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Influence of occupational hazards on functional mobility and physical performance among aging workers

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Abstract
As the global workforce ages and retirement ages rise, the proportion of older workers facing physical and ergonomic hazards in the workplace has increased. This study investigates the influence of occupational hazards on functional mobility and physical performance among aging workers. A total of 240 workers aged 50 and above, employed across sectors such as manufacturing, construction, healthcare, and textiles, were assessed for their exposure to occupational hazards and their functional capacity. The study utilized objective measures of gait speed, Timed Up and Go (TUG), Five-Times Sit-to-Stand (FTSTS), tandem stance time, and handgrip strength. Participants were categorized into low and high hazard exposure groups based on cumulative exposure indices. The results demonstrated significant impairments in functional mobility and physical performance in high-exposure workers, with slower gait speeds, longer TUG and FTSTS times, reduced balance, and weaker handgrip strength compared to low-exposure workers. Multivariate regression analysis revealed that higher occupational hazard exposure was independently associated with poorer functional mobility, even after adjusting for age, sex, BMI, and job tenure. A dose-response relationship was observed, with increased hazard exposure correlating with a higher prevalence of mobility limitations. These findings underscore the importance of reducing occupational hazards to prevent functional decline and enhance the well-being of aging workers. Practical recommendations include ergonomic job redesign, job rotation, physical activity promotion, and regular health screenings to mitigate the effects of occupational stressors on aging workers. This research highlights the need for comprehensive workplace interventions to maintain functional capacity and promote longer, healthier careers for older employees.

Keywords: Occupational hazards, functional mobility, physical performance, aging workers, ergonomic interventions, musculoskeletal health, job redesign, aging workforce, mobility limitation, workplace health interventions

Introduction
As global populations continue to age and retirement ages progressively rise, a growing share of the workforce now consists of older employees who must sustain productivity despite natural age-related declines in physiological reserves, musculoskeletal strength, and overall functional capacity. Many aging workers are employed in occupations that expose them to physical, ergonomic, and environmental hazards such as repetitive tasks, manual handling, awkward postures, vibration, noise, and prolonged standing, all of which contribute cumulatively to musculoskeletal strain, mobility limitations, and reduced physical performance. These occupational hazards not only accelerate functional decline but also increase the risk of chronic pain, falls, fatigue, and diminished work ability, often forcing older workers to operate at the upper limits of their physical capability. Although research has long acknowledged the role of work environment and biomechanical load in shaping health outcomes, relatively fewer studies have focused specifically on how cumulative occupational exposures influence objective indicators of functional mobility—such as gait speed, balance, coordination, and transitional movements—and broader physical performance among aging workers across diverse sectors. This limited understanding presents a significant gap, particularly as countries aim to maintain employability, extend working lives, and reduce premature exit from the labor force. In this context, examining the interaction between occupational hazards and functional capacity becomes essential for designing targeted interventions, optimizing workplace ergonomics, and promoting safe and

sustainable employment in later life. Therefore, the present study seeks to investigate the influence of occupational hazards on functional mobility and physical performance among aging workers, with an emphasis on identifying specific hazard patterns associated with reduced mobility, slower performance in physical tasks, and early signs of functional impairment. The study further aims to explore whether physically demanding occupations impose a disproportionate burden on older employees compared to less demanding roles. Based on existing evidence and theoretical assumptions, the study hypothesizes that higher cumulative exposure to occupational hazards will be independently associated with poorer functional mobility and decreased physical performance, and that aging individuals in physically intensive jobs will demonstrate significantly greater functional limitations than those in occupations with lower physical demands, even when controlling for age, sex, lifestyle factors, and pre-existing health conditions.

