelligence and Ergonomics with Challenges

The integration of artificial intelligence (AI) and ergonomics presents multifaceted challenges that span ethical, legal, technical, and organizational domains. In industries such as automotive and healthcare, ethical dilemmas emerge regarding liability in cases of AI-related errors, as well as privacy concerns associated with sensitive personal or medical data (Puertas & Galhardi, 2024; Alnasser et al., 2024). Moreover, the adoption of AI often leads to apprehension about workforce displacement and job restructuring, raising questions about social responsibility and the equitable distribution of technological benefits. These issues highlight the need for clear regulatory frameworks to safeguard user rights while ensuring responsible implementation.

From a technical standpoint, the effectiveness of AI-driven ergonomic systems is contingent upon the quality, accuracy, and security of the data being processed. In Enterprise Resource Planning (ERP) contexts, studies have shown that high software costs, limited interoperability, and lack of skilled personnel pose significant barriers to adoption (Benjelloun et al., 2025). Additionally, organizations often resist structural changes required for AI integration, further complicating implementation. These challenges underscore the importance of aligning technological innovations with organizational readiness and workforce training programs.

The retail and consumer packaged goods sector provides another example of the barriers to AI-powered ergonomics. Here, challenges include technological complexity, high demands for regulatory compliance, and the necessity of robust digital infrastructure (Samayamantri, 2024). The sensitivity of customer data further amplifies privacy concerns, demanding advanced cybersecurity measures. These factors demonstrate that while AI has the potential to enhance ergonomics in customer-facing industries, its implementation requires significant investment in infrastructure, governance, and workforce competence.

Despite these challenges, the literature also points to substantial opportunities offered by AI integration in ergonomics. For instance, AI-powered monitoring systems can predict workplace risks, recommend adjustments, and reduce musculoskeletal disorders, thus improving both safety and productivity (Balaji, 2025; Somaraju et al., 2024). Moreover, AI facilitates the personalization of ergonomic solutions, enabling adjustments that match individual body dimensions, preferences, and work contexts (Priyanka & Subashini, 2024). These benefits highlight the paradox of AI in ergonomics: while it poses substantial hurdles, it simultaneously provides unprecedented tools for advancing occupational health and safety.

In sum, the integration of AI and ergonomics represents a transformative yet challenging endeavor. The literature reveals a tension between the promise of improved safety, efficiency, and personalization, and the obstacles of ethics, data security, technical complexity, and workforce adaptation. Addressing these challenges requires a balanced approach that combines technological innovation with regulatory oversight, infrastructure investment, and human-centered design. Without these measures, the full potential of AI-driven ergonomics may remain unrealized.

Integration of Artificial Intelligence and Ergonomics with Applications

The integration of artificial intelligence (AI) and ergonomics has generated a wide range of applications across industries, reshaping traditional methods of workplace design, risk prevention, and operational efficiency. At its core, AI-powered ergonomic solutions rely on advanced data analytics, machine learning, and real-time monitoring to predict ergonomic risks and optimize workplace arrangements. This approach not only reduces injury-related costs but also enhances employee comfort and productivity by proactively identifying musculoskeletal risks and providing timely interventions (Balaji, 2025). The synergy between AI and ergonomics thus lays the foundation for smarter and safer workplaces.

In the automotive industry, AI applications demonstrate a dual focus on driver safety and vehicle design optimization. The integration of AI enhances ergonomic analysis in areas such as seating design, dashboard accessibility, and driver monitoring systems. While these applications improve safety and user experience, they also raise ethical and legal concerns regarding data privacy and liability in the case of system failures (Puertas

& Galhardi, 2024). These challenges underline the necessity of balancing technological advancement with regulatory compliance to ensure that AI-ergonomic systems are both effective and ethically sound.

Applications also extend to industrial machines (IMs), where AI is applied to configuration, calibration, and predictive maintenance processes. By enabling real-time monitoring and adaptive adjustments, AI reduces downtime and enhances machine performance, thereby improving workplace efficiency (Calado et al., 2024). Furthermore, AI systems in manufacturing environments can automatically analyze operator workloads and ergonomic risks, providing preventive solutions that minimize workplace injuries and streamline production (Rychtyckyj & Stephens, 2009). These developments highlight how AI is not only a tool for risk assessment but also a driver of operational innovation.

