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Original Article

Work-Related Ergonomic Factors Contributing to Musculoskeletal Pain in Cardiology Department at Mardan Medical Complex: A Cross-Sectional Study

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ABSTRACT

Background: Musculoskeletal disorders (MSDs) are highly prevalent among healthcare workers due to exposure to ergonomic and occupational stressors, particularly in procedure-intensive specialties such as cardiology. Objective: To determine the prevalence of musculoskeletal pain and assess its association with work-related ergonomic factors among cardiology staff at Mardan Medical Complex. Methods: A descriptive cross-sectional study was conducted among 69 cardiology staff using a structured Musculoskeletal Discomfort Form. Data on ergonomic exposures, workplace conditions, and musculoskeletal symptoms during the preceding week were collected. Associations were analyzed using Chi-square tests and multivariable logistic regression, adjusting for demographic and occupational confounders. Results: Musculoskeletal pain was reported by 82.6% of participants, with lower back pain being the most common complaint. Significant associations were observed with overtime duty (AOR = 3.42; 95% CI: 1.14–10.23), excessive workload (AOR = 2.95; 95% CI: 1.01–8.61), prolonged standing (AOR = 3.86; 95% CI: 1.22–12.19), awkward posture (AOR = 4.18; 95% CI: 1.31–13.31), and heavy lifting (AOR = 3.27; 95% CI: 1.05–10.17). Ergonomic training (AOR = 0.36; 95% CI: 0.12–0.98) and ergonomic workstation availability (AOR = 0.31; 95% CI: 0.10–0.91) were protective. Conclusion: Musculoskeletal pain among cardiology staff is strongly associated with modifiable ergonomic and workplace factors, highlighting the need for targeted interventions such as ergonomic training and improved workplace design. Keywords: Musculoskeletal disorders, ergonomics, cardiology staff, lower back pain, occupational health.

INTRODUCTION

Musculoskeletal disorders (MSDs) constitute a major occupational health concern globally and are recognized as a leading cause of disability, absenteeism, and reduced work efficiency across multiple professional groups (1). These conditions involve the muscles, tendons, ligaments, intervertebral discs, and peripheral nerves, and are commonly precipitated by cumulative exposure to biomechanical stressors such as repetitive motion, forceful exertion, and sustained static postures (2). Healthcare workers represent a particularly vulnerable population due to the physical and organizational demands inherent to clinical environments, including prolonged working hours, patient handling, and high-intensity workflows (3,4). Within hospital settings, specialized departments such as cardiology impose distinct ergonomic challenges, where staff frequently engage in prolonged standing during procedures, operate complex monitoring systems, and perform manual handling of patients and equipment under time-sensitive conditions (5).

Epidemiological studies have consistently reported a high prevalence of musculoskeletal pain among healthcare professionals, with estimates ranging between 60% and 90%, underscoring the magnitude of the problem (6,7). The lower back and neck are the most commonly affected anatomical regions, reflecting the biomechanical strain associated with prolonged postural load and suboptimal working positions (8). In cardiology settings, these risks may be amplified due to procedure-intensive tasks such as catheterization support, bedside monitoring, and emergency interventions, which often require sustained awkward positioning and repetitive physical effort (9). In addition to physical exposures,

organizational determinants such as excessive workload, overtime duty, inadequate staffing, and lack of ergonomic infrastructure further compound the risk, contributing to both the onset and persistence of musculoskeletal symptoms (10).

Although individual characteristics such as age, sex, and body mass index have been examined as potential determinants of MSDs, accumulating evidence suggests that modifiable occupational factors exert a more substantial influence on musculoskeletal health outcomes (11). Ergonomic risk factors—including prolonged standing, repetitive movements, awkward postures, and manual handling—have been consistently associated with increased odds of musculoskeletal pain among healthcare workers (12). Conversely, the implementation of ergonomic interventions, including structured training programs, use of assistive devices, and optimization of workstation design, has demonstrated a protective effect by reducing exposure to biomechanical strain and improving work practices (13). Despite this evidence, the integration of ergonomic principles into routine clinical practice remains inconsistent, particularly in resource-limited healthcare systems where competing priorities and infrastructural constraints may limit preventive efforts.

