



Carga biomecánica y síntomas osteomusculares en trabajadores de la salud de dos Instituciones de salud, Colombia, 2024

Biomechanical loading and musculoskeletal symptoms in health care workers from two health care providers, Colombia, 2024

Carga biomecânica e sintomas musculoesqueléticos em profissionais de saúde de duas instituições de saúde, Colômbia, 2024

RESUMEN

Introducción: Los desórdenes musculoesqueléticos afectan de manera considerable a la población económicamente activa, y son las principales causas de ausentismo en el sector salud. **Objetivo:** El objetivo del presente estudio fue: analizar la relación entre la carga biomecánica y síntomas osteomusculares en trabajadores de la salud de dos instituciones de salud, Colombia, 2024. **Materiales y métodos:** Estudio de corte transversal, correlacional con una muestra no probabilística de 272 trabajadores de dos Instituciones de Salud en Bogotá y Valledupar. Posterior a la toma del consentimiento informado, se aplicó una encuesta sociodemográfica, cuestionario nórdico musculoesquelético y se valoró la carga biomecánica con el método de Evaluación de Riesgo Individual (ERIN). Los análisis descriptivo, bivariado y correlacional fueron realizados por medio de SPSS Versión-29. **Resultados:** El análisis correlacional mostró que las mujeres presentaron prevalencias más altas en el reporte de síntomas en cuello ($r = 0,140$; $p \leq 0,05$), hombro derecho ($r = 0,163$; $p \leq 0,01$), codo derecho ($r = 0,138$; $p \leq 0,05$), muñeca derecha ($r = 0,130$; $p \leq 0,01$) y espalda alta ($r = 0,200$; $p \leq 0,01$); el riesgo biomecánico alto se correlacionó con síntomas en hombro izquierdo ($r = 0,149$; $p \leq 0,05$), y codo derecho ($r = 0,135$; $p \leq 0,05$). **Conclusión:** Se identificó mayor prevalencia de síntomas osteomusculares en mujeres, relacionadas con la carga postural, frecuencia y repetitividad en los movimientos, así como el nivel de ocupación.

Palabras clave: Dolor musculoesquelético; método ERIN; carga de trabajo; factores de riesgo; postura. (Fuente: DeCS, Bireme).

Objetivos de desarrollo sostenible: Trabajo decente y crecimiento económico. (Fuente: ODS, OMS).

ABSTRACT

Introduction: Musculoskeletal disorders significantly affect the economically active population and are the leading cause of absenteeism in the healthcare sector. **Objective:** The objective of the present study is to analyze the relationship between biomechanical load and musculoskeletal symptoms in healthcare workers at two healthcare providers in Colombia, 2024. **Materials and methods:** The present cross-sectional, correlational study used a non-probability sample of 272 workers from two health institutions in Bogotá and Valledupar. After obtaining informed consent, a sociodemographic survey, the Nordic Musculoskeletal Questionnaire, and the biomechanical load were assessed using the Individual Risk Assessment (ERIN) method. Descriptive, bivariate, and correlational analyzes were performed using SPSS Version 29. **Results:** The correlational analysis showed that women presented higher prevalences in the reporting of symptoms in the neck ($r = 0.140$; $p \leq 0.05$), right shoulder ($r = 0.163$; $p \leq 0.01$), right elbow ($r = 0.138$; $p \leq 0.05$), right wrist ($r = 0.130$; $p \leq 0.01$), and upper back ($r = 0.200$; $p \leq 0.01$). High biomechanical risk was correlated with symptoms in the left shoulder ($r = 0.149$; $p \leq 0.05$) and the right elbow ($r = 0.135$; $p \leq 0.05$). **Conclusion:** It was found that, in the sample assessed, women exhibited higher prevalences of musculoskeletal symptoms related to postural load, movement frequency and repetitiveness, as well as occupational level.

Keywords: Musculoskeletal pain; ERIN method; Workload; risk factors; posture. (Source: DeCS, Bireme).

Sustainable development goals: Decent work and economic growth. (Source: SDG, WHO).

Diana Carolina Rodríguez-Romero

Diana Derly Bueno-Castro

Mónica del Pilar Tamayo-Olmos

Johny Rojas-Rangel

Rodrigo Andres Ruiz-Lurduy

1. Fundación Universitaria del Área Andina. Bogotá, Colombia.
2. Fundación Universitaria del Área Andina. Valledupar, Colombia.

