

Analysis of Individual Factors Influencing Musculoskeletal Disorder Complaints Among Grab-Bike Online Motorcycle Drivers in Purwokerto

Putri Wulandari^{1*}, Suryanto¹, Siti Harwanti¹

¹Department of Public Health, Jenderal Soedirman University, Jalan Prof. Dr. HR Boenyamin No. 708, Purwokerto Utara, Banyumas, 53122, Central Java, Indonesia

*Corresponding Author, email: putri.wulandari2521@gmail.com

ABSTRACT

Musculoskeletal disorders (MSDs), characterized by pain, stiffness, numbness, and other physical discomforts in the muscles and supporting structures, are prevalent among online motorcycle drivers due to prolonged sitting, limited rest, and repetitive movements. This study aimed to analyze individual factors associated with MSDs complaints among Grab-Bike drivers in Purwokerto, Indonesia. A cross-sectional study was conducted using accidental sampling with 77 respondents from a population of 330 drivers. Data were collected using the Nordic Body Map (NBM) questionnaire and analyzed through univariate, bivariate (chi-square and Spearman correlation), and multivariate (multiple logistic regression) analyses. The findings showed that the factors influencing MSDs complaints were age (p value = 0.042), work tenure (p value = 0.026), body mass index (BMI) (p value = 0.182), smoking habits (p value = 0.895), exercise habits (p value = 0.863), and history of MSDs (p value = 0.529). Age and work tenure were significantly associated with MSDs complaints, while, BMI, smoking habits, exercise habits, and history of MSDs showed no significant association. The most influential factor was work tenure (OR = 6.340). Daily working hours adjustments and regular health monitoring are recommended to reduce MSDs risks in this occupational group.

Keywords: Musculoskeletal Disorders; Online Motorcycle Drivers; Work Tenure

INTRODUCTION

Transportation plays a crucial role in supporting people's daily activities and acts as a connector in a nation's development process. The advancement of globalization has significantly improved access to transportation services. One innovation that emerged is online motorcycle-based transportation, which offers the public an easier and more accessible form of mobility. Online transportation services, such as ride-sharing platforms, have significantly improved efficiency and reduced waiting times for users, making them a strong alternative to conventional transportation methods (Djavadian et al., 2022). This phenomenon has also opened up employment opportunities for people to work as online motorcycle taxi (*ojek*) drivers.

However, online motorcycle drivers face significant health risks due to prolonged exposure to environmental hazards such as air pollution, vibration, noise, and poor surrounding conditions. The working system of the application itself contributes to this risk through account tiering mechanisms—priority, normal, and non-priority accounts. In the competitive environment of ride-hailing platforms, drivers are motivated to enhance their performance to achieve higher rankings and avoid potential penalties, as adherence to company guidelines significantly influences their operational success (Idug et al., 2023). This results in longer working durations, potentially leading to overtime work. Excessive working hours are linked to negative health impacts, where workers who exceed 40 hours per week are less likely to be in good health compared to those working

fewer hours (Kurniawati, 2021).

Musculoskeletal disorders (MSDs) are among the most common health complaints among online motorcycle drivers. MSDs refer to impairments of the soft tissues caused by exposure to vibration, pressure, repetitive motion, or poor posture, either suddenly or over time (NIOSH, 2024). According to the World Health Organization, approximately 1.71 billion people worldwide experience musculoskeletal disorders (WHO, 2021). In Indonesia, data from the 2018 Basic Health Research (Riskesdas) showed that the prevalence of musculoskeletal diseases diagnosed by doctors in individuals aged ≥ 15 years was 7.30% (Riskesdas, 2018). Furthermore, data from Workers Social Security Agency in 2018 reported 123,041 cases of occupational diseases, with around 32% involving musculoskeletal injuries.

