

ASSOCIATION BETWEEN WORKING DURATION AND DRIVER CHARACTERISTICS WITH SUBJECTIVE FATIGUE AMONG DUMP TRUCK DRIVERS

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ABSTRACT

Work fatigue is a major risk factor contributing to occupational accidents in the mining industry, particularly among dump truck drivers who are exposed to long working hours, high physical demands, and harsh environmental conditions. This study aimed to analyze the relationship between work duration and driver characteristics, including age, body mass index (BMI), and length of service, with subjective fatigue levels among dump truck drivers at PT X mining site. A cross-sectional study design was employed involving 40 dump truck drivers as respondents. Subjective fatigue was assessed using the Industrial Fatigue Research Committee (IFRC) questionnaire, while relationships between variables were analyzed using the Chi-square test. The results showed that most dump truck drivers worked more than 8 hours per day (90%), were in the productive age group (72.5%) and were classified as overweight based on BMI (50%). The majority of respondents experienced low levels of subjective fatigue (80%). Bivariate analysis revealed that BMI was the only variable significantly associated with subjective fatigue ($p = 0.048$), while work duration, age, and length of service showed no significant relationship. In conclusion, body mass index was identified as the only variable significantly associated with subjective fatigue among dump truck drivers. The conclusion could be more focused on the main statistical finding. Therefore, fatigue prevention strategies should primarily focus on nutritional and health management to support driver performance and enhance occupational safety

Keywords: Driver, Dump truck, Mining, Work Fatigue.

INTRODUCTION

The mining sector plays a strategic role in Indonesia's economic development and depends heavily on effective internal transportation systems (Nurdiawati & Safira, 2020). Dump truck drivers are central to this system, responsible for continuous material transportation across vast mining areas, including loading and dumping points (Imbara et al., 2023). The prolonged driving duration, repetitive tasks, and high physical and mental demands expose dump truck drivers to a high risk of occupational fatigue, making them a critical focus in mining safety and health research.

Data from *the International Labour Organization (ILO)* in 2021 indicate that work fatigue remains a major contributor to occupational accidents worldwide, resulting in more than two million work-related deaths annually. In Indonesia, the Ministry of Energy and Mineral Resources' MODI data in 2023 reported 105 minor accidents, 65 serious accidents, and 48 deaths in the mining sector (Abdi Pratama D et al., 2024). The Indonesian Ministry of Manpower noted that 9% of

the total 7,298 work accidents that occurred in 2021. These findings highlight fatigue as a critical risk factor in occupational accidents. Among dump truck drivers in the mining sector, fatigue is influenced not only by physical workload but also by psychosocial stressors and non-ergonomic working conditions, which can impair concentration, reaction time, and driving performance. (Suwignyo et al., 2022)

Theoretically, *Heinrich's* modified domino theory explains that occupational accidents arise from interactions between human, job, and system factors, with unsafe actions as a primary cause. Work fatigue is a key trigger of unsafe actions because it reduces concentration, alertness, and decision-making ability. Previous studies report that 80–85% of occupational accidents are related to human factors, including fatigue, stress, and inadequate skills. (Nugroho SA et al., 2024)

Research conducted by the *Safety Health and Environment (SHE)* division of PT Hasnur Riung Sinergi in 2018 reported 1 case of a *dump*

truck driver whose incident was due to the mild fatigue condition of a 36-year-old worker. ⁽⁶⁾ In addition, based on secondary data from PT Mitra Mekongga Sejahtera, it was recorded that there were 15 work accidents that occurred to *dump truck* drivers , namely from January to July 2023 (Yulianti N, *et al.*, 2024) The form of accidents that occurred was such as collisions between *dump* trucks, brake failures and *dump trucks* upside down. In the case of this accident, it is related to unsafe behavior carried out by *dump truck* workers/drivers such as lack of concentration (lack of focus when driving the unit), haste and lack of mastery of *dump truck driving skills* (Iswandi E., *et al* 2019)

The mining activity that has the highest risk is the operation of the unit, especially the *hauler* unit which is included in the critical risk. Dump truck operators have higher mobility than other equipment operators due to extensive work areas covering loading and dumping activities at mines, crushers, heap leach pads, and project sites. These tasks require sustained concentration and are performed

continuously until scheduled rest periods, which increases the potential for work fatigue among hauler unit operators at PT X. Hauling activities increase the risk of work fatigue due to continuous driving, long travel distances, and repetitive loading–dumping tasks that require sustained concentration. Prolonged exposure to these conditions places dump truck operators at higher risk of physical and mental fatigue (Azzahra F., 2025)

Although work fatigue has been identified as an important factor in the cause of accidents in the mining sector, studies that specifically examine the relationship between work duration and driver characteristics (Age, Body Mass Index, and Working Period) on subjective fatigue levels in *dump truck* drivers are still limited, especially in the context of mining contractors in Indonesia. Most previous studies have focused more on work environment factors. In addition, the results of the study on the influence of individual characteristics on fatigue show inconsistent findings. Therefore, a study is needed that

analyzes the relationship between work duration and driver characteristics to subjective fatigue as a basis for strengthening fatigue management programs in the mining sector.