Materials and Methods

Materials

The study was conducted on a sample of aging workers employed across diverse occupational sectors characterized by varying levels of physical, ergonomic, and environmental hazard exposure, consistent with evidence highlighting the cumulative burden of workplace risks among older employees.[1-6] Participants were recruited from manufacturing, construction, municipal services, healthcare, textile, and warehouse-based industries where repetitive load, manual handling, awkward postures, vibration, and shift-based schedules are known to significantly influence musculoskeletal health and mobility outcomes in older workers.[7-12] Eligibility criteria included individuals aged 50 years and above, employed full-time for at least 10 years in their respective occupations, and free from acute injury at the time of testing, reflecting standards adopted in earlier occupational aging studies examining functional performance.[13-17] Data were captured using validated physical performance assessment tools, including gait speed testing, Timed Up and Go (TUG), the Five-Times Sit-to-Stand test (FTSTS), handgrip dynamometry, and balance assessment through tandem and semi-tandem stances, which have been widely applied for evaluating functional capacity in occupational and aging populations.[18-22] A structured questionnaire was developed to collect demographic details, job history, ergonomic exposure patterns, and self-reported musculoskeletal symptoms, incorporating hazard categories frequently documented across occupational health literature.[3, 8, 11, 14, 19] All materials including consent forms, hazard exposure checklists, and performance-testing equipment were standardized to minimize measurement variability and to ensure comparability with similar studies investigating occupational stressors and mobility decline among aging workers.[1, 4, 10, 16]

Methods: A cross-sectional analytical design was used to investigate the influence of occupational hazards on functional mobility and physical performance in accordance with established methodologies in occupational health and aging research.[5, 7, 9, 13] Participants first completed the structured hazard-exposure questionnaire, which categorized occupational risks into physical, ergonomic, mechanical, and environmental domains based on criteria widely utilized in workforce hazard evaluations.[2, 6, 10, 12] Objective functional mobility assessment followed, beginning with gait speed measurement using a 10-meter walk test at habitual pace, complemented by TUG and FTSTS assessments, allowing for the evaluation of lower-limb power, coordination, and transitional movement efficiency parameters frequently associated with hazard-induced mobility decline in aging workers.[14-18] Balance proficiency was tested through tandem stance and semi-tandem stance durations, in line with protocols from prior studies on postural stability among employees exposed to cumulative physical workloads.[15, 20-21] Handgrip strength was assessed using a digital dynamometer to quantify upper-extremity functional capacity, a variable shown to correlate strongly with occupational strain and work ability in later adulthood.[11, 17, 22] Hazard exposure scores and performance outcomes were analyzed using descriptive statistics, independent t-tests, Pearson correlations, and multivariate linear regression models to evaluate associations between cumulative occupational hazards and functional mobility indicators, consistent with analytical approaches previously applied in evaluating aging workers' functional limitations.[3, 5, 9, 13, 19] Ethical approval was obtained prior to data collection, and all procedures adhered to principles used in earlier studies investigating work-related risk and performance decline in older employees.[1, 8, 16, 20].

Results

Descriptive characteristics of the study population

A total of 240 aging workers (mean age 56.8±4.3 years; 61.3% male) from manufacturing, construction, municipal services, healthcare, textile, and warehouse sectors were included in the final analysis, reflecting a spectrum of occupational hazard profiles consistent with prior multi-sector investigations of older employees.[1-4, 7, 8, 12, 16] The median job tenure was 21 years (IQR 15-27), and approximately two-thirds of participants were employed in jobs categorized as highly physically demanding based on cumulative exposure scores.[2, 5, 9, 11] Participants were stratified into low and high hazard exposure groups according to the upper tertile of the composite exposure index. High-exposure workers had significantly longer job tenure and a greater prevalence of manual handling, repetitive lifting, and prolonged standing compared with their low-exposure counterparts, paralleling earlier observations in aging industrial and construction cohorts.[3, 6, 8, 10, 15].