In low- and middle-income countries, including Pakistan, there is a notable scarcity of context-specific data examining the burden and determinants of musculoskeletal disorders among specialized healthcare personnel. Existing research has largely focused on general nursing populations or surgical staff, with limited attention to cardiology teams whose occupational exposures differ in terms of procedural demands, equipment interaction, and workflow intensity (14). Furthermore, variations in institutional resources, staffing patterns, and ergonomic awareness may influence the distribution and impact of these risk factors, highlighting the need for locally generated evidence to inform targeted interventions. Without such data, efforts to design effective workplace modifications and preventive strategies remain insufficiently tailored to the specific needs of cardiology staff.

Given the high prevalence of MSDs among healthcare workers and the potential for modifiable ergonomic and organizational factors to influence their occurrence, there is a critical need to systematically evaluate these associations within cardiology departments in the local context. Such evidence is essential to guide the development of practical, evidence-based interventions aimed at reducing musculoskeletal burden, improving occupational health, and enhancing workforce productivity. Therefore, this study was undertaken to determine the prevalence of musculoskeletal pain and to assess the association between work-related ergonomic exposures—specifically prolonged standing, awkward posture, manual handling, workload, overtime duty, and availability of ergonomic resources—and musculoskeletal pain among staff working in the cardiology department of Mardan Medical Complex. The study specifically addressed the research question of whether exposure to these ergonomic and workplace factors is associated with an increased likelihood of musculoskeletal pain among cardiology personnel.

MATERIALS AND METHODS

This study employed a descriptive cross-sectional observational design to assess the association between work-related ergonomic exposures and musculoskeletal pain among cardiology staff. The cross-sectional approach was selected as it allows simultaneous measurement of exposure and outcome within a defined population, enabling estimation of prevalence and identification of associated factors in occupational health research settings (15). The study was conducted in the Cardiology Department of Mardan Medical Complex, a tertiary care hospital in Khyber Pakhtunkhwa, Pakistan, over a six-month period from December 2025 to May 2026.

The study population consisted of healthcare professionals working in the cardiology department, including physicians, nurses, technologists, and technicians. Participants were eligible if they were permanent staff members with a minimum of one year of work experience in their current role, ensuring adequate exposure to workplace ergonomic conditions. Individuals with a history of recent trauma,

diagnosed musculoskeletal or neurological disorders unrelated to occupational exposure, or conditions that could independently influence musculoskeletal symptoms were excluded. Pregnant individuals were also excluded due to physiological musculoskeletal adaptations that could confound outcome assessment. A non-probability convenience sampling technique was used to recruit participants from the available workforce during the study period, aiming to include all eligible staff members to maximize representativeness within the department.

Eligible participants were approached in person during duty hours and provided with a detailed explanation of the study objectives, procedures, and voluntary nature of participation. Written informed consent was obtained prior to enrollment. Participation was anonymous, and no identifying information was recorded to ensure confidentiality and reduce reporting bias. Data collection was carried out using a structured, pre-designed Musculoskeletal Discomfort Form adapted from standardized instruments used in occupational health research (16). The questionnaire was administered in English and comprised sections on demographic characteristics, occupational role, ergonomic exposures, workplace conditions, and musculoskeletal symptoms across specific body regions.

Exposure variables included self-reported frequency of prolonged standing, prolonged sitting, awkward posture during work, repetitive movements, and heavy lifting or manual handling, categorized as “always,” “sometimes,” or “never.” Organizational factors assessed included overtime duty, perceived workload, availability of staff support, provision of personal protective equipment, and availability of ergonomically designed workstations. Additional variables included awareness of ergonomic hazards, categorized into levels based on composite responses, and participation in ergonomic or machine-handling training. The primary outcome variable was musculoskeletal pain, operationally defined as self-reported pain or discomfort in any body region experienced during the preceding working week, consistent with standardized occupational assessment frameworks (17). A secondary outcome focused on lower back pain during the same recall period. Covariates included age, sex, body mass index, work experience, and average daily working hours.

