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Understanding Ergonomic Risks in Older Informal Caregivers: The Role and Potential of Digital Interventions

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ABSTRACT

This structured narrative literature review investigates how older informal caregivers conceptualize ergonomic risk and evaluates the effectiveness of digital interventions in mitigating such risks and the associated physical workload. A total of 36 peerreviewed articles published between 2012 and 2026 were identified through systematic searches of Scopus, Web of Science, PubMed, SAGE Journals, and Wiley Online Library. Studies were selected according to predefined eligibility criteria, with a primary emphasis on caregivers aged 60+ years and on implementations of digital ergonomic interventions. The analysis focused on caregivers' risk perception and physical load. The findings indicate that caregivers' perceptions of ergonomic risk are shaped by task intensity, emotional burden, limited ergonomic literacy, cognitive factors, and age-related physiological changes. Digital technologies designed to monitor caregiver posture show substantial potential to reduce exposure to ergonomic hazards. The robustness of these conclusions is supported by the exclusive inclusion of peer-reviewed sources and the application of stringent selection criteria. Overall, the results highlight the need for intuitive, user-friendly, and empirically validated digital solutions tailored to caregivers aged 60+ years.

Keywords: Informal caregivers, Age, Ergonomics, Risk, Digital interventions, Risk perception

INTRODUCTION

Demographic trends in Europe and worldwide indicate a rapid ageing of the workforce, which has a significant impact on the social care sector (Georgieva, 2022; Roja et al., 2018). Caregivers are increasingly facing health problems related to ergonomic risks, including musculoskeletal disorders, increased cognitive load, and a rise in chronic illnesses (Roja et al., 2018; Slob et al., 2024). As life expectancy increases, people aged 65 and older are becoming the fastest-growing demographic group globally. Projections indicate that by 2050 one in six people worldwide will be aged 65 or older, compared with one in eleven in 2019 (Nations Department of Economic et al., 2019). In the European Union, 12–18% of people aged over 50 regularly provide informal care to older adults or persons with disabilities, and in some countries this figure exceeds 20% (Health at a Glance, 2023). The aim of this literature review is a) to determine how older informal caregivers understand ergonomic risks in the homecare environment, and b) to evaluate the potential of digital interventions in reducing ergonomic risks, improving safe-care skills,

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and decreasing physical load. The significance of this narrative literature review is reinforced by the fact that the concept of ergonomic risk in the context of informal care is used inconsistently and is often conflated with the general burden of caregiving. Risk perception is a complex process shaped by emotions, cognitive characteristics, personal caregiving experience, and health literacy, yet these factors have been little studied in the group of older caregivers (Grimani et al., 2024; Lee et al., 2019). Today, digital technologies play an important role in reducing ergonomic and psychosocial risks among older informal caregivers, and the development and implementation of such solutions should be based on scientifically proven effectiveness and safety (Baudin et al., 2022). However, their effective implementation is limited by the existing digital divide among informal caregivers aged 60+, characterised by insufficient access to technology, limited digital skills, and lower technological literacy (Yin et al., 2024). A digital solution must meet the cognitive needs of the 60+ age group (Hawash, 2025). To ensure sustainable care and the well-being of caregivers themselves, it is essential to develop support systems at the political, healthcare, and community levels. An informal caregiver is a family member, friend, or neighbour who provides unpaid assistance to a care recipient with daily activities and health-related needs. Informal caregivers often lack specialised training. They are most often women, with an average age exceeding 60 years (Eby et al., 2017). Informal care is usually provided several times a week. Caregivers' physical and emotional burden is exacerbated by the cognitive and functional limitations of the care recipient. This review will analyze scientific literature on older informal caregivers' understanding of ergonomic risks and will evaluate the potential of digital interventions in improving safecare skills, reducing physical load, and preventing ergonomic risks. The review will clarify the concept of ergonomic risk in the context of informal care, define the need for digital solutions, and establish a scientific basis for digital interventions suitable for caregivers aged 60+. The significance of this study lies in its integrated perspective on understanding ergonomic risks among older informal caregivers. The results highlight the need to develop intuitive digital technologies adapted to users aged 60+, to improve caregiver safety, health, and quality of care.

METHODS

A total of 36 scientific sources were selected, covering publications from 2012 to 2026. Searches were conducted in Scopus, Web of Science, PubMed, and the publisher platforms SAGE Journals and Wiley Online Library .The literature analyzis included only peer-reviewed articles in English that examined informal caregivers, particularly in the 60+ age group, and presented empirical or theoretical data on ergonomic risks, musculoskeletal overload, physical load, and safe working techniques. Studies evaluating digital interventions virtualreality training, sensor systems, mobile applications, and digital training solutions were included, particularly those assessing their suitability for older informal caregivers. Studies focusing solely on professional caregivers or not analysing ergonomics or physical load were excluded. Literature sources were selected using the following keywords: informal caregivers, age, ergonomics, risk, digital interventions,

risk perception. In preparing this manuscript, the authors used AIbased tools, including Scopus AI and M365 Copilot (Microsoft, 2024), to support literature searches and language refinement. All screening decisions, analyses, and final interpretations were conducted independently by the authors, who take full responsibility for the integrity and accuracy of the content.