Citación:
Rodríguez-Romero DC, Bueno-Castro DD, Tamayo-Olmos MP, Rojas-Rangel J, Ruiz-Lurduy RA. Carga biomecánica y síntomas osteomusculares en trabajadores de la salud de dos Instituciones de salud, Colombia, 2024. Univ Salud [Internet]. 2026; 28(2):e9878. DOI: 10.22267/rus.262802.9878

Recibido: Noviembre 12 - 2025
Revisado: Marzo 27 - 2026
Aceptado: Abril 29 - 2026
Publicado: Mayo 07 - 2026



ISSN: 0124-7107 - ISSN (En línea): 2389-7066
Univ. Salud 2026 Vol 28 No 2
<https://doi.org/10.22267/rus>

<https://revistas.udenar.edu.co/index.php/usualud>

REFERENCIAS

1. Rodríguez Y, Pérez E, Trujillo-Murillo MA, Salazar-Marín MC. Ergonomic intervention in a Colombian meat processing plant using the ERIN method. In: Realyvásquez Vargas A, García-Alcaraz JL, Z-Flores E, editores. *New Perspectives on Applied Industrial Ergonomics*. Springer, Cham; 2021. DOI: 10.1007/978-3-030-73468-8_12

2. Rodríguez Y. Individual Risk Assessment (ERIN): Method for the Assessment of Workplace Risks for Work-Related Musculoskeletal Disorders. In: Information Resources Management Association, editor. *Research Anthology on Changing Dynamics of Diversity and Safety in the Workforce*. Hershey (USA): IGI Global Scientific Publishing; 2022. p. 1550-1576. DOI: 10.4018/978-1-6684-2405-6.ch077

3. Ho MC, Lo EW. Comparisons of three observational ergonomic tools for risk assessment on upper extremities in a pump assembly plant - a pilot study. In: Goossens R, Murata A, editors. *Advances in Social and Occupational Ergonomics*. Cham: Springer; 2020. p. 302-308. DOI: 10.1007/978-3-030-20145-6_30

4. Illahi RN, Winarno W. Work Posture Analysis Using Rula Method To Minimize Musculoskeletal Disorders Complaints Among Doctors At Pt Rusunda Medika Abadi. REKA ELKOMIKA [Internet]. 2025 Ene 31; 6(1):38-47. Disponible en: https://ejurnal.itenas.ac.id/index.php/rekaelkomika_pkm/article/view/12700

5. Ayvaz Ö, Özyıldırım BA, İşsever H, Öztan G, Atak M, Özel S. Ergonomic risk assessment of working postures of nurses working in a medical faculty hospital with REBA and RULA methods. Sci Prog [Internet]. 2023 Oct 1; 106(4):368504231216540. DOI: 10.1177/00368504231216540

6. Mun GH, Roh HL. Work-Related Musculoskeletal Risk Levels of Physical Therapists during Patient Transfers between Therapy Tables and Wheelchairs. PNF Mov [Internet]. 2025 Ago 31; 23(2):201-214. DOI: 10.21598/JKPNFA.2025.23.2.201

7. Zhang Q, Xie Q, Liu H, Sheng B, Xiong S, Zhang Y. A pilot study of biomechanical and ergonomic analyses of risky manual tasks in physical therapy. Int J Ind Ergon [Internet]. 2022 May 1; 89:103298. DOI: 10.1016/J.ERGON.2022.103298

8. Lu J, Li J, Cheng Z, Wang H, Yuan S. Analysis of poor work postures during morning care operations of intensive care unit nurses: A field research. BMC Nursing [Internet]. 2024 Oct 14; 23(1):755. DOI: 10.1186/S12912-024-02417-7

9. Annisa UN, Hasanah O, Rustam M. Description of Work Attitudes and Positions (Ergonomics) Using the Ovako Work Analysis System (Owas) Method. HC [Internet]. 2023 Dic 28; 12(2):248-257. DOI: 10.36763/HEALTHCARE.V12I2.294

10. Bhattacharya A. Costs of occupational musculoskeletal disorders (MSDs) in the United States. Int J Ind Ergon [Internet]. 2014 May 1; 44(3):448-454. DOI: 10.1016/J.ERGON.2014.01.008

