OCCUPATIONAL NOISE EXPOSURE AND INCREASED BLOOD PRESSURE AMONG AUTOMOTIVE FACTORY WORKERS IN SELANGOR

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ABSTRACT

Background: Vehicle manufacturing refers to the entire process that involved in producing a vehicle. Workers in this industry are exposed to several occupational hazards such as ventilation, heat, chemicals and noise due to the operation of the machines. This study aims to examine the exposure of noise during working to the increased of blood pressure among car manufacturing factory workers in Selangor.

Methods: Respondents (n = 70) were selected from the target group (Casting) and comparison group (Assembly) based on a random sampling method and the percentage of response was 100%. Noise Dose Badges were used for the purpose to measure the dose of individual noise exposure while Sound Pressure Level was used to measure the level of noise emitted from the source in the work environment. Meanwhile, for respondents' blood pressure measurement, OMRON Automated Blood Pressure Monitor was used.

Results: In the current article, the findings of this study show that the target group is exposed to noise levels above 85dB where the highest average noise is at the level of 105 ± 8.28 dB (A). Differences in blood pressure increments due to noise exposure is significant (Z = 3.673, p = 0.041) and association of noise exposure with increased blood pressure is also significant with systolic reading showed (r = 0.121, p = 0.03) and diastolic reading showed (r = 0.271, p = 0.02).

Conclusion: The findings emphasized that car manufacturing workers in the Casting division are at risk for the effects of increased blood pressure due to occupational noise exposure. Therefore, education and training in the workplace should be implemented and good noise intervention programs should be carried out to prevent a reduction in the work performance of employees in the future.

Keywords: Occupational Noise Exposure, Blood Pressure, Automotive Factory Workers, Non-auditory effect.

I. INTRODUCTION

In the 1960s, the Malaysian government encouraged the establishment of car assembly plants in Malaysia. In general, there are four important processes when producing a vehicle, namely press process, body process, paint process, and assembly process (trim and final).

All these processes have more complex work and require a lot of manpower to do, where workers working in the area will be exposed to several occupational hazards such as ventilation, heat, chemicals, and noise due to the operation of machines used throughout the manufacturing process of the car. In this study, researchers focus more on the noise exposure hazard. Nevertheless, all of these management need to be handled well through effective leadership and management in an organization (Abdul Jalil et al., 2021; Mohd Noh et al., 2021; Mustafa et al.,
2021; Roszi et al., 2021; Tumisah et al., 2021). Efficient management and leadership can create a good atmosphere as well as be able to address this issue (Irma et al., 2021; Suzana et al., 2021; Rohanida et al., 2021; Nazrah et al., 2021; Shahrulliza et al., 2021). All available facilities such as infrastructure and facilities should be utilized as much as possible in assisting good management (Mohd Arafat et al., 2021; Sumaiyah et al., 2021; Hifzan et al., 2021; Shahrl et al., 2021; Helme et al., 2021).

The need to implement good management and leadership in organizations and the use of materials is expressed in many studies across various fields (Mohd Ali et al., 2021; Parimala et al., 2021; Siti Jamilah et al., 2021; Nor Fauziyana et al., 2021; Noel et al., 2021). Many researchers have stated that facility management and application of certain materials can facilitate human daily work (Ahmad Shafarin et al., 2021; Junaidah et al., 2021; Farah Adibah et al., 2021; Ahmad Shakani et al., 2021; Muhamad Amin et al., 2021; Muhamad Amin et al., 2021). Therefore, everything that is to be carried out, must be accompanied by efficient management of resources and facilities to meet the needs of its effectiveness (Santibuana et al., 2021; Nor Diana et al., 2021; Zarina et al., 2021; Khairul et al., 2021; Rohani et al., 2021).