RESULTS AND DISCUSSION

The current literature does not provide clear answers on how informal caregivers aged 60+ perceive and understand ergonomic risks, nor which cognitive, emotional, physiological, and contextual factors most strongly influence their risk perception. At present, there is a lack of clarity regarding which digital interventions are most effective for this group and what their design and content should be in order to be realistically usable and acceptable for caregivers aged 60+. There is no unified understanding of the extent to which digital tools (virtual-reality training, sensor systems, mobile applications) can influence this risk perception or whether they actually reduce ergonomic load. The role of digital interventions in reducing ergonomic risk is described in the literature in a fragmented and ambiguous manner, which complicates the comparison of evidence across studies. Risk perception is a complex process that encompasses how people think, feel, and act when confronted with risk. Studies show that risk perception is primarily shaped by emotional reactions that determine how dangerous a situation appears to an individual, and these emotions influence both behaviour and decisionmaking in various situations (Grimani et al., 2024; Mayiwar et al., 2024). During informal caregiving, risk perception and responses are influenced by the caregiver's accumulated caregiving experience, which develops gradually and often at the expense of the caregiver's own health. Insufficient information makes it difficult for caregivers to recognise the significance of ergonomic risk and to determine the appropriate actions to reduce it (Cadar et al., 2022). Older informal caregivers' understanding of carerelated risks is a multidimensional process strongly influenced by care intensity, the caregiver's psychological state, and the complexity of caregiving tasks (Polenick et al., 2018). People often become caregivers without having had a choice, because care was needed for a family member. Studies have shown that more than half of informal caregivers (54.4%) had no alternative. This psychological factor strongly correlates with greater physical load, emotional stress, and declining health among caregivers (Shin et al., 2023). The quality and safety of care are limited by the caregiver's insufficient understanding of the complexity of the situation, their ability to recognise risks, and their access to adequate professional support. This means that care will be provided routinely, uncritically, with errors, or under physical overexertion. A lack of risk perception is not an individual problem but a systemic factor arising from insufficient knowledge, lack of resources, and conditions of increased physical and emotional load (Cremer et al., 2023). Access to information enhances risk perception (Lee et al., 2019). Older adults are characterised by distinct patterns of information perception and

processing, influenced by various cognitive, emotional, and environmental factors. The hyperbinding effect described by Campbell et al. (2012) indicates that older adults unconsciously perceive and link both relevant and irrelevant, or peripheral, information. This creates a broader but less filtered knowledge base, which may help reveal early risk signals (Campbell et al., 2012). Older adults spontaneously focus on positive rather than negative information. As a result, situations arise in which older informal caregivers may sometimes underestimate ergonomic risks, while at the same time being more responsive to positively framed safety and careimprovement recommendations (Carstensen & DeLiema, 2018). Older adults may have difficulty distinguishing new information from information previously acquired, and this may increase the likelihood of misidentifying ergonomic risks, which is associated with a higher risk of injury during the caregiving process (Bowman & Dennis, 2015). Studies show that subjective emotional load is the strongest mediator of caregiver burnout and stress. This means that the caregiver's own understanding and interpretation of their emotional load determines whether a situation is perceived as manageable or overwhelming, which may lead to physical and emotional overexertion, ergonomic injury, or emotional exhaustion (Gérain & Zech, 2022). In the context of informal care, the concept of ergonomic risk refers to the biomechanical, physical, and functional load that arises during caregiving activities in the home environment. It is most often associated with manual handling, lifting and transferring of the client, which significantly increases the risk of musculoskeletal disorders (Haddada et al., 2025; Ramezani et al., 2020). Caregivers frequently work in non-ergonomic postures that create a prolonged static load and contribute to the development of chronic pain (Bowman & Dennis, 2015; Hwang et al., 2019) and may cause injuries to the back, shoulder girdle structures, and upper extremities (Kim & Jeong, 2020). The ergonomic risk of informal care depends on the level of functional dependency of the care recipient. A high level of functional dependency requires manual lifting, transferring and physical assistance (Haddada et al., 2025; Ramezani et al., 2020) and increases the intensity of careIntensity is characterised by a high number of caregiving hours per week (Kang, 2016; Lacey et al., 2018) which creates a cumulative impact of caregiving load on the caregiver's health (Akyurek et al., 2026; Bauer & Sousa-Poza, 2015). Biomechanical overload is influenced by agerelated physiological vulnerability of the caregiver. The risk includes a decline in muscle mass and strength (Batsis & Villareal, 2018), deterioration in balance and functional abilities (Papalia et al., 2020; Sarvestan et al., 2021). Older caregivers are more exposed to musculoskeletal injury and disease risks (Batsis & Villareal, 2018; Cheng et al., 2022; Palmeira et al., 2025; Solianik et al., 2017). Insufficient assessment of the home environment (Mihandoust et al., 2021), limited space and inadequate housing infrastructure (Doutcheva et al., 2019) and insufficient availability of ergonomic assistive devices (Boonkhao et al., 2023) are limiting factors in caregiving that act on the caregiver's body as amplifiers of physical load and contribute to injury risk. Studies show that organised care services improve and prevent health risks caused by caregiving load (Roja et al., 2018). To reduce the impact of ergonomic load, caregivers use various load-reduction strategies that mitigate the physical and emotional

