The Relationship between Continuous Noise Exposure and Job Stress

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Abstract. Continuous noise exposure can cause many detrimental non-auditory effects on workers, one of which is increased job stress. This study aims to examine and analyze the relationship between continuous noise exposure and job stress on the workers at the Utility Unit of PT X, a factory in Gresik, East Java, Indonesia. This research uses the quantitative method with an observational analysis research design and a cross-sectional approach. The samples were drawn using a total sampling method. The research instruments employed in this study were a sound level meter (type 3M SE-402 VP 185057) and the Depression Anxiety Stress Scale 42 (DASS-42) questionnaire. The results revealed that four areas in the Utility Unit had a continuous noise intensity value of more than 85 dBA. Those areas are the Coalmil, BFW Pump, ID Fan/FD Fan, and 8 Line Elevation areas. Most respondents were exposed to continuous noise on average for 18–20 hours per week. The job stress measurement showed that 18 (45%) out of 40 respondents suffer from job stress. The data analysis using Spearman's rho test showed a significant p-value of 0.029 ($p<0.05$) and rho coefficient of 0.345, suggesting that there is a correlation between continuous noise and job stress of the workers at the Utility Unit of PT X in Gresik.

Keywords: Continuous Noise, Job Stress, Worker

1 Introduction

Among various factors that can affect a work environment are physical hazard factors, which can cause disruptions in the work atmosphere and pose negative health and safety impacts on workers. One of the most common physical hazards in a work environment is noise. In particular, noise with an intensity that exceeds the threshold value might cause serious auditory and non-auditory effects [1]. Workers can experience non-auditory effects in the form of psychological disorders, one of which is job stress. It is a mental health disorder characterized by symptoms of anxiety or depression [2]. Such symptoms can ultimately affect the productivity and performance of workers.

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According to the 2018 Basic Health Survey (Riset Kesehatan Dasar or Riskesdas) conducted by the Ministry of Health of the Republic of Indonesia, the total prevalence of mental health disorders with anxiety or depression symptoms at the age of 15 and over reached 9.8%, increasing by 3.8% from the 2013 Riskesdas. The survey also revealed that East Java Province had a prevalence rate of mental health disorders with emotional symptoms of 6.8% [3]. Chief among the mental health problems experienced by workers are job stress, which can be triggered by a noisy work environment caused by the operational equipment and machines. According to a survey conducted by Northwestern National Life as cited in [4]), 40% of workers in the United States have experienced severe job stress. Another survey conducted by the Families and Work Institute as cited in [4]), also showed that 26% of workers reported that they are often and very often burned out by their work. Yusmardiansyah and Zhara (2019) state that there is a relationship (p-value of 0.001) between noise and job stress at PT Mitra Bumi in 2019. This finding is supported by another study by Octavariny, Siregar, br Bangun, and Sartika (2020) on 32 workers at the Makmur Jaya rice mill in Dusun V Kr. Anyar, Beringin District, Deli Serdang Regency, which also found that there is a relationship between noise and job stress experienced by workers.

PT X is an industrial company located in Gresik, East Java. Each area of the factory is equipped with equipment and machines to support the production process, but there are several risks that arise from them, such as continuous noise. The noise measurement data in 2020 from PT X show that the noise intensity in the Utility Unit was 88.8 dBA, exceeding the 85 dBA threshold set in the Minister of Manpower (MOM) Regulation No. 5/2018 on Occupational Safety and Health at Work Environment. The high noise intensity in this unit can trigger health problems for the operator workers. Based on the observations and interviews conducted by the researchers between January and February 2022, the operators at the Utility Unit complained about suffering from hearing loss and headaches due to the noise exposure. Furthermore, they also complained about communication impediments, getting easily sensitive and nervous, and feeling difficult to concentrate when they are in noisy areas.

Some previous studies have examined the relationship between noise and job stress. However, the relationship between continuous noise and job stress remains scarcely studied. Hence, this study is intended to fill this gap by examining the relationship between continuous noise and work stress on the workers at the Utility Unit of PT X Gresik.

