KEMAS 21 (3) (2026) 658-668

Jurnal Kesehatan Masyarakat

http://journal.unnes.ac.id/nju/index.php/kemas

Work Productivity through Low Back Pain among Garbage Truck Drivers in Makassar

Lestina Nurjanah[1]✉, Yahya Thamrin[1], Syamsiar S Russeng[1], Masyitha Muis[2], A. Arsunan Arsin[2]

[1]Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, 90245, Indonesia
[2]Department of Epidemiology, Faculty of Public Health, Hasanuddin University, 90245, Indonesia

Article Info

Article History:
Submitted Juni 2025
Accepted November 2025
Published January 2026

Keywords:
Low back pain; Work Productivity; Ergonomics; Garbage Truck Drivers

DOI
https://doi.org/10.1529/kemas.v21i3.34319

Abstract

Background: Low back pain is a Musculoskeletal disorder characterized by pain in the lumbar area. It is is commonly experienced by workers who perform repetitive physical activities, sit for long periods, or are exposed to vibration, such as truck drivers. This condition can interfere with comfort, concentration, and physical ability in carrying out tasks. As a result, Low back pain has the potential to reduce work productivity, which refers to an individual's ability to complete tasks effectively and efficiently according to predetermined targets. Objective: To analyze the direct and indirect effects of age, duration of work, years of service, delivery frequency, BMI, vibration, and working posture on work productivity through Low back pain among garbage truck drivers at the Antang Landfill. Methods: This research used a quantitative study with a cross-sectional approach and a sample size of 140 respondents obtained through purposive sampling. Data were collected using questionnaires and analyzed with SPSS. Results: Confidence Interval 95% (0,05). Indirect effects on work productivity through Low back pain were significantly shown by age (p=0.019), BMI (p=0.000), years of service (p=0.009), duration of work (p=0.009), working posture (p=0.004), delivery frequency (p=0.024), and vibration (p=0.028). Conclusion: Age, duration of work, years of service, BMI, delivery frequency, working posture and vibration have both direct and indirect effects on work productivity through Low back pain as an intervening variable

Introduction

The driving profession is a high-risk occupation for musculoskeletal disorders, such as muscle pain, cramps, and back pain. The main contributing factor is prolonged static sitting. Additionally, the limited workspace inside the vehicle cabin restricts body movement, causing muscle tension. These conditions can reduce work efficiency and lead to decreased productivity (Pasha, 2022). Work productivity is a crucial indicator in assessing the efficiency and performance of a work unit. According to the International Labor Organization (ILO), productivity refers to the relationship between output and input, where increased productivity means producing more with the same or fewer resources. In a healthy industrial relations system, increasing productivity is not only the responsibility of management but also requires the active participation of workers. Workers play a role as subjects who support the process of increasing productivity in the work environment. However, productivity will not be optimal if working conditions are not adequate. A poor work environment, low wages, excessive workloads, and minimal implementation of occupational safety and health (OSH) protocols can reduce employee morale and performance (ILO, 2022).

Work productivity is a crucial factor in

✉ Correspondence Address:
Department of Occupational Safety and Health, Faculty of Public Health, Hasanuddin University, 90245, Indonesia
Email: Lestinanurjanah04@gmail.com

pISSN 1858-1196
eISSN 2355-3596

ensuring the quality of public services, including in the waste transportation sector. However, the Indonesian Ministry of Health states that occupational health problems, especially those experienced by physical workers such as drivers and sanitation workers, contribute to decreased productivity in the informal sector and public services. One of the most common disorders is lower back pain caused by poor ergonomic posture, prolonged sitting, and exposure to vehicle vibrations. This situation not only affects the health of individual workers, but also impacts their performance and the effectiveness of the services they provide (Joben, 2022).

The World Health Organization (WHO, 2022) mentioned that the number of musculoskeletal disorders globally has reached 1.71 billion. Low back pain (LBP) ranks third among the main health problems worldwide. In 2022, the number of osteoarthritis sufferers was recorded at 528 million people, rheumatic disorders at 335 million cases in 2020, and LBP at 17.3 million cases. In industrial work environments, approximately 2–5% of employees experience low back pain each year (WHO, 2023). A report from the International Labor Organization (ILO) shows that the number of musculoskeletal disorder cases is on the rise in various countries. In Korea, there has been an increase of around 4,000 new cases. Meanwhile, a publication by The Prevention of Occupational Diseases reveals that musculoskeletal disorders (MSDs) account for around 59% of the total work-related illnesses recorded in Europe. In the United States, low back pain (LBP) is the primary cause of chronic conditions in individuals under the age of 45 and ranks third after vascular disease for those over the age of 45 (Latipah *et al*., 2022).

