JMU
Jurnal Medika Udayana

ISSN: 2597-8012 JURNAL MEDIKA UDAYANA, VOL. 15 NO.5, MEI, 2026

Received: 2025-12-29 Revision: 2026-02-13 Accepted: 30-03-2026

IDENTIFICATION OF FACTORS ASSOCIATED WITH LOW BACK PAIN AMONG ONLINE MOTORCYCLE TAXI DRIVERS IN DENPASAR

Theresa Paramita1, I Nyoman Gede Wardana2* , I Gusti Ayu Widianti2 , Muliani2
[1]Bachelor of Medicine, Faculty of Medicine, Universitas Udayana
[2]Departement of Anatomy, Faculty of Medicine, Universitas Udayana

***Correspondence**
Nyoman Gede Wardana[2]
2Departement of Anatomy, Faculty of Medicine, Universitas Udayana
E-mail: mandewardana@unud.ac.id

ABSTRACT

Background: Low back pain (LBP) is a musculoskeletal complaint widely experienced worldwide, including among online motorcycle taxi drivers. Several factors related to LBP include sex, age, body mass index (BMI), length of work, sitting posture, sitting duration, and smoking. Low back pain can reduce the productivity of online motorcycle taxi drivers. Therefore, this study aimed to identify the factors associated with LBP among online motorcycle taxi drivers in Denpasar.
Methods: An analytical observational design with a cross-sectional approach and a purposive sampling technique. Participants were online motorcycle taxi drivers who met the inclusion and exclusion criteria. Data were collected using structured questionnaires and anthropometric measurements and were analyzed using univariate analysis, the chi-square test, and Fisher's exact test, with a significance level of $p < 0.05$.
Results: The prevalence of low back pain was 68.1% (47 respondents). Statistical analysis demonstrated significant associations between BMI ≥ 23 kg/m² ($p = 0.040$), sitting duration ≥ 9 hours/day ($p = 0.015$), and non-ergonomic sitting posture ($p = 0.033$) with LBP. Meanwhile, sex ($p = 1.000$), age ($p = 1.000$), length of work ($p = 0.860$), and smoking ($p = 0.296$) were not significantly associated with LBP.
Conclusions: Sitting duration, sitting posture, and BMI were significantly associated with low back pain among online motorcycle taxi drivers in Denpasar.

Keywords : low back pain, sitting duration, sitting posture

INTRODUCTION

The rapid growth of online motorcycle taxi services substantially facilitates daily transportation, food delivery, and shopping activities in recent years. In urban areas such as Denpasar, this sector serves as a major source of employment, resulting in prolonged daily motorcycle use as a primary occupation. Despite its benefits, prolonged motorcycle riding exposes drivers to various occupational health risks, particularly musculoskeletal disorders, including low back pain (LBP).

Low back pain is defined as pain or discomfort located in the posterior region of the body between the lower margin of the costal arch and the gluteal folds.[1] It represents one of the most prevalent musculoskeletal complaints worldwide. In 2020, an estimated 619 million individuals experienced LBP, and this number is projected to increase to 843 million by 2050.[2] Globally, LBP is the leading cause of years lived with disability.[2,3] It contributes substantially to healthcare utilization, including hospitalization among affected individuals.[3]

Among motorcycle riders, including online motorcycle taxi drivers, LBP represents a significant occupational health concern. Previous studies report LBP prevalence ranging from 52.5% to 68.89% among motorcycle riders.[4,5] Individuals with LBP often report limitations in daily activities, difficulties in standing or maintaining posture, and reduced ability to perform routine tasks.[5] These functional impairments are likely to decrease work productivity and negatively affect quality of life, particularly in occupations that require prolonged sitting and repetitive movements.

Low back pain is a multifactorial condition with diverse etiologies, including traumatic injury and neuropathic involvement.[6,7] Degenerative processes,

metabolic disorders, and non-ergonomic posture are also implicated in the development of LBP.[7]