11. Bevan S. Economic impact of musculoskeletal disorders (MSDs) on work in Europe. Best Pract Res Clin Rheumatol [Internet]. 2015 Jun 1; 29(3):356-373. DOI: 10.1016/j.berh.2015.08.002

12. Piedrahita H. Costs of work-related musculoskeletal disorders (MSDs) in developing countries: Colombia case. Int J Occup Saf Ergon [Internet]. 2006; 12(4):379-386. DOI: 10.1080/10803548.2006.11076696

13. McAtamney L, Corlett E. RULA: A survey method for the investigation of work-related upper limb disorders. Appl Ergon [Internet]. 1993 Abr 1; 24(2):91-99. DOI: 10.1016/0003-6870(93)90080-S

14. Joshi M, Deshpande V. Identification of indifferent posture zones in RULA by sensitivity analysis. Int J Ind Ergon [Internet]. 2021 May 1; 83:103123. DOI: 10.1016/J.ERGON.2021.103123

15. Mumani A, Stone RT, Momani AM. An application of Monte-Carlo simulation to RULA and REBA. Theor Issues Ergon Sci [Internet]. 2021; 22(6):673-688. DOI: 10.1080/1463922X.2021.1893406

16. Enez K, Nalbantoğlu SS. Comparison of ergonomic risk assessment outputs from OWAS and REBA in forestry timber harvesting. Int J Ind Ergon [Internet]. 2019 Mar 1; 70:51-7. DOI: 10.1016/j.ergon.2019.01.009

17. Rhen IM, Forsman M. Inter- and intra-rater reliability of the OCRA checklist method in video-recorded manual work tasks. Appl Ergon [Internet]. 2020; 84:103025. DOI: 10.1016/j.apergo.2019.103025

18. Roodbandi ASJ, Feyzi V, Foroozanfar Z, Rahimimoghadam S. The correlation between ART and OCRA methods used for posture assessment of repetitive tasks. Med Lav [Internet]. 2021 Oct 28; 112(5):370-376. DOI: 10.23749/MDL.V112I5.11117

19. Kuo HH, Lan CC, Kuo HW, Lin PY. Unraveling the Psychological Pathways Between Job Strain and Musculoskeletal Disorders: The Mediating Roles of Work-Related Fatigue and Burnout Among Hospital Nurses. *J Nurs Manag* [Internet]. 2025 Ene 1; 2025(1):8819293. DOI: 10.1155/JONM/8819293

20. Pratiwi I, Noer F, Suha MF, Fahmi AA, Gustinengti RA. Ergonomic risk assessment using ERIN and LUBA methods in roof tile product at Indonesia. *AIP Conf Proc* [Internet]. 2024; 2838(1):020011. DOI: 10.1063/5.0180212

21. Rodríguez Y, Pérez E, Trujillo-Murillo MA, Salazar-Marín MC. Ergonomic intervention in a Colombian meat processing plant using the ERIN method. In: Reay Vásquez Vargas A, García-Alcaraz JL, Z-Flores E, editors. *New Perspectives on Applied Industrial Ergonomics*. Cham (CHE): Springer; 2021. p. 273-290. DOI: 10.1007/978-3-030-73468-8_12

22. Rodríguez Y, Viña S, Montero R. ERIN: A practical tool for assessing work-related musculoskeletal disorders. *Occup Ergon* [Internet]. 2013; 11(2-3):59-73. DOI: 10.3233/OER-130210

23. Rodríguez-Ruiz Y, Guevara-Velasco C. empleo de los métodos ERIN y RULA en la evaluación ergonómica de estaciones de trabajo. *Ing Ind* [Internet]. 2011; 32(1):19-27. Disponible en: <https://www.semanticscholar.org/paper/174b3cb1348bdc91ad099d3cedd7f8ed1235e2d4>

24. Dawson AP, Steele EJ, Hodges PW, Stewart S. Development and Test-Retest Reliability of an Extended Version of the Nordic Musculoskeletal Questionnaire (NMQ-E): A Screening Instrument for Musculoskeletal Pain. *J Pain* [Internet]. 2017; 10(5):517-526. DOI: 10.1016/j.jpain.2008.11.008

25. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, *et al*. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon* [Internet]. 1987 Sep; 18(3):233-237. DOI: 10.1016/0003-6870(87)90010-x

