

Association between Occupational Exposure to Noise and Heart Function in the Ceramic Industry Workers

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Abstract

Background: Noise is the most common occupational exposure. Over an extended period, especially in occupational settings, it causes an increased risk of coronary artery disease and high blood pressure. The aim of this study was to determine the relationship between exposure to noise and cardiovascular function based on the results of electrocardiography in the ceramic tile industry. **Methods:** In this cross-sectional study, 94 healthy workers with at least one year of work experience in Yazd's ceramic tile industry were selected by simple sampling method. After completing the demographic and occupational questionnaire, electrocardiography and sounding were performed. Then, the data were analyzed using the Kolmogorov-Smirnov test and correlation test using SPSS 21 software. **Results:** In this study, all participants were male. The mean and standard deviation of age and work experience of the population under study were 35.10 (6.03) and 9.95 (4.62) years, respectively. There was no statistically significant relationship between age and work experience with electrocardiographic parameters. Although there was a significant relationship between noises and the PR interval, there was no significant relationship with other parameters. **Conclusion:** In this study, the only significant correlation was found between the noise and the PR interval. Also, although the relationship between exposure to noise and heart rate was not statistically significant, it was reversible.

Key words: Exposure to noise; Heart function; Electrocardiography; Tile industry

Introduction

Cardiovascular disease is the main cause of death around the world, including Iran.¹ In Western countries, it accounts for more than one-third of annual deaths, and, in Iran, 50% of all deaths.² Life and work in industrial societies have contributed to the increasing incidence of

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cardiovascular disease, especially atherosclerosis, so that cardiovascular disease is currently the main cause of mortality in industrialized societies.³ Exposure to contaminants, chemicals, high noise, smoking, occupational physical activity, overwork, shift work and occupational stress are risk factors that can increase the risk of cardiovascular disease.⁴ Noise is one of the most harmful factors in the work setting, and is created by devices and processes in various industries.⁵ In the United States, roughly 30 million American workers are exposed to hazardous noise in their jobs⁶, and in Iran, with consideration of labor populations, the Ministry of Health can estimate that more than 2 million workers face the harmful occupational noise.⁷ Approximately, around 600 million workers are exposed to work-related noise.⁶ Several studies have been conducted on the effects of noise in the work setting and the environment on the cardiovascular system and blood pressure. Although the results of these studies vary to a large extent, in most of these studies, the correlation between increasing the noise and the negative effects of cardiovascular system has been reported. For example, Selander et al. in their study showed that long-term exposure to road traffic noise increases the risk of myocardial infarction.⁸ Kalantari et al. also showed that exposure to industrial noise could increase the heartbeat of workers.⁹ However, in some studies, there was no significant difference between the mean heartrate in the exposed and unexposed groups.¹⁰ Skogstad et al. in their review article showed that exposure to occupational noise is significantly associated with high blood pressure, which is one of the most important risk factors for cardiovascular disease.¹¹ However, in some studies, a significant relationship between exposures with high blood pressure was not mentioned.¹² Therefore, while the mechanism of this relationship is not clear, it seems that high levels of noise cause the secretion of adrenalin and constriction of the peripheral arteries and, as a result of increasing stress, blood

pressure increases. On the other hand, the noise causes the changes in heart rate, decreasing cardiac output and increasing respiratory rate. Considering the mentioned factors and their relation with cardiovascular diseases, there are several methods for identifying cardiac dysfunction in patients. Electrocardiography is a simple, inexpensive, usable and non-invasive method for checking heart health.¹³ An electrocardiogram is used to indicate the electrical activity of the heart that has a diagnostic value in assessing the delay of electrical impulses in atrial or ventricular conduction, origin of arrhythmias, ischemia and myocardial infarction due to cardiac drugs, electrolyte imbalance impairment, electrical cardiac pacemaker performance, atrial and ventricular hypertrophy, pericarditis, and systemic diseases of the heart.¹⁴

Yazd province has numerous tile and ceramics factories, and the employees of these units are exposed to the noise. Noise is considered a hazardous physical pollutant in the workplace and has serious effects on the health of workers, including cardiovascular system. Given the importance of cardiovascular disease and its predictability, and various and contradictory studies on the impact of noise exposure to this condition, this study was conducted. It was an investigation the relationship between this risk factor and cardiac function in workers of a Yazd ceramic tile industry to fill the gaps left by previous studies.

Methods

In an analytical cross-sectional study, 94 employees of one of the tile and ceramic industries of Yazd were examined. They were aged between 21 and 58 years and had at least one year of work experience. Patients with a history of heart disease, diabetes and high blood pressure, lipid disorders, and those taking blood pressure medications were excluded.¹ The sampling method in this study was simple random sampling and the sample size was 95% based on the confidence level.