Individual factors are among the most serious contributors to MSDs in workers (Aprianto, et al., 2021). These factors include age, gender, years of employment, exercise habits, and body mass index (BMI) (Rahmah and Herbawani, 2021). Other research has also identified individual characteristics such as smoking habits, exercise routines, and medical history as significant risk factors for MSDs (Putri et al., 2022). This is supported by theoretical insights from Hutabarat (2017), who noted that age, gender, smoking behavior, physical activity, and body size all contribute to musculoskeletal complaints.

Several studies have indicated the high prevalence of MSDs among online motorcycle drivers. Sunardi et al. (2021) reported that out of 88 drivers in Kendari, 59.1% experienced MSDs symptoms. Another study found that 80% of drivers reported complaints, including back pain (80%), waist pain (60%), tingling in the hands (20%), and tingling in the thighs (10%) (Anam et al., 2020). Satrio et al. (2020) similarly found that among 66 drivers, 80.3% had complaints specifically in the lower back area.

Grab is one of the most popular online motorcycle taxi platforms in Indonesia, with its motorcycle service known as Grab-Bike. The Grab office in Purwokerto, located in North Purwokerto, manages approximately 330 active Grab-Bike drivers, making it the only online motorcycle taxi company in the city that has an official local office. This availability of an official office allowed the researchers to obtain accurate data on the total driver population and facilitated the research process compared to other platforms operating without a physical office.

The choice to focus on online motorcycle taxi drivers rather than offline motorcycle taxi drivers is also supported by the increasing prevalence and popularity of online platforms in Indonesia. According to Momentum Works, as cited by Septiani (2023), the number of active Grab users in Indonesia in 2022 reached 30.9 million in January–March, 32.6 million in April–June, 33.5 million in July–September, and 33.6 million in October–December. In Purwokerto, although offline motorcycle still maintains some presence in areas such as Terminal Bulupitu, the reach and penetration of online motorcycle taxi continue expanding, particularly around university zones and urban corridors (Wulanjani, 2024).

A preliminary survey conducted with 20 Grab-Bike drivers using the Nordic Body Map questionnaire revealed that 95% reported musculoskeletal complaints. These complaints were most commonly located in the right and left shoulders (45%), waist (60%), lower buttocks (50%), back (35%), and calves (35%).

Despite the growing number of studies on occupational health, few have specifically examined the relationship between individual factors and musculoskeletal disorders among informal transportation workers, particularly in regional cities like Purwokerto. This article offers scientific novelty by focusing on the understudied group of Grab-Bike drivers and identifying which individual factors most significantly contribute to MSDs complaints. The aim of this article is to analyze the influence of individual factors on musculoskeletal disorder complaints among Grab-Bike drivers in Purwokerto.

METHOD

This research employed a cross-sectional study design conducted in Purwokerto from Oktober to December 2024. The population consisted of 330 Grab-Bike online motorcycle drivers, from which a sample of 77 participants was selected using accidental sampling. This technique was chosen because online motorcycle taxi drivers have high mobility and unpredictable work schedules, making it difficult to implement probability-based sampling methods such as simple random or stratified sampling. Although this approach has limitations in terms of representativeness, it is commonly applied in occupational health studies involving highly mobile populations, and it was considered the most feasible method in this context. Data collection was performed using a printed version of the Nordic Body Map (NBM) questionnaire combined with structured interviews. The NBM is a standardized instrument commonly used to assess musculoskeletal complaints across different body regions. It consists of a body diagram divided into 28 anatomical areas. Respondents indicate the presence of discomfort or pain by marking the relevant body parts on the diagram and assigning a score ranging from 0 (no complaint) to 3 (severe complaint). The NBM has been widely used in occupational health and ergonomic research. In earlier studies, the NBM has been evaluated for its validity and reliability in various working populations (Sofyan and Amir, 2019). In contrast, data regarding individual factors were obtained through face-to-face interviews with the drivers using a questionnaire. Data analysis included univariate analysis to describe the sample characteristics, bivariate analysis using the Chi-square test and Spearman correlation to assess the relationships between individual factors and MSDs complaints, and multivariate analysis using multiple logistic regression to determine the most influential factors. Statistical analysis was conducted using statistical software, and the findings were presented in tables and narrative descriptions.