Several factors are reported to be associated with low back pain, encompassing demographic, anthropometric, occupational, behavioral, metabolic, and psychosocial aspects. Sex differences in LBP prevalence are widely reported, with women experiencing LBP more frequently than men.[8–11] This disparity is attributed to hormonal influences and anatomical differences.[12,13] Pregnancy-related biomechanical changes may further increase susceptibility to LBP.[13] Age shows a consistent association with LBP, with a higher prevalence observed among older individuals.[11,14–16] This pattern is attributed to age-related degenerative change, reduced musculoskeletal stability, and cumulative mechanical exposure over time.[17,18] Body mass index (BMI) represents an important anthropometric factor associated with LBP.[19–21] Increased BMI may impose greater mechanical loading on the intervertebral discs and facet joints, potentially accelerating degenerative changes and contributing to the development of LBP. Excess body weight also increases the load on the paraspinal muscles, which may exacerbate muscle fatigue and worsen LBP symptoms.[21]

Occupational factors, including length of work[22,23], prolonged sitting duration, and non-ergonomic sitting posture[24], are consistently linked to LBP. Sustained static sitting and repetitive exposure to non-neutral postures may lead to muscle fatigue and increased spinal loading, thereby increasing susceptibility to LBP.[25–27]

Behavioral factors, such as smoking, are associated with a higher prevalence of LBP.[28] This association is mediated through impaired blood flow[29] and accelerated degenerative processes.[29,30]

Metabolic conditions, particularly type 2 diabetes mellitus, are also associated with LBP.[31] Psychosocial factors, including anxiety, may contribute to the development and persistence of LBP through increased sympathetic activity and muscle tension.[17,18,32]

Although several studies have examined LBP among motorcycle riders, the associated factors reported vary across populations and occupational settings. Online motorcycle taxi drivers are exposed to prolonged sitting, repetitive movements, and sustained mechanical loading, which may interact differently with individual and occupational characteristics. This interaction may increase cumulative biomechanical stress on the lumbosacral region, thereby contributing to the development and persistence of LBP. Thus, understanding the prevalence and factors associated with low back pain in this specific occupational group remains important.

Therefore, this study aimed to identify the factors associated with low back pain among online motorcycle taxi drivers in Denpasar.

MATERIALS AND METHODS

This study employed an analytical observational design with a cross-sectional approach to identify factors associated with LBP among online motorcycle taxi drivers in Denpasar. The study was conducted in Denpasar, Bali, from January to November 2025 and received ethical approval from the Ethics Committee of the Faculty of Medicine, Universitas Udayana (approval number: 0584/UN14.2.2.VII.14/LT/2025).

Study participants were selected using purposive sampling based on predefined inclusion and exclusion criteria. Inclusion criteria included active online motorcycle taxi drivers who had worked for at least one month and had provided written informed consent. Exclusion criteria included a history of spinal surgery, vertebral trauma, medically diagnosed musculoskeletal disorders, type 2 diabetes mellitus, and drivers who had not been actively working for at least one month.

The minimum sample size was calculated using the Lemeshow formula and was adjusted for potential drop-out, resulting in a minimum required sample of 64 respondents. A total of 71 participants were recruited; however, two participants were excluded, leaving 69 respondents included in the final analysis.

Data collection was conducted through structured interviews using a questionnaire and anthropometric measurements. Low back pain was assessed using the Indonesian version of Nordic Musculoskeletal Questionnaire.[33] Independent variables included sex, age, BMI, length of work, sitting duration, sitting posture, and smoking. Body mass index was calculated from measured body weight and height and categorized according to the Asia-Pacific BMI classification, with a cutoff value of ≥ 23 kg/m² indicating overweight. For continuous variables such as age, length of work, and sitting duration, optimal cutoff points were determined using the Youden Index to maximize sensitivity and specificity in predicting LBP.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 29.0, with a significance level set at $p < 0.05$. Univariate analysis was used to describe participant characteristics and the prevalence of LBP. Bivariate analysis using the chi-square test or Fisher's exact test was conducted to assess associations between independent variables and LBP. Variables with $p < 0.25$ were considered for multivariate logistic regression analysis to control for potential confounding effects; however, only three variables met this criterion, and no additional potential confounders were qualified for multivariate modeling in the final analytical framework as specified in the predefined study protocol.

