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Research

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Maintaining Occupational Health: An Analysis of Fatigue and Safety Compliance in Construction Workers

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ABSTRACT

Background: Safety compliance is a critical component in preventing workplace accidents and ensuring employee well-being. Various factors may influence workers' adherence to safety protocols, including individual characteristics such as education level and fatigue. The purpose of this study was to examine the relationships between education level, work fatigue, and safety compliance.
Subjects and Method: This cross-sectional study involved 137 respondents, categorized by fatigue status. The dependent variable was safety compliance. Independent variables included work fatigue and education level. Instruments included the Fatigue Assessment Scale (FAS) questionnaire for fatigue. Data analysis utilized the chi-square test for fatigue and education levels.
Results: The proportion of workers who comply with safety procedures varies across education levels, but the differences are not statistically significant. In contrast, workers with higher levels of fatigue were significantly more compliant with safety practices than those with lower fatigue..
Conclusion: These findings highlight the complexity of behavioral responses to workplace demands and the need for targeted interventions.

Keywords: Occupational health and safety, fatigue, compliance, construction

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BACKGROUND

Occupational Health and Safety (OHS) is an important aspect of the construction industry. This importance is due to the nature of construction activities that often involve working at heights, operating heavy machinery, and coming into contact with hazardous materials (Soltanzadeh et al., 2019). Fatigue, often overlooked, significantly impacts workplace safety. Occupational fatigue significantly impacts safety compliance among construction workers, as it is closely related to physical and cognitive performance, which is critical to maintaining safety standards.

The construction industry is inherently dangerous due to its dynamic and labor-intensive nature, making workers highly

susceptible to fatigue, which compromises safety performance (Heng et al., 2024). 49% of construction workers experienced fatigue some days in the last three months, and 10% experienced fatigue almost every day (Zhang et al., 2015). Various factors, both environmental and occupational, influence work fatigue in construction workers. Nutritional status and work stress are significant contributors, with poor nutrition and high stress levels directly linked to increased fatigue (Fitri et al., 2024).

The combination of physical and mental fatigue increases the likelihood of making mistakes and taking risks because physical fatigue impairs a worker's motor skills and reaction time, which are critical to performing tasks safely (Emuze, 2020; Zhang et al., 2023). In addition, workers who experience high fatigue can disrupt cognitive and motor functions, which results in increased unsafe behavior and increased errors (Fang et al., 2015; Zhang et al., 2023), reduced ability to recognize hazards, and perception of safety risks that are critical to preventing accidents (Taherpour et al., 2021; Ouyang and Luo, 2025). Previous research has consistently shown a correlation between fatigue and accident frequency, with fatigue often cited as a leading cause of construction accidents, putting fatigued workers at a higher risk.

Beyond fatigue, individual demographic characteristics such as age, tenure, and education level are also recognized as influential factors in shaping safety behaviors and compliance. Age is often associated with accumulated experience and maturity, which can enhance risk perception and adherence to safety protocols (Morgan et al., 2019; Rosi et al., 2021). Older workers may possess a deeper understanding of potential hazards and the consequences of non-compliance, leading to more cautious behaviors. Conversely, tenure (length of employment) can present a more complex relationship. While greater experience might initially improve safety skills, prolonged exposure to routine tasks can, at times, lead to complacency or the development of informal shortcuts, potentially diminishing strict adherence to established safety procedures (Idrisova et al., 2018; Haas et al., 2019). In a similar way, a person's education level is thought to affect how well they follow safety rules because it helps them understand safety information better, recognize risks, and adopt safety practices (Aulia et al., 2018; Chan et al., 2023). Different educational backgrounds might equip workers with varying capacities to understand and apply complex safety regulations (Chan et al., 2023). Understanding the nuanced interplay of these demographic factors with safety compliance is key to creating targeted and effective safety interventions.

However, the results of this study revealed an intriguing finding: workers who experienced fatigue had better safety compliance than workers who did not experience fatigue. This phenomenon raises questions about the mechanisms behind the relationship between fatigue and safety compliance, potentially suggesting compensatory behaviors or heightened awareness among fatigued individuals. In this context, this study aimed to determine the differences in adherence levels between workers who experienced fatigue and those who did not and to further explore the relationships between age, tenure, education level, and safety compliance. By understanding these multifaceted relationships, it is hoped that effective strategies can be developed to improve occupational health and safety in the construction industry, benefiting all workers regardless of their fatigue status or demographic profile.