The dependent variable in this study was MSDs complaints. Based on Tarwaka's classification, MSDs are divided into four levels according to the NBM total score (low, moderate, high, and very high); however, only low (0–20) and moderate (21–41) categories were found in this study. Independent variables included age, BMI, smoking habits, work tenure, exercise habits, and history of MSDs. Each variable was categorized based on standard or commonly used classification criteria: age was grouped into low risk (<35 years) and high risk (≥35 years); BMI was classified using the Asia-Pacific cutoff of normal (<23 kg/m²) and abnormal/at risk (≥23 kg/m²); smoking habits was categorized according Indonesian Ministry of Health based on the number of cigarettes consumed per day: light smokers (1–10 cigarettes/day), moderate smokers (11–20 cigarettes/day); work tenure was divided into short tenure (<5 years) and long tenure (≥5 years); exercise habits was grouped into <3 times/week and ≥3 times/week, following prior literature and relevant health guidelines; and history of MSDs was classified as 'None' (no previous musculoskeletal conditions) and 'Present' (previous diagnosis or injury related to musculoskeletal health).

RESULTS AND DISCUSSION

Table 1. Overview of Respondent Characteristics

No	Variable	Category	Frequency	Precentage
1.	Musculoskeletal Disorders Complaints	Low (Total score 0-20)	59	76.6
		Moderate (Total score 21-41)	18	23.4
		Total	77	100
2.	Age	Low risk (<35 years)	47	61.0
		High risk (≥35 years)	30	39.0

Total			77	100
3.	BMI	Normal (<23 kg/m ²)	31	40.3
		Abnormal (≥23 kg/m ²)	46	59.7
Total			77	100
4.	Smoking Habits	Light smokers (1-10 cigarettes/day)	59	76.6
		Moderate smokers (11-20 cigarettes/day)	18	23.4
Total			77	100
5.	Exercise Habits	≥ 3x times/week	16	20.8
		< 3x times/week	61	79.2
Total			77	100
6.	Work tenure	Short tenure (< 5 years)	35	45.5
		Long tenure (≥ 5 years)	42	54.5
Total			77	100
7.	History of MSDs	None	60	77.9
		Present	17	22.1
Total			77	100

Most respondents reported MSDs complaints in the low category (76.6%), with only a smaller proportion in the moderate category. The majority of drivers were under 35 years of age (61%), yet more than half had an abnormal BMI (59.7%). Interestingly, although most respondents were classified as light smokers (76.6%), the vast majority exercised less than three times per week (79.2%), suggesting limited engagement in regular physical activity. Work tenure was relatively balanced between short and long duration, while most drivers had no prior history of MSDs (77.9%), indicating that complaints were largely current rather than recurrent.

Table 2. Summary of Bivariate Analysis Results

No	Variable	p value	Spearman Correlation (SC)	Effect
1.	Age	0,013	0,314	Significant
2.	BMI	0,040	0,266	Significant
3.	Smoking habits	1,000	-0,015	Not Significant
4.	Exercise habits	1,000	-	Not Significant
5.	Work tenure	0,002	0,381	Significant
6.	History of MSDs	0,748	-	Not Significant

Based on the results of bivariate analysis, it was found that the variables of age ($p = 0.013$), body mass index (BMI) ($p = 0.040$), and work duration ($p = 0.002$) had a significant relationship with musculoskeletal disorders (MSDs) complaints among Grab-Bike online motorcycle drivers. The age variable showed a positive correlation ($SC = 0.314$), indicating that drivers aged ≥35 years tended to have a higher risk of experiencing MSDs complaints. The BMI variable also showed a significant relationship ($SC = 0.266$), meaning that drivers with an abnormal BMI (≥23 kg/m²) tended to have more MSDs complaints. Similarly, the work duration variable showed the strongest correlation ($SC = 0.381$), suggesting that drivers who had worked for ≥5 years were more likely to experience MSDs complaints. Meanwhile, smoking habits ($p = 1.000$), exercise

habits ($p = 1.000$), and history of musculoskeletal disease ($p = 0.748$) did not show a significant relationship with MSDs complaints in this study.