Wearable technologies represent another critical application area where AI and ergonomics converge. The use of wearable sensors combined with AI provides diagnostic, prognostic, and preventive perspectives, particularly in reducing musculoskeletal disorders (Donisi et al., 2022). Similarly, advances in artificial vision and computer vision algorithms are enabling wearable devices and industrial systems to detect postures, evaluate ergonomic risks, and suggest corrective actions in real time (Farinella & Furnari, 2023). This integration offers an adaptive, individualized approach to ergonomics that goes beyond static risk assessment to deliver continuous feedback tailored to worker needs.

Finally, digital and virtual technologies are expanding the scope of AI-ergonomics applications in work-related biomechanical risk assessment. Digital human modeling and simulation, combined with AI, enable organizations to predict risks before implementation and design safer, more efficient workflows (Anacleto Filho et al., 2024). Additionally, AI-driven ergonomic interventions are now being customized to demographic-specific challenges, ensuring inclusive workplace practices that account for gender, age, and physical differences (Da Silva, 2025). These applications illustrate how AI not only enhances ergonomics from a technical perspective but also promotes inclusivity and sustainability, making it a transformative tool for the future of occupational health and safety.

Topic Experts

The insights of Jennifer J. Wang underscore the transformative role of artificial intelligence (AI) in shaping user-centered workplace environments. With a research portfolio that demonstrates significant academic influence, Wang's work emphasizes how the success of intelligent workplace features must be measured not only in terms of efficiency but also in terms of human experience. By linking AI integration directly with ergonomics, Wang highlights that user-centered design is essential to ensuring that AI-driven systems do not compromise but instead enhance human comfort, safety, and productivity (Wang, 2023). This perspective aligns with broader movements in ergonomics research that call for embedding human factors at the center of technological innovation.

Angela A. Moulden complements Wang's contributions by offering a critical focus on user-centered approaches in workplace design. Moulden's research highlights the importance of developing AI features that serve functional purposes while simultaneously elevating user satisfaction and well-being (Moulden, 2023). This perspective is particularly relevant in ergonomic contexts, where the interaction between humans and technology shapes both physical health outcomes and cognitive experiences. By prioritizing user needs in AI system design, Moulden advocates for workplace technologies that are not only efficient but also sustainable in promoting worker engagement and reducing fatigue.

The combined expertise of Wang and Moulden reveals a convergence of priorities: both scholars stress the centrality of human-centered design in integrating AI into workplace ergonomics. Their work collectively demonstrates that while AI can significantly improve workplace functionality—through automation, real-time monitoring, and predictive analytics—the true measure of success lies in its ability to adapt to human needs. This integration ensures that ergonomic principles, such as reducing musculoskeletal strain and cognitive overload, are reinforced rather than neglected in the adoption of AI technologies (Wang, 2023; Moulden, 2023).

A key implication of their findings is that AI integration in workplace ergonomics must balance technological advancement with inclusivity and accessibility. Wang's emphasis on measuring success and Moulden's focus on user experience suggest that workplace AI systems must be evaluated holistically, considering physical, cognitive, and emotional dimensions of ergonomics. This approach provides a framework for addressing challenges such as resistance to technology adoption and potential overreliance on automation.

Emerging Themes

The findings reveal several **consistent themes** in the integration of artificial intelligence (AI) with ergonomics and workplace systems. First, the role of **AI-driven ergonomics in smart manufacturing** has remained a central research focus, with consistent evidence that AI enhances collaboration between humans and machines, optimizes production efficiency, and improves workplace safety. Studies demonstrate that AI-powered ergonomic assessments can reduce musculoskeletal disorders and optimize workflow design by analyzing real-time data from sensors and predictive models (Balaji, 2025; Donisi et al., 2022). This suggests that embedding AI into manufacturing environments not only minimizes risk but also enhances productivity, laying the foundation for future hypotheses on measurable efficiency.

Another consistent theme is the application of **AI in human resource management (HRM)**. Research consistently highlights how AI transforms HR practices by enabling personalized engagement strategies, predictive employee performance monitoring, and optimized recruitment processes (Priyanka & Subashini, 2024). The potential of AI to reduce turnover rates through unbiased hiring decisions and adaptive training programs reflects the long-term value of integrating ergonomics with HR analytics. This theme reinforces the argument that AI should not be limited to physical ergonomics but extended to cognitive and organizational ergonomics, shaping a holistic view of workplace performance (Somaraju et al., 2024).

A third consistent theme is the growing focus on **human-AI collaboration in decision-making**. Rather than replacing human judgment, AI systems are being developed to complement human expertise, providing data-driven insights that increase accuracy and efficiency in strategic choices. Research emphasizes that human-centered design in AI fosters trust and improves adoption rates (Wang, 2023; Moulden, 2023). This aligns closely with ergonomic principles, which emphasize user-centered approaches, ensuring that AI not only optimizes processes but also enhances decision-making quality without undermining human autonomy.