2 Methods

This study uses a quantitative method with an observational analytical research design and cross-sectional approach. The cross-sectional approach was chosen to obtain an accurate level of assessment by collecting data within the same time period [7]. This study was conducted at PT X Gresik from May to June 2022. The population in this study consists of 40 operators of the factory's Utility Unit. The samples were drawn using a total sampling method due to the relatively small number of the population. In other words, the entire population was examined.

This study used a sound level meter (type 3M SE-402 VP 185057) to measure the continuous noise intensity and the Depression Anxiety Stress Scale 42 (DASS-42) questionnaire to measure the severity of core symptoms of depression, anxiety, and stress at work. The DASS-42 questionnaire is a complete version of the Depression Anxiety and Stress Scale questionnaire, so it can provide a more accurate description of the depression, anxiety, and stress experienced by the respondents. It is also easy to implement in a group and does not require a special training to use it [8]. The primary data in this study were collected from the continuous noise and job stress measurement results, whereas the secondary data were from the factory's Occupational Health and Safety (OHS) unit. Then, the data were analyzed to determine the relationship between the variables using the Spearman's rho correlation test. This study has passed the ethical test and received an Ethical Clearance Certificate (276/HRECC.FODM/V/2022) from the Health Research Ethics Committee, Faculty of Dentistry, Airlangga University.

3 Results

3.1 Characteristics of Respondents

Table 1. Characteristics of Samples

Variable	Total (n)	Percentage (%)
Age		
21–23 years old	8	20
24–26 years old	14	35
27–29 years old	11	27.5
30–32 years old	6	15
33–35 years old	0	0
36–38 years old	1	2.5
Years of employment		
0-2 years	2	5
3-5 years	9	22.5
6-8 years	16	40
9-11 years	9	22.5
12-14 years	3	7.5
15-17 years	1	2.5
Educational qualification		
Senior high school/vocational high school	32	80
Diploma	6	15
Undergraduate	2	5
Sex		
Male	40	100
Female	0	0
Total	40	100

Table 1 shows that from the 40 operators, 14 (35%) were 24–26 years old, and 16 (40%), or almost half of them, had worked for 6–8 years. Most of the operators (32 people, or 80%) had an educational qualification of Senior High School or Vocational High School. All of them are male.

3.2 Overview of Continuous Noise Measurement

The intensity of continuous noise was measured using a sound level meter for one minute. The following table presents the noise measurement results at the Utility Unit of PT X in Gresik.

Table 2. Results of the Continuous Noise Measurement at the Factory's Utility Unit

Control Room Area		Average
Area Sample Point	dBA	
A	76.7	75.25 dBA
B	75.8	
C	73.1	
D	74.8	
E	75.8	
F	75.3	
8 Line Elevation Area		Average
Area Sample Point	dBA	
A	92.1	90.5 dBA
B	88.9	
Boiler Feed Water Pump Area		Average
Area Sample Point	dBA	
A	98.5	97.4 dBA
B	96.3	
Coalmil Area		Average
Area Sample Point	dBA	
A	99.2	99.3 dBA
B	97.9	
C	99.7	
D	101.4	
E	98.1	
F	99.3	
Fan ID and FD Fan Area		Average
Area Sample Point	dBA	
A	91.3	93.5 dBA
B	93.6	
C	93.3	
D	95.8	