Table 3. Final Logistic Regression Model

No.	Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for	
								Exp(B)	
								Lower	Upper
1.	Age	1,267	0,622	4,150	1	0,042	3,550	1,049	12,014
2.	BMI	1,008	0,755	1,784	1	0,182	2,740	0,624	12,028
3.	Work tenure	1,847	0,831	4,944	1	0,026	6,340	1,245	32,297

Table 3 shows that, in the final modeling stage, the variables significantly associated with musculoskeletal disorder (MSDs) complaints, indicated by a p -value < 0.05 , were age ($p = 0.042$) and work tenure ($p = 0.026$), after controlling for the confounding variable of body mass index (BMI). Among these, work tenure demonstrated the strongest association with MSDs complaints, with an odds ratio (OR) of 6.340. This suggests that drivers with longer work tenure (≥ 5 years) are 6.340 times more likely to experience moderate levels of MSDs complaints compared to those with shorter work tenure.

The results of this study showed that work tenure significantly influenced musculoskeletal disorder (MSDs) complaints among Grab-Bike online drivers in Purwokerto, as evidenced by a p -value of 0.026. The majority of respondents had a long work tenure (≥ 5 years), with 42 individuals falling into this category. Drivers with a longer work tenure reported a higher prevalence of moderate MSDs complaints compared to those with a shorter tenure. This finding is consistent with the theory that MSDs complaints are cumulative in nature, increasing over time due to repetitive muscle use during work activities. Prolonged compression of nerves and blood vessels reduces oxygen delivery to muscle tissues, causing a shift from aerobic to anaerobic metabolism. This metabolic shift leads to the accumulation of lactic acid within the muscles, which can trigger a cycle of pain, muscle spasms, and further musculoskeletal dysfunction. The buildup of lactic acid irritates nerve endings, contributing to the development and persistence of musculoskeletal pain symptoms (Binder, 2023). Similarly, prolonged static sitting positions reduce muscle metabolism, especially in the lower back, neck, and shoulders, causing chronic muscle fatigue and imbalance (Dwiyanti and Ariyanto, 2020).

This finding is supported by previous studies, such as research conducted by Ferusgel et al., (2020) on female online drivers in Medan, which also identified a significant relationship between longer work tenure and an increased risk of MSDs complaints (p -value = 0.001). Additional support comes from research by Gunung et al., (2020) on DAMRI bus drivers in Mataram, indicating that drivers with a tenure of ≥ 5 years had a 2.261 times higher risk of experiencing MSDs. Similarly, Sunarya et al., (2024) found that prolonged work tenure among online motorcycle drivers in Bekasi led to a greater risk of lower back pain, with an OR value of 12.5. The cumulative exposure to non-ergonomic postures, repetitive movements, and mechanical vibrations over long periods triggers inflammation, muscle tension, and joint damage, contributing to the development of MSDs (Hafizhah and Fanani, 2024). Consequently, prolonged work tenure contributes to the cumulative musculoskeletal strain, establishing it as a significant risk factor for MSDs among online drivers.

This study found that age significantly affects musculoskeletal disorder (MSDs) complaints among Grab-Bike drivers in Purwokerto (p -value = 0.042). This supports the theory that aging influences both physical and psychological functions. Muscle discomfort tends to start from age 35 and increases with age due to tissue degeneration and reduced fluid content, which

compromise musculoskeletal stability. As people age, they become more prone to reduced bone elasticity and experience more frequent complaints of pain, especially in the neck, shoulders, and back.

Physiological changes such as decreased muscle mass, slower metabolism, and reduced tissue flexibility make individuals aged ≥ 35 more susceptible to MSDs. Research on drivers and transport workers confirms that older individuals report more frequent and severe MSDs (Rukayah and Lupita, 2020). These conditions are often due to long-term tissue wear, poor posture, and diminished recovery capacity, which contribute to pain and stiffness (Indriyani et al., 2022).