Based on these gaps, this study aims to analyze the relationship between work duration and driver characteristics (Age, BMI, Working Period) to the subjective level of fatigue in *dump truck drivers of PT X site PT Y-South Sumatra*.

RESEARCH METHODS

This research was conducted on PT X, which is a mining contractor company operating at the PT Y Site, South Sumatra as a mining concession holder (*owner*). PT X has a main role in daily operational activities in the form of transporting materials using the fleet *dump truck*, including activities *Hauling* from *front* mining to disposal areas or other supporting facilities. As a contractor, PT X is responsible for meeting the production targets set by PT Y and ensuring that all operational activities run in accordance with

occupational safety and health standards.

This study is an observational quantitative analytical study with a *cross-sectional design*, which aims to determine the relationship between working duration and driver characteristics with subjective fatigue levels. The research was conducted in the operational area of *dump truck* drivers at the mining contractor company, namely PT X. This research was conducted from July to August 2025.

The sample in this study is all *dump truck drivers* who were actively working at the time of the research at PT Y in South Sumatra which was divided into PT X partners during the study as many as 40 people, so that the entire population was used as a research sample. The sampling technique used was **total sampling**, where all members of the population who met the inclusion criteria were included as respondents. The selection of total sampling was carried out to obtain a complete and representative picture of the subjective level of fatigue in *dump truck* drivers, while minimizing selection bias that

can occur if only a part of the population is studied. Inclusion and exclusion were used as research respondents. The inclusion criteria are drivers who have worked for at least 6 months, are actively on duty, and are willing to fill out a complete questionnaire. The exclusion criteria are drivers who are on leave or sick and who fill out incomplete questionnaires.

The main instrument used was the *Industrial Fatigue Research Committee* (IFRC Japan) questionnaire to measure subjective fatigue levels. Fatigue The IFRC Questionnaire consists of 30 indicators of fatigue symptoms, such as drowsiness, loss of concentration, body aches, and focus disorders, with assessments using a frequency scale. The validity of the content of this instrument is based on the conformity of the indicator with the concept of physical and mental work fatigue, while its reliability has been tested in previous studies with a reliability coefficient value that indicates adequate internal consistency. Data on driver characteristics was also collected which included work duration per shift, age, Body Mass Index (BMI) obtained

from the calculation of weight and height, and working period. All data were analyzed using SPSS, with Chi-square test because the variables analyzed were categorically scaled which assessed the relationship between characteristic variables and work duration and subjective fatigue levels. If cells with an expected value of less than five are found, then an analysis adjustment is made (*Fisher's Exact test*). Statistical testing was carried out at a significance level of 95% ($\alpha = 0.05$). This research has obtained **research ethics approval** from the Faculty of Public Health, Diponegoro University (No: 90/EA/KEPK-FKM/2026). All respondents were given an explanation of the objectives, procedures, and benefits of the research before filling in the data was carried out. Respondents' participation is **voluntary**, and each respondent signs an **informed consent sheet** as a form of willingness to participate in the research. The confidentiality of respondents' identities is maintained and the data collected is only used for research purposes.

RESULTS

a. Univariate Analysis

Table 1. Univariate Analysis Results

Variabel	Frequency (n)	Percentage (%)
Duration of Work		
> 8 hours	36	90.0
≤ 8 jam	4	10.0
Age		
Early Adulthood (26-35 years)	29	72.5
Late Adulthood (36-45 years)	11	27.5
IMT		
<i>Underweight</i>	1	2.5
<i>Normal range</i>	11	27.5
<i>Overweight</i>	24	60.0
<i>Obese class 1</i>	3	7.5
<i>Obese class 2</i>	1	2.5
Tenure		
<6 years old	8	20.0
6 – 10 years	20	50.0
>10 years	12	30.0
Subjective Fatigue		
Low	32	80.0
Medium	8	20.0
Quantity	40	100

Based on table 1, most of the driver respondents *dump truck* PT X by 90% has a working duration of more than 8 hours per day, indicating a relatively long daily workload and increasing the potential for accumulated fatigue if not balanced with adequate rest breaks. The majority of respondents, namely 72.5%, Being in the early adulthood age group and as many as 50% of respondents have a working period of

