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Original

Aircraft Noise and its Effects on Blood Pressure and Heart Rate at Mehrabad Airport Employees

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Abstract

Background: Sound is an inevitable part of everyday life these days. Hypertension is the most significant preventible risk of immature death all around the world. The main purpose of this study is to answer this question: Does aircraft noise affect blood pressure and heart rate? **Methods**: To achieve this objective, 100 personnel from the airport were selected. Additionally, 100 personnel were selected for the control group. In this case-control study the B&K dosimeter model 4444 was used to record noise in a long time duration (8 hours) Blood pressure and heart rates were measured before and after their shift and during their work shift by connecting a dosimeter device to their body and recording noise exposure. SPSS V.22 software was used for statistical analysis. **Results**: Analyses showed that the average noise intensity in the experimental group was 87.84 ± 2.76, and in the control group, it was 70.01 ± 4.01's. Compared with the control group, mean differences between systolic (*P* <0/001) and diastolic blood pressure (*P*=0.047) was significant, while the mean differences in heart rate after the shift not have a significant (*P*> 0.05). **Conclusions**: research indicates that unacceptable noise could be a hazardous agent for hypertension. It is suggested that monitoring blood pressure, training workers, and periodic examination to be practiced to decrease blood pressure.

Keywords: Aircraft; Noise; Hypertension; Blood pressure

Introduction

Noise is defined as an undesirable sound and is among the most prevalent contaminants nowadays. Noise is the result of various industrial activities. The cause of the noise can be in a source or from a process. Noise from twister, fans, vibrating board, internal combustion engines, airport, trucks, manufacturing processes there are examples of unwanted noises around us that are routinely distributed into the atmosphere. Aircraft noise can have different origins, such as noise of the engine, take off, landing, parking, engine repairs and parts, and propeller engines.[1] Mehrabad airport, serving nearly 12 million passengers per year, is the first airport all over the country. This airport is the most crowded in Iran and has an average of 300 flights per day Figure 1.

Figure 1. Mehrabad Airport

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Noise above the permissible threshold limit causes annoyance, reduced ability, fatigue, and reduced consciousness and mental capacity.[2] According to previous studies, there is a gradient between irritation and mental wellness. The pathophysiological effects of noise on humans are very diverse and include hearing loss, irritation, insomnia, decreased learning in children, effects on the cardiovascular system, heart attack, hypertension, and arrhythmias.[3-15] According to the World Health Organization, high blood pressure is the leading cause of death from cardiovascular disorders. The American Heart Association also estimated the cost of health care for people with high blood pressure at $ 76.6 billion in 2010.[16] Furthermore, retrospective studies have shown a significant relationship between noise and hypertension.[17, 18]

In 2015, Frank Schmidt and colleagues confirmed the effects of aircraft noise on sleep disorders and hypertension.[19] Therefore, while blood pressure can indicate noise exposure, heart rate cannot be a reliable indicator.[20] The data are contradictory due to the sensitivity of main healthy factor such as blood pressure and heart rate to various factors, and that there is no complete agreement on the direct effect of noise on systolic and diastolic blood pressure and heart rate.[21] Although research has been done on the effect of noise on health in Iran, it seems that there is no complete research on aircraft noise. The most affected people are those who live in the neighborhood of the airport or people working in the aerial or land area of the airport. Research results report that in residents around the airport, neurodegenerative disorders, cardiovascular disease, and hypertension are higher than in other areas.[22] The purpose of this research can be stated by asking: Does the noise of the airport in an individual exposure have an effect on the blood pressure and heart rate of the employees or not?

Methods

Referring to a previous study based on the formula for estimating the sample size 200 employee (100 case and 100 control) in Mehrabad Airport were selected.[21] Aircraft noise in the airport was measured by B&K dosimeter 4444. Aircraft noise was recorded by the dosimeter evaluated with equivalent continuous dB (A) (Leq 8h) according to the Standard method of ISO 1999. At the first the dosimeter was calibrated by calibrator in 94 dBA and set dosimeter to frequency weighting A and time weighting SLOW. After preparing all standard requirement, a dosimeter attached to the worker's waist to measure the noise, and the microphone was placed near the employee's hearing space. After noise measurement, the dose or the level equivalent to each person that exposed was reported.