Although this study found a relationship between Body Mass Index (BMI) and musculoskeletal disorder (MSDs) complaints among Grab-Bike drivers in Purwokerto, BMI was not significantly associated with the severity of MSDs ($p > 0.05$). Most respondents had abnormal BMI values (46 out of 77), but the deviations were relatively close to the normal BMI threshold (23 kg/m^2), with only a few classified as obese. Some respondents also had adequate rest, reducing the impact of body weight on muscle strain. Additionally, a high BMI does not always indicate poor physical condition—some respondents with higher BMI may have had better muscle strength and mobility, making them less prone to MSDs. Riding posture, seat height, and handlebar distance may have a more direct influence on muscle and joint pressure (Ardana et al., 2023).

Supporting studies also indicate that BMI is not a dominant factor in predicting MSDs. Hussain et al. (2021) found that prolonged sitting, poor posture, low physical activity, high stress, and poor sleep quality play a more significant role. Other research involving public transport drivers also reported no significant association between BMI and MSDs (Fajriah and Faza, 2023; Hidayanti and Nugroho, 2023; Jaya et al., 2023). In those studies, adequate nutrition and physical resilience likely buffered the impact of body weight on MSDs risk. This suggests that BMI alone is not a reliable predictor of MSDs unless accompanied by other physical stressors or poor ergonomic conditions (Rika, 2022).

While smoking is known to have negative implications for musculoskeletal health, such as impairing oxygen delivery to muscle tissue and slowing recovery from microtrauma, its impact tends to manifest over a longer period. Additionally, biomechanical factors such as posture, riding duration, and physical workload have a more immediate effect on MSDs complaints. The influence of smoking may also be moderated by other variables like physical activity, nutrition, and sleep habits.

This finding aligns with previous studies that reported no significant association between smoking and MSDs, including research on garment workers and bus drivers (Kurniawan and Muzakir, 2024; Jaya et al., 2023). Interestingly, some non-smokers experienced more MSDs symptoms than smokers, possibly due to passive smoking or other dominant risk factors. The low variation in smoking habits among respondents and underrepresentation of heavy smokers may have limited the ability to detect a significant relationship.

Some drivers reported poor exercise habits but still engaged in physical activity through work-related tasks, such as walking to reach locations inaccessible by motorbike, carrying heavy loads, and stretching while waiting for passengers. These movements may offer some musculoskeletal benefits, yet not all forms of physical activity are equally effective in preventing musculoskeletal disorders (MSDs). Light or non-targeted exercises—those that do not specifically strengthen the muscles used during riding—may provide limited protection against MSDs.

This result is consistent with studies that found no significant relationship between exercise habits and MSDs among informal workers and sedentary employees (Hastuti et al., 2023). The lack of effect may be due to non-specific measurement methods, as exercise habits were self-reported without considering exercise type or effectiveness. Someone who claims to exercise regularly might only engage in light walking a few minutes per week, which is likely insufficient to

prevent MSDs. More structured and targeted exercise interventions could be necessary to achieve measurable protective outcomes.

The study found that 17 Grab-Bike drivers in Purwokerto reported a history of musculoskeletal conditions, mostly dislocations and bone fractures in the shoulder and leg. However, these injuries generally occurred several years ago, and their symptoms were no longer commonly experienced. All respondents with such histories had received medical treatment and physical therapy. Physical therapy can help prevent recurrence by strengthening the joints and improving stability and mobility, reducing the risk of musculoskeletal complaints (Arovah, 2021).

These findings are consistent with previous studies that reported no significant relationship between medical history and current MSDs complaints (Ningrum, 2023; Nababan *et al.*, 2024). This lack of association may be due to the effectiveness of rehabilitation and recovery over time. Moreover, most of the documented conditions were mild or non-chronic, which likely reduced their impact on current musculoskeletal health. As a result, the history of musculoskeletal disorders did not significantly influence present MSDs complaints among the drivers.