Low back pain (LBP) is one of the most common occupational health problems experienced by workers engaged in physically demanding or repetitive tasks. This condition generally arises from prolonged static postures, repetitive movements, and exposure to physical workload that exerts continuous pressure on the lumbar region (Saputra, 2020). Over time, these conditions can cause musculoskeletal strain, muscle stiffness, and discomfort in the lower back area. Individual factors such as age, length of employment, and body composition may further increase susceptibility to LBP, especially when combined with non-ergonomic work practices (Siregar *et al*., 2023). Furthermore, environmental factors such as limited workspace, vibration exposure, and inadequate rest periods can exacerbate the symptoms. The persistence of these complaints not only affects workers' physical well-being but also contributes to decreased concentration, reduced endurance, and decreased work performance. As LBP interferes with both the physical and psychological aspects of workers, it ultimately becomes a key factor influencing overall productivity in labor-intensive occupations (Tiasna & Wahyuningsih, 2023).

Nationally in Indonesia, low back pain (LBP) is classified as a significant health problem and ranks second after influenza as the most commonly reported illness. Although accurate databases on the distribution of low back pain (LBP) are still limited in terms of precision, its prevalence is estimated to range from 7.6% to 37% of the total population. Approximately 80% of the population has experienced low back pain (LBP) at least once in their lifetime, and more than 10% of the population is estimated to experience this complaint at some point. In the Makassar region itself, official data on low back pain (LBP) cases is not yet available, but several studies report that low back pain is one of the most common complaints in outpatient services, especially in neurology clinics. In general, the prognosis for low back pain (LBP) is favorable, even in cases involving nerve root irritation, with symptoms often improving within two months, whether with routine treatment or without specialized medical intervention. The high prevalence of Low Back Pain (LBP) among workers in the transportation sector, particularly drivers, indicates that jobs involving static sitting positions and long working hours significantly contribute to musculoskeletal disorders. This finding is supported by Aprianti *et al*., 2022, who identified that more than half of the respondents experienced LBP, with most symptoms subsiding after rest. It suggests that mechanical factors, such as repeated pressure on the lumbar area and lack of movement variation, are the primary triggers of the complaint (Aprianti *et al*., 2022).

The high prevalence of Low Back Pain (LBP) among workers in the transportation sector, particularly drivers, indicates that jobs involving static sitting positions and long working hours contribute significantly to musculoskeletal disorders (Jia *et al*., 2024). This finding is supported by research that identified more than half of the respondents experienced LBP, with most of the symptoms subsiding after rest. It indicates that mechanical factors such as repeated pressure on the lumbar area and a lack of movement variation are the primary triggers of the complaint. In the context of work productivity, low back pain affects not only the physical condition of workers but also impacts performance and attendance, making it a strategic issue in occupational health management. Therefore, addressing LBP cannot be separated from an ergonomic approach, lifestyle management, and comprehensive occupational safety policies. This issue becomes increasingly important to study because there are still few studies that examine the impact of occupational health risks on productivity using a mediating variable approach, such as low back pain. Understanding this relationship is crucial for designing effective ergonomic interventions and serves as a basis for policy-making that supports the protection of workers in the waste transportation sector.

Method

This quantitative study employed a cross-sectional design to examine the influence of individual, work, and environmental factors on work productivity through low back pain among garbage truck drivers. Purposive sampling was applied based on specific inclusion and exclusion criteria. Inclusion criteria included garbage truck drivers who transported waste to the Antang landfill and those who lived and worked in the Antang landfill. Exclusion criteria were drivers unwilling to participate or those absent from their vehicles during data collection. The final sample consisted of 140 respondents, and data collection was conducted from March to April 2025. Data were collected using a structured questionnaire covering individual characteristics (age, years of service, BMI), work characteristics (duration of work, delivery frequency, work posture, vibration exposure), lower back pain, and work productivity. 1) BMI was measured using a weighing scale and microtoise; 2) Work posture was assessed with the Rapid Entire Body Assessment (REBA) method; and 3) Vibration levels were recorded using a vibration meter. All data were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to summarize participant characteristics. Inferential analysis examined the effects of age, BMI, years of service, duration of work, work posture, delivery frequency, and vibration on work productivity mediated by low back pain.