6-10 years, reflecting a predominantly productive workforce with moderate job experience. In terms of nutritional status, 60% are classified as *overweight*, which can reduce physical work capacity and accelerate the onset of fatigue. Regarding subjective assessment, 80% of respondents reported low levels of fatigue, while 20% experienced moderate fatigue.

b. Bivariate Analysis

Table 2. Bivariate Analysis Cross-Tabulation Results

Variabel	Subjective Fatigue				Total		Value p
	Low		Medium		n	%	
	n	%	N	%			
Duration of Work							
>8 jam	29	72.5	7	17.5	36	90.0	0.792
≤ 8 jam	3	7.5	1	2.5	4	10.0	
Age							
Early Adulthood	23	57.5	6	15.0	29	72.5	0.859
Late Adulthood	9	22.5	2	5.0	11	27.5	
IMT							
Underweight	0	0	1	2.5	1	2.5	0.048
Normal	10	25.0	1	2.5	11	27.5	
Overweight	19	47.5	5	12.5	24	60.0	
Obese class 1	3	7.5	0	0	3	7.5	
Obese class 2	0	0	1	2.5	1	2.5	
Tenure							
< 6 years old	7	17.5	1	2.5	8	20.0	0.791
6-10 years	16	40.0	4	10.0	20	50.0	
>10 years	9	22.5	3	7.5	12	30.0	
Total	32	80.0	8	20.0	40	100	

Based on Table 2 most dump truck drivers work with **Duration of work of more than 8 hours per day (90%)**, the average driver is at **Early adulthood (72.5%)**, as well as having **6–10 years of service life (50%)**. In these dominant groups, the majority of respondents were in **Low subjective fatigue category (80%)**, which shows that in general drivers are still able to adapt to the demands of operational work in the mining area. This condition indicates the role of physical adaptation factors, work experience, and relatively supportive work management in suppressing the level of fatigue felt.

DISCUSSION**The Relationship between Work Duration and Subjective Fatigue**

Research on *dump truck drivers* at PT X shows that the majority of respondents work more than 8 hours per day, amounting to 90%. However, bivariate analysis with the *Chi-square* at PT X produces a value *p* of 0.792, indicating no significant relationship between working duration and subjective fatigue.

Research conducted by Elsa Nurahma Lubis and Dwi Fahmi (2021) confirms that long work duration, especially in the 12-hour shift system in

coal mines, contributes to moderate fatigue. However, in the present study, work duration was not significantly associated with subjective fatigue, indicating that effective shift management and rest arrangements may mitigate the impact of long working hours on fatigue levels. (Nurahma *et al.*, 2022).

The Influence of Age on Subjective Fatigue

The result bivariate analysis with *Chi-square* test yielded a *p-value* of 0.859 at PT X indicating no significant association between age and subjective fatigue. This early adult age group shows that workers in the mining sector are generally at productive age, which in theory has better physical endurance than the elderly age group.

Research by Mabry *et al.* (2022) shows that heavy vehicle drivers, including in the mining sector, often face circadian rhythm disturbances due to irregular shifts, which can affect alertness regardless of age. However, productive age tends to have physical resilience that supports adaptation to the demands of physical work, although

exposure to environmental stress remains a threat. In this study, a relatively young age distribution may be an advantage, but without proper management, the potential for fatigue remains high due to external factors such as work intensity or environmental conditions. imilarly, in the present study, age was not significantly associated with subjective fatigue, which may be explained by the predominance of drivers in early adulthood who typically possess better physical resilience and adaptive capacity. However, this does not eliminate the risk of fatigue, as external factors such as prolonged work duration, high work intensity, and challenging environmental conditions may still contribute to fatigue development. (Mabry *et al.*, 2022).

These findings emphasize the importance of fatigue prevention strategies that focus not only on age, but also on supporting factors such as safety training and shift management. Video-based fatigue detection systems, such as those proposed by Wang *et al.* (2021), can be an effective solution for monitoring

signs of fatigue in young drivers, who may tend to ignore early symptoms due to self-confidence or lack of awareness. Thus, mining companies need to integrate technology and training approaches to ensure driver productivity and safety (Wang, He and Wang, 2021).

The Relationship of Body Mass Index (BMI) with Subjective Fatigue

Bivariate analysis of PT X showed a significant relationship between BMI and subjective fatigue with a *p-value* of 0.048. This indicates that abnormal nutritional status increases the risk of work fatigue. This condition is consistent with the theory that non-optimal BMI, both *underweight* and *overweight*, can reduce physical stamina and endurance to the demands of hard work in a mining environment. Factors such as an unhealthy diet or lack of physical activity can also worsen this condition.