According to the data obtained from previous studies, the standard deviation was 1.2 and the estimated error was 243.⁹ This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd (the Ethics Committee NO: R.SSU.SPH.REC.1395.136).

Firstly, after explaining the goals of the study and obtaining written consent, a questionnaire with questions about demographic information of participants such as age and work experience, occupational data, history of disease, drug use was completed for each participant. In the second phase, electrocardiography was performed using ECG (FUKUDA CARDISUNY C120 ECG). After a brief explanation of the method and the readiness of the participants for the test, 4 limb lead and 6 chest lead were connected according to standard protocols, and the ECG was prepared in six leads and six different pre-cordial leads, and then the heart rate parameters, the duration of the QRS complex (indicating the duration of ventricular depolarization), the PR interval (indicating the time between the onset of depolarization arterialization and the start of ventricular depolarization), RR distance (the time between QRS complexes), QT interval (indicating the duration of depolarization and ventricular repolarization) were calculated by the heart rate.¹⁵

In third phase in order to determine the exposure of workers to the noise, the noise level meter TES-1351B was used with a measurement accuracy of 1.4 dB. This noise level meter was calibrated before the start of measurements by the 4,230 Calibrator B & K according to the relevant protocols. These measurements were carried out only at the stop or traffic area of the worker and in their hearing area.

Assessing the exposure of the worker to noise requires the measurement of the noise pressure level on a scale in the slow mode, as well as the determination of the exposure time for each worker separately. To do this, we first gathered information on noise resources, the number of people employed per unit, how to deal

with the duration of each exposure, its pattern of frequency, type of sound, number of shift work, as well as working hours and other environmental information. Then the 8-hour equilibrium was calculated according to the exposure time at each station according to the following formula.¹⁶

$$Leq_{8h=10} = \log \left[\frac{1}{8} \sum_{i=1}^n 10^{\frac{L_i}{10}} \times t_i \right]$$

Statistical analysis

Data were entered into the SPSS software and then analyzed statistically. The results were analyzed using descriptive statistics of SPSS software such as percentage, mean, standard deviation, and appropriate statistical tests such as the Kolmogorov-Smirnov test and correlation analysis.

Results

The participants studied in this study were 94 healthy men whose mean and standard deviation of age and work experience were 35.10 (6.03) and 9.95 (4.62), respectively. 21.3% of them were smokers and 88 of them were working on shifting circles. The Kolmogorov-Smirnov test was used to check the normal distribution of variables. The results showed that heartrate variables, RR interval and PR interval follow normal distribution (P -value > 0.05), but the parameters of QRS complex, QT interval and sound do not follow normal distribution (P -value < 0.05). The exposure level of the participants with noise in a unit of work was determined according to table 1.

According to the results of the above table, the highest exposure to noise was in glazing workers at 87.93% and the lowest noise exposure level was observed in supervisors at 65.40.

To determine the relationship between age and work experience with electrocardiographic parameters, the Pearson correlation coefficient was used for normal data and the Spearman rank-order correlation was used for abnormal data. Results were obtained according to Table 2.

Table 1. Frequency distribution of a group of workers exposure to the noise sector by labor units in a ceramic tile industry

Variable	N	Minimum	Maximum	Mean	Standard Deviation
Ferrite	3	85.18	85.56	85.36	0.19
Glaze	3	85.72	87.93	86.92	1.12
Glaze line	23	79.54	85.43	81.51	1.22
Furnace	15	80.76	81.98	81.36	0.39
Balmill	4	86.48	87.90	87.38	0.62
Mechanic	7	79.40	83.16	82.38	1.33
Packing	8	82.37	83.91	83.13	0.47
Forklift Driver	4	81.12	83.31	82.59	1.00
Crusher	1	85.91	85.91	85.91	--
Supervisor	8	65.40	87.20	81.33	6.99
Quality control	5	77.85	79.43	78.70	0.60
Press	9	77.99	85.46	83.34	2.23
Rewind	2	76.75	77.20	76.97	0.32
Electrician	2	81.64	81.99	81.81	0.25

Table 2. Correlation between age and work experience with some electrocardiographic parameters in a group of workers in one of the ceramic tile industries

variable	Work experience (years)		Age (year)	
	R	P-value	R	P-value
Heartrate (beats per minute)	-0.19	0.07	-0.10	0.32
RR interval (ms)	0.19	0.07	0.08	0.41
PR interval (ms)	0.13	0.22	0.00	0.98
QRS complex time (ms)	0.02	0.83	-0.10	0.32
QT interval (ms)	0.14	0.19	0.00	0.98

