The effects of occupational noise on blood pressure and heart rate of workers in an automotive parts industry

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Original Article

Abstract

BACKGROUND: One of the most important impacts of industrial noise is physiological and psychological effects. The increases in workers' blood pressure and heart rate were detected during and after exposure to high levels of noise. The objectives of this research were to determine whether the noise exposures have any effects on blood pressure and heart rate of workers in the automotive parts industry.

METHODS: This case study was done in 2011 at different units of an automotive parts manufacturing in Tehran. Sound pressure level was measured at different units of the factory with a calibrated instrument. Demographic features of workers were gathered with an appropriate questionnaire. Heart rate and blood pressure were measured twice in a day in the start time of work day (before exposure to noise) and middle shift hours (during exposure to noise) in the occupational physician office. For analyzing data, chi-square, independent sample t-test, paired t-test, and analysis of covariance (ANCOVA) were used. $P < 0.050$ was considered statistically significant.

RESULTS: The average age of workers in the case and control groups was 35.71 ± 8.10 and 33.40 ± 10.41 years, respectively. There was no difference between the average age of case and control groups ($P = 0.436$). The results of ANCOVA revealed the significant differences between the mean changes of heart rate $F_{(1, 37)} = 26.68$, $P < 0.001$, systolic blood pressure $F_{(1, 37)} = 21.70$, $P < 0.001$, and diastolic blood pressure $F_{(1, 37)} = 26.20$, $P < 0.001$ of workers in the case and control groups.

CONCLUSION: Exposure to industrial noise may increase the heart rate of workers. Although rises in heart rate, systolic, and diastolic blood pressure of workers in the case group were observed after exposure to noise, the values of heart rate, systolic, and diastolic blood pressure were in the normal range. Further experimental investigations are needed to determine the relationships between these variables.

Keywords: Occupational Noise, Exposure, Heart Rate, Blood Pressure, Industry

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Introduction

Noise is classified as an unpleasant sound[1] that may cause stress among workers.[2] Noise exposure can decrease the quality of life.[3] One of the most important impacts of industrial noise is physiological and psychological effects. A progressive hearing loss is an important symptom of industrial noise exposure.[4] Acute and chronic exposures to loud noise may affect heart rate and blood pressure.[5] Chronic exposure to high sound levels may affect the human pathophysiological situation and can cause heart disease.[4] The increase in workers' blood pressure and heart rate has been detected during and after exposure to high levels of noise. During exposure to noise, endocrine systems known as stress indicators may change, and this change leads to an increase in blood pressure, heart rate, and the levels of stress hormones.[1,6] The positive correlation between exposures to occupational noise and increase in blood pressure was reported.[4]

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Noise exposure can disturb normal sleeping and lack of sleep is associated with decreased human performance, awareness, and mental capacity.[7] Some other physiological effects of noise include muscle cramps, dizziness, nausea, vomiting, and increased secretion of catecholamines and cortisol.[8] Noise induces heart disease and can cause hypertension.[9] Hypertension is a multi-cause heart disease and controlled by external and internal factors.[10] Some cross-sectional studies reported the association between noise as an external factor and increases in blood pressure and heart rate.[10,11] Hypertension has been seen in the cases occupationally exposed to the noise level of 100 A-weighted decibel scale.[10] The American Conference of Governmental Industrial Hygienists standard for industrial noise is 85 dBA.[12] Exposure to noise over 97 dBA can lead to physiological and mental changes in workers.[13]

The relationship between chronic noise exposure and hypertension among automotive assembly workers was investigated. Blood pressure was measured in 150 and 119 white and black men, respectively. Among studied workers, 22.0% of white and 31.9% of the black workers showed the symptoms of hypertension. Average diastolic blood pressure of workers was higher than 90 mm of mercury.[14] Some studies have also examined the effects of occupational noise exposure on blood pressure and heart rate of workers. There was no significant difference between the blood pressure and heart rate of steel industry workers before and after noise exposure (noise levels of 85, 95, and 105 dBA). Normal systolic blood pressure of participants increased after noise exposure, but no significant differences were found.[11] In another study, the effects of occupational noise exposure on changes in blood pressure of industrial workers were determined. Overall, noise exposure (97.5 ± 10.1 dBA) failed to affect the blood pressure and heart rate of workers.[10]

More recently, literature has emerged that offers contradictory findings about occupational noise exposure and its relationships with workers' blood pressure and heart rate.[4,11,15] The semi-experimental data are rather controversial, and there is no general agreement about the effects of industrial noise on heart rate and blood pressure of workers. The objectives of this research were to determine whether noise exposure affects blood pressure and heart rate of workers in the automotive parts manufacturing industry in Tehran, Iran.