To minimize information bias, the recall period for musculoskeletal symptoms was restricted to the most recent working week, and participants were provided with standardized instructions to ensure consistent interpretation of questionnaire items. The use of a structured instrument reduced interviewer variability, and questionnaires were self-administered to limit interviewer influence. Data quality was ensured through double data entry into a secured database, with cross-verification against original forms to identify and correct discrepancies. Potential confounding was addressed by measuring key demographic and occupational variables and incorporating them into multivariable analysis. Multicollinearity among independent variables was assessed prior to regression modeling. The sample size was calculated using the OpenEpi epidemiological calculator, based on an anticipated prevalence of musculoskeletal pain derived from prior studies, a 95% confidence level, and a 5% margin of error, with adjustment for the finite population of the cardiology department (18). The calculated sample size of 69 participants was considered adequate to estimate prevalence and examine associations within the available population.

Statistical analysis was performed using IBM SPSS Statistics version 25. Continuous variables were summarized using means and standard deviations, while categorical variables were presented as frequencies and percentages. Bivariate associations between ergonomic exposures and musculoskeletal outcomes were assessed using the Chi-square test or Fisher’s exact test where appropriate, based on expected cell counts. Crude odds ratios with 95% confidence intervals were calculated to quantify the strength of associations. Multivariable logistic regression analysis was conducted to identify independent predictors of lower back pain, adjusting for potential confounders including age, sex, body mass index, work experience, and daily working hours. Variables were selected for inclusion in the multivariable model based on clinical relevance and statistical significance in bivariate analysis. Model assumptions

were evaluated, and goodness-of-fit was assessed using standard diagnostic measures. Missing data were minimal and handled using complete-case analysis to preserve analytical consistency.

Ethical approval for the study was obtained from the Institutional Research Committee and the Ethical Review Committee of Bacha Khan Medical College prior to data collection. The study was conducted in accordance with the principles outlined in the Declaration of Helsinki, ensuring voluntary participation, informed consent, confidentiality, and the right to withdraw without penalty. All collected data were anonymized and stored securely, with access restricted to the research team to ensure data integrity and reproducibility.

RESULTS

A total of 69 cardiology staff participated in the study. The prevalence of musculoskeletal pain was 82.6% (n = 57), indicating a high burden within the study population. Lower back pain was reported by 57 participants (82.6%), while neck pain was reported by 52 participants (75.4%). The association between demographic and workplace factors with musculoskeletal pain is presented in Table 1. No statistically significant associations were observed between gender (p = 0.412), profession (p = 0.238), awareness of ergonomic hazards (p = 0.168), training on proper machine handling (p = 0.091), or provision of personal protective equipment (p = 0.058) and musculoskeletal pain. However, statistically significant associations were identified for ergonomic training (p = 0.047), overtime duty (p = 0.021), excessive workload (p = 0.033), staff support (p = 0.029), and availability of ergonomic workstations (p = 0.011).

Table 1. Association of demographic and workplace factors with musculoskeletal pain (n = 69)

Variable	Category	Pain Present n (%)	Pain Absent n (%)	Crude OR (95% CI)	p-value
Gender	Male	36 (81.8)	8 (18.2)	0.85 (0.22–3.25)	0.412
	Female	21 (84.0)	4 (16.0)	Reference	
Profession	Doctor	9 (69.2)	4 (30.8)	Reference	0.238
	Nurse	16 (88.9)	2 (11.1)	3.56 (0.51–24.7)	
	Technologist	14 (82.4)	3 (17.6)	2.07 (0.32–13.3)	
	Technician	18 (85.7)	3 (14.3)	2.67 (0.41–17.1)	
Ergonomic training	Yes	16 (69.6)	7 (30.4)	Reference	0.047
	No	41 (89.1)	5 (10.9)	3.58 (1.02–12.5)	
Overtime duty	Yes	40 (90.9)	4 (9.1)	4.71 (1.24–17.8)	0.021
	No	17 (68.0)	8 (32.0)	Reference	
Excess workload	Yes	43 (87.8)	6 (12.2)	3.07 (1.01–9.36)	0.033
	No	14 (70.0)	6 (30.0)	Reference	
Staff support	Yes	24 (70.6)	10 (29.4)	Reference	0.029
	No	33 (94.3)	2 (5.7)	6.88 (1.33–35.5)	
Ergonomic workstation	Yes	21 (67.7)	10 (32.3)	Reference	0.011
	No	36 (94.7)	2 (5.3)	8.57 (1.72–42.7)	

Table 2. Association of knowledge and workplace factors with lower back pain (n = 69)

