



# The relationship between noise level and sleep quality in wood processing factory workers

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## ABSTRACT

**Background:** Many wood processing factories use giant machines to cut or shave wood according to the required needs. When processing wood, the condition workers experience exposure related to machine-generated noise. Exposure to noise generated from the work on average > 85 dB. Conditions of working hours are also long, up to 8 hours per day. There are several impacts caused by the presence of noise, one of which is the occurrence of sleep disturbances. This study aimed to determine the relationship between noise level and workers' sleep quality at the Rana Bhumi wood processing factory, Gianyar, Bali-Indonesia.

**Methods:** The research design was a cross-sectional study with a population of 30 samples of wood processing factory workers at Rana Bhumi, Gianyar, Indonesia, who met the inclusion and

exclusion criteria. Measure noise level using a sound level meter and measurement of sleep quality using the Pittsburgh sleeping quality index (PSQI). The data were analyzed using computer software with *Spearman's* rank test to determine the significant relationship between noise level and sleep quality in wood processing factory workers.

**Results:** The results showed that 30 factory workers were obtained by analyzing the relationship between noise level and sleep quality, where  $p=0.000$  ( $p<0.05$ ).

**Conclusion:** There was a significant relationship between noise levels and sleep quality in wood processing factory workers in Rana Bhumi, Gianyar, Bali, Indonesia.

**Keywords:** factory workers, noise level, sleep disturbance, sleep quality, wood processing.

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## INTRODUCTION

Today's rapid industry development in Indonesia aligns with advances in science and technology. The process of industrialization in Indonesian society is accelerating with the many establishments of companies and diverse workplaces. Industrial development is accompanied by a greater and more varied hazard risk due to the transfer of technology, where machines and work equipment are increasingly complex to support the production process. This can cause occupational health and safety problems.<sup>1</sup>

According to the Occupational Safety and Health legislation, namely Republic of Indonesia Law No. 1 of 1970 concerning occupational safety, every worker has the right to safety in working for the welfare and increasing national production and productivity.<sup>2</sup> Health is essential for productivity and increasing labor productivity as a human resource. Good health condition is an increase in good work productivity as well. Jobs that demand high work productivity can only be done by workers with excellent health conditions. Conversely, illness or health problems cause the workforce to be unproductive or less productive in carrying out their work.<sup>3</sup>

Technology and work equipment in the industry,

such as machines or tools, are now increasing and developing, ranging from type to number. Using these work machines and equipment will cause noise that disrupts communication, concentration, and enjoyment of work to lose power permanently. Noise is sound or voice whose existence is unwanted (noise is unwanted sound). In protecting workers' health, noise is defined as all unwanted sounds/sounds originating from production process tools and work tools, which can cause hearing loss at a certain level.<sup>3</sup>

World Health Organization (WHO) in 2004, high levels of occupational noise are a problem in all regions of the world. More than 30 million workers in the United States are exposed to hazardous noise; in Germany, 4-5 million people (12-15% of the workforce) are exposed to noise.<sup>4</sup> Noise sources can come from machines such as textile factories, sawmills, furniture industries, products using metal raw materials, and the automotive industry, which can produce noise exposure of 90 dB or more. According to the Minister of Manpower and Transmigration of the Republic of Indonesia Number PER.13/MEN2011 concerning the threshold value of physical and chemical factors in the workplace, the threshold limit value (TLV) of noise is 85 dB.<sup>5</sup>

Hearing loss is the partial or total inability to

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hear sound in one or both ears. Noise-induced hearing loss is a sensorineural type of hearing loss, which is initially not realized because it does not interfere with daily conversation. One of the risk factors that affect the severity of deafness is noise intensity.<sup>6</sup> According to research by Kusman et al. (2015), statistical test results showed that 20 people (68.9%) out of 29 people with noise intensity >85 dB had hearing loss, and some workers with exposure levels ≤85 dB also had hearing loss.<sup>7</sup>

The effects of noise exposure in labor can result in auditory disturbances in hearing loss and non-auditory disorders in communication disorders, fatigue, and physiological and psychological disorders. Noise also causes discomfort, impaired concentration, and insomnia.<sup>8,9</sup> This understanding needs to be given to managers and workers to understand better the risks regarding noise that will affect workers' health, including sleep quality. Sleep constitutes one of the bodily requirements that can result in changes in consciousness, such as diminished awareness and reaction to stimuli.<sup>10</sup> A person's capacity to concentrate, make decisions, and participate in everyday activities can be affected by a lack of sleep, as can the learning process, memory impairment, and emotional condition.<sup>11,12</sup>

Based on the data and observations mentioned above, researchers want to know the noise level generated by machines during wood processing which will be associated with sleep quality for workers. This research will also examine work environment conditions, occupational health, and safety.

## METHODS

This research used an analytic observational study with a cross-sectional design. The research was conducted from April 2022 to May 2022. The participants met the inclusion criteria: male aged 35-60 years, able-bodied, and willing to volunteer as a research sample from the beginning to the end of the study by signing informed consent. Meanwhile, the exclusion criteria subjects refused to participate in the study due to illness or sudden necessity. Respondents in this study were wood processing factory workers at Rana Bhumi, Gianyar, Bali, Indonesia. Based on the sample size formula used, the number of respondents in this study was 30 people who met the inclusion and exclusion criteria.

In the cross-sectional approach, data concerning the independent and dependent variables were collected simultaneously and simultaneously. Data on noise level and sleep quality were carried out simultaneously, meaning that each study subject

was collected once using a sound level meter and PSQI to measure noise level and sleep quality. Data were analyzed using SPSS version 25 computer software with the *Spearman* rank test to determine the relationship between noise level and sleep quality in Rana Bhumi, Gianyar, Bali-Indonesia.