According to Yahya (1998), noise exposure can cause a person to be unable to perform his work effectively. It can lead to sub-optimal workmanship and declining productivity. High noise levels are also capable of contributing to cardiovascular effects and moderately high noise exposure within eight hours is capable of causing an increase in the blood pressure from five to ten points (Kiong Khee Siong, 2010). The purpose of this study was to assess the noise level generated in automotive factories to the non-auditory effects of workers namely increased systolic and diastolic blood pressure. A study in Indonesia in 2016 stated that living or working in an environment that has exposure to a high level of noise can cause detrimental effects such as an increase in blood pressure and supported by many other epidemiologic studies in the literature. Thus, in this study, we linked between the level of noise and the potential risk of increased reading of respondents’ blood pressure. Previous studies showed that exposure to noise will cause people to have roller-coaster emotions. This emotional instability leading to stress (Arzahan 2015) and the pressure will cause narrowing of the arteries. This condition has forced the heart to work harder by pumping blood systemically. Consequently, blood pressure will increase (Harahap 2017).

Method

Sampling Strategy

The sample population consisted of operator workers in the assembly shop area and casting shop area in the same shift. The total population of the two places is 92 operators. A total of 52 people from the assembly manufacturing operation area and a total of 40 people from the casting shop area was involved.

Instrumentation

The Sound Level Meter (SLM) used is the TM-102 model. SLM gives reading in the decibel unit (dB), and used to collect data on the noise level readings produced in the assembly shop and the casting shop area. This tool must be calibrated before use to obtain accurate readings.

Dose badges are used to measure employee or individual noise dose exposure. The dose badge was calibrated before performing the measurement according to the Sound Dose Badge manual. The dose badge is attached to the collar of the employee’s shirt so that it is in the ear zone area as close as possible. The dose meter reader will automatically integrate the sound intensity and provide the following values:

- Average noise exposure (LAVG)
- 8 -hour weighted average time (TWA)
- Percentage of dose
- Percentage of average dose over 8 hours
- Peak Levels of Noise Exposure
Digital blood pressure monitors use blood oscillometric methods in the blood pressure measurement. This fact means the monitor detects the movement of the blood sample through the brachial artery and converts the movement into a digital reading. Oscillometric monitors do not require a stethoscope so the monitor is easy to use. The device used in this study is type BP710. The American Heart Association recommends the following guidelines for upper limits normal for blood pressure readings i.e., Systolic Blood Pressure 135 mmHg while Diastolic Blood Pressure 85 mmHg.

II. RESULTS

Demographic of the respondents

The median value for the age of the respondents is 37 (5) years with 36% of the respondents are between 35 to 41 years. More than three-quarters of respondents were Malays who give 89.5% and followed by 10.5% non-Malays. Of the respondents, 59 people are Malay, 2 are Indian and 9 are Chinese. 50 respondents were married, 18 were single and two of them were divorced. For the education level of respondents, 60 (81.4%) have SPM as the highest level of education followed by seven (7.0%) have STPM or higher education and three (5.8%) have PMR as the highest qualification. More than half of the respondents smoked more than 15 cigarettes per day. The median for the number of cigarettes is 14 (4) per day with a minimum number of one cigarette and a maximum of 40 cigarettes per day. The median for the respondent's service in the company is eight (7) years.

There were 123 (71.5%) respondents who had their job in this company as their first job followed by 49 (28.5%) respondents who had other work experience. Around 93.0% of the respondents did not have other part-time jobs but 12 (7.0%) respondents had part-time jobs as food vendors, small traders, and used-car sellers who did not have much exposure to the noise of their job.

Personal Protective Equipment (PPE) Usage

Table 1: Respondents' PPE Use and Frequency of PPE Use While Working

<table>
<thead>
<tr>
<th>PPE</th>
<th>Target Group (n=30)</th>
<th>Comparative Group (n=40)</th>
<th>Total (n=70)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weeping PPE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24 (80)</td>
<td>23 (57.5)</td>
<td>47 (67.1)</td>
</tr>
<tr>
<td>No</td>
<td>6 (20)</td>
<td>17 (42.5)</td>
<td>23 (32.9)</td>
</tr>
<tr>
<td>Wearing period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 hour/day</td>
<td>6 (20)</td>
<td>17 (42.5)</td>
<td>23 (32.9)</td>
</tr>
<tr>
<td>1 hour/day</td>
<td>2 (6.7)</td>
<td>15 (37.5)</td>
<td>17 (24.3)</td>
</tr>
<tr>
<td>2 hour/day</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>3 hour/day</td>
<td>2 (6.7)</td>
<td>3 (7.5)</td>
<td>5 (7.1)</td>
</tr>
<tr>
<td>4 hour/day</td>
<td>14 (46.6)</td>
<td>2 (5)</td>
<td>16 (22.9)</td>
</tr>
<tr>
<td>5 hour/day</td>
<td>5 (16.6)</td>
<td>3 (7.5)</td>
<td>8 (11.4)</td>
</tr>
<tr>
<td>6 hour/day</td>
<td>1 (3.4)</td>
<td>0 (0)</td>
<td>1 (1.4)</td>
</tr>
</tbody>
</table>