Table 3. Correlation of sound with some parameters of electrocardiography in a group of workers in one of the ceramic and tile industries

variable	Noise exposure(dB)	
	R	P-value
Heartrate (beats per minute)	-0.16	0.13
RR interval (ms)	0.16	0.13
PR interval (ms)	0.22	0.04
QRS complex Time (ms)	0.07	0.53
QT interval (ms)	0.04	0.73

Significant correlation was observed with electrocardiographic parameters. Although there was no significant statistical relationship between age and work experience with heartrate. The Spearman correlation coefficient was used to determine the relationship between noise and electrocardiographic parameters. The results obtained are recorded in Table 3.

According to the results, there was a positive and significant correlation between noise exposure and PR interval (*P*-value 0.035), but no significant correlation was found between the noise and other electrocardiographic parameters. Further, there was

no significant correlation between the noise and heart rate, but it was reversible.

Discussion

Noise pollution is increasingly recognized as a physical factor in the environment, which in many ways affects human health.¹⁷ In some cities, after smoking and air pollution, it is the second most important cause of myocardial infarction.¹⁸ The aim of this study was to investigate the relationship between job performance with noise and cardiovascular function using electrocardiographic results in tile and ceramic workers. The results of this study showed that there is a significant relationship between the exposure to noise and PR distance in the ECG, but there was no significant relationship with other parameters.

In this study, although there was no significant correlation between heartrate and noise, it was reversible. The study by Wanis Osiris et al. contradicts our study. The results of this study showed that exposure to noise causes changes in heartrate and systolic and diastolic blood pressure,

but between exposure to noise and other electrocardiographic parameters, including P wave, PR interval, QRS interval, and QTC interval there was no significant correlation in factory workers.¹⁷ According to the results of one meta-analysis, the prevalence of high blood pressure and abnormal ECG in workers exposed to high exposure to noise was higher than workers with low and medium exposure.¹⁹ The results of the study by Singhal et al., who also examined the chronic effects of ambient noise on heartrate, produced similar results. Singhal et al. study found that sound affects heart rate, and its elevation increases the heart rate in workers exposed to noise, which is also contradictory with our results.²⁰ The difference in these studies with the present study is probably due to the larger sample size, body mass index of the participants, because in some studies, there is a positive and significant relationship between body mass index and ECG variables such as PR interval and QRS time.²¹ On the other hand, some cross-sectional studies, including the study of Yusefizhiz et al., support the results of our study. This researcher believes that there is no significant difference between heartrate and exposure to occupational noise.²² Fogari et al. showed that there was no significant difference in heartrate with chronic exposure to noise, which is consistent with the present study.²³ Also, Dr. Zamanian et al. in their study showed that although the mean heartrate in exposed workers with noise was lower than the pre-exposure level, it was not statistically significant.¹⁰ The reason for simulates between these studies and the present study is the relatively young participants in the study; in some studies there was a significant relationship between age and some electrocardiographic variables.^{24,25} On the other hand, this finding was not consistent with this study.

Conclusion

In this study, although the error related to the influence of interventional factors such as diseases and blood pressure records, was reduced by using a

questionnaire and medical records, the results can be influenced by the physical characteristics of noise, labor load and other confounding factors. Another limitation of the present study is the type of research because in cross-sectional studies, the time sequence cannot be clearly distinguished between the exposure to noise and its consequences. In general, the results of the present study show that although there was a significant correlation between PR interval and noise, there was no correlation between noise and other electrocardiographic parameters. Also, although the relationship between exposure to noise and heartrate was not statistically significant, it was reversible. Therefore, it is recommended that more studies, especially longitudinal studies, should be repeated with larger sample size, as well as with precise recordings of exposure of workers to noises using dosimeters instead of noise level meters. This would produce more accurate results.

Conflict of interest

The authors declare no conflict of interests.

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Reference

1. Golshahi J, Sadeghi M, Zavar R, Sadeghifar M, Roohafza H. Exposure to occupational air pollution and cardiac function in workers of the Esfahan Steel Industry, Iran. *Environmental Science and Pollution Research*. 2016;23(12):11759-65.
2. Bidel Z, Hemati R, Naserifar R, Nazarzadeh M, Del Pisheh A. Association of cardiovascular risk factors and coronary arteries involvement based on angiographic findings. *Ilam university of medical sciences*. 2014;22(1):147-54. [Persian]
3. Piranfar M, Pardal A, Rajabian A, Abdelahi M. The transformation of CRP and fibrinogen are receiving aspirin in cardiovascular patients. *Researcher*. 2006;11(7):39-42. [Persian]
4. Hwang WJ, Hong O. Work-related cardiovascular disease risk factors using a socioecological approach: implications for practice and research. *European Journal of Cardiovascular Nursing*. 2012;11(1):114-26.