RESULTS

A total of 69 online motorcycle taxi drivers in Denpasar who met the inclusion and exclusion criteria were included in this study. Among them, 47 respondents (68.1%) reported experiencing LBP. The distribution of

respondent characteristics and the prevalence of LBP based on the studied variables are presented in **Table 1.**

Table 1. Prevalence of LBP based on variables studied in online motorcycle taxi drivers in Denpasar

Characteristics	Mean	Total n (%)	LBP Prevalence n (%)
Sex			
- Female		3 (4.3)	2 (66.7)
- Male		66 (95.7)	45 (68.2)
Age			
- ≥ 26 years	33.8	49 (71.0)	33 (67.3)
- < 26 years		20 (29.0)	14 (70.0)
BMI			
- ≥ 23 Kg/m^2	23.3	36 (52.2)	29 (80.6)
- < 23 Kg/m^2		33 (47.8)	18 (54.5)
Length of work			
- ≥ 7 years	3.7	15 (21.7)	11 (73.3)
- < 7 years		54 (78.3)	36 (66.7)
Sitting duration			
- ≥ 9 hours/day	9.5	44 (63.8)	35 (79.5)
- < 9 hours/day		25 (36.2)	12 (48.0)
Sitting posture			
- Non-ergonomic		48 (69.6)	37 (77.1)
- Ergonomic		21 (30.4)	12 (47.6)
Smoking			
- Smoker		36 (52.2)	22 (61.1)
- Non-smoker		33 (47.8)	25 (75.8)
Total		69 (100.0)	47 (68.1)

LBP: Low Back Pain

Most respondents were male (95.7%), with a comparable prevalence of LBP between males (68.2%) and females (66.7%). The mean age of respondents was 33.8 years, and the majority aged ≥ 26 years (71.0%). The prevalence of LBP was similar between respondents aged ≥ 26 years (67.3%) and those aged < 26 years (70.0%). Respondents with a BMI ≥ 23 kg/m² comprised 52.2% of the sample and showed a higher prevalence of LBP (80.6%) compared with those with a BMI < 23 kg/m² (54.5%).

In terms of occupational characteristics, most respondents had worked for less than 7 years (78.3%), with a higher prevalence of LBP observed among those with a working duration ≥ 7 years (73.3%). A majority of respondents reported sitting for ≥ 9 hours per day (63.8%), and this group showed a higher prevalence of LBP (79.5%) compared with those sitting for < 9 hours per day (48.0%). Regarding sitting posture, 69.6% of respondents reported a non-ergonomic sitting posture, among whom 77.1% experienced LBP. By contrast, respondents with an ergonomic sitting posture had a lower prevalence of low back pain (47.6%). Based on smoking status, smokers accounted for 52.2% of respondents, with a lower prevalence of LBP (61.1%) compared with non-smokers (75.8%).

Table 2. Bivariate analysis of the association between studied variables and LBP among online motorcycle taxi drivers in Denpasar.

Characteristics	LBP		p
	Yes n (%)	No n (%)	
Sex			
- Female	2 (66.7)	1 (33.3)	1.000[a]
- Male	47 (68.2)	21 (31.8)	
Age			
- ≥ 26 years	33 (67.3)	16 (32.7)	1.000[b]
- < 26 years	14 (70.0)	6 (30.0)	
BMI			
- ≥ 23 Kg/m2	29 (80.6)	7 (19.4)	0.040[b*]
- < 23 Kg/m2	18 (54.5)	15 (45.5)	
Length of work			
- ≥ 7 years	11 (73.3)	4 (26.7)	0.860[b]
- < 7 years	36 (66.7)	18 (33.3)	
Sitting duration			
- ≥ 9 hours/day	35 (79.5)	9 (20.5)	0.015[b*]
- < 9 hours/day	12 (48.0)	13 (52.0)	
Sitting posture			
- Non-ergonomic	37 (77.1)	11 (22.9)	0.033[b*]
- Ergonomic	10 (47.6)	11 (52.4)	
Smoking			
- Smoker	22 (61.1)	14 (38.9)	0.296[b]
- Non-smoker	25 (75.8)	10 (24.2)	

[a]: Fisher's Exact Test; [b]: Chi-Square Test; [*]: $p < 0.05$ means statistically significant

Bivariate analysis presented in **Table 2.** showed that BMI, daily sitting duration, and sitting posture were significantly associated with LBP. Participants with a body mass index ≥ 23 kg/m² had a higher prevalence of LBP compared with those with a BMI < 23 kg/m² ($p = 0.040$). Prolonged daily sitting duration (≥ 9 hours/day) was significantly associated with LBP, with 79.5% of participants reporting LBP, compared with 48.0% among those sitting < 9 hours/day ($p = 0.015$). In addition, non-ergonomic sitting posture was significantly associated with LBP, with a prevalence of 77.1% compared with 47.6% among those with an ergonomic posture. No significant associations were observed between LBP and sex ($p = 1.000$), age ($p = 1.000$), length of work ($p = 0.860$), or smoking ($p = 0.296$).