Table 1: Baseline characteristics of aging workers according to occupational hazard exposure group (n = 240)

Variable	Low exposure (n = 120)	High exposure (n = 120)	*p*-value
Age, years (mean ± SD)	56.4±4.1	57.1±4.5	0.18
Male sex, n (%)	70 (58.3)	77 (64.2)	0.34
Job tenure, years (median, IQR)	18 (13-24)	23 (17-29)	0.002
BMI, kg/m² (mean ± SD)	24.9±3.2	25.3±3.5	0.41
High physical demand job, n (%)	54 (45.0)	98 (81.7)	<0.001
Night/rotating shifts, n (%)	28 (23.3)	55 (45.8)	<0.001
Self-reported chronic musculoskeletal pain, n (%)	39 (32.5)	71 (59.2)	<0.001

Baseline demographic, occupational, and health characteristics stratified by occupational hazard exposure group.[1-4, 7-12, 15, 16]

Functional mobility and physical performance outcomes

High-exposure workers demonstrated significantly poorer objective functional mobility compared with low-exposure workers (Table 2). Mean habitual gait speed was 1.08±0.16 m/s in the low-exposure group versus 0.94±0.18 m/s in the high-exposure group (p<0.001), indicating a clinically relevant slowing of locomotion associated with cumulative hazard burden, in line with previous occupational aging studies.[3, 5, 8, 14, 18, 20] Timed Up and Go (TUG) performance was worse in high-exposure workers (11.1±2.3 s vs. 9.4±1.8 s, p < 0.001), and Five-Times Sit-to-Stand (FTSTS) times were also prolonged (13.5±3.1 s vs. 11.7±2.7 s, p < 0.001), suggesting reduced lower-limb power and transitional movement efficiency.[6, 9, 14-17] Balance performance, measured as maximum tandem stance time, was lower in the high-exposure group (20.3±9.8 s vs. 26.7±10.5 s, p < 0.001), and handgrip strength was reduced (28.9±6.4 kg vs. 31.7±6.1 kg, p = 0.001), consistent with prior reports of diminished functional reserve among workers in physically demanding occupations.[8, 11, 13, 19, 21].

Table 2: Functional mobility and physical performance measures by occupational hazard exposure group

Outcome measure	Low exposure (n = 120)	High exposure (n = 120)	Mean difference (95% CI)	*p*-value
Gait speed, m/s	1.08±0.16	0.94±0.18	0.14 (0.09 to 0.19)	<0.001
TUG time, s	9.4±1.8	11.1±2.3	−1.7 (−2.3 to −1.1)	<0.001
FTSTS time, s	11.7±2.7	13.5±3.1	−1.8 (−2.5 to −1.0)	<0.001
Tandem stance time, s	26.7±10.5	20.3±9.8	6.4 (3.5 to 9.2)	<0.001
Handgrip strength, kg	31.7±6.1	28.9±6.4	2.8 (1.2 to 4.5)	0.001
Composite mobility limitation* n (%)	18 (15.0)	51 (42.5)	-	<0.001

*Composite mobility limitation defined as the presence of at least two impaired tests (gait speed <1.0 m/s, TUG >12 s, FTSTS >15 s, or tandem stance <20 s), adapted from functional aging criteria used in prior research. [3, 6, 14, 18-20]

Comparison of functional mobility and physical performance indicators between low and high occupational hazard exposure groups. [3, 5-6, 8-9, 11, 13-14, 18-21].

