



Risk of Neurotoxic Symptoms among Motorcycle Workshop Workers in Surabaya: A Cross-Sectional Study

Wanda Melania Anggraini¹, Muhammad Fatih Rizqon Akbar², Fika Alfiana³, Moch. Sahri⁴, Aura Angelly Putri Arsanti⁵, Naufal Wafiq Belvatrivan⁶

¹ Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

² Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

³ Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

⁴ Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

⁵ Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

⁶ Departemen of Occupational Safety and Health, Faculty of Health, Universitas Nahdlatul Ulama Surabaya, East Java, Indonesia

Corresponding Author:

Wanda Melania Anggraini Email : 2440022001@student.unusa.ac.id

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ABSTRACT

This study analyzed the risk of neurotoxic symptoms among motorcycle workshop workers in Surabaya due to exposure to hazardous chemicals such as organic solvents, heavy metals, and particulate matter. The study used an analytical observational design with a cross-sectional approach involving 32 workshop workers and applied the validated German version of the Q18 questionnaire. The results showed that 28.12% of respondents experienced positive neurotoxic symptoms, with the most frequently reported complaints being excessive sweating (75%), fatigue in the hands and feet (68.75%), palpitations (56.25%), and difficulty concentrating (28.12%). Most respondents were male, aged 26–45 years, had a working period of less than 10 years, and were non-smokers. These findings indicate a tangible risk of neurotoxic disorders among motorcycle workshop workers, highlighting the need for control measures such as improved ventilation, proper use of personal protective equipment (PPE), regular health examinations, and occupational health and safety education. Further studies with larger sample sizes and biomonitoring methods are recommended.

1. INTRODUCTION

Occupational safety and health (OSH) is a crucial aspect of maintaining worker productivity and well-being. The International Labour Organization (ILO) reports that approximately 2.78 million workers die each year due to occupational accidents and work-related diseases, of which 2.4 million cases (86.3%) are attributable to occupational diseases (ILO, 2020). Data from Indonesia indicate a significant increase in cases of occupational accidents and diseases, with 265,334 cases recorded from January to November 2022 (BPJS Ketenagakerjaan, 2021). These figures highlight the urgent need for serious attention to health risk factors in informal work environments, including motorcycle workshops.

Motorcycle workshops represent one of the rapidly growing service sectors in line with the increasing number of motor vehicles in Indonesia. Workshop workers are potentially exposed to various hazardous chemical substances, such as organic solvents, benzene, toluene, heavy metals (lead, mercury, and manganese), as well as particulate matter from combustion fumes and paints (Hasanah, Widodo, & Prabowo, 2021). Exposure to these chemicals is neurotoxic in nature and may cause disturbances in both the central and peripheral nervous systems, including cognitive impairment, mood changes, tremors, and chronic fatigue (Ira, 2016; WHO, 2020).

Neurotoxic symptoms are defined as adverse changes in nervous system function resulting from exposure to chemical substances or neurotoxic physical and biological agents (Ira, 2016). Previous studies have shown that industrial workers exposed to toluene have a higher risk of experiencing cognitive impairment, headaches, and sleep disturbances (Faradisha, 2018). Other research has reported that workshop workers with chronic exposure to organic solvents experience mild tremors, increased fatigue, and difficulties in concentration (Hasanah et al., 2021).

Despite strong evidence regarding the effects of neurotoxic exposure across various industries, research specifically examining the risk of neurotoxic symptoms among motorcycle workshop workers in Surabaya remains limited. This is concerning, given that motorcycle workshops belong to the informal sector, where the implementation of occupational safety and health measures is generally inadequate, potentially increasing the risk of long-term health effects.

Therefore, this study aims to analyze the risk of neurotoxic symptoms among motorcycle workshop workers in Surabaya using the validated Q18 instrument to detect neurotoxic symptoms in working populations. This study is expected to provide preliminary evidence regarding the magnitude of neurological health risks in the motorcycle workshop sector and to serve as a basis for developing preventive and risk control policies related to occupational safety and health in informal work settings.

2. METHOD

This design was selected to examine the relationship between individual factors (age, highest educational attainment, and nutritional status) and work-related stress levels among operational workers within a specific time period, without long-term follow-up. The cross-sectional approach is widely used in occupational health research due to its ability to describe relationships between variables in a rapid and efficient manner (Ariani, 2014).

The study was conducted at PT Terminal Petikemas MNO, located in Surabaya, East Java. This site was chosen because it is one of the largest container terminals in Indonesia and has a high operational workload. Data collection was carried out from March to May 2025. The study population consisted of all operational workers at PT Terminal Petikemas MNO, totaling 281 individuals. The sample size was determined using the Slovin formula with a margin of error (α) of 10%, resulting in a sample of 74 respondents. Samples were selected using a simple random sampling technique, in which each member of the population had an equal probability of being selected as a respondent. This technique was applied to minimize bias and ensure that the sample was representative of the population.