SUBJECTS AND METHOD

1. Study Design

This study is a quantitative study with a cross-sectional research design that focuses on testing the relationship between fatigue and compliance behavior in workers. The toll road industry conducted this research on one of its construction projects in 2024. This project involves construction workers engaged in physical and high-risk work.

2. Population and Sample

The population in this study consists of construction workers who are working on highway projects. These construction workers are involved in various high-risk tasks at the project site. The sample used in this study consisted of 137 respondents, selected through the purposive sampling technique. The purposive sampling technique was used to select respondents who met the research criteria, namely construction workers directly involved in construction work on toll road projects and willing to participate in this study. Respondents were divided into two groups based on fatigue status, namely 66 respondents who did not experience fatigue (No Fatigue) and 71 respondents who experienced fatigue (Fatigue).

3. Study Variables

The independent variable in this research is work fatigue. The dependent variable is safety compliance.

4. Operational Definition of Variables

Work fatigue: refers to a condition of physical and mental exhaustion experienced by workers as a result of job demands during or after working hours.

Safety compliance: refers to the extent to which construction workers adhere to established safety procedures and protocols in the workplace.

5. Study Instrument

Data for this research were collected using two main instruments designed to measure two main variables, namely work fatigue and safety compliance among construction workers. Fatigue Assessment Scale (FAS) questionnaire to measure the level of work fatigue. The FAS questionnaire is designed to assess the physical and mental fatigue experienced by workers during or after work. Respondents are asked to assess their level of fatigue based on the symptoms experienced, such as tiredness, lethargy, or concentration disturbances.

The assessment was conducted using a 5-point Likert scale (1: Not at all fatigued, 2: Not fatigued, 3: Somewhat fatigued, 4: Fatigued, 5: Very fatigued). Based on the assessment results, workers are categorized into two groups: no fatigue (workers who score 1 or 2) and experiencing fatigue (workers who score 4 or 5). Safety Compliance Questionnaire to measure the level of safety compliance, the safety compliance questionnaire is designed to assess the extent to which workers adhere to the safety procedures in place at the workplace. The assessment is conducted using a 5-point Likert scale (1: never comply, 2: rarely comply, 3: sometimes comply, 4: often comply, 5: always comply). Based on the results of this questionnaire, workers are categorized into two groups, namely 1) Good Compliance (workers who score 4 or 5) and Poor Compliance (workers who score 1 or 2).

6. Data Analysis

A descriptive statistics analysis was used to describe the distribution frequency of education level, fatigue level, and safety compliance among workers. The bivariate analysis using a chi-square test.

7. Research Ethics

Research ethical issues, including informed consent, anonymity, and confidentiality, were addressed carefully during the study process. The research ethical clearance approval letter was obtained from the Research Ethics Committee at Dr. Moewardi

Hospital, Surakarta, Indonesia, No. 1.042/-IV/HREC/2024, on April 29, 2024.

RESULTS

1. Univariate Analysis

A total of 137 respondents participated in this study. The age of the respondents ranged from 17 to 70 years, with a mean age of 35.15 years (SD = 11.13) (Table 1). The study shows that the construction workforce consists of a highly varied age group, from young workers to senior workers. This average age falls into the productive age category, which theoretically has a good working capacity but remains vulnerable to work pressure and fatigue due to high work intensity. Respondents' length of service (tenure) ranged from 1 to 20 years, with an average tenure of 6.06 years (SD = 4.71) (see table 1). This variation shows that there are workers with both very short and very long work experience. Workers with longer tenure tend to be more familiar with safety procedures but may also experience a decrease in vigilance due to routine. Conversely, new workers may lack a thorough understanding of safety protocols.

Table 1. Descriptive Statistics of Respondents' Age and Work Tenure (n = 137)

Research Variables	Mean	SD	Minimum	Maximum
Age	35.15	11.13	17	70
Tenure	6.06	4.71	1	20

Table 2 shows that by gender, almost all respondents were male (99.3%), reflecting the dominance of men in the construction sector, which is known for heavy physical labor. The majority of respondents were high school graduates (51.1%), indicating the importance of comprehensive safety training to ensure that understanding of safety procedures is not solely dependent on formal educational background. A total of 71 respondents (51.8%) experienced work fatigue based on an assessment using the Fatigue Assessment Scale (FAS), while 66 respondents (48.2%) did not experience tiredness. Meanwhile, 85 respondents (62%) showed a good level of compliance with work safety, and 52 respondents (38%) were classified as less compliant (Table 2).