26. Pugh JD, Gelder L, Williams AM, Twigg DE, Wilkinson AM. Validity and reliability of an online extended version of the Nordic Musculoskeletal Questionnaire (NMQ-E2) to measure nurses fitness. 2015; 24(23-24):3550-3563. DOI: 10.1111/jocn.12971

27. Kakaraparthi VN, Vishwanathan K, Gadhavi B, Reddy RS, Tedla JS, Samuel PS, *et al*. Application of the rapid upper limb assessment tool to assess the level of ergonomic risk among health care professionals: A systematic review. *Work* [Internet]. 2022; 71(3):551-564. DOI: 10.3233/WOR-210239

28. Kakaraparthi VN, Vishwanathan K, Gadhavi B, Reddy RS, Tedla JS, Alshahrani MS, *et al*. Clinical Application of Rapid Upper Limb Assessment and Nordic Musculoskeletal Questionnaire in Work-Related Musculoskeletal Disorders: A Bibliometric Study. *Int J Environ Res Public Health* [Internet]. 2023 Ene 20; 20(3):1932. DOI: 10.3390/IJERPH20031932

29. Carneiro P, Villarroja A, Colim A, Torres M, Arezes P. Ergonomic Study of Nursing tasks in Surgical Hospital Services. In: *Health and Social Care Systems of the Future: Demographic Changes*. Digital; 2019 [citado 2025 Jun 5]. Disponible en: https://books.google.es/books?hl=es&lr=&id=VUefDwAAQBAJ&oi=fnd&pg=PA28&dq=REBA+and+nmq+AND+Health+workers+ots=4PT3XDnbfsig=_N30eJBLQlyRZlIR6tIEgpRDYol#v=onepage&q=REBA%20and%20nmq%20AND%20Health%20workers&f=false

30. Ruiz YR. ERIN: a practical tool for assessing exposure to risk factors for work-related musculoskeletal disorders. In: Bagnara S, Tartaglia R, Albolino S, Alexander T, Fujita Y, editors. *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018)*. Cham (CHE): Springer; 2019. p. 369-379. DOI: 10.1007/978-3-319-96083-8_49

31. Ruíz YR, Mergarejo EP, Pastor WAB. Procedimiento para la prevención de desórdenes musculoesqueléticos: Aplicación en trabajos de minería subterránea. *Rev Int Cic Salud* [Internet]. 2020; 17(3):54-69. Disponible en: <https://dialnet.unirioja.es/servlet/articulo?codigo=7507967>

32. Londoño JL. Metodología de la Investigación Epidemiológica. Moderno M, editor. Bogotá (COL); 2004. p. 1-247.

33. Millán-Guerrero RO, Trujillo-Hernández B, Caballero-Hoyos JR. Introducción a La Epidemiología Clínica Y Estadística. 2015. p. 266. Disponible en: https://www.researchgate.net/publication/315116161_INTRODUCCION_A_LA_EPIDEMIOLOGIA_CLINICA_Y_ESTADISTICA

34. Rodríguez-Ruiz Y, Rico H, Jobany J. Confiabilidad inter-observador del Método de Evaluación de Riesgo Individual. *Hacia Promoc Salud* [Internet]. 2013; 18(1):41-56. Disponible en: <http://www.redalyc.org/articulo.oa?id=309126802004>

35. Ministerio De Salud. Resolución 8430 de 1993: Por la cual se establecen las normas científicas, técnicas y administrativas para la investigación en salud. Bogotá (COL): MinSalud; 1993 Oct 4. Disponible en: <https://www.minsalud.gov.co/sites/rid/lists/bibliotecadigital/ride/de/dij/resolucion-8430-de-1993.pdf>

36. Manzini JL. Declaración de Helsinki: Principios éticos para la investigación médica sobre sujetos humanos. *Acta Bioeth* [Internet]. 2000 Dec; 6(2):321-334. DOI: 10.4067/S1726-569X2000000200010

37. Crisanty PA, Utama AAGES, Dewi AANTN, Tianing NW. Prevalence of low back pain in handcrafters. *PTJI* [Internet]. 2024; 5(2):119-122. DOI: 10.51559/ptji.v5i2.203

38. Akolokwu AS, Hart F, Mato CN. The Prevalence and Impact of Low Back Pain Among Anaesthesia Care Providers in South-South, Nigeria. *Niger Med J* [Internet]. 2023; 64(4):471-477. DOI: 10.60787/NMJ-64-4-221