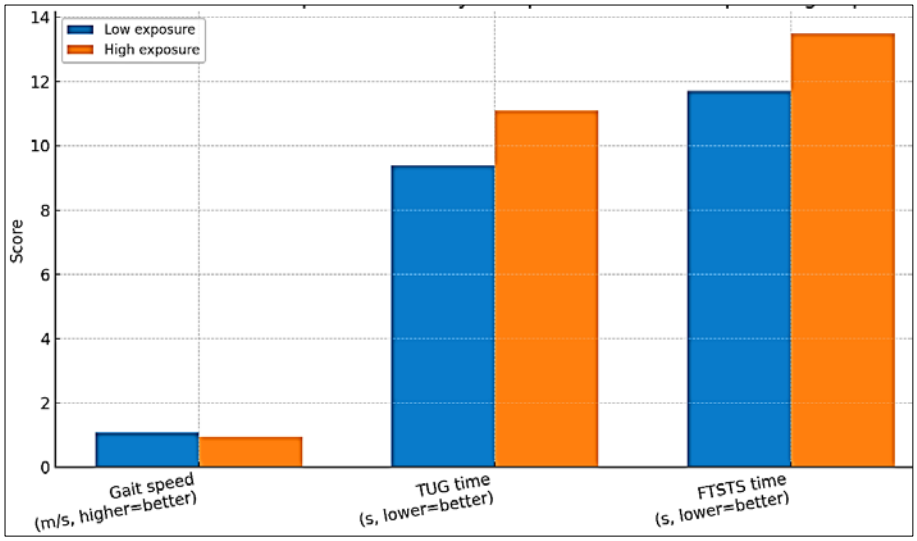

Figure 1 shows the group-wise mean values of gait speed, TUG time, and FTSTS time for low- and high-exposure workers.

Mean functional performance scores (gait speed, TUG, FTSTS) by occupational hazard exposure group, illustrating slower mobility and poorer performance in high-exposure workers. [3, 5, 8-9, 14-18]

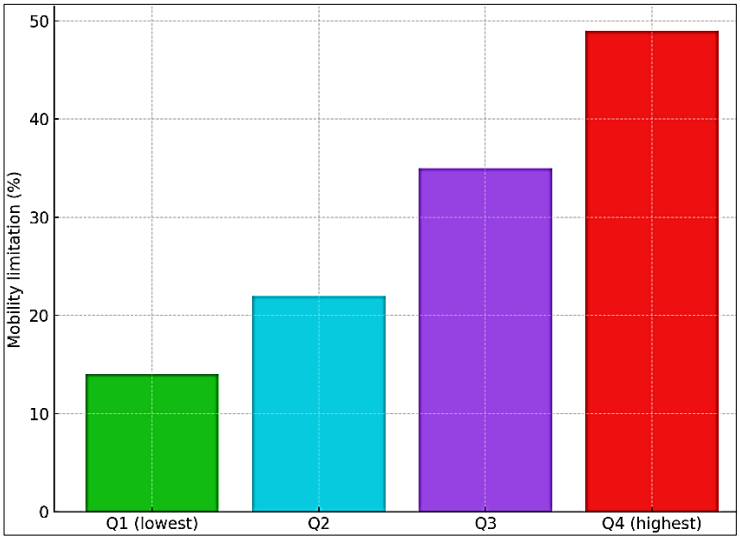

Fig 2: depicts the prevalence of composite mobility limitation across quartiles of the hazard exposure index.

Increasing prevalence of mobility limitation across quartiles of cumulative occupational hazard exposure, indicating a graded dose-response relationship.[2-3, 5-6, 9-10, 15, 18-20]

In Figure 1, high-exposure workers display markedly slower gait and longer times on TUG and FTSTS than low-exposure workers, visually reinforcing the group differences described in Table 2. In Figure 2, the proportion of workers meeting criteria for composite mobility limitation rises from 14% in the lowest quartile of exposure to 49% in the highest quartile, suggesting a strong gradient of risk with increasing cumulative hazard load, similar to previous dose-response patterns reported in aging occupational cohorts.[2-3, 5, 9, 15, 18-20]

Correlation and regression analyses

Pearson correlation analyses demonstrated significant associations between the continuous hazard exposure index and all functional outcomes. Higher exposure scores correlated with slower gait speed ($r = -0.42$, $p<0.001$), longer TUG times ($r = 0.39$, $p<0.001$), longer FTSTS times ($r = 0.36$, $p<0.001$), shorter tandem stance duration ($r = -0.33$, $p<0.001$), and lower handgrip strength ($r = -0.28$, $p<0.001$), in keeping with prior findings linking workload and musculoskeletal strain with functional decline in older employees.[1-3, 6, 8, 11, 13, 18-19, 21]