Table 2. Frequency Distribution of Respondents by Gender, Education Level, Fatigue Status, and Safety Compliance (n = 137)

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	136	99.3
	Female	1	0.7
Education Level	Primary school	14	10.2
	Junior High School	47	34.3
	Senior High School	70	51.1
	Graduate	6	4.4
Fatigue	No fatigue	66	48.2
	Fatigue	71	51.8
Compliance	Less	52	38
	Good	85	62

2. Bivariate Analysis

Table 3 showed that the proportion of workers who comply with safety procedures varies across education levels, but the differences are not statistically significant. This suggests that education level alone does not determine whether a worker is likely to comply with safety procedures.

Table 3. Cross tabulation between education level and safety compliance (n=137)

Education level	Compliance						OR	p
	Less		Good		Total			
	n	%	n	%	n	%		
Primary school	3	21.4	11	78.6	14	100	4.03	0.258
Junior High School	17	36.2	30	63.8	47	100		
Senior High School	31	44.3	39	55.7	70	100		
Graduate	1	16.7	5	83.3	6	100		

Table 4 shows that among workers with low fatigue, 68.2% were less compliant with safety regulations, while only 31.8% demonstrated good compliance. In contrast, among workers with high fatigue, only 9.9% were less compliant, and 90.1% showed good safety compliance. Table 4 showed that workers with higher levels of fatigue were more compliant with safety practices than those with lower fatigue (b= 19.59; 95% CI= 7.68 to 49.98; p<0.001).

Table 4. Statistical test results of fatigue with safety compliance (n=137)

Fatigue level	Compliance status						OR	95% CI		p
	Less		Good		Total			Lower limit	Upper limit	
	n	%	n	%	n	%				
Low	45	68.2	21	31.8	66	100	19.59	7.68	49.98	<0.001
High	7	9.9	64	90.1	71	100				

DISCUSSION

Cultural demands and the physical nature of the work, which is considered masculine, mean that the construction industry is dominated by men (Çınar, 2020). The construction industry has heavy workloads and high physical demands, many hazardous tasks and conditions (Khodabandeh et al., 2016), making workers vulnerable to physical exhaustion and even occupational deaths (Zhang et al., 2023; Zong et al., 2024). Although most workers who are male may have greater physical capacity to perform strenuous work, occupational health and safety factors still need to be considered. Most workers may have basic skills in construction, as indicated by the education level, which mostly ends at high school; hence, the importance of more thorough safety training, which includes fatigue management and strategies to improve compliance with safety procedures (Gultekin et al., 2024). Education improves workers' knowledge and skills in risk assessment and safety practices (Wang et al., 2019).

The age range illustrates the diversity of workers in the construction sector, encompassing both young and older individuals. The average age of respondents, 35 years, in this study is included in the young group. Workers are usually divided into younger (45 years and below) and older (46 years and above) groups (Hashiguchi et al., 2021). In Nigeria, age groups ranging between 16 and 30 years, 31 to 45 years, and 46 to 58 years are the most common (Aka et

al., 2024). While the average age of construction workers in the US is around 42.6 years old (Sokas et al., 2019). Similarly, the average age of migrant construction workers in China is 41.7 years old (Wang et al., 2024). Older workers often underestimate safety risks, necessitating ongoing safety refreshers (Idrees et al., 2017; Han et al., 2019). In addition, young workers are more prone to accidents due to pressures in the work environment and a lack of training (Idrees et al., 2017).

The research findings show a weak but significant positive correlation between age and safety compliance. This indicates that the older the respondents are, the higher their level of compliance with safety standards tends to be. Although this relationship is not very strong, its statistical significance shows a consistent trend. This pattern is in line with previous literature, which shows that in general, older workers have more experience, which contributes to higher compliance with safety standards, as this experience makes them better understand the importance of safety measures and the consequences of non-compliance (Rembiasz, 2017). Other studies have also found that older individuals may have a higher perception of risk, which influences compliance with safety standards, as they are more likely to recognize the hazards associated with non-compliance and take the necessary precautions (Kim and Kim, 2017). Psychological and behavioral factors: older individuals often have a higher sense of responsibility and awareness of social expectations that influence their compliance with safety standards (Peng and Chan, 2019). In addition, older workers tend to have more experience and knowledge of safety protocols, which increases their compliance. Their expectations about aging and its impact on their abilities and perceived strong organizational support may lead to more cautious behavior (Peng and Chan, 2019).