Variable	Category	LBP Present n (%)	LBP Absent n (%)	Crude OR (95% CI)	p-value
Awareness level	Low	30 (90.9)	3 (9.1)	3.43 (1.01–11.6)	0.038
	Moderate	23 (74.2)	8 (25.8)	Reference	
	High	4 (80.0)	1 (20.0)	1.39 (0.13–14.4)	
Ergonomic training	Yes	15 (65.2)	8 (34.8)	Reference	0.026
	No	42 (91.3)	4 (8.7)	5.60 (1.47–21.3)	
Machine handling training	Yes	20 (69.0)	9 (31.0)	Reference	0.041
	No	37 (92.5)	3 (7.5)	5.55 (1.31–23.4)	
PPE provided	Yes	23 (69.7)	10 (30.3)	Reference	0.019
	No	34 (94.4)	2 (5.6)	7.39 (1.47–37.1)	
Overtime duty	Yes	41 (93.2)	3 (6.8)	7.69 (1.87–31.5)	0.003
	No	16 (64.0)	9 (36.0)	Reference	
Excess workload	Yes	44 (89.8)	5 (10.2)	4.74 (1.39–16.1)	0.012
	No	13 (65.0)	7 (35.0)	Reference	
Ergonomic workstation	Yes	20 (64.5)	11 (35.5)	Reference	0.004
	No	37 (97.4)	1 (2.6)	20.4 (2.43–171.5)	

Table 3 presents the association between specific ergonomic exposures and lower back pain. Significant associations were observed for prolonged standing (p = 0.002), awkward posture (p = 0.009), and heavy lifting/manual handling (p = 0.015). Prolonged sitting did not show a statistically significant association (p = 0.118).

Table 3. Association of ergonomic risk factors with lower back pain (n = 69)

Ergonomic factor	Exposure	LBP Present n (%)	LBP Absent n (%)	Crude OR (95% CI)	p-value
Prolonged standing	Always	30 (93.8)	2 (6.2)	5.56 (1.19–25.9)	0.002
	Sometimes	27 (73.0)	10 (27.0)	Reference	
Awkward posture	Always	25 (92.6)	2 (7.4)	6.67 (1.33–33.4)	0.009
	Sometimes/Never	32 (76.2)	10 (23.8)	Reference	
Heavy lifting	Always	21 (95.5)	1 (4.5)	7.64 (0.88–66.1)	0.015
	Sometimes/Never	36 (76.6)	11 (23.4)	Reference	

Ergonomic factor	Exposure	LBP Present n (%)	LBP Absent n (%)	Crude OR (95% CI)	p-value
Prolonged sitting	Always	8 (88.9)	1 (11.1)	1.94 (0.22–17.1)	0.118
	Sometimes/Never	49 (81.7)	11 (18.3)	Reference	

Multivariable logistic regression analysis identified independent predictors of lower back pain after adjusting for potential confounders (Table 4). Overtime duty (AOR = 3.42; 95% CI: 1.14–10.23; p = 0.028), excessive workload (AOR = 2.95; 95% CI: 1.01–8.61; p = 0.048), prolonged standing (AOR = 3.86; 95% CI: 1.22–12.19; p = 0.022), awkward posture (AOR = 4.18; 95% CI: 1.31–13.31; p = 0.016), and heavy lifting/manual handling (AOR = 3.27; 95% CI: 1.05–10.17; p = 0.041) were significantly associated with increased odds of lower back pain. Ergonomic training (AOR = 0.36; 95% CI: 0.12–0.98; p = 0.046) and availability of ergonomic workstations (AOR = 0.31; 95% CI: 0.10–0.91; p = 0.033) demonstrated protective associations.