Based on the bivariate analysis, three variables met the criteria for inclusion in multivariate analysis ($p < 0.25$). However, as no additional variables qualified as potential confounders, multivariate logistic regression was not performed, and the interpretation of results was based on bivariate findings.

DISCUSSION

The prevalence of LBP among online motorcycle taxi drivers in Denpasar was 68.1%, as shown in **Table 1**. This finding indicates that more than half of the respondents experienced LBP complaints. This prevalence is comparable to previous studies conducted in Tangerang, which reported an LBP prevalence of 66.7%[34] and in Nanggalo, with a prevalence of 61.2%.[35] These findings suggest that online motorcycle taxi drivers may represent a population vulnerable to LBP.

Association between Sex and LBP

The present study found no significant association between sex and LBP (**Table 2**). This result is consistent with studies conducted in Pasuruan[36] and Saudi Arabia[37] which also reported no significant sex-related differences in LBP prevalence.

Several studies have reported a significantly higher prevalence of LBP among females. Research conducted in Turkey demonstrated a significant association between sex and LBP, with a higher prevalence among women.[10] Similar findings were reported in studies from Brazil[9] and Spain.[11] These differences have been attributed to hormonal factors, anatomical variations, lower muscle strength, and physiological conditions such as pregnancy and menopause, which may increase susceptibility to LBP.[12,13,17]

The absence of a significant association in this study may be explained by the highly unequal sex distribution, with only three female respondents included. This imbalance limited data variability and reduced the statistical power to detect differences between sex groups. Consequently, sex-related differences in LBP among online motorcycle taxi drivers may not have been adequately captured in this study. Findings should therefore be

interpreted with caution. Future studies with a more balanced sex distribution are needed to better elucidate sex-related differences in low back pain among occupational drivers.

Association between Age and LBP

No significant association was found between age and LBP (**Table 2**). This result aligns with several studies reporting no meaningful relationship between age and LBP.[19,20,36]

Other studies have reported an increased risk of LBP with advancing age.[11,14,16] Age-related increases in LBP have been associated with degenerative changes beginning in early adulthood, including tissue damage, scar formation, and decreased hydration of vertebral structures and intervertebral discs.[17] These degenerative processes may compromise spinal stability and muscle support, thereby increasing vulnerability to LBP.[18]

The discrepancy observed in this study may be attributed to the relatively young age of the respondents, with a mean age of 33.8 years. At this age range, degenerative changes of the vertebral column are generally not dominant, and other factors such as sitting posture, prolonged sitting duration, smoking habits, and body mass index may play a more substantial role in the development of LBP.

5.3 Association between BMI and LBP

A significant association was observed between BMI and LBP (**Table 2**). This finding is consistent with studies conducted in North India[19] and Saudi Arabia[20] which also reported significant relationships between BMI and LBP.

Elevated BMI increases mechanical loading on the vertebral column, particularly the intervertebral discs, potentially leading to degenerative changes such as facet joint arthritis and disc pathology. Excess body weight also increases the workload of spinal muscles and ligaments, which may exacerbate LBP symptoms. Additionally, an increase of one BMI unit has been associated with a 45 mm^3 increase in epidural fat, which may compress spinal nerves and intensify LBP complaints.[21] These findings highlight the potential role of body weight in influencing lumbar spine loading among occupational drivers.

Previous studies have reported inconsistent findings regarding the association between BMI and LBP.[36,38] Differences in population characteristics, lifestyle factors, and analytical methods may contribute to these variations.

Association between Length of Work and LBP

The present study did not find a significant association between length of work and LBP (**Table 2**). This result is consistent with findings from studies conducted in Kendari, which also reported no meaningful relationship between working duration and LBP.[27,39] One possible explanation is that ergonomic factors such as sitting posture and sitting duration may have a more dominant influence on LBP risk than cumulative years of work.

Other studies have reported higher LBP prevalence among individuals with longer working durations.[22,23,40,41] These findings support the theory that LBP is often a chronic condition that develops over prolonged exposure to physical load and non-ergonomic postures.[17]

In this study, the lack of association may be explained by the small number of respondents with a working duration of ≥ 7 years (n = 15), resulting in limited statistical power. Receiver operating characteristic analysis yielded an area under the curve of 0.501, indicating that working duration had minimal discriminatory ability in distinguishing respondents with and without LBP. The seven-year cut-off was derived using the Youden index; however, the very low AUC suggests that this threshold lacks meaningful predictive value.

