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Occupational noise exposure and blood pressure among steel industry workers

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Abstract:

Studies on the relationship between noise exposure at the workplace and hearing impairment among workers have been conducted extensively compared to the effects on non-auditory effects such as blood pressure, stress disorders and sleep disturbance. The purpose of this study was to investigate the effect of occupational noise exposure on workers' blood pressure. A cross-sectional study was conducted among 60 workers from 12 different sections at a steel manufacturing plant. Recruitment of participants was based on inclusive and exclusive criteria as well as voluntary participation. The noise levels exposed to the participants were measured using the Dosimeter for 8 hours working period. Blood pressure was measured using an Automatic Sphygmomanometer before, during, and after working hours. There was a significant relationship between noise exposure and blood pressure; $r = 0.51$, $p < 0.001$. There were also significant differences in blood pressure between before, during and after exposure to noise, $p < 0.05$. Exposure to occupational noise can be associated with changes in blood pressure.

Keywords: Blood pressure, Occupational noise

1. INTRODUCTION

It is estimated that 70% of occupational noise exposure is from the manufacturing process [1]. Industries classified under this category are the paper [2], rubber [3] and steel [4] industries. The relationship between exposure to noise at the workplace and auditory effects to workers has been verified and well accepted by many researchers [5]-[8]. Hence, recent studies have focused on non-auditory effects such as blood pressure, sleep disturbance and stress. Abnormal blood pressure is one of the risk factors for hypertension. Several studies have shown that exposure to noise higher than 85 dB(A) at work can lead to hypertension among workers [2], [9]-[11]. The relationship between noise exposure and non-auditory effects is still debated among researchers due to inconsistent findings [12]. According to Chen et al. (2017), most cohort studies show a significant relationship between occupational noise exposure and increases in blood pressure compared with other study designs [13]. The purpose of the present study was to investigate the relationship between occupational noise exposures on blood pressure among steel industry workers.

2. MATERIALS AND METHODS

A cross-sectional study was conducted at a steel manufacturing company in Shah Alam, Peninsular Malaysia. The information collected from participant included the demographic background of the participants, measurement of personal noise level exposed by each participants and measurement of blood pressure before, during and after exposure to noise.

2.1. Participants

Recruitment of participants was voluntary. Before the study, prospective participants were screened using inclusion criteria (aged between 18-57 years and job tenure more than 6 months) and exclusion criteria (those with hypertension and cardiovascular disease). Participants' demographic information taken were age, gender, job tenure and work unit.

2.2. Noise exposure level

Personal noise exposure was measured using the noise dosimeter over an 8-hour working period. The tool was placed to the participants' belt or pocket whilst the microphone was clip to their collar. The noise dosimeter was calibrated every time before performing a new measurement. All routine calibration and sound measurement performed followed the manual procedures provided by the manufacturer.

2.3. Measurement of blood pressure

Participants' blood pressure was measured 3 times and mean values were taken as final readings. To do this, researchers have attended a blood pressure-taking course

supervised by a trained Nurse and certified by a Medical Practioner. The tool used was an accordance to OMRON M3 IT Automatic. The blood pressure measurements were taken in a sitting position and have rested at least 5 minutes. The interval between the first, second and third measurement was 30 seconds. The procedure for measuring blood pressure was according to the manual provided by the manufacturer. Blood pressure is considered high if the systolic value ≥ 140 mmHg or diastolic value ≥ 90 mmHg [14].

2.4. Statistical analysis

Raw data were analysed using the Statistical Package for Social Science (SPSS) v23. Cleaning and transformation of data were performed to check the validity of the variable. Normality test was conducted on the continuous variable. The distribution considered normal when the Shapiro-Wilk value > 0.05. It was evaluated the assumptions for the inferential test. The non-parametric test was used because some of the test assumptions were not fulfilled. Spearman's rank correlation test was used to determine the relationship between noise exposure and participants' blood pressure while Kruskal-Wallis test was performed to compare blood pressure between, before and after exposure to noise.

3. RESULTS AND DISCUSSION

3.1. Demographic background

Table 1: Participants' demographic background

Variables	Classification	n (%)
Age (years)	<20	6 (10.2)
	21-30	26 (42.4)
	31-40	16 (27.1)
	41-50	10 (16.9)
	51-60	2 (3.4)
Gender	Male	56 (93.3)
	Female	4 (6.7)
Job Tenure	6 – 12 months	32 (53.3)
	13 – 24 months	5 (8.3)
	> 24 months	23 (38.3)
Work Unit	Small Press	10 (16.7)
	Large Press	5 (8.3)
	Medium Press	4 (6.7)
	Line A	4 (6.7)
	Line C (Rivet)	5 (8.3)
	Line C (Upstairs)	4 (6.7)
	Line E	8 (13.3)
	Line F	4 (6.7)
	Welding Shop	5 (8.3)
	Press Maintenance	6 (10.0)
	Die Maintenance	4 (6.7)
	Kowake	1 (1.7)

N=60

The total number of workers in the study location was 105. However, only 75 met the inclusion and exclusion criteria. According to Krejcie & Morgan (1970), 63 people were required to reach a representing sample. Only 60 employees completed all measurements while the rest withdrew from the study for personal reasons. Table 1 shows a summary of participants' demographic background.