Materials and Methods

This case study was done in 2011 at different units of an automotive parts manufacturing (Fan Avar Company) industry in Tehran. Exposed group members (cases) consisted of 26 workers who worked in various functional units of the industry. These workers with the age range of 20-56 years old had exposure to high levels of occupational noise (sound levels over 85 dBA). Sixteen unexposed office employees with the age range of 21-52 years were considered as control group. These employees were not exposed to high levels of occupational noise in their workplace (sound levels under 85 dBA).

Before the experiment was conducted, the workers' medical records were investigated. Workers with hearing problems, head injuries, hypertension, and other cardiovascular diseases were excluded from the study. All selected workers signed a consent form before participating in the research.

Sound pressure levels were measured at heavy pressing, manual pressing, cutting, metalworking lathe, and also administrative unit of the factory with a calibrated sound level meter (B&K model, Germany).

Demographic features of workers were gathered with an appropriate questionnaire. All workers occupationally exposed to high noise levels (noise levels over 85 dBA) with no previous history of heart disease were considered. Heart rate and blood pressure were measured twice in a day in the start time of work day (before exposure to noise) and middle shift hours (during exposure to noise) in the occupational physician office.[10] Heart rate monitor (PM80 Heart Rate Monitor Watch, Germany) was used to measure the workers' heart rate for 1 minute in the presence of the occupational physician. Blood pressure was measured twice at the workers right arms. After 5 minutes resting in order to minimize the adverse effects of some factors such as stress and activities,[1,10] the sphygmomanometer cuff (Model 1002/Presameter, Riester, Germany) was applied to measure systolic and diastolic blood pressure.[16] The measurements were done by a specially trained nurse. A normal systolic and diastolic blood pressure for human is 120-129 and 80-84 mmHg, respectively.[17] Human has the heart rate of 60-100 beat/minutes under normal resting conditions.[18]

Data were analyzed using SPSS software (version 18.0, SPSS Inc., Chicago, IL, USA). Numerical data were reported by mean and standard deviation (SD) and qualitative variables with frequency and percentage. Normality of numerical variables was tested by Shapiro-Wilk statistical method. The Chi-square test was applied to compare the proportions in several groups. Independent sample t-test was used to

compare the demographic and clinical factors between case and control groups at baseline noise levels. Analysis of covariance (ANCOVA) was used to determine the differences in the mean changes of response variables in case and control groups adjusting for work experience. Paired t-test was applied to inter-group comparisons. The result is significant at the $P < 0.050$.

Results

Eight workers (30.77%) were involved in the heavy pressing, 38.46% of them (10 workers) in manual pressing, 15.38% (4 workers) in cutting, and 15.38% of them (4 workers) in metalworking lathe unit. The noise levels during the work shift were in the range of 85-108 dBA.

The average and SD of age in the case group was 35.71 ± 8.10 years. The control group was in the average age of 33.40 ± 10.41 years. Table 1 shows the demographical features of workers in the case and control groups. Sample t-test showed no significant difference between the average age of case and control group members ($P = 0.436$).

Working experience of the case group was 60.73 ± 3.17 months. The working experience of the control group was 53.56 ± 3.72. Sample t-test revealed a significant difference between the average work experience in the case and control groups ($P = 0.002$). There were not significant differences in other demographical features of workers in case and control groups (Table 1). Mean body mass index (BMI) in the case and control groups was 23.16 ± 0.90 kg/m² (20.36-24.64) and 24.39 ± 0.62 kg/m². There was no significant difference in the mean BMI between the case and control groups ($P = 0.600$).

The results of independent samples t-test failed to show any significant differences in diastolic blood pressure ($P = 0.541$), systolic blood pressure ($P = 0.842$), and heart rate ($P = 0.681$) of workers in the case group before exposure to noise and baseline systolic and diastolic blood pressure levels and heart rate of workers in the control group (Table 1).

The results of paired t-test indicate that there was a significant difference between heart rate and diastolic blood pressure of all workers in the case and control groups before and after noise exposure ($P < 0.050$), but there were increases in systolic blood pressure of workers just in the case group before and after noise exposure. No increase in systolic blood pressure of workers in the control group was detected (Table 2).

Table 1. Comparisons between demographical features of workers and clinical factors before exposure to noise

Variables	Exposed group (cases) (n = 26)	Unexposed group (controls) (n = 16)	P
Age (year) (mean ± SD)	35.71 ± 8.10	33.40 ± 10.41	0.436*
Height (cm) (mean ± SD)	176.10 ± 9.40	173.40 ± 9.61	0.375*
Weight (kg) (mean ± SD)	71.90 ± 8.46	73.40 ± 7.83	0.569*
Months of work experience (mean ± SD)	60.73 ± 3.17	53.56 ± 3.72	0.002*
Diastolic blood pressure (mmHg)	76.17 ± 0.84	76.92 ± 0.73	0.541*
Systolic blood pressure (mmHg)	115.63 ± 1.00	115.91 ± 0.70	0.842*
Heart rate (bpm)	74.38 ± 1.20	75.19 ± 1.56	0.681*
High school education [n (%)]	15 (57.7)	4 (25)	
Bachelor of sciences [n (%)]	8 (30.8)	8 (50)	0.112**
Master's degrees [n (%)]	3 (11.5)	4 (25)	
Married workers [n (%)]	20 (77.0)	12 (75)	0.887**