In this method, EMSIG barometer was used to measure blood pressure and polar pulse rate was used for heart rate before and after the shift in the case and control group. This study was accomplished at Mehrabad Airport in Tehran. The method used in this study was to measure systolic and diastolic blood pressure and heart rate before the shift work, followed by during the work. The dosimeter (B&K Model 4444) was connected to the staff that measured and reported eight hours of received noise. In the end, systolic and diastolic blood pressure and heart rate were measured after the shifts.

The case group in this study included 100 occupational noise-exposed employees who were selected randomly from different units after the double-blind trial. In this study, the employees were employed in different airport jobs (4 groups: Marshaller, Traffic, Firefighting, Training), and the age range of workers who were exposed to noise above the threshold was 35.51 ± 3.6 years old Table 1. The control group in this study included 100 non-noise-exposed employees. The control group's age range was 38.63 ± 6.24 years old Table 1. The control group was matched with the case groups in BMI, age rang and work experience.

Exclusion criteria included the history of kidney disease, adrenal gland (super-renal), large amounts of aldosterone and heart Cushing's syndrome, hypertension, obesity, diabetes, and family history of hypertension. Almost 38% of those who were

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contacted and had rejected to participate responded to a short questionnaire about their demographic data. Demographic data such as records of medical diseases, drug use, sound exposed, toxic substances, smoking, drinking and use of personal protective equipment were the items considered in the questionnaire. Before measuring blood pressure and heart rate, the employees avoided alcohol, caffeine (tea, coffee, and chocolate), and smoking, rested for five minutes, and were prevented from walking. The participant sat comfortably on the armchair with a flat back. Measurements were recorded in the absence of pressure on the legs and ankles.

Blood pressure and heart rate parameters were measured and recorded by a trained nurse before and after the shift in accordance with the standard method Figure 2. Before and after the shift, systolic and diastolic blood pressure was recorded as the average of three measures (the time interval between each measurement was one minute). Hypertension was described as systolic blood pressure ≥ 140 mmHg and/or a diastolic blood pressure ≥ 90 mmHg. Since most of the participants studied were male (about 98.7%), the employees in this study were limited to males.

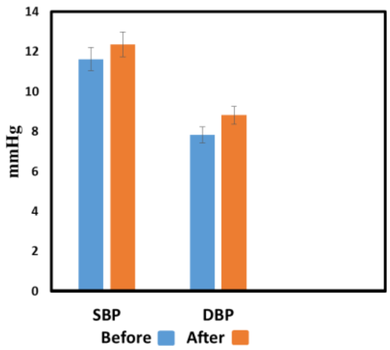

Figure 2. Comparison of systolic blood pressure and diastolic blood pressure before and after the shift.

Statistical Analyses

The sample size was calculated using a previous study by a statistician and epidemiologist based on the formula for estimating the sample size of 100 cases and 100 controls.[21] SPSS V.22 was used for all statistical analyses. The normality of distribution of continuous variables was tested by the one-sample Kolmogorov-Smirnov test. Continuous variables with normal distribution were presented as mean (standard deviation [SD]). Classified variables were represented as frequencies (%). An independent sample t-test was used to analyze the difference in mean noise, systolic, diastolic, and heart rate in the case and control group. Furthermore, a paired sample t-test was used to analyze the difference in mean noise, systolic, diastolic, and heart rate before and after the shift.

Results

In this study, 200 people were evaluated, 100 of whom formed the case and 100 of the control groups. Demographic data Table 1, including age, height, weight, work experience, BMI, were prepared with a conventional questionnaire. The mean and standard deviation of age in the case group was 35.51 ± 3.56, and in the control group, it was 38.63 ± 6.24. The mean and standard deviation of BMI in the case group was 26.65 ± 5.7 and was 25.45 ± 3.20 in the control group. The mean and standard deviation of work experience in the case group was 10.21 ± 3.8 and in the control group was 12.48 ± 6. Independent t-test showed a significant difference between age, height, weight, and work experience in case and control groups ($P< 0.05$), whereas the BMI mean was not significant in both the groups ($P> 0.05$) Table 1.