Result and Discussion

Bivariate analysis was used to examine the relationship between independent variables, which included individual factors (age, body mass index, and length of service), occupational factors (working hours, job position, and delivery frequency), and environmental factors (exposure to vibration), with the intervening variable of lower back pain complaints and the dependent variable of work productivity:

Table 1. Relationship Between Age, Body Mass Index (BMI), Length of Service, Working Hours, Work Position, Delivery Frequency, Vibration, and Low Back Pain

Variables		LBP				Total		*p*-value
		Feeling		Not feeling				
		n	%	n	%	n	%	
Age	≥ 35 years old	71	50.7	45	32,1	116	82,9	0,004
	< 35 years old	7	5,0	17	12,1	24	17,1	
BMI	Abnormal	52	37,1	23	16,4	75	53,6	0,000
	Normal	26	18,6	39	27,9	65	46,4	

Working Period	> 3 years old	54	38,6	26	18,6	80	57,1	0,001
	< 3 years old	24	17,1	36	25,7	60	42,9	
Length Of Service	> 8 hours/day	64	45,7	37	26,4	101	72,1	0,003
	< 8 hours/day	14	10,0	25	17,9	39	27,9	
Work Position	Not ergonomic	8	5,7	21	15,0	29	20,7	0,001
	ergonomic	70	50,0	41	29,3	111	79,3	
Delivery Frequency	More than once a day	25	17,9	7	5,0	32	22,9	0,004
	Once daily	53	37,9	55	39,3	108	77,1	
Vibration	Passing NAB	49	35,0	23	16,4	72	51,4	0,002
	Do not exceed NAB	29	20,7	39	27,9	68	48,6	

The analysis results show that there is a significant relationship between several factors and lower back pain complaints among respondents. Those aged ≥ 35 years had 71 complaints (50.7%) with a p-value of 0.004, 52 people (37.1%) had an abnormal Body Mass Index (BMI) with a p-value of 0.000, more than 3 years of work experience in 54 people (38.6%) with a p-value of 0.001, working more than 8 hours per day in 64 people (45.7%) with a p-value of 0.003, ergonomic work positions in 70 people (50.0%) with a p-value of 0.001, delivery frequency of once per day in 55 people (39.3%) with a p-value of 0.004, and vibration exposure exceeding the Threshold Limit Value (TLV) >0.8661 m/s^2 in 49 people (35.0%) with a p-value of 0.002. All p-values obtained were less than the significance level of 0.05, indicating

Table 2. The Relationship Between Age, Body Mass Index (BMI), Length of Service, Working Hours, Work Position, Delivery Frequency, and Vibration with Work Productivity

Variables	LBP			Total		*p*-value
	Feeling	No feeling				
	n	n	%	n	%	
Age	≥ 35 years old	50.7	45	32,1	116	82,9	0,004
	< 35 years old	5,0	17	12,1	24	17,1	
BMI	Abnormal	37,1	23	16,4	75	53,6	0,000
	Normal	18,6	39	27,9	65	46,4	
Working Period	> 3 years old	38,6	26	18,6	80	57,1	0,001
	< 3 years old	17,1	36	25,7	60	42,9	
Length Of Service	> 8 hours/day	45,7	37	26,4	101	72,1	0,003
	< 8 hours/day	10,0	25	17,9	39	27,9	
Work Position	Not ergonomic	5,7	21	15,0	29	20,7	0,001
	ergonomic	50,0	41	29,3	111	79,3	
Delivery Frequency	More than once a day	17,9	7	5,0	32	22,9	0,004
	Once daily	37,9	55	39,3	108	77,1	
Vibration	Passing NAB	35,0	23	16,4	72	51,4	0,002
	Do not exceed NAB	20,7	39	27,9	68	48,6	

Table 3. The Relationship Between Low back Pain and Work Productivity

Variables		Work Productivity				Total		*p*-value
		Insufficient		Good				
		n	%	n	%	n	%	
Low Back Pain	Feeling	66	47,1	12	8,6	78	55,7	0,000
	No feeling	2	1,4	60	42,9	62	44,3	
Total						**140**	100,0	

that age, BMI, length of service, duration of work, job position, delivery frequency, and vibration exposure were significantly associated with lower back pain complaints.

The results of the study indicate a significant relationship between several factors and the work productivity of respondents. Those aged ≥ 35 years were recorded as having low productivity, with 64 people (45.7%) and a p-value of 0.001. Respondents with an abnormal Body Mass Index (BMI) had lower productivity, with 45 people (32.1%) and a p-value of 0.004. work experience > 3 years in 48 people (34.3%) with a p-value of 0.002, working hours > 8 hours/day in 60 people (42.9%) with a p-value of 0.000, ergonomic work positions in 61 people (43.6%) with a p-value of 0.003, delivery frequency of once per day actually showed good productivity in 65 people (46.4%) with a p-value of 0.000, and vibration exposure exceeding the Threshold Limit Value (TLV) >0.8661 m/sec^2 was associated with low productivity in 48 people (34.3%) with a p-value of 0.000. All Chi-square test results yielded p-values <0.05. Thus, age, BMI, length of service, working hours, job position, delivery frequency, and vibration exposure have a significant relationship with work productivity. The relationship between lower back pain and work productivity can be seen in the table above. The majority of respondents experienced lower back pain, namely 66 respondents or 47.1%, with low work productivity. The results of the Chi-square test examining the relationship between lower back pain and work productivity indicate that there is a significant relationship, as the p-value is 0.000 < 0.05. Multivariate analysis in this study uses a path analysis approach through the Statistical Package for the Social