39. Islam MJ, Ahmed S, Islam KMK, Al Mamun MA, Roy SK, Chakraborty SR. Characteristics of low back pain and its associated factors among healthcare providers at a tertiary hospital in Sylhet city: A cross-sectional study. *Bull Fac Phys Ther* [Internet]. 2023; 28:42. DOI: 10.1186/s43161-023-00152-9

40. Ministerio de la Protección Social. Guía de Atención Integral Basada en la Evidencia para Desórdenes Musculoesqueléticos (DME) relacionados con Movimientos Repetitivos de Miembros Superiores (Síndrome de Túnel Carpiano, Epicondilitis y Enfermedad de De Quervain (GATI-DME) [Internet]. 2006. p. 1-136. Disponible en: https://www.epssura.com/guias/guias_mmss.pdf

41. Nguyen NP, McGuirk H. Evaluating the effect of multifactors on employee's innovative behavior in SMEs: Mediating effects of thriving at work and organizational commitment. *International Journal of Contemporary Hospitality Management* [Internet]. 2022 Ene 1; 34(12):4458-4479. DOI: 10.1108/IJCHM-11-2021-1354

42. Sultana R, Cheema S, Cheema U, Parveen S, Cheema SA. Contributing Factors Towards Low Back Pain Among Front Line Health Care Workers in Lahore, Pakistan. *PJHS-Lahore* [Internet]. 2023; 4(2):154-159. DOI: 10.54393/pjhs.v4i02.629

43. Feyzi V, Komeili A, Kumeleh SM, Vahedi H, Izadi N, Sahlabadi AS. Examining the Concordance between ART and ERIN Methods in the Assessment of Musculoskeletal Disorders in Dental Students of Shahid Beheshti University of Medical Sciences. *Open Dent J* [Internet]. 2024 Sep 11; 18:e18742106333335. DOI: 10.2174/0118742106333335240906050720

44. Feiz-Arefi M, Chahardoli Z, Babaei-pouya A. Musculoskeletal Disorders Evaluation of Glass Factory Workers using the Discomfort Survey Questionnaire and Assessment Repetitive Tasks (ART) Method. *Int J Musculoskel Pain Prev* [Internet]. 2020. DOI: 10.52547/ijmpp.5.1.280

45. Yizengaw MA, Mustofa SY, Ashagrie HE, Zeleke TG. Prevalence and factors associated with work-related musculoskeletal disorder among health care providers working in the operation room. *Ann Med Surg* [Internet]. 2021; 72:102989. DOI: 10.1016/j.amsu.2021.102989

46. Abo-Naser L, Leibner G, Vilenski RG, Luria S, Kriger Y. Gender differences in prevalence of musculoskeletal disorders (MSDs) among surgeons. *Perioper Care Oper Room Manag* [Internet]. 2025 [citado 2026 Abr 3]. 40:100542. DOI: 10.1016/j.pcorn.2025.100542

47. Li Y, Li Q, Zhang L, Li Y, Yuan S. Development of a Risk Assessment Index System of Non-Specific Neck-Shoulder Pain in Physicians and Nurses: A Delphi and Analytic Hierarchy Process Study in China. *Pain Management Nursing* [Internet]. 2026 [citado 2026 Abr 3]; 27(2):198-206. DOI: 10.1016/j.pmn.2025.08.008

48. Koyuncu A, Kaya K, Kaya O, Yava A. The impact of work-related musculoskeletal pains on routine tasks among operating room nurses: A multicenter cross-sectional study. *Pain Manag Nurs* [Internet]. 2025 [citado 2026 Abr 3]; 26(1):88-96. DOI: 10.1016/j.pmn.2024.08.003

49. Rodríguez Y, Monsalve P. Inter-rater reliability of the individual risk assessment (ERIN) method. In: Black NL, Neumann WP, Noy I, editors. *Proceedings of the 21st Congress of the International Ergonomics Association (IEA 2021)*. Cham: Springer; 2021. p. 818-824. DOI: 10.1007/978-3-030-74611-7_111

50. Ericsson P, Björklund M, Wahlström J. Exposure assessment in different occupational groups at a hospital using Quick Exposure Check (QEC) - A pilot study. *Work* [Internet]. 2012; 41(S1):5718-5720. DOI: 10.3233/WOR-2012-0929-5718