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To compare noise, systolic, diastolic, and heart rate in the case and control group, an independent t-test was applied. The results showed that there was a significant difference in systolic (*P*=0.023), diastolic (*P*=0.023), and noise variables (*P*<0.001). However, there was no significant difference in the heart rate variable (*P*=0.734) Table 2.

A paired sample t-test was used to analyze the difference in mean noise, systolic, diastolic, and heart rate before and after the shift. The mean difference between systolic blood pressure in the case (*P* <0/001) and the control group (*P*=0.047) was significant. Moreover, the mean difference between diastolic blood pressure after the shift in the two groups was significant (*P* <0/001). However, the mean difference in heart rate before and after the shifts was not significant in the two groups (*P*> 0.05). Before the shift in the case group, systolic blood pressure was reported 11.61± 0.81(mmHg) and after the shift 12.37 ± 0.80(mmHg). Before the shift, systolic blood pressure in the control group was reported 11.86 ± 0.85 (mmHg) and after the shift as 11.96 ± 0.76 (mmHg). In the case group, diastolic blood pressure before the shift was reported as 7.82 ± 0.71 (mmHg) and after the shift as 8.81 ± 0.74 (mmHg), and in the control group as 8.04±0.60 and 7.82 ± 0.60 mmHg, respectively. Heart rate before the shift in the case group was reported 74.28 ± 6.90 (bit/second), and after the shift 73.79± 6.62(bit/second). Systolic blood pressure in the control group was reported as 73.93 ± 7.37 (bit/second) before the shift and 75.24 ± 6.00 (bit/second) after the shift Table 3.

The correlation between the equivalent sound level and systolic, diastolic blood pressure and heart rate was shown in Figures 3, 4, and 5.

Table 1. Mean and Standard Deviation of Employees' Age, Height, Weight, Work Experience and BMI

	Mean ± SD Case	Mean ± SD Control	*P*-Value
Age (year)	35.51 ± 3.56	38.63 ± 6.24	<0.001*
Height (cm)	180 ± 6	176 ± 6	<0.001*
Weight (kg)	84.85 ± 10	79.36 ± 12.9	0.001*
BMI (kg/m2)	26.65 ± 5.7	25.45 ± 3.2	0.074*
Work experience (year)	10.21 ± 3.8	12.48 ± 6	0.002*

*T-test

Table 2. The Mean and Standard Deviation of Systolic Blood Pressure, Diastolic Blood Pressure, and Heart Rate Before the Shift in Case and Control Group

Variables	Mean ± SD Case	Mean ± SD Control	*P*-Value*
SBP	11.61 ± 0.81	11.8 ± 0.85	0.023*
DBP	7.82 ± 0.71	8.04 ± 0.6	0.023*
HR	74.28± 6.92	73.9 ± 7.37	0.734*
Noise	87.84±2.76	70.01±4.01	<0.001*

*T-test

Table 3. Comparison of Mean Systolic, Diastolic and Heart Rate Variables in the Case and Control Groups Before and After the Shift

Variables	Group	Mean ± SD Before Shift	Mean ± SD After Shift	*P*-Value
SBP1(mmHg2)	Case	11.61 ± 0.81	12.37±0.80	<0.001*
	Control	11.86±0.85	11.96±0.76	0.571*
DBP3(mmHg)	Case	7.82±0.71	8.81±0.74	<0.001*
	Control	8.04±0.60	7.82±0.6	<0.453*
HR (bits/second)	Case	74.28±6.90	73.79±6.62	0.386*
	Control	73.93±7.37	75.24±6.00	0.222*

*T-test

[1] systolic blood pressure before the shift
[2] millimeters of mercury
[3] Diastolic blood pressure before the shift