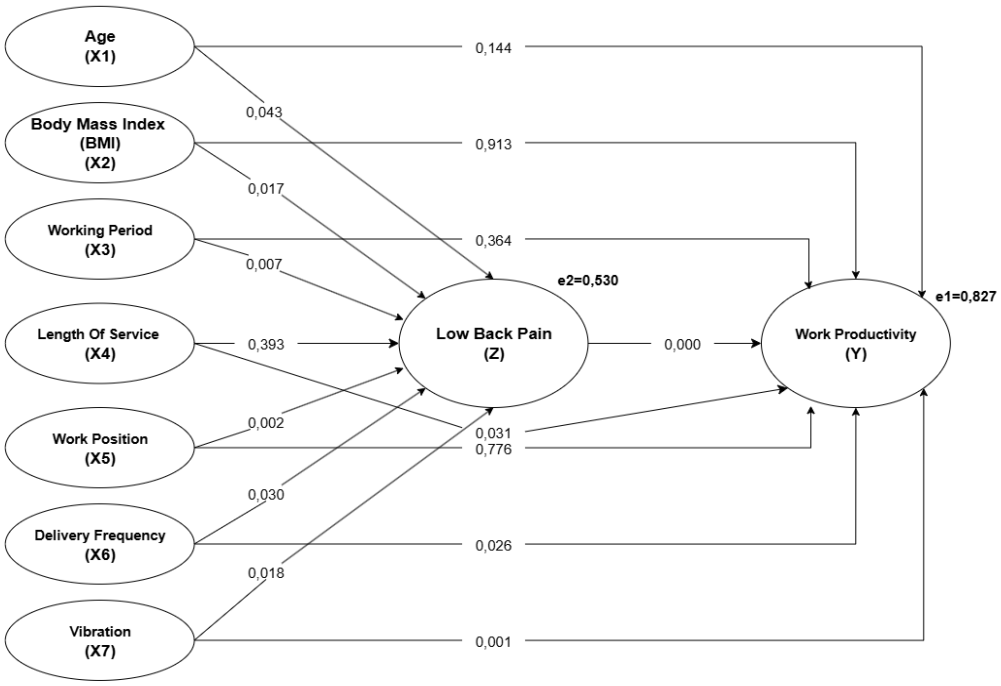

Figure 1. Path Analysis Model Construction

Table 4. Results of the Analysis of the Direct Effect of Independent Variables on Dependent Variables and Intervening Variables

No	Research Variables	Direct Effect		
		Estimate	*p*	Conclusion
1	Age→Low Back Pain	0,203	0,043	Significant
2	BMI→Low Back Pain	0,179	0,017	Significant
3	Working Period →Low Back Pain	0,206	0,007	Significant
4	Length Of Service →Low Back Pain	0,074	0,393	Insignificant
5	Work Position→Low Back Pain	-0,290	0,002	Significant
6	Delivery Frequency→ Low Back Pain	0,191	0,030	Significant
7	Vibration→Low Back Pain	0,175	0,018	Significant
8	Age→Work Productivity	0,096	0,144	Insignificant
9	BMI→ Work Productivity	-0,005	0,913	Insignificant
10	Working Period → Work Productivity	0,045	0,364	Insignificant
11	Length Of Service → Work Productivity	0,122	0,031	Significant
12	Work Position→ Work Productivity	-0,017	0,776	Insignificant
13	Delivery Frequency→ Work Productivity	0,129	0,026	Significant
14	Vibration → Work Productivity	0,162	0,001	Significant
15	Low Back Pain→ Work Productivity	0,686	0,000	Significant

Sciences (SPSS) software. This method allows testing the direct and indirect effects between variables, using regression analysis involving intervening variables. Intervening variables act as mediators that bridge the relationship between independent and dependent variables. The conceptual model design used in this study is shown in the following figure.