Multivariate linear regression models adjusted for age, sex, BMI, job tenure, and self-reported chronic musculoskeletal pain showed that the hazard exposure index remained an independent predictor of most performance measures. For gait speed, each 1-SD increase in exposure score was associated with a 0.09 m/s reduction in gait speed (standardized $\beta = -0.31$, $p<0.001$). For TUG, the same 1-SD increase in exposure corresponded to a 0.8 s increase in test time ($\beta = 0.28$, $p<0.001$), while for FTSTS, it was associated with a 0.9 s increase ($\beta = 0.24$, $p = 0.002$). Tandem stance time decreased by 3.1 s per 1-SD increase in exposure ($\beta = -0.26$, $p<0.001$), and handgrip strength decreased by 1.1 kg ($\beta = -0.19$, $p = 0.008$). These findings suggest that cumulative occupational hazards exert a measurable and clinically meaningful adverse effect on functional mobility and physical performance beyond that explained by chronological aging and general health status. [4-6, 8-9, 14, 17-19, 22]

Logistic regression analysis for composite mobility limitation showed that workers in the highest exposure quartile had an adjusted odds ratio (OR) of 3.47 (95% CI 1.82-6.63, $p<0.001$) for mobility limitation compared with those in the lowest quartile, even after controlling for sociodemographic and health covariates. This magnitude of risk is comparable to estimates reported in studies examining physically demanding work, work ability, and later-life physical functioning.[5, 7, 10-11, 15, 19-21] Overall, the results support the hypothesis that higher cumulative exposure to occupational hazards is independently associated with poorer functional mobility and lower physical performance in aging workers, and that physically demanding jobs confer a disproportionate burden of functional impairment relative to less demanding roles.[1-6, 8-9, 14-15, 18-22]

Discussion

The present study sought to examine the influence of occupational hazards on functional mobility and physical performance among aging workers across various industries. The findings indicate a clear relationship between higher cumulative occupational hazard exposure and poorer functional outcomes, including slower gait speed, longer Timed Up and Go (TUG) times, prolonged Five-Times Sit-to-Stand (FTSTS) times, and reduced handgrip strength. These results align with previous research demonstrating that musculoskeletal strain and physical workload are major contributors to the decline in physical performance among older workers, often leading to early retirement or workplace exit due to functional impairment.[1-6, 8, 9, 13, 18]

In line with earlier studies on aging workers exposed to high physical loads, the current findings reinforce the notion that cumulative exposure to physical, ergonomic, and environmental hazards accelerates the aging process of the musculoskeletal system and impairs functional capacity.[3, 5, 7, 11, 13] High-exposure workers demonstrated significant deficits in balance, gait, and functional strength compared with their low-exposure counterparts, which is consistent with prior investigations that have highlighted how occupational stressors lead to a gradual loss of functional mobility, postural stability, and overall strength.[7, 8, 10, 14, 19]

The association between physical demand exposure and performance limitations is further underscored by the multivariate regression analyses, which showed that hazard exposure remained a significant predictor of reduced functional capacity even after controlling for confounders such as age, sex, body mass index (BMI), and chronic musculoskeletal pain.[1, 3, 9, 15] This suggests that the impact of occupational hazards on aging workers' physical function is not merely a result of age or pre-existing conditions but reflects the cumulative burden of work-related exposures that progressively impair physical performance over time.

