Occupational noise exposure and the effects on blood pressure of grass-cutting workers

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Abstract. This study aims to identify the determinants of key forces in the external and internal environment of event management to propose a sustainable environment analysis framework that will help organizers to improve the sustainability of the strategy formulation. The proposed framework incorporates sustainability practices, previous research on sustainable event management, existing strategies of sustainable strategic management, and the results from this study. This framework has adopted PEST Analysis (a framework used to analyse and monitor macro-environmental factors that may have a profound impact on an organization's performance) in external environment analysis and Mckinsey 7s Framework in internal environment analysis to identify sustainable-related determinants of key forces to propose common sustainable practices to get common acceptance for sustainability. The identified determinants were applied in the proposed framework to guide event organizer when identifying key forces of external and internal environment which can influence to achieve sustainability in the event. On top of this, SWOT Analysis (a strategic planning technique used to help an organization to identify strengths, weaknesses, opportunities, and threat related to business competition) was adopted to help event organizers to identify the opportunities and threats in the external environment and understand the strengths and weakness of the organization to formulate effective sustainable strategies and move their events toward sustainability.

1. Introduction

Over 275 million people are affected by noise globally and 80% of them are from developing countries [1], indicating a high risk of hearing loss and detrimental health effects among workers. In Malaysia, 70% workers investigated were diagnosed as having NIHL in the year 2010 after being exposed to loud noise [2].

While typically noise is common among manufacturing workers, exposure among landscaping workers is always oversighted and studies on this group are limited. Grass cutting activities that are categorized under the agricultural sector were reported as the second highest cause of non-permanent hearing disability after the industrial sector [3].

Owing to the abundance of rainfall and high humidity in Malaysia that accelerate grass growth, it is necessary for grass to be cut at least once or twice per month [4]. A higher frequency of exposure indicates a greater risk of acquiring NIHL

A previous study reported that when handling landscape machines (e.g. lawnmower, leaf blower, gas and electric edges), most exposures exceeded the Noise Exposure Limits (NEL) which was 82 to 102 dB(A) after 8 to 10 hours per day [5]. The groundskeepers in North Carolina Universities also stated that 76.0% of 176 workers exposed to >85 dB(A) and 29.3% were exposed to >90 dB(A) by using riding mowers [5]. This shows that most grass cutting workers can be exposed to noise higher than the permissible level.

In Malaysia, typically grass cutting workers do not wear PPE while conducting the task [6][7]. Besides noise, they are also exposed to particulate matter and dangerous exhaust fumes such as PAH (polycyclic aromatic hydrocarbons) and BTEX (benzene, toluene, ethylbenzene and xylene) which are harmful to the respiratory system [8][9].

Exposure to noise>85dB(A) could also affect the blood pressure of workers [10][11][12]. These researchers highlighted that noise exposure has an association with the blood pressure increment because noise disturbance can cause stress where stress hormones such as cortisol [10] and epinephrine [13] are secreted to activate the sympathetic nervous system to reduce the stress but increase blood pressure [14]. Besides, high secretion of vasoconstrictors in urine that can cause high blood pressure was also the effect of noise exposure ≥ 85 dB(A) [15]. Human pathophysiological can be affected by chronic exposure to high sound levels and promote heart disease [16].

Blood pressure and heart rate have been reported to increase after exposure to high noise [17][18]. Blood pressure and heart rate increased mainly due to the changes in endocrine systems known as a stress indicator, releasing high levels of stress hormones [19].

Seeing the limited number of studies on grass-cutting workers in developing countries despite the high risk, this study was conducted to monitor environmental noise and occupational noise exposure among the workers, and correlate it with blood pressure increase.

2. Methodology

2.1 Environmental noise monitoring

This study was conducted at Sultan Abdul Aziz Golf and Country Club (SAASGC), Shah Alam. The area was divided into six sections for environmental noise monitoring, using a pre-calibrated sound level meter (Extech, SL510) in accordance with the OSHA Technical Manual.

