Salud, Ciencia y Tecnología. 2025; 5:2175
doi: 10.56294/saludcyt20252175

ORIGINAL

Analysis of Factors Influencing Work Fatigue Among Workers in Noise-Exposed Environments at The Antang Furniture Industrial Area

Análisis de los factores que influyen en la fatiga laboral en trabajadores en entornos expuestos al ruido en el polígono industrial de muebles de Antang

Nurjannah Husaeni[1], Yahya Thamrin[1], Masyitha Muis[1], Atjo Wahyu[1], Nurhaedar Jafar[2]

[1]Universidad Hasanuddin, Departamento de Seguridad y Salud Ocupacional. Makassar, Indonesia.
[2]Universidad Hasanuddin, Departamento de Nutrición. Makassar, Indonesia.

Cite as: Husaeni N, Thamrin Y, Muis M, Wahyu A, Jafar N. Analysis of Factors Influencing Work Fatigue Among Workers in Noise-Exposed Environments at The Antang Furniture Industrial Area. Salud, Ciencia y Tecnología. 2025; 5:2175. https://doi.org/10.56294/saludcyt20252175

Submitted: 01-05-2025 **Revised:** 04-07-2025 **Accepted:** 10-09-2025 **Published:** 11-09-2025

Editor: Prof. Dr. William Castillo-González

Corresponding author: Nurjannah Husaeni

ABSTRACT

Introduction: work fatigue in the informal furniture industry in Antang, Makassar, is triggered by noise, long hours, and heavy loads, which reduce health and productivity and increase the risk of accidents, so a comprehensive K3 program is needed to overcome it.
Method: this study uses a mixed-methods method with a sequential explanatory design, combining quantitative analysis of 103 furniture industry workers in Antang Makassar through questionnaires and direct measurements, as well as qualitative phenomenological analysis through in-depth interviews, observations, and documentation to comprehensively reveal the factors that influence work fatigue.
Results: bivariate analysis of 103 respondents showed a significant relationship ($p < 0,05$) between age, nutritional status, sleep quality, use of PPE, length of service, smoking habits, and physical workload with the level of work fatigue; ordinal logistic regression found five variables significantly influencing work fatigue, namely age ($p = 0,041$), nutritional status ($p = 0,037$), use of PPE ($p = 0,027$), length of service ($p = 0,000$), and physical workload ($p = 0,039$), with the model explaining 54 % of the variation in work fatigue (Nagelkerke $R^2 = 0,540$); in-depth interviews revealed that workers ≥45 years old experienced decreased stamina, eating habits affected energy, use of PPE was beneficial although sometimes uncomfortable, and length of service and heavy physical workload exacerbated by noise caused fatigue and decreased work motivation.
Conclusions: research in the Antang Makassar Furniture Industrial Area shows that age, nutritional status, length of service, use of ear protection, and physical workload significantly affect work fatigue, so that workload adjustments, nutritional education, rest arrangements, and the use of appropriate protective equipment are essential to improve worker health and productivity.

Keywords: Age; Nutritional Status; Workload; Work Fatigue; Smoking; Length of Service; APT.

RESUMEN

Introducción: la fatiga laboral en la industria del mueble informal en Antang, Makassar, se desencadena por el ruido, las largas horas y las cargas pesadas, que reducen la salud y la productividad y aumentan el riesgo de accidentes, por lo que se necesita un programa K3 integral para superarlo.
Método: este estudio utiliza un método mixto con un diseño explicativo secuencial, que combina el análisis cuantitativo de 103 trabajadores de la industria del mueble en Antang Makassar a través de cuestionarios y mediciones directas, así como el análisis fenomenológico cualitativo a través de entrevistas en profundidad, observaciones y documentación para revelar de manera integral los factores que influyen en la fatiga laboral.

Resultados: el análisis bivariado de 103 encuestados mostró una relación significativa (p < 0,05) entre la edad, el estado nutricional, la calidad del sueño, el uso de EPP, la antigüedad, el hábito de fumar y la carga de trabajo física con el nivel de fatiga laboral; la regresión logística ordinal encontró cinco variables que influyeron significativamente en la fatiga laboral, a saber, la edad (p = 0,041), el estado nutricional (p = 0,037), el uso de EPP (p = 0,027), la antigüedad (p = 0,000) y la carga de trabajo física (p = 0,039), y el modelo explicó el 54 % de la variación en la fatiga laboral (Nagelkerke R^2 = 0,540); las entrevistas en profundidad revelaron que los trabajadores ≥45 años experimentaron una disminución de la resistencia, los hábitos alimenticios afectaron la energía, el uso de EPP fue beneficioso aunque a veces incómodo, y la antigüedad y la gran carga de trabajo física exacerbada por el ruido causaron fatiga y disminuyeron la motivación laboral.
Conclusiones: las investigaciones realizadas en el área industrial de muebles de Antang Makassar muestran que la edad, el estado nutricional, la antigüedad, el uso de protección auditiva y la carga de trabajo física afectan significativamente la fatiga laboral, por lo que los ajustes de la carga de trabajo, la educación nutricional, los acuerdos de descanso y el uso de equipos de protección adecuados son esenciales para mejorar la salud y la productividad de los trabajadores.