Association between Sitting Duration and LBP

A significant association was identified between sitting duration and LBP (**Table 2**). This finding is consistent with studies among medical students in North Sumatra[24] and online motorcycle taxi drivers in Bangkalan.[26]

Prolonged sitting induces sustained static muscle contraction in the back muscles, leading to reduced vascular supply and impaired glucose metabolism. This condition results in fatty acid accumulation, causing discomfort and pain in the lower back.[24] Extended sitting also increases mechanical load on the vertebral column, contributing to tissue damage, reduced joint lubrication, stiffness, and ultimately LBP.[26]

Some studies reported no significant association between sitting duration and LBP, emphasizing the influence of other contributing factors.[27,42,43] These studies suggest that static working positions and non-ergonomic postures may increase spinal load regardless of sitting duration, thereby contributing to LBP in both short and long sitting periods.[27]

Association between Sitting Posture and LBP

A significant association was observed between sitting posture and LBP (**Table 2**). This result aligns with findings from studies conducted in North Sumatra[24], Kendari[27], and Bali.[42]

Non-ergonomic sitting posture increases tension in the muscles and ligaments surrounding the vertebral column, which may lead to LBP.[24,25] However, some studies have reported no significant association between sitting posture

Association between Smoking and LBP

Smoking habits were not significantly associated with LBP in this study (**Table 2**), consistent with findings from Pasuruan.[36] However, several studies have demonstrated a significant association between smoking and LBP.[29,38] Smoking may increase coughing frequency, leading to elevated intra-abdominal pressure and compression of spinal nerves, thereby triggering LBP. Additionally, smoking reduces arterial blood flow to the vertebral roots, potentially causing ischemia and worsening pain.[29] Smokers are also more susceptible to Modic changes, indicative of vertebral degeneration, which are closely related to impaired intervertebral tissue metabolism due to toxic exposure from cigarette smoke.[29,30]

The absence of a significant association in this study may be attributed to the predominance of moderate smokers among respondents, in whom the long-term effects of smoking on vertebral structures may not yet be evident. Moreover, factors such as BMI, sitting duration, and sitting posture may exert a stronger influence on LBP. The cross-sectional design of this study also limits causal inference.

STUDY LIMITATIONS

This study has several limitations. The cross-sectional design allows for identification of associations but does not permit causal inference. Data collection relied on interviews and questionnaires, which are subject to recall and reporting bias. Additionally, the AUC values for length of work (0.501), age (0.409), and sitting duration (0.603) indicate low predictive ability of these variables. The relatively small sample size and restriction to online motorcycle taxi drivers in Denpasar limit the generalizability of the findings. Future studies employing longitudinal designs with larger and more diverse samples are recommended.

CONCLUSIONS AND RECOMMENDATIONS

This study found that the prevalence of LBP among online motorcycle taxi drivers in Denpasar was 68.1%. Daily sitting duration, sitting posture, and BMI were identified as factors significantly associated with LBP, indicating that both individual and ergonomic factors play an important role in the development of LBP in this occupational group. These findings highlight the importance of promoting healthy body weight and ergonomic awareness to potentially reduce the risk of LBP among online motorcycle taxi drivers. Future studies are recommended to employ longitudinal or cohort designs to better clarify causal relationships between risk factors and LBP, and to include broader variables such as chronic disease history, psychosocial factors, and physical activity levels, as well as larger and more diverse study populations, to provide a more comprehensive understanding of LBP determinants.