2.2 Personal Noise Exposure Measurement

Workers selected as participants in this study were contract workers hired to manage and maintain the turf and lawn of the golf club. 18 male workers with at least 1 year of work experience in grass-cutting activity were recruited in the study. Personal noise exposure was monitored using a personal noise dosimeter (Extech, SL400) by clipping the microphone on the collar of the workers throughout their working hours. Typically, their working hours are from 5.00 am to 9.00 a.m.

2.3 Blood pressure measurement

Workers known to have hypertension or other chronic illness such as cardiovascular diseases and *diabetes mellitus* were excluded from this study. Blood pressure before and after exposure was measured using a digital sphygmomanometer, after a minimum of 5-minute rest [20].

2.4 Statistical Analysis

Data obtained were analysed by Statistical Package for the Social Sciences (SPSS) software. A paired t-test was performed to analyse if there is a mean difference of systolic and diastolic blood pressure after the intervention of noise exposure. Bivariate Correlation (Pearson Coefficient) was also performed to analyse the relationship between personal noise exposure with systolic and diastolic blood pressure after being exposed to noise.

3. Result and Discussion

3.1 Mapping of environmental noise

Figure 1 shows noise maps in six sections of SAASGC. Each point at every section showed different sound power levels derived from grass-cutting machines (the noise source) levels, with the loudest noise level (dB) is indicated by red color and the lowest is indicated by green color.

As observed, the farther the distance from the noise source, the lower the sound level values and

vice versa, hence giving different color contours. This is because noise source produces waves and carried energy that is derived via vibration where the amount of energy is fixed at the moment it is generated. Once the wave moves away from its source in all directions, the energy carried by the wave is distributed at the same time over the circumference of an ever-larger circle [21]. Noise maps assist in predicting the affection of noise to the public [22]. Typically, if a model is correctly developed, a true noise can be obtained for monitoring and management systems where detailed noise control action plans along with the results can be acquired [23].

Sections A, D, E and F in Figure 1 show that the noise levels around the residential areas were between 55 – 65 dB(A) and the grass-cutting activity started around 5.00 am and ends around 9.00 am. The Planning Guidelines for Environmental Noise Limits and Control by the Department of Environment Malaysia suggests that the maximum permissible sound level in Schedule 1 for low-density residential areas should not exceed 50 dB(A) and 40 dB(A) from 7.00 am – 10.00 pm and 10.00 pm – 7.00 am respectively [24]. As of this, grass-cutting activity in the residential area of SAASGC has violated the specified noise level in both periods.

Residents of SAASGC usually have their morning jog around 7.30 am – 8.00 am where at this hour, the grass-cutting activity is still on-going. So, these residents were indirectly affected by the environmental noise as they passed by the noise produced by the grass cutting machines of about 60 to 70 dB(A). Although the noise exposure was only for a short time, the fact that noise can cause annoyance and disturbance is undebatable as previously highlighted [15][25][26].

The most affected by noise exposure is undoubted, the grass-cutting workers themselves since they were continuously exposed to the noise source throughout the task. However, they did not wear any hearing protectors as none was provided.

Also, other workers in the vicinity (i.e. those working around golf bunkers, small cafés, and clubhouses) were potentially affected by noise exposure ranging from 60 – 75 dB(A). These groups of workers did not wear hearing protectors, as their job tasks did not directly expose them to noise.

3.2 Personal Noise Exposure and Blood Pressure Before and After Noise Exposure

Figures 2 and 3 show that workers were exposed to noise exposure ranging from 84.1 (Sample 10) to 86.9 dB(A) (Sample 17). All of the samples exceeding the action level of 82 dB(A), with most of them exceeded the NEL (8-hour Time Weighted Average) as specified in the Occupational Safety and Health (Noise Exposure) Regulations 2019.