51. Paulsen R. Reliability of ergonomic exposure assessment: Comparing the Strain Index and the OCRA Checklist [Thesis]. Fort Collins (USA): Colorado State University; 2007. Disponible en: <https://stacks.cdc.gov/view/cdc/211823>

52. Rosecrance J, Paulsen R, Gilkey D, Murgia L, Gall T. Ergonomic issues in ewe cheese production: Reliability of the Strain Index and OCRA Checklist risk assessments. *Journal of Agricultural Engineering* [Internet]. 2013; 44(S2):e139. DOI: 10.4081/JAE.2013.381

53. Paulsen R, Schwatka N, Gober J, Gilkey D, Anton D, Gerr F, *et al.* Inter-rater reliability of cyclic and non-cyclic task assessment using the hand activity level in appliance manufacturing. *Int J Ind Ergon* [Internet]. 2014; 44(1):32-38. DOI: 10.1016/J.ERGON.2013.10.001

54. Rosecrance J, Paulsen R, Murgia L. Risk assessment of cheese processing tasks using the Strain Index and OCRA Checklist. *Int J Ind Ergon* [Internet]. 2017 Sep 1; 61:142-148. DOI: 10.1016/J.ERGON.2017.05.009

55. Paulsen R, Gallu T, Gilkey D, Reiser R, Murgia L, Rosecrance J. The inter-rater reliability of Strain Index and OCRA Checklist task assessments in cheese processing. *Appl Ergon* [Internet]. 2015 Nov 1; 51:199-204. DOI: 10.1016/j.apergo.2015.04.019

56. Abdol Rahman MN, Abdul Rani MR, Mohd Rohani J. WERA tool for assessing exposure risk factors of work-related musculoskeletal disorders: a reliability and validity study. In: *Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management*. Istanbul (Turkey); 2012 Jul 3-6. p. 417. Disponible en: <https://ieomsociety.org/ieom2012/pdfs/103.pdf>

57. Diego-Mas JA, Alcaide-Marzal J, Poveda-Bautista R. Errors Using Observational Methods for Ergonomics Assessment in Real Practice. *Hum Factors* [Internet]. 2017; 59(8):1173-1187. DOI: 10.1177/0018720817723496

58. Hassani M, Kabiesz P, Hesampour R, Ezbarami SM, Bartnicka J. Prevalence of musculoskeletal disorders, working conditions, and related risk factors in the meat processing industry: Comparative analysis of Iran-Poland. *Work* [Internet]. 2022; 74(1):309-325. DOI: 10.3233/WOR-211362

59. Lin SC, Lin LL, Liu CJ, Fang CK, Lin MH. Exploring the factors affecting musculoskeletal disorders risk among hospital nurses. *PLoS One* [Internet]. 2020; 15(4):e0231319. DOI: 10.1371/journal.pone.0231319

60. Kourouma KR, Yaméogo WME, Doukouré D, Agbré Yacé ML, Tano Kamelan A, Coulibaly-Koné SA, *et al.* Feasibility study on the adoption of the WHO safe childbirth checklist by front-line healthcare providers and managers in Burkina Faso and Côte d'Ivoire. *Pilot Feasibility Stud* [Internet]. 2020 Oct 6; 6(1):150. DOI: 10.1186/S40814-020-00691-1

61. García-Maroto M, Luceño-Moreno L, Martín-García J. Modelo esfuerzo-recompensa, salud y enfermedad en personal sanitario: Una revisión sistemática. *Ansiedad Estres* [Internet]. 2022; 28(1):16-29. Disponible en: <https://dialnet.unirioja.es/servlet/articulo?codigo=8370272>

62. Ankomah SE, Amoah MK, Fushieini A, Kumah E, Mensah FAO, Agyei SK, *et al.* Ergonomic risk factors and musculoskeletal disorders among healthcare professionals in Ghana. *J Bodyw Mov Ther* [Internet]. 2025 [citado 2026 Abr 3]; 45:167-173. DOI: 10.1016/j.jbmt.2025.08.027

63. Wang K, Zeng X, Li J, Guo Y, Wang Z. The prevalence and risk factors of work-related musculoskeletal disorders among nurses in China: A systematic review and meta-analysis. *Int J Nurs Stud* [Internet]. 2024; 157:104826. DOI: 10.1016/j.ijnurstu.2024.104826