5. Golmohammadi R, Amjad Sardrudi H, Dormohammadi A, Musavi S. Study of occupational noise - induced hearing loss in a tractor manufacturing plant. *Occupational Medicine Quarterly*. 2012;4(2):28-33. [Persian]
6. Pouryaghoub G, Mehrdad R, Mohammadi S. Interaction of smoking and occupational noise exposure on hearing loss: a cross-sectional study. *BMC public health*. 2007;7(1):137.
7. Hojati M, Golmohammadi R, Aliabadi M. Determining the Noise Exposure Pattern in a Steel Company. *Journal of Occupational Hygiene Engineering*. 2016;2(4):1-8. [Persian]
8. 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.
9. Kalantary S, Dehghani A, Yekaninejad MS, Omid L, Rahimzadeh M. The effects of occupational noise on blood pressure and heart rate of workers in an automotive parts industry. *Arya atherosclerosis*. 2015;11(4):215.
10. Zamanian Z, Rostami R, Hasanzadeh J, Hashemi H. The Effect of Occupational Noise Exposure on Blood Pressure and Heart Rate among Workers of a Steel Industry. *Health*. 2015;5(4):355-60. [Persian]
11. Skogstad M, Johannessen HA, Tynes T, Mehlum IS, Nordby K-C, Lie A. Systematic review of the cardiovascular effects of occupational noise. *Occupational medicine*. 2016;66(1):10-6.
12. Pourabdiyan S, Ghotbi M, Yousefi H, Habibi E, Zare M. The epidemiologic study on hearing standard threshold shift using audiometric data and noise level among workers of Isfahan metal industry. *Koomesh*. 2009;10(4):253-60. [Persian]
13. Bertone J. Editor Practical approach to cardiac evaluation in the field. *AAEP Proceedings*. 1999;45:266-70.
14. Rahimi Panahea J, Afhami MR, Hassanzadeh Salmasi P, Baradaran R. Role of routine preoperative ecg on anesthesia planning in elderly patients. *Armaghane danesh*. 2005;9(4):25-33. [Persian]
15. Ashley EA, Niebauer J. *Cardiology explained*. London: Remedica; 2004.
16. Golmohammadi R. *Noise and Vibration Engineering*. 4th ed. Tehran: Daneshjoo; 2014.
17. Wanis Osiris G. The association between noise exposure and blood pressure and ecg of workers in egyptian factories. [Poster] at: The 21st International Congress on Sound and Vibration; 2014 july 13-17; China: Beiging. Giza: Egypt; 2014.
18. Hygge S, Boman E, Enmarker I. The effects of road traffic noise and meaningful irrelevant speech on different memory systems. *Scandinavian journal of psychology*. 2003;44(1):13-21.
19. Tomei G, Fioravanti M, Cerratti D, Sancini A, Tomao E, Rosati M, et al. Occupational exposure to noise and the cardiovascular system: a meta-analysis. *Science of the total environment*. 2010;408(4):681-9.
20. Singhal S, Yadav B, Hashmi SF, Muzammil MD. Effects of workplace noise on blood pressure and heart rate. *Biomedical research*. 2009;20(2):122-6.
21. Swamy KNN, Kumar A, Sudhir GK. Association between Ecg Variables and Body Mass Index: A Cross – Sectional Study. *Evolution of medical and dental sciences*. 2015;4(96):16132-5.
22. Yousefi Rizi HA, Dehghan H. Effects of occupational noise exposure on changes in blood pressure of workers. *ARYA Atheroscler*. 2012;8:183-6.
23. Fogari R, Zoppi A, Corradi L, Marasi G, Vanasia A, Zanchetti A. Transient but not sustained blood pressure increments by occupational noise. An ambulatory blood pressure measurement study. *Hypertension*. 2001;19(6):1021-7.
24. Bachman S, Sparrow D, Smith LK. Effect of aging on the electrocardiogram. *The American journal of cardiology*. 1981;48(3):513-6.
25. Macfarlane PW, Mclaughlin SC, Devine B, Yang TF. Effects of age, sex, and race on ECG interval measurements. *Electrocardiology*. 1994;27:14-9.