The majority of construction workers have sufficient experience. Workers with longer tenure may be more familiar with safety procedures and managing risks in the workplace, and they may be more accustomed to work environments that often demand high physical endurance. In contrast, workers with a shorter tenure, such as one year, may still be learning about a new scope of work. This conclusion is consistent with research showing that novice workers may rely more on intuition about safety and risk, whereas experienced workers are usually more logical in their understanding of safety and risk (Andersen and Grytnes, 2021). In addition, higher confidence in identifying hazards can be demonstrated by experienced workers (Dzeng et al., 2016).

Younger workers and those with shorter tenure may require additional training to increase their awareness and compliance with safety procedures (Wang et al., 2019). Workers who are more senior or have longer tenures may need to change the types of tasks they perform to prevent overexerttion, as this condition increases the risk of injury (Delloiacono, 2016; Oranye et al., 2016; Baidwan et al., 2018). This shows how important it is to take a more personalized approach to managing labor in the construction sector. Taking the age and tenure of workers into account can help create better safety policies and support workforce sustainability.

The results show that there is an interesting pattern in the relationship between education levels and safety compliance. Although statistical analyses showed that this difference was not statistically significant, the pattern of compliance distribution by education level provides helpful information for contextual interpretation and practical implications. The finding that

the undergraduate education level has the highest percentage in the 'good compliance' category indicates that higher formal education may contribute to a better understanding of the importance of work safety. This is in line with previous literature, which shows that individuals with higher levels of education tend to have better cognitive abilities in understanding safety risks and regulations and exhibit more structured and organized work behavior (Meng and Chan, 2020; Xia et al., 2020). Interestingly, the primary education level also showed a relatively high percentage of 'good compliance', which may indicate the presence of non-cognitive factors such as compliant attitudes, resignation to the rules, or the strong influence of direct supervision in the workplace. Workers with primary education may tend to follow rules without much questioning, especially if they are in a work environment with close supervision or a strong safety culture.

Although the statistical analysis shows that the relationship between education levels and safety compliance is not statistically significant, the distribution of the data reveals an interesting pattern. Workers with very low education (elementary school) and higher education (university degree) showed a higher percentage of "good" compliance, while those with secondary education (junior high school and senior high school) showed a higher rate of "poor" compliance-especially in the senior high school group that recorded poor compliance. The construction sector study also found an inverted U-shaped curve resembling this pattern. According to Chan et al (2023), the relationship between education level and safety performance is not linear. The study showed that individual learning ability and a resilient safety culture are important factors that moderate the effect of education on safety behavior. In organizations that support learning and have a strong safety culture, workers with higher education tend to be able to apply their knowledge to improve safety behavior. In contrast, workers with basic education often demonstrate compliance out of obedience to instructions rather than deep understanding.

Meanwhile, research by Yuan et al (2024) used the SCB-ANN (Safety Compliance Behavior-Artificial Neural Network) model and found that new-generation construction workers with higher education showed higher compliance when supported by organizational factors such as clear leadership, structured training, and effective communication. However, they also noted that workers with secondary education tended to experience decreased compliance due to overconfidence or inconsistent risk perceptions, which were not matched by critical thinking skills or long-term risk understanding. This finding is in line with several behavioral psychology theories, namely: 1) Dunning-Kruger effect: Individuals with intermediate levels of knowledge tend to overestimate their abilities, resulting in less compliance with safety procedures because they feel they "know enough", 2) Cognitive Load Theory: Workers with secondary education may have difficulty in understanding complex SOPs due to limited information processing capacity. These findings suggest that safety training should be tailored to education levels: 1) Primary education (SD): Use visual-based approaches and direct instructions that are easy to understand and apply, 2) Secondary education (junior high school): Apply interactive and reflective learning methods, such as real incident case studies, to improve risk awareness and analytical skills, 3) Higher education (undergraduate): Focus on risk management-based training and an active role in safety planning on projects.