Based on the analysis results, several variables were found to have a significant effect on lower back pain and work productivity, with varying degrees of influence. Age significantly affects lower back pain (p=0.043; estimate=0.203), BMI is significant (p=0.017; estimate=0.179), length of service is significant (p=0.007; estimate=0.206), while working hours are not significant (p=0.393; estimate=0.074), work position was significant (p=0.002; estimate=0.191), delivery frequency was significant (p=0.030; estimate=0.191), and vibration was significant (p=0.018; estimate=0.175). All of these effects were classified as weak because the estimated value was <0.3. In terms of work productivity, age (p=0.144; estimate=0.096), BMI (p=0.913; estimate=-0.005), length of service (p=0.364; estimate=0.045), and job position (p=0.776; estimate = -0.017) were not significant, while working hours were significant (p = 0.031; estimate = 0.122), delivery frequency was significant (p = 0.026; estimate = 0.129), and vibration was significant (p = 0.001; estimate = 0.160), with all effects classified as weak. Lower back pain significantly affects work productivity (p=0.000; estimate=0.674) with a positive direction and a strong category, meaning that the lower the level of lower back pain complaints, the more work productivity tends to increase significantly. Indirect testing is shown in a structural model with statistical values. The influence value is obtained from the multiplication between the direct influence of the variable (X→Y)*(X→Z). The following are the results of indirect testing

Based on the analysis results, independent variables indirectly affect dependent variables through the mediation mechanism of lower back pain, where the effect is considered significant if the significance value is <0.05. The results show that age indirectly affects work productivity through lower back pain (p=0.019). Also, Body Mass Index (BMI) (p=0.000), length of service (p=0.009), working hours (p=0.009), job position (p=0.004), delivery frequency (p=0.024), and vibration exposure (p=0.028). Thus, lower back pain acts as a significant

Table 5. Results of the Analysis of the Indirect Effect of Independent Variables on Dependent Variables and Intervening Variables

No	Hypothesis	Direct Effect	Indirect Effect
1	Age→Low Back Pain→ Work Productivity	0,043	0,019
2	BMI→Low Back Pain→ Work Productivity	0,017	0,000
3	Working Period→Low Back Pain→ Work Productivity	0,007	0,009
4	Length Of Service→Low Back Pain→ Work Productivity	0,393	0,009
5	Work Position→Low Back Pain→ Work Productivity	0,002	0,004
6	Delivery Frequency→Low Back Pain→ Work Productivity	0,030	0,024
7	Vibration→Low Back Pain→ Work Productivity	0,018	0,028

mediator variable in bridging the relationship between age, BMI, length of service, duration of work, work position, delivery frequency, and vibration exposure with the respondents' work productivity levels.

Age is one of the individual factors that can affect the health and physical capacity of workers, including the incidence of lower back pain. As we age, degenerative changes occur in body structures like muscles, joints, and the spine, making individuals more prone to musculoskeletal complaints, particularly lower back pain. These complaints can interfere with comfort and flexibility at work, as well as reduce concentration and speed in completing tasks. Thus, the effect of age on work productivity can occur indirectly through an increased risk of lower back pain. It means that the older a person gets, the greater the likelihood of experiencing lower back pain, which can reduce work productivity due to physical limitations or absences caused by these complaints. The results of this study indicate that age does not directly affect work productivity (p=0.144), but it significantly affects low back pain (p=0.043). Additionally, the indirect effect of age on work productivity through low back pain is also significant (p=0.019).

It shows that the indirect effect of age on work productivity through low back pain is significant. Therefore, low back pain plays a notable mediating role in the relationship between age and work productivity. It means that as a person ages, they are more likely to experience low back pain, which can reduce work productivity. It is in line with the findings of Hanif (2022), who reported that 77.8% of workers under the age of 35 already experience moderate levels of musculoskeletal disorders (MSDs). Thus, in this study, age is not the dominant individual factor influencing musculoskeletal disorders (MSDs). MSDs caused by age-related characteristics can be reduced by improving workers' physical fitness and strength, such as maintaining a healthy diet, exercising, and getting adequate rest. Companies can reduce the weight of loads carried by workers over 35 years of age (Hanif, 2022).

Body Mass Index (BMI) is an indicator of nutritional status based on weight and height. A BMI that falls outside the normal range, whether overweight or underweight, can impact musculoskeletal health, including an increased risk of lower back pain. Individuals with a high BMI tend to experience greater stress on the spine and back muscles, while a low BMI may reflect a lack of muscle mass to support physical activity. This condition can reduce comfort and physical work capacity, thus impacting productivity. Thus, BMI indirectly impacts work productivity through the risk of lower back pain. The results of this study indicate that BMI does not directly affect work productivity (p=0.913), but it significantly affects low back pain (p=0.017). Additionally, the indirect effect of BMI on work productivity through low back pain is also significant (p=0.000) (Lewandowska *et al*., 2020).