CONCLUSION

The factors influencing MSDs complaints among Grab-Bike online motorcycle drivers in Purwokerto, Indonesia were age and work tenure. Factors not influencing MSDs complaints included BMI, smoking habits, exercise habits, and history of MSDs. Among these, work tenure was the most influential factor. It is recommended that Grab-Bike drivers, particularly those with longer work durations, consider reducing their daily working hours where possible and ensure adequate rest periods during their shifts. This aligns with Article 90 of Law Number 22 of 2009 concerning Road Traffic and Transportation, which stipulates a maximum of 8 working hours per day for public transport drivers, with a mandatory 30-minute break after every 4 hours of continuous driving. Routine stretching exercises targeting commonly affected areas such as the neck and lower back are also advised to alleviate muscle strain due to prolonged sitting. Furthermore, drivers experiencing persistent or recurring discomfort should be encouraged to undergo regular medical check-ups to facilitate early intervention and prevent the worsening of symptoms.

REFERENCES

- Anam, K., Muhammad, I. and Anugrah, F. (2020) 'Analisis Keluhan Fisik Pengendara Ojek Online di Kabupaten Banyuwangi', *Prosiding Seminar Nasional IPTEK Olahraga*, pp. 1–5.
- Aprianto, B., Hidayatulloh, A.F. and Zuchri, F.N. (2021) 'Faktor Risiko Penyebab Musculoskeletal Disorders (MSDs) Pada Pekerja : A Systematic Review', *Jurnal Kesehatan Tambusai*, 2, pp. 16–25.
- Ardana, H.D., Juhara, S. and Rahayu, M. (2023) 'Usulan Desain Sasis Sepeda Motor Listrik Menggunakan Pendekatan Data Antropometri', *Jurnal Ilmiah Fakultas Teknik*, 3(2), pp. 158–169. Available at: <https://doi.org/10.33592/jimtek.v3i2.3766>.
- Arovah, N.I. (2021) *Olahraga Terapi Rehabilitasi pada Gangguan Musculoskeletal*. Yogyakarta: UNY Press.
- Binder, M.R. (2023) 'Chronic Musculoskeletal Pain and Disability: A Problem of Trapped Lactic Acid', *Rehabilitation Science*, 7(4), pp. 43–50.
- Djavadian, S., Farooq, B. and Meshkani, S.M. (2022) 'Demand for shared mobility to complement public transportation: human-driven and automated vehicles', *Shared Mobility and Automated Vehicles: Responding to socio-technical changes and pandemics*, pp. 191–210. Available at: https://doi.org/10.1049/pbtr020e_ch10.