Palabras clave: Edad; Estado Nutricional; Carga de Trabajo; Fatiga Laboral; Tabaquismo; Antigüedad en el Servicio; APT .

INTRODUCTION

Along with current industrial developments, labor has become the central element responsible for managing raw materials, machines, equipment, and various other processes.[1] The implementation of occupational safety and health programs in industry is expected to support the creation of a safe and healthy work environment for workers and optimal work productivity. However, potential hazards and risks in the workplace can impact worker health.[2] One of the complaints that often arises is fatigue experienced by workers in the industrial sector.[3] Work fatigue, which can lead to errors and accidents, is a significant cause of injury in the industrial sector, contributing 34 % of lost work hours. Data from the WHO and the Japanese Ministry of Labour indicate that 65 % of workers experience physical fatigue, 28 % experience mental fatigue, and 7 % experience severe stress, posing a significant threat to the health and productivity of workers worldwide.[4]

Surveys in the US and UK show a high prevalence of fatigue, with 24–25 % of adults experiencing it. Research on 100 sufferers revealed that 64 % of cases were caused by psychological factors, 3 % by physical factors, and 33 % by a combination of both.[5] Nearly 40 % of workers in the US experience fatigue, which costs the economy up to $136 billion annually, with an average lost work time of 5,6 hours per week compared to 3,3 hours for workers without fatigue. In Indonesia, 36 % of the 847 workplace accidents in 2012 were attributed to fatigue, and in 2013, there were 35 917 reported cases of workplace accidents, highlighting the significant impact on productivity and the increased occupational safety risks.[6]

In Indonesia, an average of 414 work-related accidents occur every day, with 27,8 % caused by fatigue. This is also one of the leading causes of 21 735 cases in 2012, 35 917 cases in 2013, and 24 910 cases in 2014, resulting from excessive workload and unfavorable environmental conditions.[7] Factors such as gender, nutritional status, age, medical history, work shifts and postures, length of service, workload, and duration of work can trigger fatigue, especially in jobs with high skill and psychomotor ability demands that exceed an individual's standard capacity.[8] Fatigue can be measured through job evaluations, psychomotor tests, eye blink tests, subjective questionnaires, and mental tests, with questionnaires and reaction timers being the most common methods. Exposure to high noise (>85 dB) in industrial environments has been shown to disrupt concentration, cause physical and mental complaints, and be a significant factor in increasing workload and triggering fatigue.

Potential physical hazards, such as noise exposure, can disrupt occupational health and safety; therefore, regular health checks are essential in all sectors to prevent work from being neglected.[9] Industrial noise exposure is a global problem, with over 600 million workers affected, including 30 million in the US, 4–5 million in Germany, and 30–50 % of industrial workers in Indonesia, particularly in the informal sector. The ability of Indonesia's informal sector to compete depends heavily on its ability to address issues such as noise that disrupts productivity.[10] BPS data shows that the informal sector workforce remains dominant nationally, with a proportion of 64,70 % in 2023. In South Sulawesi, it reached 64,22 %, or 2 573 million people, in 2020, higher than the previous year.[11]

The informal sector in South Sulawesi, particularly the furniture industry, makes a significant contribution to the economy and employment. However, the dominant use of machinery in this sector is a significant source of noise, which can lead to hearing loss and work fatigue due to the physical and psychological impacts of long-term exposure.[12] Various factors such as work duration, lack of sleep, stress, health status, nutrition, and the

work environment contribute to fatigue, which accounts for approximately 50 % of industrial accidents. A study of 81 trailer truck drivers at PT AMI revealed that 92,6 %experienced mild fatigue, with 90,1 % of them reporting thirst as the primary symptom.[13] Research on Coal Hauling and Overburden Unit operators at PT BUMA found that of the various individual and job factors studied, sleep time and health status had a significant influence on complaints of fatigue.[14]

The Antang Furniture Industrial Estate in Makassar serves as a hub for informal sector furniture production, where workers are at a high risk of experiencing work fatigue. However, related research—especially that which highlights psychological factors, overtime work, and work monotony—is still limited.[15] Initial observations show that furniture workers stand for eight hours plus overtime in a noisy environment with heavy workloads, manual tools, and high production pressure, which increases the risk of work fatigue. This condition does not fully align with the principles of K3, so it is essential to investigate it to identify the causal factors and formulate recommendations for improvement. Therefore, based on the description above and initial observations made, the author intends to research factors related to work fatigue in workers exposed to noise in the informal business sector of the Antang Furniture Industrial Area, Makassar City.

METHOD

Research Design and Methodology

This study employs a mixed-methods approach with a sequential explanatory design, which involves collecting and analyzing quantitative data first, followed by qualitative data to explain and complement the quantitative findings. The study is observational in nature and takes place in Antang Village, Manggala District, Makassar City.

Timeline and Context

The data collection took place over a period of two months (April–May 2025), focusing on the furniture industry in the informal sector. The project was conducted in eight furniture businesses in Antang Village, involving 103 workers who were selected using a total sampling technique.