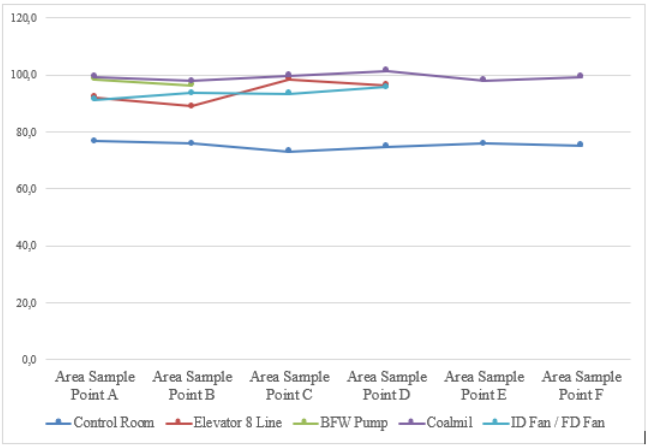

Fig. 1. Continuous Noise Intensity Changes at PT X's Utility Unit

Based on Table 2, the results of the continuous noise measurements in several points at the utility unit revealed that the highest noise intensity average is 99.3 dBA, which is in the Coalmil area, and the lowest noise intensity average is 75.25 dBA, which is in the Control Room area. The Boiler Feed Water Pump area has an average noise intensity of 97.4 dBA, followed by the ID Fan and FD Fan area and 8 Line Elevation area with an average of 93.5 dBA and 90.5 dBA, respectively. This also means that four out of the five work areas measured have noise intensity above the threshold. From Figure 1, it can be seen that the continuous noise intensity decreases in the 8 Line Elevation and Boiler Feed Water from the area sample point A to B. Meanwhile, in the Control Room, BFW Pump, Coalmil, ID Fan/FD Fan, the continuous noise intensity changes in an unstable trend in each each sample point area.

Table 3. Frequency Distribution of the Samples, by Work Area

Work Area	n
Control Room (CCR)	19
8 Line Elevation	8
Boiler Feed Water Pump	5
Coalmil	6
Fan ID and FD Fan	2
Total	40

Table 3 shows there are 19 respondents in the Control Room area, 8 respondents in the 8 Line Elevation area, 5 respondents in the Boiler Feed Water Pump area, 6 respondents in the Coalmil area, and 2 respondents in the Fan ID and FD Fan area.

Table 4. Frequency Distribution of Continuous Noise Exposure

Noise Exposure Duration (1 week)	n (%)
15–17 hours	7 (17.5%)
18–20 hours	12 (30%)
21–23 hours	3 (7.5%)
24–26 hours	10 (25%)
27–29 hours	1 (2.5%)
30–32 hours	5 (12.5%)
33–35 hours	2 (5%)
Total	40 (100%)

Table 4 shows the frequency distribution of of continuous noise exposure, in which it is known that out of the 40 operators, 2 (5%) received the longest continuous noise exposure (33–35 hours) a week, whereas 12 (30%) of them received continuous noise exposure for 18–20 hours a week. All the operators work eight hours a day or 40 hours a week.

Table 5. Frequency Distribution of Continuous Noise Exposure in Areas with <85 dBA

Noise Exposure Duration (1 week)	n (%)
15–17 hours	0 (0%)
18–20 hours	4 (21%)
21–23 hours	3 (16%)
24–26 hours	7 (37%)
27–29 hours	0 (0%)
30–32 hours	3 (16%)
33–35 hours	2 (10%)
Total	19 (100%)

Table 5 shows that from 19 respondents, 7 (37%) are exposed to continuous noise for five hours per day.

Table 6. Frequency Distribution of Continuous Noise Exposure in Areas with >85 dBA

Noise Exposure Duration (1 week)	n (%)
15–17 hours	7 (33%)
18–20 hours	8 (38%)
21–23 hours	0 (0%)
24–26 hours	3 (14%)
27–29 hours	1 (5%)
30–32 hours	2 (10%)
33–35 hours	0 (0%)
Total	21 (100%)

Table 6 shows that from 21 respondents, 8 (38%) are exposed to continuous noise for four hours per day.

3.3 Overview of Job Stress Level Measurement

Table 7. Results of the Job Stress Level Measurement

Stress Level	n (%)
Normal	22 (55%)
Mild	5 (12.5%)
Moderate	8 (20%)
Severe	3 (7.5%)
Very severe	2 (5%)
Total	40 (100%)

Table 7 shows the results of the job stress level measurement using the Depression Anxiety Stress Scale - 42 (DASS-42) questionnaire given to 40 respondents. It was found that almost half of the respondents (18 people, or 45%) experience work stress. Five respondents experience mild job stress, eight respondents experience moderate job stress, three respondents experience severe job stress, and two respondents experience very severe job stress.