Work-related stress was measured using a questionnaire consisting of 20 items assessed on a 5-point Likert scale (1–5). Instrument validity was tested on 30 workers outside the study sample, yielding correlation coefficients (r calculated) greater than the r table value (0.361), indicating that the instrument was valid. Reliability testing was conducted using Cronbach's Alpha, with a value of 0.86, indicating very high reliability. Subjective workload was assessed using the NASA Task Load Index (NASA-TLX) questionnaire, which comprises six dimensions: mental demand, physical demand, temporal demand, performance, effort, and frustration level. Questionnaires were self-administered by respondents under the supervision of the researcher. Nutritional status was assessed by measuring body weight and height to calculate body mass index (BMI).

Univariate analysis was performed to describe the frequency distributions of age, educational level, nutritional status, and work-related stress levels. Bivariate analysis was conducted using Spearman's rank correlation test to examine the relationships between individual factors and work-related stress. Statistical significance was determined at a p -value < 0.05 with a 95% confidence level

3. RESULTS

Characteristics of Respondents

This study involved 32 motorcycle workshop workers in Surabaya. The majority of respondents were in the adult age group (26–45 years), accounting for 28 individuals (87.5%), while the remaining 4 respondents (12.5%) were classified in the older age group (46–55 years). In terms of sex, the workforce was predominantly male, with 30 respondents (93.75%), whereas only 2 respondents (6.25%) were female.

Most respondents were non-smokers, totaling 23 individuals (71.87%), while 9 respondents (28.12%) reported smoking. Regarding duration of employment, 28 respondents (87.5%)

had worked for less than 10 years, whereas 4 respondents (12.5%) had a working period of more than 10 years.

Table 3.1 Distribution of respondents' characteristics.

Variable	Categories	n	%
Age	Adult (26-45 years old)	28	87,5
	Older Adults (46-55 years old)	4	12,5
Gender	Man	30	93,75
	Woman	2	6,25
Smoking Habits	Yes	9	28,12
	No	23	71,87
Duration of Employment	≤ 10 Years	28	87,5
	> 10 Years	4	12,5

Distribution of Neurotoxic Symptoms

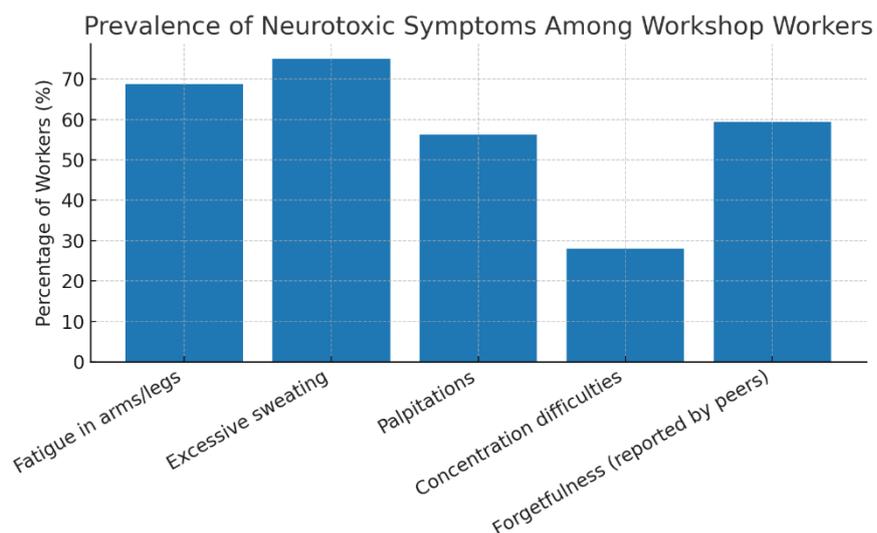
The results of the assessment using the Q18 questionnaire showed that 9 respondents (28.12%) were classified as positive for neurotoxic symptoms. The most frequently reported symptoms were fatigue in the hands and feet (68.75%), excessive sweating (75.00%), palpitations (56.25%), and forgetfulness as reported by co-workers (59.37%). Cognitive symptoms, such as difficulty concentrating, were also reported by 9 respondents (28.12%).

Table 3.2 Distribution of Neurotoxic Symptoms among Respondents

Neurotoxic Symptoms	n	%
Fatigue in hands/feet	22	68,75
Excessive sweating	24	75,00
Palpitations	18	56,25
Forgetfulness (reported by co-workers)	19	59,37
Difficulty concentrating	9	28,12
Numbness in hands/feet	7	21,87
Feeling depressed without reason	9	28,12
Nausea	6	18,75
Prolonged pain	0	0,00

Distribution of Neurotoxic Symptoms

To further illustrate the distribution, the main neurotoxic symptoms are visualized in the following figure:



The findings of this study indicate that nearly one-third of motorcycle workshop workers in Surabaya experienced neurotoxic symptoms. Physical symptoms such as extreme fatigue, excessive sweating, and palpitations were the most dominant complaints, while cognitive symptoms, including difficulty concentrating and forgetfulness, were also reported by some respondents. These findings are noteworthy, as the majority of respondents were still of productive working age and had a relatively short duration of employment (<10 years). Therefore, the occurrence of neurotoxic symptoms is likely associated with workplace environmental factors, particularly exposure to neurotoxic chemical substances.