Population and Sample

The universe of this study includes workers in the informal furniture industry in Antang Village, while the population consists of workers in eight furniture businesses located in the area. The selection process involved all workers from these businesses, leading to a sample size of 103 respondents.

Survey and Application Process

The survey was carried out using a self-administered questionnaire distributed to all 103 workers in the selected furniture businesses. The questionnaire included items related to personal identity, subjective fatigue levels, and questions designed to assess the physical and environmental work conditions. Data from the questionnaires were collected and stored in a secure database for further analysis.

Data Collection and Processing

The quantitative data were collected using direct measurements (e.g., oximeter readings, noise levels) and questionnaires. The sound level meter was used to measure the intensity of noise exposure at various workstations, while oximeters were used to measure SpO2 levels both at rest and during work hours. The sound level meter was calibrated according to the manufacturer's specifications, and the measurements were conducted at three different points in each workstation, taking 5-minute readings each time, at a distance of 1 meter from the workers' ear. In-depth interviews were conducted, focusing on gathering personal experiences related to work fatigue and noise exposure. These interviews were transcribed and analyzed for common themes.

Data Analysis

The quantitative data were analyzed using SPSS software. Descriptive statistics (univariate analysis) were used to summarize the data, followed by bivariate analysis to examine relationships between variables using chi-square tests. Multivariate analysis was conducted using ordinal logistic regression, where the dependent variable was work fatigue, and the independent variables included noise exposure, working hours, job demands, and work experience. The qualitative data were processed using the stages of data collection, data reduction, data display, and drawing conclusions. This analysis was aimed at exploring how workers perceive and experience fatigue in relation to their work environment and noise exposure.

Ethical Aspects

The study followed ethical guidelines as specified by the ethics committee, with ethical approval obtained

under No. 588/UN4.14.1/TP.01.02/2025 and research protocol number 21325062071. Participants were informed about the purpose of the study, their voluntary participation, and the confidentiality of their responses. Informed consent was obtained from all participants.

RESULTS

Analysis Univariate

Measurement of noise intensity in the work environment in the Antang Furniture industrial area. Measurements were conducted at 8 points in each furniture unit.

Table 1. Respondent characteristics

Sampling Location	Average Measurement Results (Tool Operating)	NAB	Status
Unit 1	92 dB	85 dB	Tall
Unit 2	90 dB	85 dB	Tall
Unit 3	89 dB	85 dB	Tall
Unit 4	88 dB	85 dB	Tall
Unit 5	89 dB	85 dB	Tall
Unit 6	90 dB	85 dB	Tall
Unit 7	87 dB	85 dB	Tall
Unit 8	89 dB	85 dB	Tall

Based on table 1, noise measurements in the furniture industry showed levels of 88–92 dBA, exceeding the limit set by the Indonesian Minister of Manpower Regulation No. 5 of 2018 when the machine is fully operational. Of the 103 respondents, the majority were aged <45 years (59,2 %) with abnormal nutritional status (68,9 %), 53,4 %had poor sleep quality, and 41,7 % regularly used Hearing Protection Devices (APT). A total of 69,9 % worked more than 8 hours a day, 22,3 % were smokers, 63,1 % experienced light workloads, and 65 %of respondents experienced severe work fatigue.

Bivariate Analysis

Table 2. The relationship between several variables and work fatigue

Variables	Category	Severe Fatigue	Mild Fatigue	p-Value
Age	Risky	33	8	0,008
	No Risk	34	28	
Nutritional status	Abnormal	40	31	0,006
	Normal	27	5	
Sleep Quality	Bad	42	13	0,010
	Good	25	23	
Use of APT	No	24	6	0,004
	Sometimes	23	7	
	Routine	20	23	
Length of working	It is not in accordance with	57	15	0,000
	In accordance	10	21	
Smoking Habit	Smoke	57	23	0,014
	Do not smoke	10	13	
Physical Workload	Heavy	19	19	0,014
	Light	48	17	

The results of the cross-tabulation analysis in table 2 revealed that all tested variables, including age, nutritional status, sleep quality, use of Hearing Protection Equipment (PPE), length of service, smoking habits, and physical workload, exhibited a significant relationship with the level of work fatigue ($p < 0,05$). The risk age group (≥45 years), abnormal nutritional status, poor sleep quality, not regularly using PPE, working more than 8 hours, smoking habits, and heavy physical workload all increased the likelihood of severe fatigue.

The results of the model fitting information test showed a decrease in the -2 Log Likelihood value from 131 to 80 663 with a significance of $p = 0,000$.

Multivariate Analysis

Table 3. Case processing summary			
Dependent Variable		**N**	**Marginal Percentage**
Work Fatigue	Severe Fatigue	67	65,0 %
	Mild Fatigue	36	35,0 %
Valid		103	100,0 %
Missing		0	
Total		103	

Based on the results of the ordinal logistic regression analysis in table 3, information was obtained regarding the number of research samples. The number of respondents in the mild work fatigue category was 36 (35,0 %), while the number of respondents in the severe work fatigue category was 67 (65,0 %). The total research sample consisted of 103 respondents, with no missing data. Thus, all samples were declared valid for further analysis.