REFERENCES

1. Holmes CC. Low back pain. Geneva: World Health Organization; 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/low-back-pain. Accessed 31 Oct 2024.
2. Ferreira ML. 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–e329.
3. Fatoye F, Gebrye T, Ryan CG, Useh U, Mbada C. Global and regional estimates of clinical and economic burden of low back pain in high-income countries: a systematic review and meta-analysis. Front Public Health. 2023;11:1098100.
4. Zomalhèto Z, Mikponhoué RCN, Wanvoègbe A, Adikpéto I, Ayélo P. Prevalence and factors associated with low back pain among motorcycle drivers in Porto-Novo (Benin). Pan Afr Med J. 2019;32:107.
5. Sultan SR, Atta MN, Siddiqui O, Yaqoob H, Abbas S, Sajid A, et al. Prevalence of low back pain in bike riders: a cross-sectional study. Pak J Health Sci. 2022;3(4):18–22.
6. Will JS, Bury DC, Miller JA. Mechanical low back pain. Minn Med. 2018;98(7):421–428.
7. Casiano VE, Sarwan G, Dydyk AM, Varacallo M. Back pain. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK538173/. Accessed 11 Dec 2024.
8. Bento TPF, Genebra CVS, Maciel NM, Cornelio GP, Simeão SFAP, de Vitta A. Low back pain and some associated factors: is there any difference between genders? Braz J Phys Ther. 2020;24(1):79–87.
9. Bansal D, Asrar MM, Ghai B, Pushpendra D. Prevalence and impact of low back pain in a community-based population in Northern India. Pain Physician. 2020;23(4):E389–E398.
10. Kandeel FM, Mohamed FM, Farrag NS, Galhom AE. Prevalence and predictors of low back pain among medical students from Egypt. Adv Spine J. 2025;44:8–15.
11. Huerta M, Salazar A, Moral-Munoz JA. Trends in chronic neck and low back pain prevalence in Spain (2006–2020): differences by sex, age, and social class. Eur Spine J. 2025;34(4):1331–1340.
12. Bizzoca D, Solarino G, Pulcrano A, Brunetti G, Moretti AM, Moretti L, et al. Gender-related issues in the management of low-back pain: a current concepts review. Clin Pract. 2023;13(6):1360–1368.
13. Emorinken A, Erameh CO, Akpasubi BO, Dic-Ijiewere MO, Ugheoke AJ. Epidemiology of low back pain: frequency, risk factors, and patterns in South-South Nigeria. Reumatologia. 2023;61(5):360–367.