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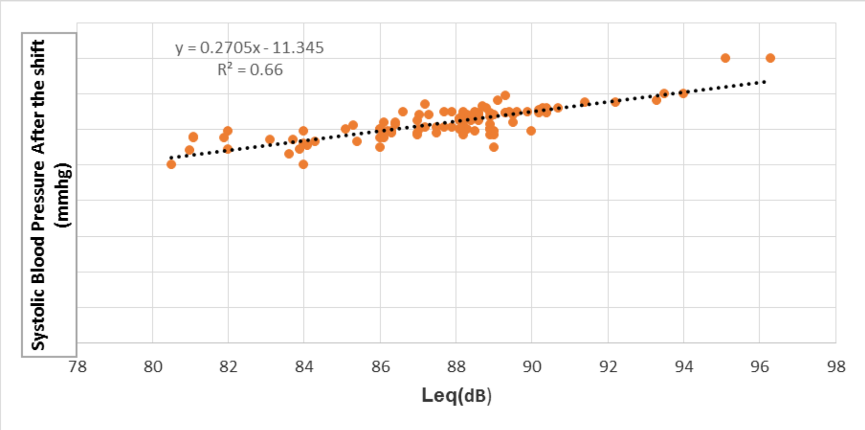

Figure 3. The correlation between the equivalent sound level and systolic blood pressure

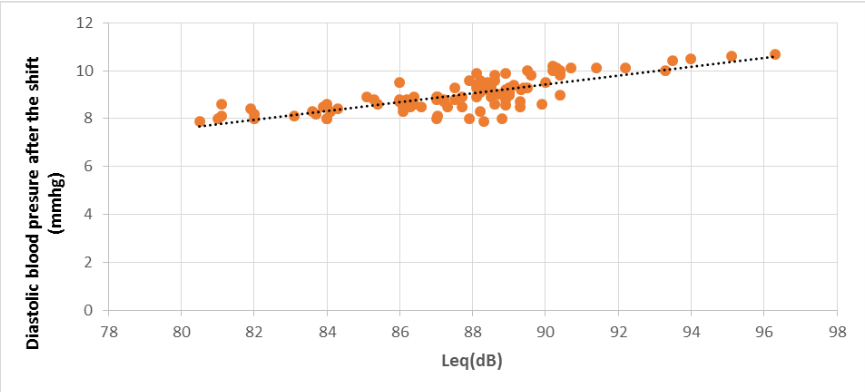

Figure 4. The correlation between the equivalent sound level and diastolic blood pressure

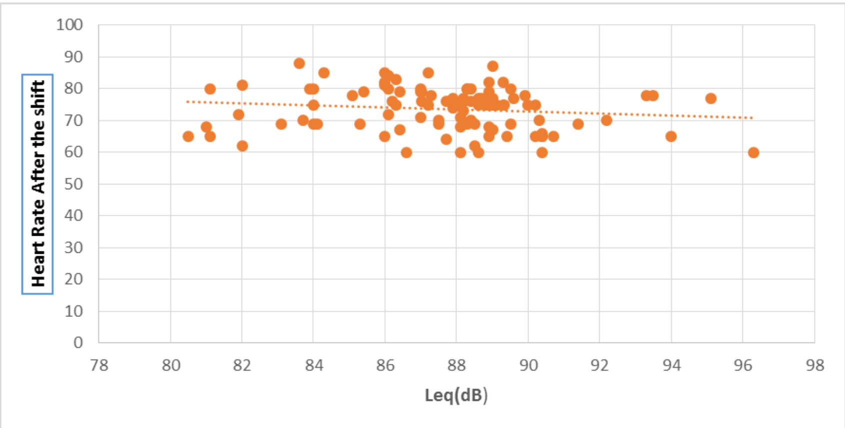

Figure 5. The correlation between the equivalent sound level and heart rate

Discussion

The principle purpose of this research was to investigate the association between noise and effects on systolic, diastolic blood pressure, and heart rate in Mehrabad airport staff. In this research, for the case group, the exposure to aircraft noise was higher than the threshold limit, and this factor led to an increased effect on blood pressure while it had no significant effect on heart rate. The average systolic (12.28 mmHg) and diastolic (8.76 mmHg) blood pressure of employees increased after exposure to aircraft noise (2005-2018). In this study, a dose-response