Research by Talebi et al. (2022) underscores that individual factors, including physical conditions, play an important role in predicting *dump truck* driver fatigue. Abnormal BMI can

affect the body's metabolism, so drivers with poor nutritional status tend to tire more quickly when working in extreme environmental conditions (Talebi, Rogers and Drews, 2022). This encourages the need for workplace health programs, such as nutrition counseling and periodic health check-ups, to keep drivers' BMI within the normal range. This finding is consistent with the results of the present study, which showed a significant association between BMI and subjective fatigue, while other variables were not significant. Therefore, workplace health interventions focusing on nutritional management and regular health monitoring are essential to reduce fatigue risk and support driver performance in mining operations.

The Effect of Working Time on Subjective Fatigue

Bivariate analysis with *the Chi-square* test yielded a *p-value* of 0.791, indicating the absence of a significant relationship between working time and subjective fatigue. Although longer tenure may enhance operational skills and task familiarity, it does not

automatically protect drivers from fatigue when exposure to monotonous tasks, extended driving demands, and environmental stressors persists. This finding indicates that fatigue is more strongly shaped by dynamic working conditions and individual coping strategies rather than by duration of employment. These findings also indicate that longer work experience does not necessarily reduce or increase the risk of fatigue, but rather is influenced by other factors such as working conditions or personal habits.

A study by Nurahma et al. (2022) found that working life has a significant relationship with fatigue in dump haul truck operators, mainly due to accumulated exposure to challenging work environments. However, in this study, the lack of a significant relationship may have been due to variations in the drivers' training or adaptation to their duties. Drivers with longer service life may have developed strategies to cope with fatigue, but without an adequate fatigue management system, risks remain (Nurahma et al., 2022).

CONCLUSION

This study shows that most dump truck drivers at PT X work more than 8 hours per day and are predominantly in the productive age group. Statistical analysis revealed no significant relationship between working duration, age, or length of service and subjective fatigue levels. However, Body Mass Index (BMI) was significantly associated with subjective fatigue ($p = 0.048$), indicating that BMI is the main factor related to fatigue among dump truck drivers at PT X.

ADVICE

Based on research findings that show a significant relationship between Body Mass Index (BMI) and fatigue in dump truck drivers, it is suggested that companies strengthen nutrition intervention programs as an effort to maintain worker fitness. This program can include regular health checkups, nutritional counseling, and weight control activities. In addition, the *health challenge* such as healthy weight loss, *Fun Walk*, and structured sports need to be implemented.

The application of fatigue

monitoring systems, such as those developed by Li et al. (2025), suggests that technologies such as *the Generalized Fatigue Driving Monitoring System* (GFDMS) can reduce the incidence of fatigue by providing *real-time* alerts. This system is relevant to this study, where long durations can be monitored to prevent unsafe driving behavior. Better management of work durations, such as balanced shift rotation or daily work hour limitations, may be a practical recommendation to reduce the risk of *dump truck driver fatigue* (Li et al., 2025).

Optimizing work schedules and ensuring adequate rest periods remain important to prevent fatigue accumulation, even though working duration was not significantly associated with subjective fatigue in this study. Mandatory stretching programs should be continued as part of fatigue management to maintain drivers' physical readiness during mining operations.

In addition, the use of *flicker fusion–reaction timer test* As an early detection method, objective fatigue is a

relevant recommendation. This physiological examination is able to measure the threshold of blinking to detect a decline in visual and cognitive function that is not always subjectively perceived by the driver. The implementation of this test periodically can Helping companies ensure operator readiness before work, so that the risk of fatigue and potential accidents can be reduced more effectively.

BIBLIOGRAPHY

- Azzahra, F. (2025) Peningkatan Kinerja Keselamatan Kerja Di Pt X Dengan Metode Hirarc Pada Kegiatan Loading Dan Hauling Skripsi Firli Azahra Gushady Program Studi Teknik Pertambangan 2025 M / 1446 H.
- Elsa Nurahma Lubis, A. and Dwi Fahmi, F. (2021) 'Pengenalan Dan Definisi Hukum Secara Umum (Literature Review Etika)', *Jurnal Ilmu Manajemen Terapan*, 2(6), pp. 768–789. Available at: <https://doi.org/10.31933/jimt.v2i6.622>.
- Iswandi, E. and Birawaputra, I. (2019) 'Analisis Potensi Kecelakaan Kerja Pada Kegiatan Penambangan Dan Pengolahan Serta Workshop DiPt. Pulau Lemon Distrik Manokwari Selatan Kabupaten Manokwari', *INTAN Jurnal Penelitian Tambang*, 2(1), pp. 10–22.
- Li, T. et al. (2025) 'Development and application of a generalized fatigue driving monitoring system for open-pit mining vehicles: A case study in a myanmar copper mine', *Results in Engineering*, 26(December 2024), p. 105206. Available at: <https://doi.org/10.1016/j.rineng.2025.105206>.