Table 4. Goodness of fit test			
	Chi-Square	**Df**	**Sig.**
Person	302,962	83	0,000
Deviance	79,277	83	0,595

It can be concluded that table 4 obtained a significant value from the Goodness-of-fit test (model suitability test) of 0,595, where the value of 0,595> 0,05. So the model used is by the observation data in the field (model fit), and H0 is accepted.

Table 5. Results of the determination coefficient analysis	
Cox and Snell	0,392
Nagelkerke	0,540
McFadden	0,385

Ordinal logistic regression analysis revealed the highest Pseudo R-squared value in the Nagelkerke model at 0,540. This means that the independent variable explains 54,0 %of the variation in the dependent variable, while the remaining 46,0 % is attributed to other factors outside the scope of the study.

Table 6. Simultaneous test results				
Model	**-2 Log Likelihood**	**Chi-Square**	**Df**	**Sig.**
Intercept Only	131			
Final	80 663	51 263	8	0,000

Table 7. Partial test results					
Variables	**Estimate**	**Std. Error**	**Wald**	**df**	**Sig.**
Threshold					
Fatigue = 1	4,604	2,415	3,635	1	0,057
Location					
Age	1,378	0,675	4,164	1	0,041
Nutritional status	-1,553	0,745	4,346	1	0,037
Sleep Quality	0,601	0,598	1,009	1	0,315
Use of APT	0,791	0,358	4,896	1	0,027
Length of working	2,470	0,685	13,002	1	0,000
Smoking Habit	0,649	0,656	0,979	1	0,322
Physical Workload	-1,238	0,601	4,244	1	0,039

The results of the logistic regression analysis revealed five variables that significantly influenced work fatigue: age (p = 0,041), nutritional status (p = 0,037), use of ear protection (p = 0,027), length of service (p < 0,001), and physical workload (p = 0,039). Meanwhile, sleep quality (p = 0,315) and smoking habits (p = 0,322) did not significantly influence the incidence of work fatigue.

Interview Result

Analysis of the age variable in this study reveals that informal sector workers experience different aspects of work fatigue, adaptation strategies, rest duration, motivation, and decreased physical abilities across age groups. Workers over 45 years of age tend to experience decreased stamina, so that work that once felt easy now becomes more difficult. This is evident in the statement of one informant:

"...if you want to compare it to before, it feels much harder now than when I was younger. Back then, I still had plenty of energy, but now I feel exhausted after just half a day of work..."(RF, 50 Years).

Age differences also influence work adaptation strategies. Older workers tend to adjust their work pace and methods to suit their physical abilities, as one informant noted.

"I just get plenty of rest if I do not have too much work. Because I cannot do as much work as I used to. Especially when it comes to lifting, but now, I can only be pushed by my mom using that tool."(RF, 50 Years).

In contrast, younger workers are still able to perform physical tasks quickly and with short breaks. Despite the decline in physical abilities experienced by older age groups, work motivation remains high, driven by family responsibilities and economic needs. As one informant expressed,

"...age does have a big influence, sis. Do not ask if you are tired, especially since we are here from morning until we go to bed and then go home. Well, we have to force ourselves to make ends meet."(RF, 50 Years).

Eating patterns and breakfast habits are factors directly impacting the stamina of informal sector workers. Several informants reported that skipping breakfast causes the body to feel tired quickly, makes it difficult to focus, and reduces energy for physical work. One informant said,

"I usually have breakfast before leaving. If I do not have time, I usually bring food here, because if I do not have breakfast, I feel really weak. I do not have the energy to do anything."(RF, 50 Years).

Eating regularly also plays a crucial role. Many workers admit to eating irregularly, sometimes only once or twice a day, which can lead to decreased physical endurance. One informant described,

"Sometimes I eat lunch at 3 p.m., sometimes I do not have time to eat at all. It is because I work all morning, especially when there are many orders."(BR, 37 Years).

This condition causes the body to tire more quickly, become sleepy, and even tremble if it continues to exert itself without adequate nutrition. As workers age, they also notice changes in nutritional needs. What was once considered sufficient is no longer sufficient to sustain physical activity without rapid fatigue. As noted,

"When I was young, I could work without breakfast. But now, if I do not eat rice and noodles, I quickly feel tired. As soon as I start work, I feel like I am already exhausted."(SL, 45 Years).

Use of Hearing Protection (EPP) among workers exhibits diverse meanings and subjective experiences, heavily influenced by personal perceptions and daily work situations. Some workers use it because they are bothered by loud, continuous machinery, which can trigger dizziness or fatigue more quickly. However, many also choose not to use it because they find it hot, uncomfortable, or difficult to communicate with coworkers. One worker revealed,

"Yes, I usually use it to cover my ears. There are also many small ones sold. I usually use it when I work near very noisy machines."(RF, 50 Years).

In terms of comfort, many report that APTs are beneficial, but they often cause feelings of heat, stuffiness, and even dizziness with prolonged use. Some find them comfortable at first, but over time, they become uncomfortable, prompting them to reflexively remove them. One informant described,

"It is comfortable at first, but if it lasts for a long time, your ears will get hot and your ears will get wet with sweat."(RF, 50 Years).