4. DISCUSSIONS

The results of this study indicate that the majority of operational workers at PT Terminal Petikemas MNO experienced severe work-related stress (89.2%). This condition suggests that work in the container terminal sector is characterized by a high level of occupational pressure. Such pressure may arise from strict performance targets, heavy physical and mental workloads, occupational accident risks, and interpersonal relationships in the workplace.

According to Robbins (2006), work-related stress can be triggered by several factors, including task demands, role demands, interpersonal relationships, organizational structure, and leadership. Among operational workers, high task and role demands, as well as leadership styles that strongly emphasize performance targets, may serve as major stressors. These findings are consistent with reports from the International Labour Organization (ILO, 2020), which state that workers in the logistics sector tend to experience higher levels of work-related stress compared to those in other sectors.

The analysis revealed a significant relationship between age and work-related stress ($p = 0.000$; $r = 0.446$). The positive correlation indicates that increasing age is associated with higher levels of work-related stress. This finding is in line with the study by Fitri (2013), which reported that older workers tend to experience higher stress levels than younger workers. This phenomenon may be explained by the increasing burden of responsibility faced by older workers, both in the workplace and within their families. In addition, age-related declines in physical condition may reduce workers' capacity to cope with demanding job requirements (Hasibuan, 2013). However, other studies suggest that older workers may possess better coping strategies than younger workers (Kurniawan et al., 2019). This

indicates that age not only influences stress levels but also affects individuals' ability to manage stress.

This study also found a significant relationship between educational attainment and work-related stress ($p = 0.000$; $r = -0.492$). The negative correlation suggests that higher levels of education are associated with lower levels of work-related stress. This finding is consistent with the study by Irkhami (2015) among offshore industrial divers, which demonstrated that higher education equips workers with better cognitive abilities, communication skills, and coping strategies to manage occupational pressure. Higher educational attainment also enables workers to access more strategic positions with relatively lower physical workloads (Mangkunegara, 2011). Conversely, workers with lower educational levels (junior or senior high school) tend to have limited problem-solving skills, making them more susceptible to stress when encountering workplace challenges (Candraditya et al., 2017).

In contrast to age and education, this study did not find a significant relationship between nutritional status and work-related stress ($p = 0.167$). This finding suggests that physiological factors such as nutritional status are not the primary determinants of work-related stress among operational workers. This result differs from the study by Candraditya et al. (2017), which reported an association between nutritional status and stress levels among healthcare workers. The discrepancy may be attributed to differences in job characteristics, as work in container terminals is more strongly influenced by external factors—such as workload, work relationships, and performance targets—than by workers' physiological conditions. Nevertheless, maintaining adequate nutritional status remains important, as good physical health can support workers' stamina in performing physically demanding daily activities (WHO, 2021).

The findings of this study have several important implications for company management. Older workers should be provided with workload adjustments or assigned to positions with lower physical risk. The company should also offer continuous training opportunities to improve the skills of workers with lower educational backgrounds, enabling them to cope more effectively with workplace challenges.

Although nutritional status was not significantly associated with work-related stress, the company should continue to provide health programs, such as routine medical examinations and access to sports facilities. Psychological counseling, stress management training, and recreational activities may serve as effective strategies to reduce work-related stress levels (ILO, 2020; Ministry of Manpower of the Republic of Indonesia, 2022).

This study employed a cross-sectional design, which limits its ability to establish causal relationships. In addition, the variables examined were restricted to individual factors and did not include organizational factors such as work shifts, leadership style, and social support. Furthermore, work-related stress was measured using a subjective questionnaire, which may introduce perception bias.

5. CONCLUSION

This study demonstrates that the majority of operational workers at PT Terminal Petikemas MNO experienced severe levels of work-related stress. Age and educational attainment were found to be significantly associated with work-related stress, whereas nutritional status showed no significant relationship. Therefore, companies need to consider workers' individual characteristics when designing stress management programs—such as training, counseling, and social support—to reduce the risk of work-related stress and enhance productivity.

Companies are encouraged to develop more targeted stress management programs by taking into account differences in workers' age and educational background. Such programs may include job skills training, psychological counseling, and reward or recognition systems as forms of appreciation for employee performance. In addition, companies are advised to foster a more supportive work environment by enhancing open communication between workers and supervisors, as well as organizing regular social activities—such as outings or family gatherings—to alleviate psychological pressure. Workload management should also be optimized to ensure a more balanced distribution of tasks, particularly for workers with lower educational backgrounds who may be more vulnerable to stress. From the workers' perspective, improving mental health literacy and coping skills is essential to enable more adaptive responses to job demands, as well as to encourage the utilization of company-provided counseling services to maintain psychological well-being.

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