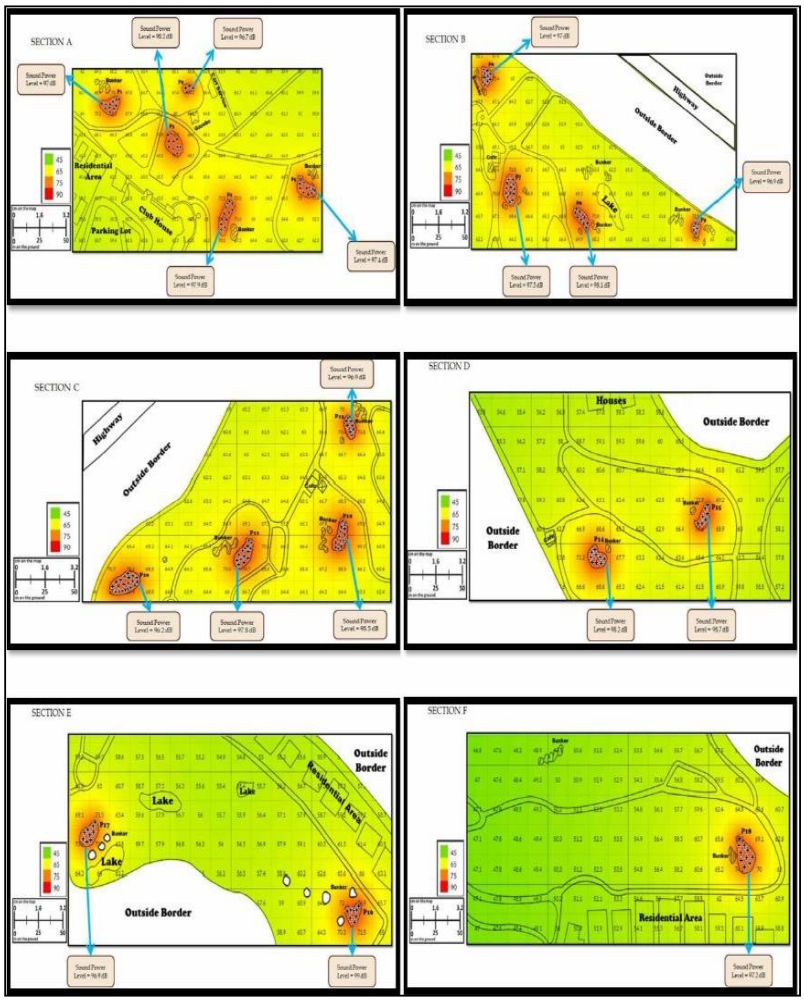

Figure 1. Noise maps for the sections in the environmental noise monitoring

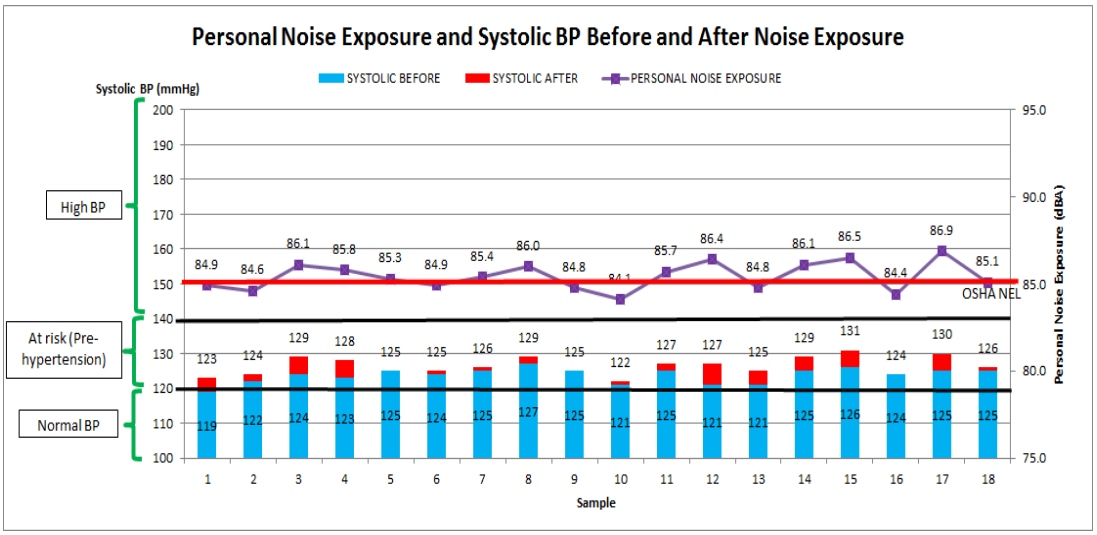

Figure 2. Results of personal noise monitoring and systolic blood pressure before and after noise exposure

Several studies of grass-cutting workers conducted in Malaysia also resulted in noise exposure ≥82 dB(A) [3][6][7]. This indicates that grass-cutting workers are exposed to loud noise, therefore reasonable measures should be taken to minimise noise-related health effects as after prolonged exposure, it will eventually affect the workers' health [13].