Despite this, some still use them in high-noise work areas, recognising their positive impact on hearing health. Regarding effectiveness, some workers find APTs quite helpful in reducing tinnitus and preventing dizziness after exposure to loud machinery. Those who regularly wear them report reduced fatigue from exposure, although comfort challenges remain the primary reason for inconsistent use. This is in line with the testimony of a worker who said,

"Wearing ear protection helps to prevent ringing in your ears after work, but you have to get used to it, because if you're not used to it, it is uncomfortable to wear."(SL, 47 Years).

For some workers, long working hours are considered an integral part of their routine, although they often cause varying degrees of fatigue. Some view long working hours as a natural consequence of their job demans, while others find them burdensome when the hours feel long and draining. Some workers say they are accustomed to it, but others find themselves quickly fatigued, especially when the workload is high or the job requires constant attention and concentration.

"I usually go in the morning and come home in the evening, sometimes if I have much work, I stay until the evening. I am used to it, but if it is continuous, it gets tiring" (AR, 45 years old).

"Sometimes it feels like it takes forever when I am working on a machine, especially if I am standing all the time. Overtime makes it even more tiring," (SN, 39).

"I just follow the work hours, whether it is long or short, depending on the work that day. If I am done, I go home; if not, I continue," (RM, 50 years old).

From these various perspectives, it is clear that perceptions of working hours are influenced by physical condition, type of work, and individual habits. Some can adapt without feeling overly burdened, while others experience a significant impact on their stamina and health from working long hours continuously. The physical workload experienced by workers often stems from repetitive activities that require significant strength over long periods. Lifting boards, chopping wood, and manually arranging materials are considered everyday routines, despite the physical demands they place on the body.

"In my opinion, the workload in a place like this is really hefty. Just look at how they have to lift boards and large pieces of wood every day, not to mention the process of stacking them, cutting them until they are assembled like that, stacked high on the side so the wood can hold them, so it has to be done manually," (RM, 50 years old).

Continuously engaging in such activities can quickly lead to fatigue, muscle aches, and a decline in stamina with age. Another worker said that lifting heavy loads is no longer his ability. He prefers to delegate such tasks to younger colleagues, as the workload is high, especially for manual labour. However, for other workers, the weight of the workload sometimes depends on the number of orders received.

"Actually, the workload also depends on the orders. If it is busy, the workload is heavy, but if it is not, it is not. It depends," (SR, 46 years old).

Repetitive physical activity performed in unergonomic positions slowly impacts the body's endurance. Fatigue is not just felt in the moment; instead, it accumulates over time.

"If you have been standing and lifting for a long time, your body will immediately feel heavy. The back and knees are the ones that hurt the most, especially if you have been working all day," (MN, 51 years old).

Some admit that when they were young, the workload felt light, but over time, physical strength decreased.

"When I was young, I could lift wood from morning until evening. But now, even before noon, my body already feels heavy. My legs often ache, and my back often hurts," (AR, 57 years old).

For some workers, demanding tasks are not just physical, but also require concentration and precision. Cutting or engraving materials with a machine requires complete focus, as the slightest error can be costly.

"Chopping wood is also hard. Not only do your hands get tired, but you also have to focus to avoid measuring errors. After working for a long time, your concentration can easily become distracted," (SN, 39).

Activities like this, when performed continuously, become increasingly complex as stamina decreases due to long work hours and intense time pressure. Increased work volumes over time exacerbate fatigue. The sheer number of orders reduces rest time, and work hours often end later into the evening.

"If I have a lot of work, my closing time is usually pushed back. Sometimes I have to work overtime until the evening. It's really tiring, not to mention having to go back in early the next morning," (AR, 45 years old).

For those who experience this situation, not only is energy drained, but eating patterns and rest rhythms are also disturbed.

"When I have much work to do, I do not have time to sit down. Even eating is usually slow," (RM, 50 years old).

From various perspectives, workload, duration, and volume of work are interrelated in shaping workers' experiences of fatigue. Continuous physical exertion without adequate recovery, coupled with time pressures and responsibilities, makes what once seemed like a simple job now a significant challenge, especially for those who have spent years in the same work environment.

Daily work activities in the furniture industry often last long, sometimes requiring overtime due to a high volume of orders. RF (50 years old) shared his experience, "As a business owner here, I am always in the field with other workers, but sometimes I monitor the process, help cut materials if necessary, sometimes I also work overtime if there are many orders." NW (51 years old) added, "I usually start work in the morning, help organise the workflow, sometimes I also directly participate in the cutting or finishing section if there are not enough people. If I work overtime, I also monitor until the evening." Meanwhile, ARF (57 years old) said, "I start work at 7 am until the afternoon. Sometimes I help with technical work if there are not enough people, especially when orders are tight. Overtime is normal, especially if there are many orders."

The crowded and noisy work environment is a challenge for workers. RF (50 years old) said, "The atmosphere is quite noisy because almost all the tools use machines, especially when cutting wood or sanding, the machine noise is usually deafening. However, that is normal, if there is much material and you want to work for a long time, it makes noise, but otherwise, it is not too much." ARF (57 years old) added, "The environment is quite crowded and noisy. Almost all workers use machines, so the sound of saws, drills, and sandpaper is like a noise

competition." SL (47 years old) also said, "This place is not very spacious, so when all the tools are on, it is very noisy. Plus, the workers communicate while shouting, and the atmosphere becomes very crowded."