- Dwiyanti, N. and Ariyanto, A. (2020) 'Hubungan Posisi Kerja Statis Terhadap Kejadian Nyeri Leher Pada Operator Komputer: Narrative Review', pp. 2–14. Available at: [chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/http://digilib.unisayogya.ac.id/5702/1/NindaDwiyanti_1610301043_S1Fisioterapi - Ninda 09 %281%29.pdf](chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/http://digilib.unisayogya.ac.id/5702/1/NindaDwiyanti_1610301043_S1Fisioterapi-Ninda09%281%29.pdf).
- Fajriah, N. and Faza, T.B. (2023) 'Analisis Risiko Keluhan Otot pada Aktivitas Mengemudi Bus dengan Metode HARM', Seminar Nasional Teknologi Informasi ..., pp. 14–22. Available at: <http://ejournal.uin-suska.ac.id/index.php/SNTIKI/article/view/25144%0Ahttp://ejournal.uin-suska.ac.id/index.php/SNTIKI/article/download/25144/9971>.
- Ferusgel, Agnes., Masni., Arti, N.A. (2020) 'Faktor yang Mempengaruhi Risiko Musculoskeletal Disorders (MSDs) pada Driver Ojek Online Wanita Kota Medan', Jurnal Penelitian Kesehatan Suara Forikes, 11, pp. 68–72.
- Gunung, I. P., Pebrunto, H., Wiatma, D. S., and Syahbani, A. H. (2020) 'Hubungan Usia, Masa Kerja, dan Durasi Kerja dengan Musculoskeletal Disorders (MSDs) pada Sopir Bus DAMRI Mataram Tahun 2020', 9.
- Hafizhah, N. A., and Fanani, E. (2024) 'Analisis Masa Kerja, Posisi Kerja dan Keluhan Musculoskeletal Disorders pada Driver Ojek di Kota Malang', Sport Science and Health, 6(3), pp. 278–292. Available at: <https://doi.org/10.17977/um062v6i32024p278-292>.
- Hastuti, A., Yulianti and Sulolipu, A. M. (2023) 'Faktor Yang Berhubungan Dengan Keluhan Musculoskeletal Disorders (MSDs) Pada Pegawai Yang Menggunakan Komputer Di RSUP Dr. Tadjuddin Chalid Kota Makassar', Window of Public Health Journal, 4(3), pp. 493–504. Available at: <https://doi.org/10.33096/woph.v4i3.812>.
- Hidayanti, E.F. and Nugroho, B.Y.S. (2023) 'Musculoskeletal Disorders and Body Mass Index (Bmi) Among Trans Rapid Bus (Brt) Drivers in Semarang', International Conference on Multidisciplinary Approaches in Health Science, 1(1), pp. 338–345. Available at: <https://ejournal.poltekkes-denpasar.ac.id/index.php/icmahs/article/view/3019>.
- Hussain, S., Zafar, M. and Awan, Z. (2021) 'Prolonged sitting, BMI and musculoskeletal discomfort among office workers: A cross-sectional study.', International Journal of Environmental Research and Public Health, 18(11), p. 5623.
- Hutabarat, Y. (2017) Dasar-Dasar Pengetahuan Ergonomi. Malang: Media Nusa Creative.
- Idug, S., Akinbode, M., and Bello, O.M. (2023) 'Performance evaluation of ride-hailing drivers in urban transport systems: Implications for service quality and driver motivation', Journal of Transport and Land Use, 16(1), pp. 101–119.
- Indriyani, Badri, P. R. A., Oktariza, R. T., and Ramadhani, R. S. (2022) 'Analisis Hubungan Usia, Masa kerja dan Pengetahuan terhadap Keluhan Musculoskeletal Disorders (MSDs)', Jurnal Kesehatan, 13(1), pp. 186–191. Available at: <https://doi.org/10.26630/jk.v13i1.2821>.
- Jaya, Bima and Porusia, M. (2023) Faktor-faktor Yang Berhubungan Kejadian Musculoskeletal Disorder Pada Pengemudi Bus Batik Solo Trans Kota Surakarta.
- Kurniawan, E. A. and Muzakir, H. (2024) 'Faktor-Faktor Yang Berhubungan Dengan MSDS Pada Penjahit Di Pt. Andria Fesyen Indonesia Tekstile', Indonesian Journal of Science, 1(3), pp. 890–895.
- Kurniawati, E. (2021) Manajemen Sumber Daya Manusia. Pekalongan: Penerbit Nasya Expanding Management.
- Minna Rika, A. K. (2022) 'Hubungan Antara Indeks Masa Tubuh Dengan Keluhan Muskuloskeletal Disorders (Studi Kasus pada Pekerja Operator Container Crane PT. X Surabaya)', Media Gizi Kesmas, 11(2), pp. 365–370. Available at: <https://doi.org/10.20473/mgk.v11i2.2022.365-370>.
- Nababan, D. P. W., Is, J. M., Nabela, D., Putra, O., and Wintah(2024) 'Hubungan Faktor Individu dan Pekerjaan dengan Keluhan Musculoskeletal Disorders (MSDs) pada Karyawan Kantor