According to Chan et al (2023), education level has a significant positive effect on

construction workers' safety performance. Moreover, individual learning ability and a robust safety culture have moderating effects that strengthen the correlation. This finding is important because it shows that formal education alone is not enough- learning ability (e.g., reflection on experience, adaptation of SOPs) and a supportive organizational culture (access to information, rewards recognition) are catalysts for transforming knowledge into concrete safety actions. Training programs should adopt "learning-by-doing" methods and shared reflection (incident simulation, post-mortem learning sessions) so that all levels of education can deeply internalize OHS actions. Another study by Yuan et al (2024) showed that there are important differences between new generation workers (NGCWs) and older generation workers (OGCWs). Compliance in NGCWs is strongly influenced by organizational factors-strong leadership, transparent communication, and prosocial morale-whereas in OGCWs it is influenced by individual factors, such as burnout, psychological resilience, and severe work pressure. This suggests that intervention design strategies for NGCWs focus on organizational systems such as leadership safety rounding and mentoring to build commitment and a sense of belonging. In contrast, for OGCWs, by activating resilience-building programs, physical load reduction, and flexibility of project schedules for mental and physical health. Another important point highlighted by (Chan et al (2023), the importance of learning from incidents (LFI): aspects such as management commitment, information sharing, and learning content are strong predictors of improved safety performance. Bayesian analysis showed that information sharing and utilization had the highest sensitivity, followed by management commitment-management's ability to respond to and apply post-incident lessons. Therefore, we cannot view education as the exclusive predictor of safety compliance. Education interacts with organizational systems and individual capacities, which collectively shape the safety behavior of construction workers.

The study found that workers who did not experience fatigue had lower safety compliance. This is not in line with research which that suggests that as mental fatigue increases, safety compliance decreases, or that workers who do not experience fatigue may lead to better safety behaviors (fatigue negatively impacts compliance; hence, workers who do not experience fatigue may be more likely to comply with safety protocols and participate in safety practices) (Alroomi and Mohamed, 2022). However, other studies emphasize that psychosocial factors play an important role for workers in experiencing fatigue and adherence to safety protocols (Jaladara and Hasanbasri, 2024). Safety compliance is also influenced by knowledge and supervision (Ayu et al., 2018).

The results showed that workers who did not experience fatigue but had low safety compliance could be due to a lack of knowledge and supervision in the work environment. In addition, if the organizational culture does not emphasize safety, workers may not feel compelled to comply with safety procedures even if they are not tired (Farhadi and Davoodi, 2020; Curtis et al., 2023). Other factors need to be considered for workers who do not experience fatigue but have low safety compliance. These other factors include worker overconfidence. Workers who feel refreshed and not fatigued may feel overconfident and assume they will not have an accident, thus ignoring safety procedures (Di-Giampaolo et al., 2024). There is a correlation between high levels of self-confidence and engaging in risky behavior; overconfidence can contribute to accidents

(Bushuven et al., 2023). In the workplace, overconfidence can also come in the form of perceived overqualification, where workers may feel overconfident in their abilities, potentially leading to innovative behavior but also increasing the risk of ignoring safety protocols if psychological safety is not properly maintained (Lu et al., 2023).

Boredom or routine is also considered for workers who do not experience fatigue but have low safety compliance. When workers become too comfortable or familiar with their tasks, they can become less vigilant and more likely to ignore safety regulations. Research shows that boredom and routine in the workplace can significantly affect workers' vigilance and compliance with safety regulations, leading to potential safety hazards. Automation and repetitive tasks often make workers' tasks monotonous, which can result in decreased attention and increased mind wandering, negatively impacting efficiency and safety (Hinss et al., 2022).

Furthermore, a factor is a lack of risk awareness. Fatigued workers may be less aware of potential risks in the workplace and therefore less compliant with safety procedures. Lack of risk awareness among non-fatigued workers can lead to reduced compliance with safety procedures, as fatigue significantly impacts safety attitudes and hazard recognition. Research shows that fatigue is an important factor affecting safety performance in construction environments, with higher levels of fatigue correlating with poorer safety attitudes and lower hazard recognition performance (Taherpour et al., 2021). The result suggests that workers who do not feel fatigued may not perceive the same level of risk, potentially leading to complacency and non-compliance with safety protocols. In addition, the construction sector, known for its high-risk activities, suggests that factors such as nutritional status and work stress are linked to occupational fatigue, which in turn affects safety compliance (Fitri et al., 2024). In addition, compliance with the Occupational Health and Safety Management System (SMK3) is significantly influenced by worker awareness and supervision, with awareness contributing 28.4% to compliance (Wahyuningtyas et al., 2023). This conclusion implies that even without feeling tired, a lack of awareness can reduce compliance with safety measures. In high-risk environments such as healthcare, fatigue is recognized as a major risk to patient and staff safety, with fatigue management systems being critical in mitigating this risk (Redfern et al., 2023).