Table 4. Multivariable logistic regression analysis for lower back pain (n = 69)

Variable	Adjusted OR (95% CI)	p-value
Ergonomic training (Yes)	0.36 (0.12–0.98)	0.046
Overtime duty (Yes)	3.42 (1.14–10.23)	0.028
Excess workload (Yes)	2.95 (1.01–8.61)	0.048
Ergonomic workstation (Yes)	0.31 (0.10–0.91)	0.033
Prolonged standing (Always)	3.86 (1.22–12.19)	0.022
Awkward posture (Always)	4.18 (1.31–13.31)	0.016
Heavy lifting (Always)	3.27 (1.05–10.17)	0.041

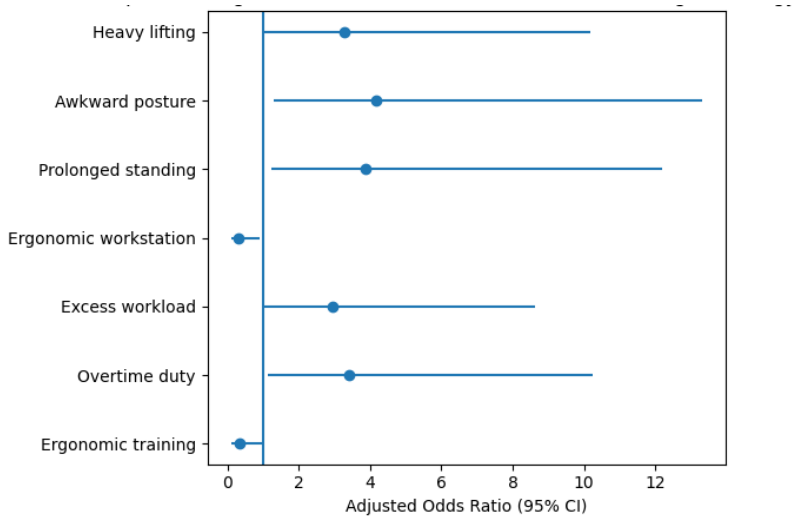

Figure 1 Independent Ergonomic Predictors Of Lower Back Pain Among Cardiology Staff

The figure demonstrates a clear gradient in the magnitude of association between ergonomic exposures and lower back pain, highlighting distinct clusters of risk-enhancing and protective factors. Awkward posture exhibited the strongest association (AOR = 4.18; 95% CI: 1.31–13.31), followed closely by prolonged standing (AOR = 3.86; 95% CI: 1.22–12.19) and overtime duty (AOR = 3.42; 95% CI: 1.14–

10.23), indicating that sustained biomechanical strain and extended work duration substantially increase the likelihood of lower back pain. Heavy lifting (AOR = 3.27; 95% CI: 1.05–10.17) and excess workload (AOR = 2.95; 95% CI: 1.01–8.61) also demonstrated elevated odds, reinforcing the cumulative impact of physical and organizational stressors. In contrast, ergonomic workstation availability (AOR = 0.31; 95% CI: 0.10–0.91) and ergonomic training (AOR = 0.36; 95% CI: 0.12–0.98) showed protective effects, with their confidence intervals entirely below or close to the null value, suggesting meaningful risk reduction. The asymmetry and width of confidence intervals, particularly for high-risk exposures, indicate variability and possible sample size constraints, yet the consistent directionality across multiple factors supports a clinically significant pattern where modifiable ergonomic conditions strongly influence musculoskeletal outcomes.

DISCUSSION

The present study demonstrates a high prevalence of musculoskeletal pain among cardiology staff, with 82.6% of participants reporting symptoms, and identifies several modifiable ergonomic and organizational factors significantly associated with lower back pain. These findings are consistent with global evidence indicating that healthcare workers experience a substantial burden of musculoskeletal disorders due to occupational exposures inherent to clinical practice (19). The predominance of lower back and neck pain aligns with prior literature, which attributes these patterns to sustained postural load, repetitive movements, and biomechanical stress during patient care and procedural tasks (20). In the context of cardiology departments, where prolonged standing during procedures and rapid-response tasks are common, the observed high prevalence underscores the cumulative physical demands of this specialty.

The study findings highlight that organizational factors, particularly overtime duty and excessive workload, significantly increase the likelihood of musculoskeletal pain. Participants engaged in overtime duties had more than threefold higher odds of lower back pain, while those reporting excess workload demonstrated nearly threefold increased risk. These results are in agreement with previous studies that have shown extended working hours and high job demands contribute to fatigue, reduced recovery time, and increased susceptibility to musculoskeletal strain (21,22). The lack of adequate staff support further exacerbates these conditions, suggesting that workforce distribution and staffing adequacy are critical determinants of occupational health outcomes. This reinforces the importance of administrative and policy-level interventions alongside individual ergonomic strategies.