Table 8. Results of the Job Stress Level Measurement in Work Areas with <85 dBA

Stress Level in Work Areas with <85 dBA	n (%)
Normal	7 (36.8 %)
Mild	4 (21.1%)
Moderate	4 (21.1%)
Severe	3 (15.7%)
Very severe	1 (5.3%)
Total	19 (100%)

Based on Table 8, in work areas where the continuous noise intensity is less than 85 dBA, more than half of the respondents (63.2 %) experience job stress. Both mild and moderate job stress are experienced by 8 (21.1%) of the 19 respondents working in areas with continuous noise intensity of less than 85 dBA.

Table 9. Results of the Job Stress Level Measurement in Work Areas with >85 dBA

Stress Level in Work Areas with >85 dBA	n (%)
Normal	15 (71.4%)
Mild	1 (4.8%)
Moderate	4 (19%)
Severe	0 (0%)
Very severe	1 (4.8%)
Total	21 (100%)

Based on Table 9, 6 (28.6%) of the 21 respondents who work in areas with a noise intensity of more than 85 dBA experience mild, moderate, and very severe job stress. Most respondents (71.4%) have a normal job stress level.

3.4 Results of the Spearman's rho Correlation Test between Continuous Noise and Job Stress

Table 10. Spearman's rho Correlation Test Results

			Continuous Noise	Job Stress
Spearman's rho	Continuous Noise	Correlation coefficient	1000	0.345
		Sig.	-	0.029
		N	40	40
	Work Stress	Correlation coefficient	0.345	1000
		Sig.	0.029	-
		N	40	40

Table 10 shows that the significance value (p) is 0.029. Since it is less than α (p<0.05) and has a correlation coefficient value of 0.345, it indicates a weak and linear relationship between continuous noise and work stress. The greater the continuous noise exposure, the greater the job stress, and vice versa.

4 Discussion

4.1 Continuous Noise

Noise is one of the physical work disturbances that occurs more than 70% and come from production activities in industries and factories, including the chemical industry [9]. Noise is an unwanted and disturbing sound that comes from work equipment and machines, which can cause hearing impairments and psychological issues to the workers, ultimately reducing work productivity. In the chemical industry, the noise is typically continuous with a certain level of frequency and intensity, as well as a long duration [10].

Based on Table 2, four out of five work areas have a continuous noise intensity that exceeds the 85 dBA threshold stipulated in the MOM Regulation No. 5/2018. Those work areas are the 8 Line Elevation (90.5 dBA), Boiler Feed Water Pump (97.4 dBA), Coalmil (99.3 dBA), and ID Fan and FD Fan (93.5 dBA). This is because those areas are in proximity with each other. Those areas also use large equipment and machines where the raw materials are processed to generate power (electricity and steam), hence producing the continuous noise. Meanwhile, the Control Room has a continuous noise intensity of only 75.25 dBA (below the noise threshold) because its location is specially designed employing the enclosure concept (sound-absorbing building) using

steel-coated doors and soft-board coated walls. This is in line with the opinion of Sasmita, Reza, and Rozi (2021), who state that the installation of soundproofing or enclosure made of polycarbonate, glass, aluminum, steel, plywood, and composite materials can abate noise.

From Table 3, it is known that as many as 21 operators who work in the 8 Line Elevation, Boiler Feed Water Pump, Coalmil, and ID Fan and FD Fan areas are exposed to continuous noise that exceeds the threshold value. Meanwhile, the workers in the Control Room area are not exposed to continuous noise that exceeds the threshold value. The side effects of noise exposure can cause temporary or permanent loss of hearing sensitivity. In addition, noise can also cause health issues, such as cardiovascular and psychological issues, namely job stress [12]. OHS needs to be applied in both formal and non-formal industries, as manifested through the use of personal protective equipment (PPE) [13]. PPE for hearing in the forms of ear plugs and ear muffs must be worn by the workers when working in noisy areas to reduce the intensity of noise received [14].