Refreshed workers may prioritize productivity and task completion, disregarding perceived safety measures that slow down their work. The pressure for productivity in the workplace can significantly affect worker behavior, often leading them to prioritize task completion over safety measures. This phenomenon is particularly evident in high-pressure environments where tight schedules and performance benchmarks are the norm. For example, in the construction industry, production pressures stemming from tight schedules and ineffective management can lead to increased stress and a tendency to prioritize productivity over safety, resulting in accident-prone environments and reduced safety behaviors (Neale and Gurmu, 2022).

Several factors may explain why fatigued workers still comply with safety procedures. One possibility is self-awareness: fatigued workers may be more aware of the risk of accidents and therefore more careful in following safety procedures to avoid injury (Patrisia, 2018). Additionally, company supervision and policy could play a role; strict regulations and effective supervision may ensure that even tired workers continue to adhere to safety rules (Aulia et

al., 2018). Training and education are also essential contributors—workers who have received adequate safety training are more likely to follow safety procedures, even when fatigued. An effective safety training program incorporating online and offline methods, can help workers retain and apply safety knowledge consistently (Wang et al., 2019). Furthermore, the positive relationship between safety training and safety performance, as demonstrated in a study conducted at Giatmara, suggests that well-trained workers are more likely to comply with safety regulations and reduce the risk of accidents even under physical fatigue (Rules, 2023). Lastly, safety culture within the organization may influence compliance. A strong safety culture can encourage adherence to safety procedures regardless of a worker's physical condition. Organizational culture, when supported by continuous and effective training, fosters internalization of safety norms, thereby enhancing consistent safety behavior (Alkhaledi et al., 2023).

Construction workers may not experience fatigue but still lack safety compliance due to several interrelated factors. Firstly, informal safety communication between crew members and workmates significantly impacts safety compliance and participation. Effective communication among crews promotes better safety compliance, while workplace camaraderie increases safety participation, indicating that a lack of such communication can lead to non-compliance even in the absence of fatigue (Acheampong et al., 2024). In addition, cognitive-related factors also play an important role; dynamic interactions in workers' cognitive processes, including perception and competence, are critical to safety management. Cognitive failures in safety management are caused by poor awareness and knowledge of safety. These shortcomings can lead workers to underestimate the risks and opt for safe actions (Deng et al., 2022; Cheng et al., 2024).

Environmental factors such as hot climate, vibration, and altitude changes also contribute to occupational fatigue, but proper management through work break cycles and cooling arrangements can reduce fatigue without necessarily increasing safety compliance (Heng et al., 2024). In addition, unsafe behavior, which is a significant cause of workplace accidents, is influenced by knowledge, supervision, and fatigue (Kao et al., 2019; Zhang et al., 2023). Even in the absence of fatigue, inadequate supervision and insufficient knowledge can lead to unsafe practices and non-compliance with safety standards (Putri and Wahyuningsih, 2024). Finally, while nutritional status and work stress are directly related to fatigue, they do not necessarily correlate with safety compliance. Workers with excellent nutritional status and low stress levels may still show non-compliance if other factors such as supervision and cognitive competence are not well managed (Fitri et al., 2024).

AUTHOR CONTRIBUTION

Yeremia Rante Ada' contributed to the development of the concept and main idea of the study, as well as the overall design of the study. She was also responsible for the initial preparation and drafting of the manuscript, which included the formulation of the hypothesis and research objectives. In addition, he also did the final editing of the manuscript.

Sumardiyono focused on the literature search and definition of intellectual content. He compiled a literature review relevant to the research topic and identified gaps in the literature that the study sought to fill. He also participated in the editing of the manuscript to ensure that the content matched the references.

Reni Wijayanti was responsible for the implementation of the experimental study and data collection. She ensured the experimental methods were in line with the research design and managed the team in the data acquisition process.

Farhana Syahrotun Nisa Suratna plays a role in data analysis and statistical analysis. She performed statistical calculations and interpretation of the data generated from the experimental studies and ensured the accuracy of the analysis results.

Bachtiar Chahyadhi contributed to manuscript preparation and editing. He reviewed sections of the manuscript to ensure consistency in the format and language used. He also fact-checked the data presented in the manuscript and the results of the analysis.

Maria Paskanita Widjanarti contributed to the final review of the manuscript, providing critical feedback on its overall content and identifying areas that needed clarification or further development. She also helped ensure that all contributions and findings were clearly presented in the final manuscript.

Rachmawati Prihantina Fauzi provide input in the preparation of the manuscript, especially in the methodology section. He also reviews and edited the results section for clarity and relevance.

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CONFLICT OF INTEREST

There is no conflict of interest in this study.

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