Biomechanical exposures emerged as strong predictors of lower back pain, with prolonged standing, awkward posture, and heavy lifting demonstrating significant associations. Among these, awkward posture exhibited the highest adjusted odds, indicating its central role in the development of musculoskeletal symptoms. These findings are supported by existing evidence emphasizing that non-neutral body positioning and repetitive strain significantly increase spinal loading and musculoskeletal injury risk The absence of a significant association with prolonged sitting in this study may reflect the nature of cardiology workflows, where dynamic tasks and standing-based procedures predominate over sedentary activities. This suggests that interventions should prioritize optimizing posture and reducing standing-related strain rather than focusing solely on sedentary ergonomics.

Importantly, the study identified ergonomic training and the availability of ergonomically designed workstations as protective factors against musculoskeletal pain. Participants who had received ergonomic training demonstrated significantly lower odds of lower back pain, indicating the effectiveness of education in promoting safer work practices. Similarly, access to ergonomic workstations was associated with reduced risk, highlighting the role of environmental modifications in mitigating biomechanical stress. These findings are consistent with prior research demonstrating that structured ergonomic interventions, including training programs and workstation redesign, can significantly reduce the incidence of musculoskeletal disorders among healthcare workers (22). The protective effect

observed in this study suggests that relatively low-cost, implementable interventions may yield meaningful improvements in occupational health.

From a methodological perspective, the findings should be interpreted considering certain limitations inherent to the study design. The cross-sectional nature of the study precludes causal inference, and the observed associations cannot establish temporal relationships between exposure and outcome. The use of convenience sampling may limit generalizability beyond the study setting, and the relatively small sample size may contribute to wider confidence intervals and reduced precision in effect estimates. Additionally, reliance on self-reported data introduces the possibility of recall and reporting bias, although efforts were made to minimize these through a short recall period and anonymized data collection. Despite these limitations, the study provides valuable context-specific insights into ergonomic risk factors within a cardiology department, addressing an important gap in the literature from low- and middle-income healthcare settings.

Overall, the study reinforces the concept that musculoskeletal disorders among healthcare workers are largely driven by modifiable occupational factors rather than immutable individual characteristics. The consistent association of workload, ergonomic exposures, and workplace conditions with musculoskeletal pain highlights the need for a comprehensive, systems-level approach to prevention. Integrating ergonomic training into routine staff development, optimizing staffing and workload distribution, and improving workplace design are essential strategies to reduce the burden of musculoskeletal disorders and enhance the well-being and productivity of cardiology personnel.

CONCLUSION

Musculoskeletal pain is highly prevalent among cardiology staff and is significantly associated with modifiable workplace and ergonomic factors, including overtime duty, excessive workload, prolonged standing, awkward posture, and manual handling, while ergonomic training and access to properly designed workstations demonstrate protective effects; these findings emphasize the need for targeted ergonomic interventions, workload management strategies, and institutional support measures to reduce the burden of musculoskeletal disorders and improve occupational health outcomes among healthcare professionals.

REFERENCES

1. Centers for Disease Control and Prevention. Work-related musculoskeletal disorders & ergonomics. Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion; 2023. Available from: https://www.cdc.gov/workplacehealthpromotion/health-strategies/musculoskeletal-disorders. Accessed 2023 Aug 25.

2. Sulaiman SK, Kamalanathan P, Ibrahim AA, et al. Musculoskeletal disorders and associated disabilities among bank workers. Int J Res Med Sci. 2015;3(5):1153–8. doi:10.5455/2320-6012.ijrms20150523.

3. Muthelo L, Sinyegwe NF, Phukubye TA, et al. Prevalence of work-related musculoskeletal disorders and its effects amongst nurses in the selected intellectual disability unit of the Limpopo Province. Healthcare. 2023;11(5):777. doi:10.3390/healthcare11050777.

4. Bonfiglioli R, Caraballo-Arias Y, Salmen-Navarro A. Epidemiology of work-related musculoskeletal disorders. Curr Opin Epidemiol Public Health. 2022;1(1):18–24. doi:10.1097/PXH.0000000000000003.

5. Mengistu DA, Gutema GD, Demmu YM, et al. Occupational-related upper and lower extremity musculoskeletal pain among working population of Ethiopia: systematic review and meta-analysis. INQUIRY. 2022;59. doi:10.1177/00469580221088620.