Working conditions that require heavy physical exertion and constant noise can lead to decreased motivation and feelings of boredom. ARF (57 years old) admitted, "I have, especially if the work environment is too noisy and the pressure of orders is high, sometimes I suddenly get emotional easily, but usually also less enthusiastic in the afternoon." UD (53 years old) agreed, "Sometimes, especially when the tools are noisy, I usually just want to get it done quickly, I do not feel like talking, as if I do not have the energy." GS (55 years old) also said, "Honestly, I have. When I am exhausted, especially with the constant noise of the machines, I get emotional easily and do not want to talk to the team members.".

DISCUSSION

Age

Age is a significant factor influencing a worker's physiological abilities and endurance, with increasing age often resulting in decreased physical capacity and increased fatigue, particularly in physically demanding work. Research indicates a significant correlation between age and fatigue levels, with workers over 40 years of age more likely to experience decreased concentration and slower reaction times compared to younger workers.[16] However, the results of a study at PT. Sarandi Karya Nugraha, which included workers over 30 years old (52,4 %), showed that while respondents with severe fatigue were older (mean rank 43,50 vs. 37,50), statistical tests indicated no significant relationship between age and work fatigue (p = 0,400).[18] This discrepancy highlights that while age has the potential to influence body endurance at work, it is not always consistent. Age is often influenced by many other factors that can contribute to a decrease in the level of body endurance at work. For example, qualitative findings from in-depth interviews reveal that older workers in the informal furniture sector experience fatigue more quickly, with decreased stamina and slower recovery compared to younger workers. This suggests that while age alone may not be the primary predictor, it interacts with other factors such as the physical demands of the job and the worker's ability to adapt to those demands. Therefore, while age plays a role in increasing fatigue risk, the interaction with job pressures, working hours, and repetitive tasks is more significant in explaining the observed effects in the informal sector.

Nutritional Status

Meeting balanced nutritional needs is crucial for maintaining workers' energy and work capacity, as nutritional deficiencies can trigger fatigue. Research shows that energy intake, derived from carbohydrates, proteins, and fats, must be balanced with energy needs to prevent fatigue and ensure optimal work performance.[19] In the context of the informal furniture sector, poor nutritional status is closely linked to increased work fatigue. The Body Mass Index (BMI) has been used to assess nutritional status, with findings indicating a significant association with work fatigue levels (p=0,006). Workers with abnormal nutritional status are more likely to experience severe fatigue than those with normal nutritional status. Qualitative findings from in-depth interviews corroborate this result, showing that irregular eating patterns, lack of balanced nutrition, and the habit of skipping breakfast lead to decreased energy and endurance, thus increasing fatigue risk. In many informal work environments, such as the furniture sector, workers often do not have access to sufficient breaks or nutrition, exacerbating the risk of fatigue, particularly during heavy physical labor. This connection emphasizes the need for interventions to improve nutritional status among informal workers. Not only does better nutrition support physical well-being, but it also enhances workers' ability to withstand the stressors associated with repetitive, physically demanding tasks, and exposure to environmental factors like noise.

Sleep Quality

Poor sleep quality is a significant contributor to fatigue, reducing focus, slowing down responses, and increasing the risk of errors in high-concentration or hazardous environments. Workers in the informal furniture sector with poor sleep quality were found to experience significantly higher levels of work fatigue (40,8 %) compared to those with good sleep quality (24,3 %), as indicated by the Chi-Square test results (p=0,010).[21] However, while bivariate analysis revealed a significant relationship between sleep quality and work fatigue, the multivariate analysis showed no significant influence of sleep quality on work fatigue (p = 0,315), suggesting that when controlling for other variables, sleep quality alone does not explain fatigue levels. Despite this, qualitative data provide insight into why sleep quality may be a key factor. Workers in the informal furniture industry often report disturbed sleep patterns, with long working hours, high production pressure, and environmental noise contributing to poor sleep. These findings suggest that while sleep quality alone may not be the most dominant predictor of work fatigue in multivariate models, it still plays a crucial role in workers' recovery and their ability to perform physical tasks. Poor sleep disrupts the body's recovery mechanisms, particularly in high-stress, noisy environments.[21]

Length of Working Hours

Work durations exceeding 8 hours per day without clear time arrangements are frequently experienced by informal sector workers, resulting in reduced rest time and an increased risk of physical fatigue. Studies show that working more than 8 hours significantly increases fatigue levels compared to shorter work durations, thus reducing productivity and work quality.[22] A global study by the WHO and ILO[23] shows that working more than 55 hours per week increases the risk of chronic fatigue, stroke, and heart disease, which are concerning issues across various sectors. In the informal sector, long work hours, coupled with exposure to environmental noise, accelerate fatigue by disrupting biological rhythms and causing workload accumulation without adequate rest. Bivariate analysis using the chi-square test revealed a significant relationship between work duration and work fatigue levels (p = 0,000), indicating that long working hours contribute to increased fatigue and higher error rates due to insufficient rest. Workers in the informal furniture sector often face long working hours without adequate breaks, leading to physical fatigue and decreased concentration. The combination of extended hours and the physical demands of repetitive work in a noisy environment exacerbates the risk of fatigue, as shown in qualitative interviews. These findings highlight the importance of managing work hours and implementing regular breaks to prevent fatigue accumulation. Adjusting work hours, introducing more frequent breaks, and reducing workload intensity during long shifts would significantly reduce fatigue risks.[24]