- di Departemen Tambang PT. Semen Padang Tahun 2023', *Jurnal Kesehatan Tambusai*, 5(2), pp. 5619–5631.
- Ningrum, R.N. (2023) 'Keluhan Musculoskeletal Disorders (MSDS) Pada Pekerja', *HIGEIA (Journal of Public Health Research and Development)*, 7. Available at: <https://doi.org/https://doi.org/10.15294/higeia.v7iSup.63921>.
- NIOSH (2024) Musculoskeletal Health Program, NIOSH. Available at: [https://www.cdc.gov/niosh/research-programs/portfolio/musculoskeletal.html#:~:text=Musculoskeletal disorders \(MSDs\) are soft,%2C vibration%2C and awkward positions](https://www.cdc.gov/niosh/research-programs/portfolio/musculoskeletal.html#:~:text=Musculoskeletal disorders (MSDs) are soft,%2C vibration%2C and awkward positions).
- Putri, F.R.O., Faizal, D. and Adha, M.Z. (2022) 'Analisis Determinan Gangguan Muskuloskeletal di Kantor Kesehatan Pelabuhan Kelas II Banten', *Frame of Health Journal*, 1(1), pp. 66–79.
- Rahmah, S. and Herbawani, C.K. (2021) 'Faktor Resiko Penyebab Keluhan Musculoskeletal Disorders (MSDS) Pada Pekerja: Tinjauan Literatur', *PREPOTIF: Jurnal Kesehatan Masyarakat*, 6(1), pp. 1–14. Available at: <https://doi.org/10.31004/prepotif.v6i1.2909>.
- Riskesdas (2018) Laporan Riset Kesehatan Dasar 2018. Jakarta.
- Rukayah, S. and Lupita, L. (2020) 'Faktor-Faktor yang Berhubungan dengan Tingkat Kelelahan Kerja Pada Pengemudi Ojek Online di Wilayah Jakarta Timur Tahun 2019', *Jurnal Persada Husada Indonesia*, 7(25), pp. 31–37. Available at: <https://doi.org/10.56014/jphi.v7i25.287>.
- Satrio, M. A., Juhanna, I. V., Winaya, I. M. N., and Wibawa, A. (2020) 'Hubungan Sikap Kerja dan Durasi Berkendara Terhadap Kejadian Low Back Pain Non Spesific pada Pengemudi Ojek Online di Kota Denpasar', *Majalah Ilmiah Fisioterapi Indonesia*, 8(2), pp. 22–26.
- Septiani, L. (2023) 'Tren Jumlah Pengguna GoTo Gojek dan Grab, Siapa Paling Cepat?' , *Katadata* (Accessed: 26 September 2025).
- Sofyan, D. and Amir (2019) 'Determination of musculoskeletal disorders (MSDS) complaints level with Nordic Body Map (NBM)', *IOP Conference Series: Materials Science and Engineering*, 505(1), p. 012033. doi:10.1088/1757-899x/505/1/012033.
- Sunardi, Wati, A., Alchamdani, and Ayathollah, A., (2021) 'Faktor yang Berhubungan dengan Keluhan Musculoskeletal Disorders (MSDs) pada Pengendara Ojek Online', 12(February), pp. 155–159. Available at: <https://doi.org/10.33846/sf12nk334>.
- Sunarya, P.A., Chairani, A., Hardini, N., and Bustamam, N. (2024) 'Masa Kerja dan Lama Kerja Berhubungan dengan Keluhan Nyeri Punggung Bawah pada Pengemudi Ojek Daring Relationship between Working Period and Length of Work with Low Back Pain Complaints in OnlineTaxi Bike Drivers Partisipan dan Desain Studi', 16(3), pp. 135–140.
- WHO (2021) Cardiovascular diseases (CVDs). Available at: [https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-\(cvds\)](https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)) (Accessed: 28 March 2023).
- Wulanjani, R. (2024) Analisis Eksistensi Ojek Konvensional di Era Ekonomi Digital Perspektif Ekonomi Syariah (Studi Kasus Komunitas Ojek Konvensional Terminal Bulupitu Purwokerto). thesis. Universitas Islam Negeri Prof. K.H. Saifuddin Zuhri Purwokerto.