## RESULTS

The characteristics of respondents based on age in factory workers can be seen in [Table 1](#). Distribution of data by age with an age range of 36-40 years totaling four people (13.3%), an age range of 41-45 years totaling four people (13.3%), an age range of 46-50 total of 11 people (36.7%) and the age range 51-55 amounted to 7 people (23.3%) and the age range 56-60 amounted to 4 people (23.3%).

The hypothesis test aims to prove a relationship between noise level and sleep quality in wood processing factory workers to determine the relationship between noise levels and sleep quality. Spearman's rank correlation analysis was carried out. The results of *Spearman's* rank correlation analysis can be seen in [Table 2](#). [Table 2](#) below shows that respondents with a noise level of 81-85 dB had good sleep quality, namely three respondents (10%), and with moderate sleep quality, two respondents (6.7%). Respondents with a noise level of 86-90 dB with good sleep quality, namely one respondent (3.3%), moderate sleep quality, 14 respondents (46.7%) with poor sleep quality three respondents (10%). Then seven respondents with a noise level of 91-95 dB with poor sleep quality were (23.3%).

## DISCUSSION

The age level influences labor productivity because it relates to a worker's physical abilities. Workers of productive age tend to be physically stronger than workers of non-productive age. The higher the age of the workforce, the work productivity will decrease. Older workers tend to have lower productivity. The analysis test results were obtained, showing a significant relationship between noise level and sleep quality of wood processing factory workers. Noise is all unwanted sound originating from production process equipment or work equipment which, at a certain level, can cause hearing loss. It is determined that the TLV of noise is 85 dB as the highest intensity and is a value that is still acceptable to workers without causing illness or health problems in daily work for no more than 8 hours a day or 40 hours a week.<sup>5,13</sup>

Research Park et al. (2017) stated that individuals with higher noise sensitivity tend to interpret noise negatively as a threat or disturbance and react emotionally compared to individuals with low

noise sensitivity. As a result, individuals with high sensitivity will find it difficult to get used to or adapt to noise, causing sleep disturbance problems. Noise sensitivity is also mentioned as an intermediary for the impact of noise on health.<sup>14</sup>

Based on research by Heo et al. (2013), it was found that temperature in the workplace ( $p < 0.001$ ) also had an effect on sleep quality compared to noise ( $p = 0.005$ ). In general, increases in the hormone cortisol and the hypothalamic-pituitary-adrenocortical (HPA) axis play an essential role in sleep, and disruption of these functions can cause sleep disturbances. Therefore, it can be surmised that the temperature in the workplace can directly affect the HPA axis and increase cortisol, and consequently, sleep disturbances occur.<sup>15</sup> In addition, the psychosocial factors of workers are also a significant cause of sleep disturbances. It was found that high job demands, lack of social support, and appreciation in the work environment significantly affect workers' sleep quality.<sup>16,17</sup>

Adult humans aged 26-64 years need sleep 7-9 hours/day and may only be exposed to noise of 85 dB for 8 hours/day. Lack of sleep time and too often exposure to high noise continuously results in increased cortisol hormones in humans. It can cause psychological disturbances such as stress to disrupt sleep patterns.<sup>18</sup> Noise causes sleep disturbances or reduces a person's quality of life and increases the prevalence of health problems because it affects the body's biological systems. Sleep disturbances manifest as cardiovascular system disorders, including coronary artery calcification, atherogenic lipid profile, atherosclerosis, obesity, type 2 diabetes, and hypertension.<sup>19</sup> Psychiatric disorders such as anxiety and mood disorders may also occur. The minimum sound level recommended by WHO is expected to be an excellent environmental benchmark for a population to live in to reduce the

level of noise-related morbidity.<sup>20</sup>

Research by Gitanjali and Anath (2003) revealed that workers who receive noise exposure during the day will disturb their sleep at night and can cause stress directly. Noise exposure will change the rapid eye movement (REM) sleep stages, where REM sleep is essential for maintaining mental and emotional balance, which can cause stress.<sup>21</sup>

Based on the discussion above, this study has several limitations. First, the number of samples is limited even with the total sampling technique. This was caused by the company's policy which only allowed research to be carried out in specific sectors. Second, there are still many factors in the work environment and sleep environment that have not been controlled by researchers, such as temperature, which affects workers' sleep quality.

## CONCLUSION

This study found a significant relationship between noise levels and sleep quality in wood processing factory workers in Rana Bhumi, Gianyar Regency.

## CONFLICT OF INTEREST

This research has no conflict of interest.

## ETHICAL CONSIDERATION

Before beginning the study, the authors requested permission to give sample information.

## AUTHOR CONTRIBUTIONS

IGAH compiled the study design, data collection, and data analysis and drafted the manuscript; IGAH, IAAS, and NC participated in the literature search, drafting, and revising of the manuscript. All authors have read and approved the final version of the manuscript.

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**Table 1.** Characteristics of respondents based on age

Characteristic	Category	Frequency	Percentage (%)
Age	36-40	4	13.3
	41-45	4	13.3
	46-50	11	36.7
	51-55	7	23.3
	56-60	4	23.3

**Table 2.** Result of Spearman rank test of dose of noise level and sleep quality

Noise Level	Sleep Quality						Total		P-value
	Good		Average		Poor		N	%	
	f	%	f	%	f	%			
81-85 dB	3	10.0	2	6.7	0	0.0	5	16.7	0.000
86-90 dB	1	3.3	14	46.7	3	10.0	18	60.0	
91-95 dB	0	0.0	0	0.0	7	23.3	7	23.3	
Total dB	4	13.3	16	53.3	10	33.3	30	100.0	

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