3.2. The personal noise exposure level

Participants were selected from 12 working sections in the production line. Therefore, their exposure to noise also varied, depending on the activities performed. Figure 1 shows the distribution of personal noise exposure results by section. The lowest level detected was 66 dB(A) whilst to highest was 93dB(A). Other studies conducted at different types of the manufacturing process have noise levels between 75 - 106 dB (A) [1], [3]. A cross-sectional study in Jordan investigated workers chronically exposed to noise

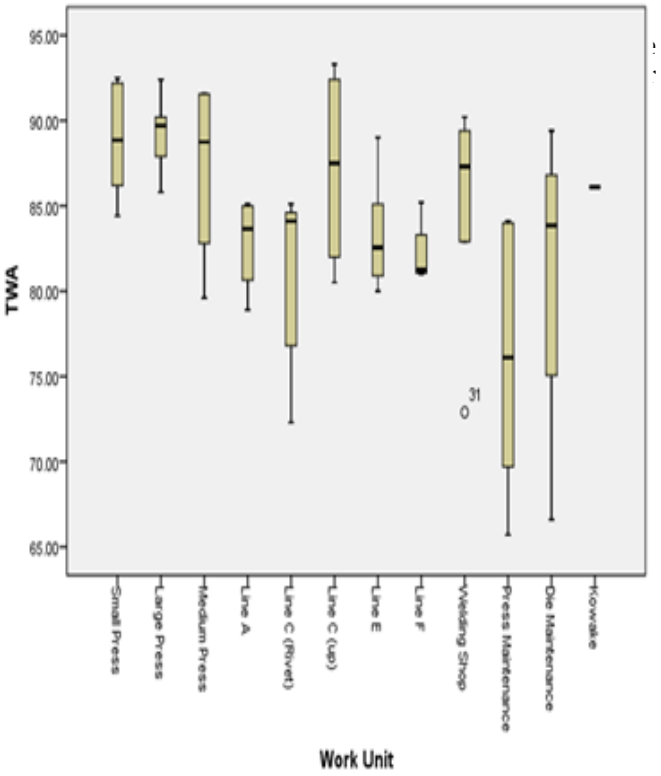

Figure 1: Distribution of personal noise exposure level among participants by work location

The present study shows that only 4 sections produced noise of more than 90 dB(A). Out of 60 participants, 33 (55%) were exposed to noise above 85 dB(A) as shown in Table 2. Some comparative studies used employee from lower noise exposure as a comparative group such as to investigate whether exposure to loud noise can cause hypertension or hearing impairment [9], [10]. A study by Zamanian et al. (2013) investigates the effect of occupational noise exposure on blood pressure and heart rate of steel industry workers. Only 13 (23%) from 60 areas had a noise level over 85 dB(A) and 23 (39%) had an level (65 – 85 dB) [4].

Table 2: Number of participants exposed to noise below and above 85 dB(A).

Work Unit	<85 dB(A)	>85 dB(A)
Small press	1	9
Medium press	1	3
Large press	0	5
Line A	3	1
Line C (Rivetting)	2	3
Line C (Upper level)	2	2
Line E	4	4
Line F	3	1
Welding shop	2	3
Press maintenance	6	0
Die maintenance	3	1
Kowake	0	1

N=60

3.3. Blood pressure level

Blood pressure of each participant was taken three times; i.e. before, during, and after exposure to noise. The mean readings of systolic (SBP) and diastolic (DBP) blood pressure are shown in Table 3.

Table 3: Participants' blood pressure levels before, during and after exposure to noise

SBP	Min	Max
Before	117	121
During	132	140
After	115	124
DBP		
Before	79	83
During	86	94
After	82	85

N=60

The normal blood pressure for men aged 18-59 years is between 120/80 - 131/87 mmHg. Employees who have higher than the stated range were excluded from the participants' list before the study embark. The range of participants' blood pressure in the present study was consistent with some previous studies results. In the present study; systolic blood pressure before, during, and after exposure to noise ranged between 117 - 121, 132 - 140 and 115 - 124 whilst diastolic between 79 - 83, 86 – 94 and 82 – 85 respectively [9], [15]. Participants had normal blood pressure before exposure, increased during exposure and return to the ordinary range after no longer exposure to noise. The results indicate that exposure to occupational noise may influence the level of blood pressure among participants.

3.4. The relationship between noise exposure and blood pressure level

Spearman's rank correlation test was used to determine the relationship between noise exposure and the participants' blood pressure. There was a significant relationship between exposure to noise and blood pressure. However, the strength of the relationship between both variables was moderate; $r = 0.51$, $p < 0.01$. This result was consistent with other studies conducted in Italy [9], Taiwan [10] and Jordan [15]. Although Asunta et al. (2015) had studied the effect of continuous exposure to occupational noise on cardiovascular, they also reported a significant relationship between noise exposure and the prevalence of hypertension [9]. Chang et al. (2012) not only reported the changes of blood pressure when exposed to noise but also reported a significant relationship between exposure to occupational noise with the prevalence of hypertension among participants [10].

3.4. The differences of blood pressure level between before, during and after noise exposure

Kruskal Wallis test was used to compare the blood pressure between before, during and after exposure to occupational noise. There was a significant difference in blood pressure during exposure compared with before and after exposure, $p < 0.05$. However, no significant difference was found in blood pressure between before and after exposure to noise, $p > 0.05$. The present study indicates that most participants' blood pressure back to normal range when they were not exposed to noise after finishing work. Although the results were higher compared to before exposure, it might get better blood pressure level when they get ample rest. We could not find a specific study to support our findings.

4. CONCLUSION

Finding from this present study revealed exposure to workplace noise may change the participants' blood pressure. No significant relationship was found between age and job tenure with the blood pressure. A prospective study should be conducted in the future to determine whether to investigate whether continuous changes in blood pressure may cause hypertension.

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