Smoking Habit

Fatigue, which is characterized by decreased energy, is influenced by various factors, including smoking. Smoking disrupts workers' cardiorespiratory fitness, exacerbating physical conditions and increasing the risk of work fatigue.[25] Research in the Antang furniture industry shows that workers who smoke are more likely to experience severe fatigue (55,3 %) compared to non-smokers (9,7 %), with statistical analysis indicating a significant relationship (p=0,014). Smoking reduces respiratory system performance, decreasing oxygen levels in the blood, and accelerating the onset of fatigue. However, while smoking habits are correlated with increased fatigue in this context, qualitative data indicate that the combined effects of smoking, exposure to noise, long working hours, and other environmental stressors may be more potent than smoking alone. These factors compound the risks of fatigue, making smoking a significant but secondary contributor to work fatigue in the informal furniture sector.[26]

Use of Ear Protective Equipment (APT)

Personal protective equipment (PPE), particularly ear protection (APT), is essential for reducing the intensity of noise exposure in the workplace, thereby preventing hearing loss and mitigating the physiological and psychological impacts of noise, such as work fatigue. Compliance with the use of PPE, however, is influenced by various factors, including workers' awareness of risks and the comfort of the equipment.[27] Research on 103 respondents showed that workers who regularly use APT report lower levels of work fatigue compared to those who do not or only occasionally use APT, with bivariate statistical analysis (p = 0,004) and multivariate analysis (p = 0,027, estimate = 0,791) confirming that APT use significantly reduces the risk of work fatigue, even when controlled for other variables. Qualitative findings support this result, showing that although ear protection is available, workers' compliance is often low due to discomfort or lack of knowledge about its importance. Enhancing training on the benefits of ear protection and improving the design of PPE to increase comfort can lead to better compliance and reduced fatigue in noisy environments.[28]

Physical Workload

Workload refers to the pressure workers feel due to task demands, impacting their performance and health. High physical workloads, such as repetitive lifting and the use of manual tools, can exceed workers' physiological capacities, leading to fatigue.[29] Noise exposure in such conditions worsens the situation by adding additional physiological stress and reducing concentration. Data from 103 respondents showed a significant relationship between physical workload and work fatigue levels (p = 0,039), where heavy activities like lifting materials and using manual tools triggered muscle pain and fatigue, especially in older workers. Qualitative interviews reveal that workload is a primary factor contributing to fatigue. The higher the physical workload, the more likely workers are to experience fatigue.[30] These findings align with other research, which shows that workload is the most significant factor determining fatigue levels. The lack of structured work-rest time arrangements in the Antang furniture industry further exacerbates this issue.

CONCLUSION

The research conducted at the Antang Furniture Industrial Estate in Makassar City highlights the complex interplay of factors contributing to workers' fatigue, particularly age, nutritional status, work duration, physical workload, and hearing protection. To mitigate fatigue and promote a healthier, more productive workforce, it is essential for business owners to implement tailored strategies that address these factors. This

includes optimizing workload distribution based on workers' age and physical capabilities, promoting proper nutrition and consistent rest periods, and ensuring the availability and comfort of hearing protection in noisy environments. Further, addressing high physical workloads through better task management and ergonomics will contribute to reducing fatigue. Future research should explore the long-term impact of these interventions on worker health and productivity, as well as the effectiveness of integrated approaches that combine these factors in the informal sector.

REFERENCES

1. Handayani K. Adaptive strategies to retain the workforce in the era of society 5.0: Facing the challenges of cobots. J Multidisciplinary Research Nation. 2024;1(3):185–200.

2. Thamrin Y. Work Fatigue Among Seaweed Workers in Takalar District. Media Kesehat Masy Indones. 2020;16(2):272–80.

3. Kusworo DA. TA: Implementation Of Occupational Safety And Health In The Alsintan Workshop Of Uptd Bbitp Of Lampung Province. Lampung State Polytechnic; 2021.

4. Asriyani N, Karimuna SR. Factors related to the occurrence of work fatigue in workers at PT. Kalla Kakao Industri in 2017. Haluoleo University; 2017.

5. Permatasari A, Munandar S. Factors related to work fatigue in employees at Matahari Department Store Lippo Plaza Kendari Branch in 2016. Haluoleo University; 2017.

6. Kott S, Droux J. Globalizing social rights: the International Labor Organization and beyond. Springer; 2013.

7. Azmy PA. Factors Related to Work Fatigue in Oil Palm Fruit Harvesters at PT. Perkebunan Nusantara IV Kebun Bandar Selamat. UIN North Sumatra Medan; 2024.