4.2 Job Stress

According to Tarwaka (2011), job stress is a form of emotional, cognitive, behavioral, and physiological reactions to various negative aspects of work, work community, and work environment experienced by the workers. In the world of industrial work, job stress can be induced due to the unbalanced environmental conditions and social factors with the workers' physical and mental abilities. Job stress is not triggered only by a stressful physical environment, such as noise, lighting, microclimate, and vibration [16]. There are other things that contribute to job stress, such as social changes, economic conditions, family situations, co-workers factors, and the individual themselves [17]

As shown in Table 6, 22 respondents have a normal level of job stress. Meanwhile, 5 respondents experience mild job stress, 8 respondents experience moderate job stress, 3 respondents experience severe job stress, and 2 respondents experience very severe job stress. The stress level varies because there are differences in the duration of continuous noise exposure and intensity in each work area in the factory's Utility Unit. There are three stress symptoms of stress, namely psychological symptoms (characterized by tension, anxiety, frustration, and irritability), behavioral symptoms (characterized by irregular eating patterns, irregular sleep patterns, and poor interpersonal relationships with co-workers) and physiological symptoms (characterized by digestive disorders, irregular pulse, and hypertension [18]. This is in line with the research conducted by [19], which revealed that there is a relationship between depression as a sign of stress symptom and hypertension in women and men aged 15–64 years in Indonesia. Workers need to have a good psychological endurance to reduce the risk of work stress. As such, they can understand their own capacity and ability to solve problems. Meanwhile, workers who do not have a good psychological endurance will be vulnerable to job stress and conflicts [20].

4.3 The Relationship between Continuous Noise Exposure and Job Stress

The Spearman's rho correlation test shows that there is a relationship between continuous noise and job stress on workers at the Utility Unit of PT X in Gresik, as proven by the significance value (p) of 0.029 and rho value of 0.345. If the significance value (p) is $< \alpha = 0.05$, H0 is rejected and H1 is accepted. The positive rho value of 0.345 indicates that there is a weak and linear relationship between continuous noise and job stress. If the noise intensity increases, the job stress will also increase, and vice versa. The relationship between continuous noise and job stress in this study is categorized as weak because there are several other factors that can trigger job stress, such as workload and individual factors that were not examined in this study.

This statement is like-minded with the research conducted by Ratnaningtyas, Ismaya, Puji, Hasanah, and Afriyani (2021), where the results bivariate analysis obtained $p\neg < \alpha = 0.05$, which means that noise has a correlation with the job stress of workers at PT X. A similar study was also conducted by Parinduri, Ginting, Irmayani, and Prabaja (2020), showing the results of the Chi-square test with a p value of 0.031 ($p < 0.05$), indicating that there is a significant relationship between noise and job stress. A research conducted by [23] in the textile industry also shows that there is a relationship between noise exposure, sensitivity, and noise disturbance on job satisfaction and job stress with a p-value of 0.001 ($p < 0.001$). Unfavorable working conditions can inevitably cause job stress, whereas a good work environment will boost the workers' performance and productivity, as they can work safely and comfortably [24].

Job stress can reduce workers'productivity and performance. Therefore stress management and motivation building are of paramount importance to ensure that they can carry out their duties and responsibilities well [25]. There are several things that can be done to manage job stress, such as doing meditation and yoga, as well as implementing a healthy lifestyle [26]. A healthy lifestyle can be applied by doing regular physical activities and following a healthy diet, as these activities can contribute to reducing oxidative stress or free radicals in the body, that is to improve health and become an alternative to process job stress [27].

5 Conclusion

This study has revealed that there is a relationship between continuous noise and job stress on the workers at the Utility Unit of PT X in Gresik, as shown by the Spearman's rho correlation test that resulted in a significant p-value of 0.029 ($p < 0.05$) and rho value of 0.345. It is recommended for the company to check the machines and conduct maintenance regularly to control the continuous noise and provide time for recreation and exercise to manage the job stress of their workers. This study did not take into account the workers' workload and individual factors that might contribute to triggering job stress. Therefore, further studies with more stress-inducing variables and instruments are needed.

Author's Contribution

MYA, MY, AS contributed to the design and study selection. MYA, MY, AS, SK contributed to the data analysis. All authors write the manuscript.

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