In contrast, several **rising themes** are emerging, reflecting shifts in research priorities. The integration of **AI and wearable technology for workplace health and safety** has gained momentum, with studies showing how wearable sensors paired with AI analytics can proactively identify risks, monitor physical strain, and prevent injuries in real time (Donisi et al., 2022). This marks a transition from reactive to proactive health and safety management, demonstrating the rising importance of AI in supporting well-being at work. Similarly, the application of **AI in occupational health and safety (OHS)** represents a growing area, where predictive analytics and automated safety management systems are being explored to reduce accidents and streamline compliance (Anacleto Filho et al., 2024). These developments suggest a paradigm shift toward AI-enabled preventive interventions in ergonomics.

Finally, the emerging integration of **AI in interior design and smart building systems** represents an innovative rising theme that extends ergonomics into the physical and environmental dimensions of workplaces. AI-driven smart environments are being designed to adapt to occupant preferences, optimize energy efficiency, and create healthier indoor conditions (Da Silva, 2025). These advances highlight a shift toward integrating ergonomics with sustainable building design, where user satisfaction, productivity, and environmental considerations converge. This theme suggests that the scope of AI in ergonomics is expanding beyond individual and organizational levels to encompass broader environmental and societal impacts.

CONCLUSION

This study has reviewed the integration of artificial intelligence (AI) and ergonomics across multiple domains, highlighting innovations, challenges, and applications that shape the evolving landscape of human-centered AI. The key findings demonstrate that AI has consistently contributed to enhanced ergonomics in smart manufacturing, workplace design, and human resource management by improving safety, efficiency, and decision-making accuracy. At the same time, rising themes such as AI-driven wearable technologies, occupational health and safety applications, and intelligent building systems reflect emerging directions that extend ergonomics beyond traditional physical considerations into cognitive, organizational, and environmental domains. While the literature highlights significant benefits, it underscores persistent challenges including ethical concerns, data privacy, technological complexity, and workforce readiness.

From a **theoretical perspective**, this review contributes to the growing body of knowledge on socio-technical systems by illustrating how AI can be aligned with ergonomic principles to create more adaptive, user-centered environments. The findings emphasize the need to expand ergonomic theory from its classical human-machine interaction focus to encompass hybrid systems in which human, technological, and organizational factors are deeply intertwined. This contributes to a refined understanding of human-centered AI, offering a conceptual framework that situates ergonomics as a bridge between technological advancement and human well-being.

In terms of **practical implications**, the study highlights opportunities for industries to adopt AI-enhanced ergonomic solutions to reduce workplace injuries, optimize productivity, and enhance employee well-being. For example, in smart manufacturing, AI-based ergonomic assessments can minimize risks associated with repetitive tasks, while in HRM, AI systems can support employee engagement and retention. In occupational safety, AI-enabled wearables and predictive analytics provide actionable insights for proactive risk management. Organizations adopting these applications must, however, balance innovation with safeguards that address ethical, legal, and social challenges, ensuring that AI is implemented responsibly and equitably.

Despite these contributions, the study acknowledges several **limitations**. First, much of the reviewed literature remains conceptual or exploratory, with limited large-scale empirical validation of AI-driven ergonomic applications. Second, existing research tends to focus on specific sectors—such as manufacturing and healthcare—while other domains, including education, public administration, and creative industries, remain underexplored. Third, the rapid evolution of AI technologies raises concerns about the longevity of findings, as innovations often outpace academic assessment and validation. Finally, cross-cultural differences in workplace practices and acceptance of AI are insufficiently addressed in current research, limiting the generalizability of results.

To address these gaps, **future research** should focus on longitudinal and cross-industry studies that empirically measure the effectiveness of AI-driven ergonomic solutions in improving safety, productivity, and well-being. There is also a need to investigate the ethical and social implications of AI in ergonomics, particularly in relation to employee autonomy, trust, and equity. Additionally, interdisciplinary approaches that combine ergonomics, AI, psychology, organizational behavior, and sustainability studies could provide a more holistic understanding of human-centered AI. Finally, exploring the role of AI in emerging contexts—such as hybrid workplaces, remote work, and climate-resilient infrastructure—would enrich both theoretical and practical insights, ensuring that the integration of AI and ergonomics supports not only efficiency but also long-term human development.

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