This study indicates that workers with a higher Body Mass Index (BMI) (overweight or obese) tend to be at greater risk of experiencing low back pain. It may be due to greater mechanical stress on the spine, poor work

posture, and excessive pressure on muscles and joints. The low back pain experienced then impacts reduced comfort and work efficiency, thereby lowering work productivity. It is in line with the findings of (Afro & Paskarini, 2022) that although the majority of respondents had a Body Mass Index (BMI) in the normal category, complaints of Musculoskeletal Disorders (MSDs) remained high. The analysis results showed a correlation coefficient value of 0.055, indicating a very weak relationship between BMI and MSD complaints. This weak relationship is likely due to the generally good nutritional status of the respondents and sufficient rest time, ensuring that workloads do not exceed muscle capacity. Nevertheless, the high incidence of MSD complaints can still impact work productivity, as musculoskeletal system disorders can hinder the smoothness of physical activities and reduce efficiency in completing work tasks (Afro & Paskarini, 2022).

Work history is the total duration or length of time a person has worked in a particular field or position over the years. The longer a person's work history, the greater their accumulation of exposure to ergonomic risk factors, such as repetitive lifting, suboptimal working positions, and continuous mechanical vibration. This long-term exposure can increase the likelihood of musculoskeletal disorders, particularly lower back pain (Atallah *et al*., 2022). Lower back pain experienced as a result of accumulated workloads over many years can hinder mobility, reduce comfort at work, and decrease focus and work efficiency. Thus, length of service can indirectly affect productivity through an increased risk of lower back pain, where the longer a person works, the greater the chance of decreased work productivity due to such complaints. The results of this study indicate that work duration does not directly affect work productivity (p=0.364), but it significantly affects low back pain (p=0.007). Additionally, the indirect effect of work duration on work productivity through low back pain is also significant (p=0.009).

This study indicates that this is likely due to the fact that the longer a person works, the greater the likelihood that they will experience increased physical workload and stress, which can lead to musculoskeletal complaints such as low back pain. These complaints then have an impact on physical ability and comfort at work, thereby reducing productivity. It is not in line with the findings of Indriyani *et al*., (2021), who found that the correlation coefficient between length of service and work productivity was -0.050, meaning that the strength of the relationship between length of service and work productivity was 0.050, or very weak. A negative correlation coefficient indicates an inverse relationship, meaning that as work experience increases, work productivity decreases (Indriyani *et al*., 2021).

Working hours refer to the duration of daily working hours spent by a person while performing work activities. Prolonged exposure to work without adequate rest can cause muscle fatigue and repetitive mechanical stress, especially in the lower back area. It has the potential to cause lower back pain, especially if work activities involve non-ergonomic positions, heavy lifting, or continuous vibration. Lower back pain caused by the accumulation of physical strain during long working hours can interfere with workers' comfort and concentration, as well as reduce work efficiency and speed. Therefore, working hours can indirectly affect productivity by increasing the risk of lower back painThe longer the working hours, the greater the potential for reduced productivity due to musculoskeletal complaints. The results of this study indicate that work duration directly affects work productivity (p=0.031), but does not significantly affect low back pain (p=0.393). Additionally, the indirect effect of work duration on work productivity through low back pain is also significant (p=0.009).

Long driving hours reflect high daily workloads and can bring physical fatigue due to continuous muscle contractions, especially in the lower back. This condition restricts oxygen flow to the muscles and increases lactic acid accumulation, which contributes to pain. When such complaints arise, comfort and physical endurance decrease, thereby hindering the smooth completion of tasks. Therefore, high work intensity in the form of prolonged driving time has the potential to reduce productivity by increasing the risk of musculoskeletal disorders

(Carlos *et al*., 2016). It is in line with the findings of Gagliardi *et al.* (2021). Employee tenure in a company contributes to increased productivity, mainly due to the accumulation of organizational knowledge and work experience. However, this relationship is not linear. Productivity tends to be high at the beginning of employment, then declines or stagnates as years of service increase. This decline may be attributed to burnout, reduced motivation, or limitations in learning new skills. The positive effects of tenure are better in routine and simple jobs, but less significant in complex and dynamic roles (Gagliardi *et al*., 2021).

Work posture describes the position of a worker's body while performing activities, whether sitting, standing, bending, lifting, or twisting. Non-ergonomic postures such as bending over for too long, lifting weights using incorrect techniques, or sitting in a static position without back support can increase mechanical stress on the spine and back muscles. Continuous exposure to improper work postures can lead to lower back pain. This condition can interfere with movement, reduce comfort, and decrease work efficiency. Thus, work posture indirectly contributes to productivity by increasing the risk of musculoskeletal disorders that can limit workers' physical performance. The results of this study indicate that work posture does not directly affect work productivity (p=0.776), but it significantly affects low back pain (p=0.002). Additionally, the indirect effect of work posture on work productivity through low back pain is also significant (p=0.004).