Environmental Noise Measurement and Employee Exposure

Noise measurement involves environmental noise sampling in both target group areas and comparison. Basically, the two main locations involved are the Casting Shop, which is responsible for the full production of car engine parts, and the Assembly Shop for the assembly of car panels and components. The results are shown in table 2 below. Consequently, the highest average noise level (LAVG) was obtained from the furnace area (Casting Shop) which handling the main panel mold formation with combustion activity of car parts at the level of 105.03 ± 8.28 dB (A). On the other hand, the lowest noise level was found from the A2 Door line (Assembly Shop) which carried out CBU door installation activities at the level of 66.08 ± 2.36 dB (A).

Table 2: Average level of ambient noise during the work period for the target group and comparison

<table>
<thead>
<tr>
<th>Respondent Group</th>
<th>Average sound pressure level (Lavg) (Min ± SD)</th>
<th>Min sound pressure level (dBA)</th>
<th>Max sound pressure level (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target Group (Casting Shop)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Campro 90.35 ± 4.78 83.4 94.3
CPS 96.30 ± 5.33 90.4 103.0
Die 96.05 ± 3.20 91.6 99.2
Mieruka 98.50 ± 1.61 97.0 100.2
Lab 99.33 ± 8.67 93.8 112.2
Furnace 105.03 ± 8.28 93.6 112.1
Kaizen 92.58 ± 10.33 74.7 100.2
Scrap 80.05 ± 0.92 79.4 80.7

Comparative group
(Assembly Shop)
A1 Line 92.25 ± 10.33 81.0 101.8
A1 Sub Assy 81.33 ± 2.00 80.0 84.3
A1 Door 75.96 ± 3.02 71.1 79.3
A1 Island 74.34 ± 5.46 65.9 79.3
A2 SUB 85.40 ± 5.28 79.3 88.5
A2 Station 12 74.80 ± 5.79 66.5 79.1
A2 Door 66.08 ± 2.36 64.1 70.1
A3 67.50 ± 4.46 64.3 75.3
A2 Big Part 75.00 ± 3.48 69.4 78.3

Table 3: Individual Noise Exposure Level

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average level of daily noise exposure (TWA)</td>
<td>92.8 ± 5.7 dB(A)</td>
</tr>
<tr>
<td>Average noise exposure level (LAVG)</td>
<td>97.1 ± 6.6 dB(A)</td>
</tr>
<tr>
<td>Noise dose exposure level</td>
<td>165 ± 94.6 %</td>
</tr>
<tr>
<td>Estimated daily working dose level</td>
<td>261 ± 126.6 %</td>
</tr>
</tbody>
</table>

Table 4: Differences in the average level of noise exposure of respondents’ group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Median (IQR)</th>
<th>Target Group (n=30)</th>
<th>Comparative Group (n=40)</th>
<th>Z value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average noise exposure level (LAVG)</td>
<td>96.6(28.8-36.1)</td>
<td>74.5 (28.8-36.1)</td>
<td>-6.641</td>
<td>0.000*</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at p value < 0.05

Table 5: Differences in the blood pressure level due to noise exposure.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Median (IQR)</th>
<th>Target Group (n=50)</th>
<th>Comparative Group (n=40)</th>
<th>Z value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased blood pressure reading systolic</td>
<td>120 (0-13)</td>
<td>120 (0-13)</td>
<td>-2.041</td>
<td>0.041*</td>
<td></td>
</tr>
<tr>
<td>diastolic</td>
<td>80 (0-12)</td>
<td>80 (0-12)</td>
<td>-3.673</td>
<td>0.000*</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at p value < 0.05