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correlation between aircraft noise and the risk of hypertension was observed. The results of this study are consistent with the result of other research.[15, 23] Neghab et al (2009) also confirm this result in his paper.[24] In this study, the results reveal that there is no significant difference between aircraft noise and heart rate, which are similar to previous research.[25-27] heart rate activity might differ according to noise. Further studies will be required to ascertain the role of noise type.[26] In many types of research, the relationship between noise and hypertension has been investigated.[3-15]

However, the results are still contradictory. Moreover, there was no significant relationship between noise and blood pressure in the control group, and this result was confirmed before and after shifts. These results are supported by previous research.[16, 21, 28-31] After reviewing for 10 years, Chang et al. (2011) claimed that noise higher than the permissible threshold (85 dB) increases systolic blood pressure to 3.2 (95% CI: 0.22 - 6.20) mm Hg and diastolic blood pressure to 2.5 (95% CI: 0.10-4.80) ($P < 0.05$).[32] This study was conducted at Mehrabad Airport in Tehran. Interference factors such as the history of work, sex, age, and BMI were adjusted. Noise exposure was evaluated by the dosimetry method via the equivalent continuous sound level (Leq, 8 h, dB (A)) .

Abbate et al. (2002) in his research showed that blood pressure is effective in the presence of aircraft noise, while heart rate cannot be an effective index of aircraft noise. Similarly, in the present study, diastolic blood pressure was more influenced by aircraft noise.[27] In Aydin, Y. (2007)'s paper, noise traffic affection on systolic blood pressure was more pronounced than the diastolic one. It seems that the mental perception of noise can also be a significant factor in the effect of sound on hypertension.[33] In Belojevic G. et al. (2008)'s research they reached to this conclusion that noise has a direct effect on hypertension. In this study, the target group was children in kindergartens where conversation and environment (in the open space) are higher than standard. Results revealed that it had a significant effect on children's blood pressure.[34] Yaqubi et al. (2016) in a similar study, concluded that the balance in the range of 85-75 and 85-95 dB caused a change in blood pressure, but there was no significant correlation between the increases in the equivalent sound level and the heart rate.[35] Wiesenberger et al. (1996), by examining in a simulated manner, concluded that the effect of noise on heart rate is temporary, and when the noise is removed, the heart rate returns to its previous condition.[36] As mentioned earlier, the heart rate is sensitive to environmental conditions, mental health, and many other parameters. Some restrictions of this research was the high sensitivity of blood pressure and pulse rate to the environmental, physical, and mental conditions of the subjects. Inaccessibility to job examinations and lack of access to airport sound maps was another limitation of the study.

Conclusion

In the case group, the risk of employees developing hypertension, especially diastolic blood pressure, was higher than other group. Diastolic blood pressure was more influenced by aircraft noise. According to the present findings and previous research, heart rate cannot be regarded as an effective indicator of aircraft noise. To improve employee conditions against a noisy environment and reduce its effects on health, the following suggestions are recommended:

1.Occupational examinations should be carried out continuously before and after hiring personnel to assess the health status of the employees.

2.Personnel should be continuously trained to use earmuffs or earplugs and follow safety and health principles

3.The timing of shift work should be scheduled according to the principles of benefit management-health.

4. Insulation of buildings and staff resting place should be carried out.

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5.Sound maps using sound pollution software 6 could be designed.

6.Installing sound measuring instruments and controlling noise pollution should be continued.

Blood pressure and heart rate are very mutable due to environmental, psychological, and physical conditions. Thus, conflicting factors should be considered. It is also suggested that researchers consider conflicting factors such as body temperature, sunlight, and hour of work, shift work, mental and psychological factors, and chemical pollution in the air. Recognizing these factors can provide more accurate information.

Conflicts of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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