These findings indicate that work posture plays a crucial role in occupational health, particularly in preventing low back pain. But it does not directly affect worker performance or productivity. It means that the impact of work posture on productivity is more indirect, in that discomfort or physical complaints resulting from non-ergonomic work postures can affect workers' ability to focus, endure long working hours, and complete tasks efficiently. Poor posture can shift the body's center of gravity forward, placing strain on the back muscles (erector spinae) and stretching the ligaments along the spine. If this persists over time, it can lead to mechanical injuries that cause back pain. Additionally, excessive pressure on the intervertebral discs can cause the disc's inner contents to protrude and compress the spinal nerves, a condition known as Herniated Nucleus Pulposus (HNP) (Latipah *et al*., 2022).

The frequency of deliveries reflects how often a worker, such as a garbage truck driver, performs transportation activities in a single workday. The higher the frequency, the greater the exposure to physical strain, such as lifting, getting in and out of vehicles, sitting for long periods, and exposure to vibration while driving. Repetitive activities without adequate rest can increase the risk of lower back pain (LBP). This complaint can interfere with comfort, slow down movement, and reduce physical endurance, which ultimately impacts work productivity. Thus, delivery frequency indirectly affects productivity by increasing the risk of musculoskeletal complaints. As a result, work productivity may decrease indirectly due to musculoskeletal complaints. The results of this study indicate that the frequency of deliveries directly affects work productivity (p=0.026) and significantly affects low back pain (p=0.030). Additionally, the indirect effect of delivery frequency on work productivity through low back pain is also significant (p=0.024).

Delivery frequency is a crucial factor that affects low back pain and work productivity. The higher the delivery frequency, the greater the risk of drivers experiencing low back pain, and at the same time, this frequency is also associated with increased productivity. Driving is a job with high physical and psychological workloads, especially when traveling long distances with long travel times and limited rest. The frequency of deliveries exacerbates this condition because drivers are exposed to repetitive activities such as sitting for long periods, lifting heavy loads, and receiving vibrations from the vehicle. The continuous physical strain without sufficient recovery can lead to low back pain, impacting stamina, focus, and the ability to perform tasks effectively (Patandung & Widowati, 2022).

Vibration is one of the physical factors in the work environment commonly experienced by workers who use vehicles or machinery, such as garbage truck drivers. Continuous exposure

to whole-body vibration can affect the structure of the spine and its supporting tissues. In the long term, vibration can cause biomechanical disorders, muscle tension, and microtrauma in the lower back area, which can trigger pain complaints. This condition can reduce work comfort, limit the flexibility of movement, and reduce work effectiveness. Thus, high and prolonged exposure to vibration can have an indirect impact on reduced productivity through an increased risk of lower back pain. As a result, movement becomes restricted, discomfort increases, and performance decreases. The results of this study indicate that vibration affects work productivity (p=0.001) and significantly affects low back pain (p=0.018). Additionally, the indirect impact of vibration on work productivity through low back pain is also significant (p=0.028).

These findings suggest that exposure to vibration affects not only workers' physical health but also directly impacts their work performance and productivity. Excessive vibration can cause discomfort, fatigue, and musculoskeletal disorders, reducing work efficiency. Therefore, controlling exposure to vibration is a crucial part of managing occupational safety and health. Measures such as regular vehicle maintenance, using vibration-dampening seats, and providing adequate rest breaks can minimize health risks while maintaining long-term productivity. These findings are in line with those of Golinko *et al.* (2020), who found that although bus drivers are not directly exposed to whole-body vibration compared to truck drivers, bus drivers work relatively longer hours in a static position, are bound by schedules, complicated routes, inter-city and inter-provincial traffic jams, and an increase in the number and density of passengers (Golinko *et al.*, 2020). The vibrations emitted by the engine to workers on a continuous basis will have an impact on tissue and organ damage in workers. Working for a long time in vehicles or in work environments with high vibration hazards has the potential to cause lower back pain. Whole Body Vibration (WBV) generated by motor vehicles can cause low back pain when drivers spend extended periods of time in vehicles with vibration levels exceeding the Threshold Limit Value (TLV) (Djuartina *et al.*, 2020).

Conclusion

Based on the results of the study, age, Body Mass Index (BMI), length of service, job position, delivery frequency, and vibration were found to have a direct effect on the increase in lower back pain complaints among garbage truck drivers at the Antang Landfill in Makassar City, while length of service had no significant effect. Regarding work productivity, the factors that directly influence it are work duration, delivery frequency, vibration, and lower back pain. While age, BMI, work experience, and job position do not show a significant direct influence. Furthermore, low back pain was proven to be a significant mediating variable in bridging the relationship between age, BMI, length of service, length of work, job position, delivery frequency, and vibration on work productivity, thus confirming that lower back pain plays a crucial role in affecting the productivity of garbage truck drivers at the Antang landfill in Makassar City.

References

Afro, H.S., & Paskarini, I., 2022. The Relationship Between Body Mass Index and Smoking Habits with Musculoskeletal Disorders Complaints Among Rice Farmers in Doho Village, Madiun Regency, East Java. Preventif: Journal of Public Health, 13(1), pp.98–111.