* t-test; ** Chi-square; SD: Standard deviation

Table 2. Comparisons of heart rate and blood pressure of workers in the case and control groups

Groups	Sound pressure level (dB)	Parameters	Heart rate (bpm)	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)
Unexposed group (controls)	53	Start time	75.19 ± 1.56	115.91 ± 0.70	76.92 ± 0.73
		Mid-shift	76.94 ± 1.18	116.39 ± 0.79	77.11 ± 0.63
		P (paired t-test)	< 0.001	0.280	0.026
Exposed group (cases)	85-108	Start time	74.38 ± 1.20	115.63 ± 0.99	76.17 ± 0.84
		Mid-shift	88.96 ± 6.80	127.31 ± 5.92	85.44 ± 3.74
		P (paired t-test)	< 0.001	< 0.001	< 0.001

The results of ANCOVA revealed the significant differences between the mean changes of heart rate $F_{(1, 37)} = 26.68$, $P < 0.001$, systolic blood pressure $F_{(1, 37)} = 21.70$, $P < 0.001$, and diastolic blood pressure $F_{(1, 37)} = 26.20$, $P < 0.001$ of workers in the case and control groups.

Discussion

The results showed that exposure to high level of noise may affect the heart rate, systolic, and diastolic blood pressure levels of exposed workers.

The mean of changes in heart rate of workers in the case group was 14 bpm from resting condition after noise exposure during the work shift. The results of ANCOVA revealed that there were significant differences in the mean changes of response variables (heart rate, systolic blood pressure, and diastolic blood pressure) between the case and control group members ($P < 0.001$). A rise in average systolic (11.68 mmHg) and diastolic blood pressure (9.28 mmHg) was observed in case group workers after exposure to 85-108 dB sound level.

Contrary to expectations, this study found that exposure to noise (53 dB) under recommended exposure standards may increase heart rate and diastolic blood pressure of workers in the control group. The results of the study did not show any significant differences between systolic blood pressure of workers in the control group in start time of work day and middle shift hours. The results indicate that significant rises in average systolic and diastolic blood pressure were found in the case group worker after exposure to noise compared with workers in the control group ($P < 0.001$). The findings of the current study are consistent with those of Kristal-Boneh et al. who found higher heart rate in workers exposed to higher noise levels.[5] These results are consistent with those of other studies and suggest that occupational exposure to noise may lead to increases in heart rate of workers.[19]

The results of the study showed that long time exposure to noise during a work shift have effects on heart rate, systolic blood pressure, and diastolic blood pressure of workers. It is encouraging to compare this figure with that found by Stansfeld and Matheson who found that exposure to high levels of noise can increase the systolic and diastolic blood pressure of workers.[20]

Overall, occupational exposure to noise in an automotive parts manufacturing industry affects workers' blood pressure in this study. The results of a cohort study was done by Sorensen et al. showed that a rise of 0.26 mmHg in systolic blood pressure was seen in participants exposed to road traffic noise levels.[21] The results of Neghab et al. study showed that occupational exposure to noise may increase the risk of hypertension in exposed group.[22] However, the results of some cross-sectional studies indicated that no significant differences were found between noise exposure and increases in blood pressure and heart rate of workers.[10,11] Although, the results of this study showed a significant effects of exposure to high levels of noise on increases in heart rate and blood pressure of workers, in all studied workers systolic and diastolic blood pressure were in the normal range of blood pressure criteria. The limitation of this study is that the mean of months of work experience in the case and control groups was significantly different ($P = 0.002$). Another limitation of this study was that the numbers of cases and controls were relatively small. Further research with adequate numbers of cases and controls is necessary to investigate the relation between occupational noise exposure and increases in heart rate and blood pressure of industrial workers. The use of hearing protection equipment can help to protect workers from adverse effects of occupational exposure to high levels of noise.[23] Workplace safety and health programs may have strong effects on reduction of injuries in workplaces.[24]

Conclusion

According to the results of the study, exposure to industrial noise may increase the heart rate of workers. Although rises in heart rate, systolic, and diastolic blood pressure of workers in the case group were observed after occupational exposure to noise, the values of heart rate, systolic, and diastolic blood pressure were in the normal range. Further experimental investigations are needed to determine the relationships between these variables.

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Conflict of Interests

Authors have no conflict of interests.