64. Jacquier-Bret J, Gorce P. Worldwide work-related musculoskeletal disorder prevalence among nurses: Systematic review and meta-analysis. *Saf Sci* [Internet]. 2025; 191:106970. DOI: 10.1016/j.ssci.2025.106970

65. Rodríguez Y, Viña S, Montero R. A Method for Non-experts in Assessing Exposure to Risk Factors for Work-related Musculoskeletal Disorders—ERIN. *Ind Health* [Internet]. 2013; 51(6):622-626. DOI: 10.2486/indhealth.2013-0008

66. Asghari E, Dianati, Abdollahzadeh F, Mohammadi F, Asghari P, Jafarabadi MA, *et al.* Musculoskeletal pain in operating room nurses: Associations with quality of work life, working posture, socio-demographic and job characteristics. *Int J Ind Ergon* [Internet]. 2019 Jul 1; 72:330-337. DOI: 10.1016/j.ergon.2019.06.009

67. Nascimento JMRS, Bispo LGM, Silva JMN. Risk factors for work-related musculoskeletal disorders among workers in Brazil: A structural equation model approach. *Int J Ind Ergon* [Internet]. 2024 [citado 2026 Abr 3]; 99: 103551. DOI: 10.1016/j.ergon.2024.103551

68. Santos C, Gabriel AT, Quesma C, Nunes IL. Risk factors, symptoms, and prevalence of lower limb work-related musculoskeletal disorders among orthopedic surgeons. *Int J Ind Ergon* [Internet]. 2024 [citado 2026 Abr 3]; 101:103597. DOI: 10.1016/j.ergon.2024.103597

69. Tahernejad A, Makki F, Rezaei E, Marzban H, Tahernejad S, Sahebi A. Musculoskeletal disorders in emergency medical services personnel: A systematic review and meta-analysis. *Public Health* [Internet]. 2024; 237:107-115. DOI: 10.1016/j.puhe.2024.08.020

70. Gao G, Ng SSM, Man SS, So BCL. Ergonomic risk assessment methods for work-related musculoskeletal disorders among healthcare workers: A systematic review. *J Safety Res* [Internet]. 2025 Dic 1; 95:189-196. DOI: 10.1016/j.jsr.2025.10.001

71. Davison C, Cotrim TP, Gonçalves S. Ergonomic assessment of musculoskeletal risk among a sample of Portuguese emergency medical technicians. *Int J Ind Ergon* [Internet]. 2021 Mar 1; 82:103077. DOI: 10.1016/j.ergon.2020.103077

72. Almaghrabi A, Alsharif FH. Prevalence of Low Back Pain and Associated Risk Factors among Nurses at King Abdulaziz University Hospital. *Int J Environ Res Public Health* [Internet]. 2021; 18(4):1567. DOI: 10.3390/ijerph18041567

73. Khairunnisa, Tamtomo D, Murti B, Masters' Khairunnisa. Meta-Analysis of the Effect of Heavy Lifting on Low Back Pain Among Health Workers. *Indonesian Journal of Medicine* [Internet]. 2024; 9(3):388-397. DOI: 10.26911/theijmed.2024.9.3.766

74. El-Soud AMA, El-Najjar AR, El-Fattah NA, Hassan AA. Prevalence of low back pain in working nurses in Zagazig University Hospitals: An epidemiological study. *Egypt Rheumatol Rehabil* [Internet]. 2014; 41:109-115. DOI: 10.4103/1110-161X.140525

75. Belay MM, Worku A, Gebrie SA, Wamisho B. Epidemiology of low back pain among nurses working in public hospitals of Addis Ababa, Ethiopia. *East Cent Afr J Surg* [Internet]. 2016; 21(1):113-131. DOI: 10.4314/ECAJS.V21I1.139040

76. Alammari MA, Alammari AA, Alammari AA, Alammari AA, Alammari NA, Alabdali MYI. Psychosocial and Occupational Factors Associated With Low Back Pain Among Healthcare Professionals: A Systematic Review. *Cureus* [Internet]. 2025; 17(1):e77426. DOI: 10.7759/cureus.77426

77. Pinto RNC, Silva MC, Caputo E, Domingues M. Low back pain prevalence and associated factors in nurses from Brazilian primary health units. *Work* [Internet]. 2021; 70(1):279-285. DOI: 10.3233/WOR-213572