6. Briggs AM, Woolf AD, Dreinhöfer K, et al. Reducing the global burden of musculoskeletal conditions. Bull World Health Organ. 2018;96(5):366–8. doi:10.2471/BLT.17.204891.

7. Ferreira ML, de Luca K, Haile LM, et al. Global, regional, and national burden of low back pain, 1990–2020, its attributable risk factors, and projections to 2050: a systematic analysis of the global burden of disease study 2021. Lancet Rheumatol. 2023;5(6):e316–29. doi:10.1016/S2665-9913(23)00098-X.

8. Bevan S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Pract Res Clin Rheumatol. 2015;29(3):356–73. doi:10.1016/j.berh.2015.08.002.

9. Shaikh S, Siddiqui AA, Alshammary F, et al. Musculoskeletal disorders among healthcare workers: prevalence and risk factors in the Arab World. In: Handbook of Healthcare in the Arab World. 2021. p. 2899–2937. doi:10.1007/978-3-030-36811-1_129.

10. Rypicz Ł, Karniej P, Witczak I, et al. Evaluation of the occurrence of work-related musculoskeletal pain among anesthesiology, intensive care, and surgical nurses: an observational and descriptive study. Nurs Health Sci. 2020;22:1056–64. doi:10.1111/nhs.12767.

11. Bailey CR, Radhakrishna S, Asanati K, et al. Ergonomics in the anaesthetic workplace. Anaesthesia. 2021;76(12):1635–47. doi:10.1111/anae.15530.

12. Honkonen T, Ahola K, Pertovaara M, et al. The association between burnout and physical illness in the general population—results from the Finnish Health 2000 study. J Psychosom Res. 2006;61(1):59–66. doi:10.1016/j.jpsychores.2005.10.002.

13. Vargas-Prada S, Macdonald EB. Increased reporting of musculoskeletal pain in anaesthetists: is it an occupational issue? Anaesthesia. 2019;74(3):274–6. doi:10.1111/anae.14537.

14. Carayon P, Wust K, Hose B-Z, et al. Human factors and ergonomics in health care. In: Salvendy G, Karwowski W, editors. Handbook of human factors and ergonomics. Hoboken (NJ): John Wiley & Sons; 2021. p. 1417–37.

15. Leifer S, Choi SW, Asanati K, et al. Upper limb disorders in anaesthetists: a survey of Association of Anaesthetists members. Anaesthesia. 2019;74(3):285–91. doi:10.1111/anae.14446.

16. Tolu S, Basaran B. Work-related musculoskeletal disorders in anesthesiologists: a cross-sectional study on prevalence and risk factors. Ann Med Res. 2021;26(7):1406–14. doi:10.5455/annalsmedres.2019.04.211.

17. Anson JA, Mets EJ, Vaida SJ, et al. Are we hurting ourselves? What is the prevalence of back pain in anesthesia providers? J Clin Anesth. 2016;34:502–6. doi:10.1016/j.jclinane.2016.06.009.

18. Albayadi E, Soliman A, Alyeddin WF. Prevalence of musculoskeletal disorders in anesthesiologists in Ismailia Governorate. Egypt J Anaesth. 2023;39(1):289–95. doi:10.1080/11101849.2023.2193016.

19. Bin Homaid M, Abdelmoety D, Alshareef W, et al. Prevalence and risk factors of low back pain among operation room staff at a tertiary care center, Makkah, Saudi Arabia: a cross-sectional study. Ann Occup Environ Med. 2016;28(1):1. doi:10.1186/s40557-016-0089-0.

20. Weston G, Zilanawala A, Webb E, et al. Long work hours, weekend working and depressive symptoms in men and women: findings from a UK population-based study. J Epidemiol Community Health. 2019;73(5):465–74. doi:10.1136/jech-2018-211309.

21. Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233–7. doi:10.1016/0003-6870(87)90010-x.

22. Epstein S, Sparer EH, Tran BN, et al. Prevalence of work-related musculoskeletal disorders among surgeons and interventionalists: a systematic review and meta-analysis. JAMA Surg. 2018;153(2):e174947. doi:10.1001/jamasurg.2017.4947.