The greatest systolic blood pressure increment was 5% (Sample 12) followed by 4% (Sample 3, 4, 15, 17). Meanwhile, the greatest diastolic blood pressure increment was 4% (Sample 11, 12, 14, 15).

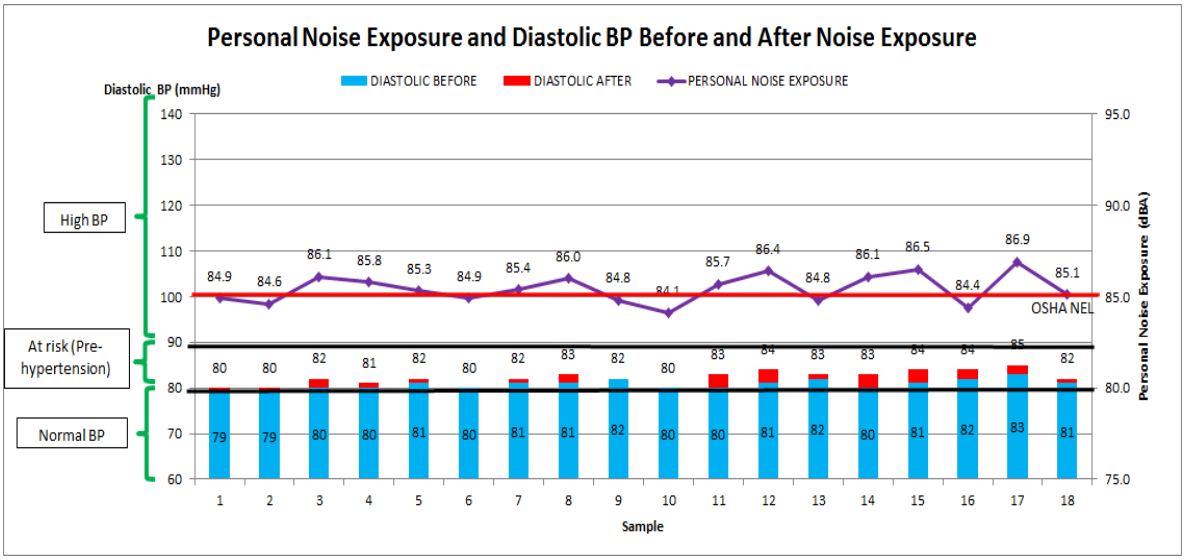

Figure 3. Results of personal noise monitoring and diastolic blood pressure before and after noise exposure

There is a correlation between personal noise exposure and systolic blood pressure [r=0.925, p=0.000]. as well as diastolic blood pressure [r=0.638, p=0.004]. The trend is consistent with previous studies [11][12]. However, a weak association between noise exposure and increased blood pressure has also been reported [10][13]. It is believed that high blood pressure and other non-communicable diseases, is multifactorial in its causes and has its level of association to the blood pressure such as age, years of working, alcohol consumption, drug history, cigarette smoking, food intake and BMI [10][13][20][27] and many more. In many cases, most researchers supported the association but were never definite on the association.

4. Conclusion

Noise pollution is indeed one of the dangerous pollutants that may cause serious impacts of health to either the public or workers. In this study, it is shown that the further the distance from the noise source (grass-cutting activity), the lower the sound level values and vice versa, hence showing different color contours in the noise map.

Personal noise exposure in this study exceeded the Noise Exposure Limit of 90 dB(A) and action level (82 dB(A). This study also showed that SBP and DBP increased by up to 5% after being exposed to the noise. There is also association between personal noise exposure and SBP and DBP (r = 0.926; r = 0.638).

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Acknowledgements
The authors gratefully acknowledge the management of SAASGC and Greencare Services Sdn. Bhd. for granting access and giving full co-operation throughout the study