References

1. Baneshi R, Pourakbari R, Abshahi M. Investigation

of the impact of noise exposure on blood pressure in tiremanufacturing workers. ARYA Atherosclerosis Journal 2012; 8(Special Issue in National Hypertension Treatment): S137-S141.
2. Evans GW, Johnson D. Stress and open-office noise. J Appl Psychol 2000; 85(5): 779-83.
3. Shepherd D, McBride D, Welch D, Dirks KN, Hill EM. Evaluating the impact of wind turbine noise on health-related quality of life. Noise Health 2011; 13(54): 333-9.
4. Omari S, De-Veer A, Amfo-Otu R. The silent killer: an assessment of level of industrial noise and associated health effects on workers. International Journal of Basic and Applied Sciences 2013; 2(2): 165-9.
5. Kristal-Boneh E, Melamed S, Harari G, Green MS. Acute and chronic effects of noise exposure on blood pressure and heart rate among industrial employees: the Cordis Study. Arch Environ Health 1995; 50(4): 298-304.
6. Selander J, Nilsson ME, Bluhm G, Rosenlund M, Lindqvist M, Nise G, et al. Long-term exposure to road traffic noise and myocardial infarction. Epidemiology 2009; 20(2): 272-9.
7. Muzet A. Environmental noise, sleep and health. Sleep Med Rev 2007; 11(2): 135-42.
8. Khanjani N, Rahimi Moghadam S. Evaluation of Hearing Loss and Changes in Blood Pressure of Welders in a 4 Year Period. Int J Occup Hyg 2013; 5(4): 172-6.
9. Tomei F, Fantini S, Tomao E, Baccolo TP, Rosati MV. Hypertension and chronic exposure to noise. Arch Environ Health 2000; 55(5): 319-25.
10. Yousefi Rizi HA, Dehghan H. Effects of occupational noise exposure on changes in blood pressure of workers. ARYA Atherosclerosis Journal 2012; 8(Special Issue in National Hypertension Treatment): S183-S186.
11. Zamanian Z, Rostami R, Hasanzadeh J, Hashemi H. Investigation of the effect of occupational noise exposure on blood pressure and heart rate of steel industry workers. J Environ Public Health 2013; 2013: 256060.
12. American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists; 2011.
13. Ising H, Michalak R. Stress effects of noise in a field experiment in comparison to reactions to short term noise exposure in the laboratory. Noise Health 2004; 6(24): 1-7.
14. Tarter SK, Robins TG. Chronic noise exposure, high-frequency hearing loss, and hypertension among automotive assembly workers. J Occup Med 1990; 32(8): 685-9.
15. Lang T, Fouriaud C, Jacquinet-Salord MC. Length of occupational noise exposure and blood pressure. Int Arch Occup Environ Health 1992; 63(6): 369-72.
16. von Bibra H, Paulus WJ, St John SM, Leclerque C, Schuster T, Schumm-Draeger PM. Quantification of diastolic dysfunction via the age dependence of diastolic function-impact of insulin resistance with and without type 2 diabetes. Int J Cardiol 2015; 182: 368-74.
17. Vasan RS, Larson MG, Leip EP, Kannel WB, Levy D. Assessment of frequency of progression to hypertension in non-hypertensive participants in the Framingham Heart Study: a cohort study. Lancet 2001; 358(9294): 1682-6.
18. Ahrens T, Rutherford K, Rutherford Basham KA. Essentials of Oxygenation: Implication for Clinical Practice. Sudbury, MA: Jones & Bartlett Learning; 1993. p. 51.
19. Tomei G, Fioravanti M, Cerratti D, Sancini A, Tomao E, Rosati MV, et al. Occupational exposure to noise and the cardiovascular system: a meta-analysis. Sci Total Environ 2010; 408(4): 681-9.
20. Stansfeld SA, Matheson MP. Noise pollution: non-auditory effects on health. Br Med Bull 2003; 68: 243-57.
21. Sorensen M, Hvidberg M, Hoffmann B, Andersen ZJ, Nordsborg RB, Lillelund KG, et al. Exposure to road traffic and railway noise and associations with blood pressure and self-reported hypertension: a cohort study. Environ Health 2011; 10: 92.
22. Neghab M, Maddahi M, Rajaeefard A. Hearing Impairment and Hypertension Associated with Long Term Occupational Exposure to Noise. Iran Red Crescent Med J 2009; 11(2): 160-5.
23. Guseva Canu I, Faust S, Canioni P, Collomb P, Samson E, Laurier D. Arh Hig Rada Toksikol 2013; 64(2): 99-107.
24. Jafari MJ, Gharari M, Ghafari M, Omidi L, Kalantari S, Asadolah Fardi GR. The Influence of Safety Training on Safety Climate Factors in a Construction Site. Int J Occup Hyg 2014; 6(2): 81-7.

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