8. SUNTARI WAYU. The Relationship Between Work Fatigue, Work Time, And Work Load Withproductivity Of Fish Loading And Unloading Workers At Rembank Port In 2021. Diponegoro University; 2022.

9. Hanani AD. Analysis of potential hazards in the work environment at tailor Y in Palembang. Syntax Idea. 2021;3(2):238–45.

10. Bahri ES. Sustainable Community Empowerment. Fam Publishing; 2019.

11. BPS South Sulawesi Province. No Title. South Sulawesi; 2020.

12. Ulfa AL. The Relationship Between Noise Levels and Individual Characteristics with Hearing Loss Complaints in Metal Manufacturing Home Industry Workers in Ngingas Utara Village, Sidoarjo Regency. AIRLANGGA UNIVERSITY; 2020.

13. Kristanto A. Study of Risk Factors Associated with Fatigue of Trailer Truck Drivers at PT. AMI. Univ Indones. 2012;

14. Mulyani T. Factors Related to Fatigue Complaints in Coal and Overburden Hauling Unit Operators at PT Buma, a Working Partner of PT Berau Coal Lati Tanjung Redeb, East Kalimantan in 2012. Univ Indones. 2012;

15. Kandrina AA, Rezania Asyfiradayati S. Description of Fatigue Levels in Welding Workshop Workers in the Kusumodilagan Area of Surakarta. Muhammadiyah University of Surakarta; 2023.

16. Agustin A, Ihsan T, Lestari RA. Overview of Factors Influencing Work Fatigue in Textile Industry Workers in Indonesia. J Occupational Health and Safety and Environment. 2021;2(2):138–51.

17. Andarini YD. Work Stress as a Risk Factor for Subjective Fatigue in Weaving Loom Unit Workers at Pt. X. J Ind Hyg Occup Heal Vol. 2017;1(2).

18. Mu'minah N. Factors Related to Work Fatigue in Production Workers at PT. Sarandi Karya Nugraha in

2020. UIN SYARIF HIDAYATULLAH JAKARTA-FIKES; 2021.

19. Mangeka GMO, Mansur MA, Amir S, Jafar N. Intake Of Macro Nutrition, Fiber, And Sodium Workers Pt Masmindo Dwi Area. J Gizi Masy Indones (The J Indones Community Nutr. 2023;12(1).

20. Chairani MF, Situngkir D, Putri EC, Nitami M. Sleep Quality as a Predicting Factor for Work Fatigue in Firefighters. J Ind Hyg Occup Heal. 2023;7(2):127–37.

21. Carlos D, Yasnani Y, Afa JR. Factors Related to Fatigue of Tank Truck Drivers at the Fuel Terminal of PT. Pertamina (Persero), Latambaga District, Kolaka Regency, 2016. Haluoleo University; 2016.

22. Nachnul Ansori ST, Agustina IF, Mustika Ratnawati Faizzah MT. Analysis of Work System Design. Media Nusa Creative (MNC Publishing); 2025.

23. Basner M, Babisch W, Davis A, Brink M, Clark C, Janssen S, et al. Auditory and non-auditory effects of noise on health. Lancet. 2014;383(9925):1325–32.

24. Syahputra H, Syafindy DM. Expert System for Hepatitis Diagnosis Using Certainty Factor Method. J Sains Inform Terap. 2023;2(1):45–50.

25. Junianto AWT, Prasetyo Y. The Relationship between Nicotine Addiction Level and Physical Fitness of Automotive Engineering Students. Medikora. 2014;12(1):153508.

26. Rahayu RP, Effendi L. Factors related to work fatigue in the McD Production Area Department, Plant M, PT "X" in 2017. Environ Occup Heal Saf J. 2020;1(1):51–60.

27. Ardiyansyah D, Kahar F, Suratman S, Sri Rejeki DS, Pramatama S, Yusuf M. The Relationship between Noise Level and Work Stress. Int J Med Sci Clin Res Stud. 2023;3(01):100–4.

28. Fitriyani BB, Wahyuningsih AS. The relationship between knowledge about ear protection devices (Ear Plugs) and compliance with their use among workers in the weaving section of the Weaving Department of PT. Daya Manunggal. Unnes J Public Heal. 2016;5(1):10–8.

29. Anizar A. Occupational Safety and Health Engineering in Industry. 2009;

30. Kasih BAT. The Relationship Between Age, Workload, Body Position, and Physical Activity with the Incidence of Low Back Pain in Nurses at EMC Sentul Hospital in 2023. J Pengabdi Ilmu Kesejahteraan. 2023;3(2):160–74.

FINANCING

The authors did not receive financing for the development of this research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

Data curation: Nurjannah Husaeni.
Formal analysis: Nurjannah Husaeni.
Research: Nurjannah Husaeni.
Methodology: Nurjannah Husaeni.
Project management: Nurjannah Husaeni, Yahya Thamrin, Masyitha Muis.
Software: Nurjannah Husaeni.
Supervision: Yahya Thamrin, Masyitha Muis.
Validation: Atjo Wahyu, Nurhaedar Jafar.
Display: Nurjannah Husaeni.
Drafting - original draft: Nurjannah Husaeni.
Writing - proofreading and editing: Nurjannah Husaeni.