- Mabry, J.E. *et al.* (2022) 'Unravelling the Complexity of Irregular Shiftwork, Fatigue and Sleep Health for Commercial Drivers and the Associated Implications for Roadway Safety', *International Journal of Environmental Research and Public Health*, 19(22). Available at: <https://doi.org/10.3390/ijerph192214780>.
- Nugroho, S.A., Akbar, S.A. and Rahmatullah, I. (2024) 'Faktor-faktor yang Berhubungan dengan Kecelakaan Kerja pada Operator Dump Truck di Bagian Produksi di Perusahaan Tambang Batubara', *Faletehan Health Journal*, 11(02), pp. 217–226. Available at: <https://doi.org/10.33746/fhj.v11i02.703>.
- Nurahma, A.P. *et al.* (2022) 'The Relationship Between Mental Workload and Sleep Quantity with Work Fatigue among Haul Dump Truck Operators in Coal Mining', *Indonesian Journal of Occupational Safety and Health*, 11(3), pp. 333–342. Available at: <https://doi.org/10.20473/ijosh.v11i3.2022.333-342>.
- Nurdiawati, E. and Safira, R.A.D. (2020) 'Hubungan antara Keluhan Kelelahan Subjektif, Umur dan Masa Kerja terhadap Produktivitas Kerja pada Pekerja', *Faletehan Health Journal*, 7(02), pp. 113–118. Available at: <https://doi.org/10.33746/fhj.v7i02.106>.
- Pratama, D.A., Zulfikar, I. and Setyawati, N.F. (2024) 'Faktor-Faktor Penyebab Kelelahan Kerja Pada Pengemudi Dump Truk Di Pt Abc', *Jurnal Keselamatan, Kesehatan Kerja dan Lindungan Lingkungan*, 10(1), pp. 121–128.
- Sari, D. and Setiawan, M. (2021) 'Pengaruh Tangibility, Pertumbuhan Perusahaan, Resiko Bisnis dan Profitabilitas Terhadap Kebijakan Hutang (Studi Empiris pada Perusahaan Property dan Real Estate yang Terdaftar di Bursa Efek Indonesia Tahun 2017-2019)', *Jurnal Eksplorasi Akuntansi*, 3(2). Available at: <file:///C:/Users/User/Downloads/SERI DIKTAT KULIAH.pdf>.
- Setiawan, B., Fauzan, A. and Norfai (2020) 'Tingkat Kelelahan Kerja Pada Driver Dump Truck Ditinjau Dari Aspek Masa Kerja Dan Usia Di Pt Hasnur Riung Sinergi Site Pt Bhumi Rantau Energi Tahun 2019', *Mtph Journal*, 4(2), pp. 167–186.
- Suwignyo, Apriyani and Saputri, A.A. (2022) 'Pengawasan, Sikap dan Pengetahuan Kesehatan dan Keselamatan Kerja dengan Perilaku Aman Pekerja pada Bagian Driver Dump Truck Coal di PT. Mitra Indah Lestari Samarinda', *Jurnal Penelitian Kesehatan Suara Forikes*, 13(1), pp. 98–102.
- Talebi, E., Rogers, W.P. and Drews, F.A. (2022) 'Environmental and Work Factors That Drive Fatigue of Individual Haul Truck Drivers', *Mining*, 2(3), pp. 542–565. Available at: <https://doi.org/10.3390/mining2030029>.
- Wang, Y., He, Z. and Wang, L. (2021) 'Truck driver fatigue detection based on video sequences in open-pit mines', *Mathematics*, 9(22). Available at: <https://doi.org/10.3390/math9222908>.
- Yulianti, N., Pratiwi, A.D. and Nurfadilah, H, S. (2024) 'Faktor-Faktor yang Berkorelasi dengan Tindakan Tidak Aman Saat Berkendara Pada Sopir Dump Truck di PT. Mitra Mekongga Sejahtera Pomalaa', *MAHESA : Malahayati Health Student Journal*, 4(3), pp. 838–846. Available at: <https://doi.org/10.33024/mahesa.v4i3.13652>.