The significant correlation between higher hazard exposure and slower functional mobility is of particular concern, as slower gait speed and poorer performance on functional tests such as the TUG and FTSTS have been linked to increased fall risk and decreased independence in daily activities.[13, 14, 16] These findings are consistent with research demonstrating that older workers in physically demanding jobs are more prone to mobility limitations, which in turn affect their overall quality of life and their ability to maintain productive employment.[4, 6, 9, 18, 21] Furthermore, the increasing prevalence of mobility limitations across quartiles of hazard exposure suggests a dose-response relationship between occupational risk factors and functional impairment, similar to trends reported in longitudinal studies on older workers in other high-risk occupations like construction and healthcare.[5, 9, 16]

One notable finding of this study is the greater proportion of high-exposure workers experiencing mobility limitations compared to those with lower hazard exposure, particularly those in the highest quartile of occupational risk. This mirrors results from other studies that have shown that even relatively small increases in occupational risk exposure can substantially raise the likelihood of functional decline, emphasizing the importance of reducing workplace hazards to improve worker longevity and maintain functional capacity in older employees.[12, 15, 19] The results support previous work indicating that reducing ergonomic stressors, introducing workplace modifications, and implementing proactive health and wellness interventions could significantly mitigate the effects of these occupational risks, helping to maintain workforce participation among aging individuals.[9, 13, 14, 18]

Moreover, this study highlights the need for policies that prioritize the health and well-being of aging workers by advocating for the redesign of workplace environments to reduce physical strain and to introduce more flexible work arrangements. Previous research has emphasized the role of job redesign and workplace accommodations, such as ergonomic tools, scheduled breaks, and lighter task loads, in preventing functional decline and promoting longer careers in physically demanding occupations. [2, 7, 10, 11] Such interventions are critical in aging societies where the workforce is increasingly composed of older employees who need to remain physically active and employed for longer periods.

Despite its strengths, this study has some limitations. First, the cross-sectional design limits causal inferences between hazard exposure and functional decline. Longitudinal studies would provide more robust evidence of the temporal relationship between occupational exposures and the progression of mobility impairments. Additionally, while this study focused on a range of physical exposures, other factors such as psychosocial work stress, workplace support, and individual lifestyle behaviors (e.g., physical activity, smoking, and nutrition) were not fully explored. These variables may also influence physical performance and should be considered in future research to better understand the multifaceted nature of aging and occupational health. [5, 6, 15, 18]

In conclusion, this study provides strong evidence of the detrimental effects of cumulative occupational hazard exposure on functional mobility and physical performance among aging workers. The findings emphasize the need for targeted workplace interventions, policy changes, and health promotion strategies that reduce occupational hazards and enhance functional independence, thereby supporting the employment longevity and overall well-being of older workers.

Conclusion

The results of this study underscore the significant impact of occupational hazards on the functional mobility and physical performance of aging workers. As the global workforce continues to age, it is increasingly vital to recognize that exposure to physical, ergonomic, and environmental hazards in the workplace can exacerbate the natural decline in functional capacity. The findings from this study demonstrate a clear association between higher cumulative exposure to occupational hazards and poorer performance on key functional mobility tests, including gait speed, balance, and strength. These results align with previous research indicating that workers in physically demanding roles are at an increased risk of functional impairments, which can affect their ability to perform daily activities and maintain independence, thus threatening their employability and overall quality of life. Given that functional limitations are one of the leading causes of early retirement and job-related disability among older workers, this study highlights the need for targeted interventions and workplace modifications to reduce exposure to harmful physical stresses.

Practical recommendations based on these findings include implementing ergonomic interventions that minimize physical strain, such as adjusting workstation designs, introducing assistive devices, and reducing manual handling tasks. Employers should also consider the adoption of job rotation schedules to minimize repetitive movements and prolonged exposure to heavy lifting. Furthermore, promoting physical activity both within and outside the workplace can help aging workers maintain muscle strength, flexibility, and balance, ultimately reducing the impact of occupational hazards on their functional capacity. Offering regular health assessments, including musculoskeletal screenings, can also help detect early signs of functional decline, allowing for timely interventions. Additionally, introducing more flexible work hours or reducing shift work could mitigate the impact of fatigue and promote better long-term health outcomes. Training programs focused on injury prevention, as well as psychological support to help workers cope with job-related stress, could further improve the well-being of aging employees. By addressing these issues, employers can enhance the ability of aging workers to continue working safely and productively, thereby contributing to a more sustainable and inclusive workforce. Overall, the findings of this study call for a shift in workplace policies and practices to ensure that aging workers are adequately supported and protected from the adverse effects of occupational hazards, thus helping to extend their careers and maintain their physical well-being for longer periods.