stress associated with the caregiving role. Ergonomic risk perception among older informal caregivers is determined by their ability to process new information. One of the existing solutions that influence ergonomic risks is virtual reality-based caregiver training (VR) (Wang et al., 2023; Wijma et al., 2018). VR training can reduce stress, anxiety, and burnout among caregivers (Tang et al., 2024). VR platforms provide a safe environment for simulating complex care situations, allowing caregivers to practice lifting, transferring, and positioning the care recipient without physical risk (Hellmers et al., 2022). This approach promotes the acquisition of correct body mechanics and can significantly reduce the risk of musculoskeletal disorders. Studies confirm that the implementation of VR training improves caregiver knowledge and exercise quality of movement, as well as reduces the long-term risk of developing back pain. Digital solutions that analyse caregiver postures and body positions during client handling, hygiene care, and daily caregiving tasks make a substantial contribution to reducing ergonomic risks among informal caregivers. These tools allow caregivers to access online ergonomic assessments and receive evidence-based information on safe lifting, environmental adjustments, and reduction of risk factors. Regular access to evidence-based information can improve caregiver knowledge levels and quality of care (Hellmers et al., 2022; Purwati et al., 2025). These tools help caregivers understand how daily tasks, patient transfers, or moving heavy objects can be performed more safely and ergonomically using correct postures, movement trajectories, and assistive equipment (Hellmers et al., 2022; Hwang et al., 2019). Training interventions delivered through mobile applications significantly improve informal caregivers' knowledge, attitudes, and skills in providing care for their relatives. Digitally guided physical activity and exercise programmes play a particularly important role in reducing ergonomic risks among informal caregivers. Such interventions can provide practical recommendations to reduce musculoskeletal overload during daily caregiving activities. These programmes can be customised to the individual needs of caregivers, improving their physical functioning and psychological well-being. In general, the digital tools described in the literature demonstrate a wide spectrum of potential. They can not only reduce physical load, but also improve caregiver skills, support their physical and emotional well-being, and provide an evidence-based approach to ergonomicrisk prevention. The integration of such tools into informal care can significantly influence caregiver health outcomes, especially in situations where traditional training is not available (Baik et al., 2023). The readiness and acceptance of digital solutions among older informal caregivers vary significantly depending on several factors, including digital literacy, perceived usefulness, and the specific needs of caregivers and care recipients. Digital skills among older caregivers differ widely. Studies indicate that a considerable proportion of older adults are unable to use digital technologies effectively without assistance, which can lead to frustration and discontinuation of technology use (Bergh et al., 2025; Boyle et al., 2022). Innovative technologies can substantially enhance caregiver autonomy and reduce load when co-designed with users and tailored to their actual needs. However, to implement innovative technologies, informal caregivers require support provided through training or assistance from relatives. For older adults, technology initially appears stressful and difficult to use, but after training,

technostress and anxiety decrease, and technologies become more adaptable to daily life (Pani et al., 2024). A simple, intuitive interface is most suitable for both older adults and caregivers (Kim et al., 2023).

CONCLUSION

The analysis of scientific literature indicates that ergonomic risk perception among older caregivers is fragmented and is significantly influenced by emotional, cognitive, and physiological factors, as well as care intensity, inadequacies in the home environment, and a lack of information on correct care techniques. Digital interventions demonstrate a strong potential to reduce ergonomic risks by improving caregiver knowledge and the quality of care and movement execution. However, their effective use depends on the digital literacy of the user and the design adapted to the 60+ age group. The results of this narrative literature review suggest that both the concept of ergonomic risk and the role of digital solutions require more precise definition, particularly in the context of older caregivers. Further research is required to refine the conceptualisation of ergonomics for older caregivers and to develop and empirically validate digital interventions that are userfriendly, cognitively accessible, and effective in informal care for the 60+ age group, thereby ensuring safer and more sustainable care in an ageing society. To ensure sustainable care and the well-being of caregivers themselves, it is essential to develop support systems at the political, healthcare, and community levels.

STUDY LIMITATIONS

There is limited literature available that directly analyses ergonomic risk perception among older informal caregivers and there is insufficient analysis of the implementation of digital solutions in this population.

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