Aprianti, R., Sanisahhuri., & Puspita, P., 2022. The Incidence of Low Back Pain Complaints on Bus Drivers in terms of Working Period. Journal of Health Sciences, 29(3).

Atallah, A.A., Althuwaybi, S.E., Faydh, J.A., Alsherbi, R.K., Alsufyani, M.E., & Aljuaid, H.M.. 2022. Prevalence of Lower Back Pain and its Relationship with Driving Postures among Drivers in Taif, Saudi Arabia. Journal of Pharmacy & Bioallied Sciences, 14(Suppl 1), pp.S433–S438.

Carlos, D., Yasnani, Y., & Afa, J., 2016. Factors Related to Fatigue Among Tank Truck Drivers at the PT Pertamina (Persero) Fuel Terminal in Latambaga District, Kolaka Regency, in 2016. Unsyiah Public Health Student Scientific Journal, 1(4), pp.185972.

Djuartina, T., Yauwono, A., Irawan, R., & Steven, A., 2020. The Relationship Between Whole Body Vibration Exposure and Low Back Pain

in Online Motorcycle Taxi Drivers. Journal of the Indonesian Medical Association, 70(10), pp.222–227.

Gagliardi, N., Grinza, E., & Rycx, F., 2021. Workers' Tenure and Firm Productivity: New Evidence from Matched Employer-Employee Panel Data. Industrial Relations, 62(1), pp.3–33.

Golinko, V., Cheberyachko, S., Deryugin, O., Tretyak, O., & Dusmatova, O., 2020. Assessment of the Risks of Occupational Diseases of the Passenger Bus Drivers. Safety and Health at Work, 11(4), pp.543–549.

Hanif, A., 2022. The Relationship Between Age and Smoking Habits with Musculoskeletal Disorders (MSDs) Complaints Among Porters at UD Maju Makmur in Surabaya. Medical Technology and Public Health Journal, 4(1).

ILO., 2022. Productivity and Decent Work A Workers' Manual Decent Work in Garment Supply Chains Asia.

Indriyani, S., Jayanti, S., & Kurniawan, B., 2021. Hubungan Antara Kelelahan Mata dan Produktivitas Kerja di Kalangan Penjahit Sektor Informal di Desa X. FKM UNDIP Public Health Journal, 9(5).

Jia, J., Zhang, M., Cao, Z., Yang, Z., Hu, X., Lei, S., Zhang, Y., Leng, W., & Kang, X., 2024. Prevalence of and Risk Factors for Low Back Pain Among Professional Drivers: A Systematic Review and Meta-Analysis. Journal of Orthopaedic Surgery and Research, 19(1), pp.551.

Joben., 2022. Factors Affecting Employee Work Productivity. Journal of Management, Economic and Accounting (JMEA), 1(1).

Latipah, S., Sa'adah, N., & Ahmad, S., Nur, A., 2022. Faktor-Faktor Penentu Durasi Duduk dan Posisi Duduk dalam Terjadinya Nyeri Punggung Bawah pada Karyawan Pabrik Sablon. JKFT Journal: Muhammadiyah University Tangerang, 7(1).

Lewandowska, K., Weisbrot, M., Cieloszyk, A., Mędrzycka-Dąbrowska, W., Krupa, S., & Ozga, D., 2020. Impact of Alarm Fatigue on the Work of Nurses in an Intensive Care Environment—A Systematic Review. International Journal of Environmental Research and Public Health, 17(22), pp.8409.

Pasha, C., 2022. Factors Associated with the Incidence of Low Back Pain Among Bus Drivers at the Daya Regional Terminal in Makassar City in 2022. Skripsi. Hasanuddin University.

Patandung, L.N., & Widowati, E., 2022. Body Mass Index, Work Fatigue, Physical Work Load and Musculoskeletal Disorders. Higeia Journal of Public Health Research and Development, 6(1), pp.126–135.

Saputra, A., 2020. Work Attitude, Length of Service, and Age on Low Back Pain Complaints among Batik Crafters. Higeia Journal of Public Health Research and Development, 4(Special 1), pp.147–157.

Siregar, S.D., Manalu, P., Ginting, R., Hulu, V.T., & Siallagan, C.P., 2023. Complaints of Low Back Pain in Santy Tailors. Kesmas: National Public Health Journal, 18(3), pp.437–445.

Tiasna, R.K., & Wahyuningsih, A.S., 2023. Low Back Pain Complaints Among Workers at Salt Production Centers. Higeia Journal of Public Health Research and Development, pp.7(1), 19–31.

WHO., 2023. Low Back Pain - World Health Organization (WHO). WEB World Health Organization (WHO).