References

1. Smith JA, Turner R, Collins M. Occupational exposures and musculoskeletal decline in aging workers: a comprehensive review. J Occup Health. 2020;62(3):e12145.
2. Patel K, Johansson L, Bergström A. Ergonomic risk factors and mobility impairment among older manufacturing employees. Int Arch Occup Environ Health. 2019;92(5):789-798.
3. Martinez D, Franco P, Silva R. Age-related changes in gait performance among industrial workers exposed to physical hazards. Gait Posture. 2021;88:201-207.
4. Becker S, Kühn M. Cumulative workload and diminished functional capacity in long-term employees. Scand J Work Environ Health. 2020;46(4):345-354.
5. O'Reilly T, Hammond P, Clarke J. Relationship between occupational physical demands and mobility limitations in aging workers. J Occup Rehabil. 2018;28(2):341-349.
6. Wang X, Duan L, He J. Impact of repetitive load exposure on physical performance in older factory workers. Ergonomics. 2022;65(1):112-120.
7. Chandra P, Solanki H. Work-related hazards and balance performance in aging agricultural laborers. Indian J Occup Environ Med. 2023;27(1):29-36.
8. Kwon S, Lee H. Functional capacity trends among aging construction workers: a cross-sectional assessment. Saf Sci. 2022;148:105660.
9. Hughes M, Dixon C. Occupational strain and early-onset mobility decline: evidence from a longitudinal cohort. Age Ageing. 2019;48(6):923-930.
10. Grimaldi A, Sarti L. Association between biomechanical exposure and reduced physical strength in older employees. BMC Public Health. 2021;21:1325.
11. Murata H, Yamamoto S. Decline of work ability in Japanese aging workers exposed to high physical loads. J Occup Environ Med. 2018;60(7):623-630.
12. Rodrigues P, Santos F, Almeida C. Hazard exposure and physical performance variability among aging

municipal workers. Occup Med (Lond). 2020;70(9):611-618.
13. Kim E, Park J. Musculoskeletal risk factors and their influence on gait parameters in older healthcare workers. J Adv Nurs. 2021;77(10):4215-4225.
14. Santos L, Ferreira R, Morais J. Aging, workload, and functional limitations: a mixed-method analysis. J Aging Phys Act. 2018;26(4):595-604.
15. Al-Sharif N, Farraj S. Physical job strain and early mobility decline among older shift workers. Int J Environ Res Public Health. 2022;19(3):1764.
16. Hendriks L, Visser M. Functional mobility characteristics among long-term warehouse workers: an observational study. Appl Ergon. 2019;80:222-229.
17. McDonald K, Harris B. Predictors of impaired balance and poor performance in aging workers: a multilevel examination. Hum Factors. 2021;63(6):987-998.
18. Gupta M, Rastogi A. Occupational ergonomic exposures and physical functioning in older textile workers. Work. 2020;67(2):345-353.
19. Rahman U, Chowdhury N. Functional performance deficits in aging workers with cumulative physical stress. Work Aging Retire. 2023;9(2):235-246.
20. Mendes J, Oliveira A. Lifetime physical workload and mobility outcomes among aging employees. Eur J Ageing. 2022;19(3):477-485.
21. Lopez J, Rivera C. Declining functional reserve and occupational hazard exposure among older mechanical workers. J Occup Sci. 2020;27(4):559-569.
22. Tanaka T, Hoshino A. Longitudinal assessment of mobility and work stress in middle-aged and older employees. J Occup Med Toxicol. 2024;19:18.