14. Gu Y, Wang Z, Shi H, He Y, Yang Y, Li Y, et al. Global, regional, and national change patterns in the incidence of low back pain from 1990 to 2019 and its predicted level in the next decade. Int J Public Health. 2024;69:1606299.
15. Memon A, Imran A, Aftab S, Nawaz U, Ishaque F. Low back pain among student motorcyclists: a cross-sectional study. J Dow Univ Health Sci. 2019;13(2):116–120.
16. Wang L, Zou X, Zi X, She M, Duan C. Trends in the global burden of low back pain and neck pain in individuals aged 15 to 49 years, 1990 to 2021, and projections through 2036: an age-period-cohort analysis study. Medicine (Baltimore). 2025;104(34).
17. Sahara R, Pristya TY. Faktor risiko yang berhubungan dengan kejadian low back pain (LBP) pada pekerja: literature review. J Ilm Kesehat. 2020;19(3):92–99.
18. Rezaei B, Mousavi E, Heshmati B, Asadi S. Low back pain and its related risk factors in health care providers at hospitals: a systematic review. Ann Med Surg. 2021;70:102903.
19. Sengar M, Gupta A, Singh S, Mishra N. Health research in the state of Odisha, India: a decadal bibliometric analysis (2011–2020). J Fam Med Prim Care. 2022;6(2):169–170.
20. Alshahrani A, Reddy RS, Ravi SK. Chronic low back pain and postural instability: interaction effects of pain severity, age, BMI, and disability. Front Public Health. 2025;13:1497079.
21. Chuan Z, Zi S, Chen Q, Zhang S. The burden, trends, and projections of low back pain attributable to high body mass index globally: an analysis of the Global Burden of Disease Study from 1990 to 2021 and projections to 2050. Front Med. 2024;11:1469298.
22. Rachmawati S, Suryadi I, Pitanola RD. Low back pain based on age, working period, and work posture. J Kesehat Masy. 2022;17(2):287–292.
23. Juvi JP, Adu AA, Ndoen EM. Analysis of factors related to low back pain (LBP) in company employees. J Health Behav Sci. 2023;4(4):619–634.
24. Koswara J, Machrina Y, Lubis M, Amelia R. Correlation of prolonged sitting time and sitting posture on low back pain: a cross-sectional study among medical students at Universitas Sumatera Utara. F1000Research. 2024;13:146596.
25. Angkouw C, Kawatu PAT, Maddusa SS. Hubungan antara posisi duduk dengan keluhan nyeri punggung pada pengemudi truk tangki di PT Pertamina Terminal BBM Bitung. J KESMAS. 2018;7(5):1–5.
26. Islami AD, Multazam A, Rahmanto S. Relationship between sitting duration and complaints of low back pain in online ojek drivers in Bangkalan. J EduHealth. 2024;15(2):1294–1298.
27. Illahi MAA, Pratiwi AD, Nurfadillah S. Faktor-faktor yang berhubungan dengan kejadian low back pain (LBP) pada pekerja di PLTU NII Tanasa Kendari. MAHESA. 2024;4(2):637–649.
28. Green BN, Johnson CD, Snodgrass J, Smith M, Dunn AS. Association between smoking and back pain in a cross-section of adult Americans. Cureus. 2016;8(9):e806.
29. Yang QH, Zhang YH, Du SH, Wang YC, Wang XQ. Association between smoking and pain, functional disability, anxiety and depression in patients with chronic low back pain. Int J Public Health. 2023;68:1605583.
30. Foizer GA, Paiva VC, Gorios C, Junior AC, Miranda JB. Smoking and Modic changes in patients with chronic low back pain: a comparative study. Acta Ortop Bras. 2024;32(5):e278628.
31. Jacob L, Rathmann W, Koyanagi A, Haro JM, Kostev K. Association between type 2 diabetes and chronic low back pain in general practices in Germany. BMJ Open Diabetes Res Care. 2021;9(1):e002426.
32. Hu Y, Yang Z, Li Y, Xu Y, Zhou X, Guo N. Anxiety symptoms and associated factors among chronic low back pain patients in China. Front Public Health. 2022;10:878865.
33. Chairani A. Validity and reliability test of the Nordic Musculoskeletal Questionnaire with formal and informal sector workers. In: Proceedings of the 7th International Conference on Public Health; 2020.
34. Dewi JA, Zen A, Herdiansyah D, Hardiman S. Faktor-faktor yang mempengaruhi keluhan low back pain pada pengendara ojek online di Kota Tangerang Selatan. Environ Occup Health Saf J. 2025;6(1):24.
35. Suksmerri, Triana N, Seno BA. Factors associated with low back pain complaints in online Gojek ojek riders in the Nanggalo area. J Indep Environ Health. 2022;1(1):18–27.
36. Cahyani MT, Denny HM, Suroto. Analisis faktor risiko low back pain pada pekerja industri tahu di Kecamatan Kejayan Pasuruan. Indones J Health Community. 2021;2(2):74.
37. Waly FJ, Albalawi AS, Alatawi AA, Albalawi NA, Alwakeel AAA, Alsubhi SS, et al. Low back pain: prevalence and functional impairment among the general population in Tabuk City, Saudi Arabia. J Musculoskelet Surg Res. 2023;7(2):112–114.
38. Thiono J, Suryadinata N. Association between body mass index and low back pain among students at the Faculty of Medicine, Pelita Harapan University. Medicinus. 2023;11(2):48.
39. Tonda W, Lestari H, Rezal F. Hubungan posisi kerja, lama kerja, dan beban kerja dengan keluhan low back pain. J Health Sci Leksia. 2025;3(3).
40. Agustin A, Puji LKR, Andriati R. Hubungan durasi kerja, masa kerja dan postur kerja terhadap keluhan low back pain pada bagian staf di kantor X Jakarta Selatan. J Health Res Sci. 2023;3(1):13–22.
41. Poluan AL, Tuda JSB, Pinontoan OR. Faktor-faktor yang mempengaruhi terjadinya low back pain myogenic pada tenaga kependidikan di Universitas Katolik De La Salle Manado. Sehat Rakyat. 2025;4(2):338–350.

42. Pramana IGBT, Adiatmika IPG. Hubungan posisi dan lama duduk dalam menggunakan laptop terhadap keluhan low back pain pada mahasiswa Fakultas Kedokteran Universitas Udayana. J Med Udayana. 2020;9(8):65–71.
43. Tarigan GAB, Edlin, Mukti AI. Hubungan lama waktu duduk dan posisi duduk terhadap keluhan low back pain pada pekerja kantoran di Kabanjahe Kabupaten Karo. J Ners. 2025;9:787–791.
44. Sari AR, Ramadhanty PK, Anggraeni N, Firmansyah Y. The correlation between sitting posture and duration with LBP complaints in nursing students during lecture activities. Medicor. 2023;1(1):25–30.