78. Mijena GF, Geda B, Dheresa M, Fage SG. Low Back Pain Among Nurses Working at Public Hospitals in Eastern Ethiopia. *J Pain Res* [Internet]. 2020; 13:1349-1357. DOI: 10.2147/JPR.S255254

79. Mesquita MAS, Chagas KF. Factors associated with low back pain in workers' health. *Revista Científica Multidisciplinar Núcleo do Conhecimento*. 2022; 3:61-75. DOI: 10.32749/nucleodoconhecimento.com.br/health/workers-health

80. Anjali PAB, Thanaya SAP, Indrayani AW, Antari NKAJ. The correlation between work posture and lower back pain among tailors. *PTJI* [Internet]. 2024; 5(1):91-94. DOI: 10.51559/ptji.v5i1.198

81. Mazni NIM, Latif RA, Bekti Y. Prevalence and Factors Affecting Lower Back Pain Among Nurses in Rehabilitation Hospital Cheras, Malaysia. *Health Dyn* [Internet]. 2025; 2(3):95-104. DOI: 10.33846/hd20302

82. Coenen P, Kingma I, Boot C, Bongers P, van Dieën JV. Inter-rater reliability of a video-analysis method measuring low-back load in a field situation. *Appl Ergon* [Internet]. 2013; 44(5):828-834. DOI: 10.1016/j.apergo.2013.02.006

83. Negash NA, Tadele A, Ferede AJ. Prevalence and Associated Factors of Low Back Pain Among Healthcare Professionals at University of Gondar Comprehensive and Specialized Hospital, Northwest Ethiopia: Cross-Sectional Study. *J Pain Res* [Internet]. 2022; 15:1543-1552. DOI: 10.2147/JPR.S351987

84. Mekonnen T. Work-Related Factors Associated with Low Back Pain Among Nurse Professionals in East and West Wollega Zones, Western Ethiopia, 2017: A Cross-Sectional Study. *Pain Ther* [Internet]. 2019; 8:239-247. DOI: 10.1007/s40122-019-0129-x

85. Ayane D, Takele A, Feleke Z, Mesfin T, Mohammed S, Dido A. Low Back Pain and Its Risk Factors Among Nurses Working in East Bale, Bale, and West Arsi Zone Government Hospitals, Oromia Region, South East Ethiopia, 2021 -Multicenter Cross-Sectional Study. *J Pain Res* [Internet]. 2023; 16:3005-3017. DOI: 10.2147/JPR.S410803

86. Banga D, Samuel T, Yihune M, Bekele G, Molla E, Borie YA, et al. Prevalence of low back pain and associated factors among nurses working in public hospitals of Hawassa city, southern Ethiopia: A cross-sectional study. *Heliyon* [Internet]. 2024; 10(9):e30300. DOI: 10.1016/j.heliyon.2024.e30300

87. Gashawbeza B, Ezo E. Prevalence and factors associated with low back pain among health care providers in public hospitals of Gamo zone, Southern Ethiopia. *SAGE Open Med* [Internet]. 2022; 10. DOI: 10.1177/20503121221114311

88. Hasheminejad N, Amirmahani M, Tahernejad S. Biomechanical evaluation of midwifery tasks and its relationship with the prevalence of musculoskeletal disorders. *Heliyon* [Internet]. 2023 Sep 1; 9(9). DOI: 10.1016/j.heliyon.2023.e19442

89. Gbeti C, Abasimi E, Mutaru AM, Wumbei A. Perceived Risk Factors of Work-Related Musculoskeletal Disorders Among Nurses and Midwives in Northern Ghana: An Exploratory Mixed-Method Study. *Int J Afr Nurs Sci* [Internet]. 2026; 24:100977. DOI: 10.1016/j.ijans.2026.100977

90. Dimate García AE, Rodríguez Romero DC, González Rincón EY, Pardo López DM, Garibello Cubillos Y. Método OCRA en diferentes sectores productivos. *Nova* [Internet]. 2019 Jun 15; 17(31):9-66. DOI: 10.22490/24629448.3621

91. Lau MH, Armstrong TJ. The effect of viewing angle on wrist posture estimation from photographic images using novice raters. *Appl Ergon* [Internet]. 2012; 42(5):634-643. DOI: 10.1016/j.apergo.2010.08.008