Table 6: The association between noise exposure level, noise dose, and the effect of increased blood pressure

<table>
<thead>
<tr>
<th>Variable</th>
<th>Rs value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average noise exposure level</td>
<td>0.121</td>
<td>0.038*</td>
</tr>
<tr>
<td>Increased blood pressure reading systolic</td>
<td>-0.271</td>
<td>0.023*</td>
</tr>
</tbody>
</table>
Table 1:

<table>
<thead>
<tr>
<th>Noise dose level</th>
<th>Increased blood pressure reading</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>systolic</td>
<td>0.255</td>
</tr>
<tr>
<td></td>
<td>diastolic</td>
<td>-0.366</td>
</tr>
</tbody>
</table>

*Significant at p value < 0.05

III. DISCUSSION

Respondents from car engine manufacturing areas specializing in engine block manufacturing (Casting Shop) were included in the target group based on their noise exposure exceeding 85 dB (A) during their work period. On the other hand, employees from the panel assembly section, car interior section, CBU quality inspection in (Assembly Shop) were included in the comparison group based on lower exposure to noise less than 85 dB (A). All respondents have worked for the company for at least 1 year.

Based on the Factory and Machinery (Noise Exposure) Regulations 1989, readings in almost all work environments of the target group, namely Casting Shop, show noise levels at least above the 85dB action limit and the 90dB allowable exposure limit. While in the assembly shop area, the exposure level is lower than permissible noise level at below 85 dB. These results are similar to the findings of a previous study conducted at a Car Manufacturing Plant in Iran conducted in 2010-2011 by Attarchi et al. (2013) where the noise level in the target area and the comparison in the car manufacturing area as a whole were at mean value of 62dB to 102dB. The target group working in the Casting Shop showed most noise levels above the allowable exposure limit of 90 dB (A) compared to the Assembly Shop because the noise was coming from the use of larger machine operations in the Casting Shop. Comparatively, Assembly Shop has no large machines operated other than the conveyor which moving the car as well as noise only from the use of hand tools for the installation of car interiors. Respondents’ exposure to such noise was categorized as chronic exposure based on the median duration of occupational noise exposure.

Results from dose meter showed that all respondents were exposed to noise levels above the allowable exposure dose according to the Factories and Machinery (Noise Exposure) Regulations 1989. These findings are quite similar to some previous studies such as those conducted in textile factories by Talbott et al. (1985) in which more than three-quarters of respondents exposed to noise levels above the permissible exposure limit of 85 dB (A) for an 8-hour working period. Dose exposure indicates the level of noise received by an individual during the working period and is influenced by the amount of noise levels that exist in the environment where they work. The previous study noted that high noise in the textile industry affected the exposure dose of workers above the allowable dose level.

As for the results of systolic and diastolic blood pressure differences, this study found that there were significant differences in blood pressure readings between the target and comparison groups. These results are also supported by findings for previous research studies such as studies by Verbeek, Dijk, and Vries (1987) that showed increased blood pressure for groups of respondents exposed to over 80dB of noise. Studies by Lee, Choy, and Lee (2009) showed that there was an increase in blood pressure for male workers in the study as a result of chronic exposure to noise after controlling all disturbing variables such as age, family history of hypertension, changes in body mass index (BMI), smoking, alcohol intake, and the pattern of exercise.

Furthermore, the similar results of significant correlations between noise exposure and blood pressure are found in the study by Attarchi, et al. (2012). In the study, they have evaluated the relationship between occupational exposure to noise with blood pressure (BP) in shift workers. The study was conducted in the year 2010 involving a rubber manufacturing company and data was collected through direct interviews. Workers were divided into four groups and data of systolic and diastolic blood pressure levels were compared between these four groups. The results showed that there was a significant relationship between noise exposure more than permissible limit and work shift with hypertension (p <0.05).

IV. CONCLUSION

In conclusion, the findings of this study showed that the target group consisting of workers from the car engine manufacturing division (Casting Shop) were exposed to noise levels of more than 85 dB (A) during the 8 hours they worked. Statistical analysis showed a significant association between noise exposure with non -auditory effects i.e., increased systolic and diastolic blood pressure.

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REFERENCES


