CARDIOVASCULAR EFFECTS OF SHORT TERM NOISE OF A CONSTANT FREQUENCY AND INTENSITY

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Background: The term noise is commonly used to describe sounds that are disagreeable or unpleasant. Noise has become a very important 'stress factor' in the environment of man. Noise has many effects on exposed population. Many experts have investigated the acute effects of short-term loud noise on cardiovascular parameters. The main objective of this study was to observe the effect of exposure to short-term noise on blood pressure and heart rate. **Methods:** One hundred and seventeen normotensive medical students (61 male and 56 female), aged 18–23 years were exposed to 90 dB sound of 4000 Hz for 10 minutes. Blood pressure and heart rate was measured at regular 3-minute intervals before, during, and after the production of noise. The subjects selected for the study were themselves control group by exposing them to experimental conditions, without production of noise. **Results:** Systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial pressure and heart rate increased in 57.26%, 70.94%, 34.19%, 73.50% and 88.89% of the total subjects, respectively; while the pulse pressure decreased in 44.44% of the total subjects. Average rise in systolic blood pressure, diastolic blood pressure, pulse pressure, mean arterial pressure and heart rate was 2.462 mm Hg, 3.064 mm Hg, 0.42 mm Hg, 2.157 mm Hg and 8.938 respectively ($p<0.05$). **Conclusion:** Blood pressure and heart rate increase during exposure to noise and remain elevated for a certain period of time, usually 2–11 minutes, even after exposure to noise.

Keywords: noise, blood pressure, heart rate

INTRODUCTION

Excessive and unnecessary noise is disliked by almost every individual. Exposure to noise may lead to various psychological and physiological effects. The noise production has increased to a greater extent due to industrialization and crowded road traffic. Moreover, modern mechanical facilities in our every day life have also added to this dilemma. Noise is often defined as an 'unwanted sound'.[1] The term noise is commonly used to describe sounds that are disagreeable or unpleasant, produced by acoustic waves of random intensities and frequencies.[2] Noise may be continuous, intermittent, impulsive or explosive and may be steady state or fluctuant. Some familiar examples of noise are the jingling of keys, clapping of hands, the rapport of a gun, the roar of street traffic, and the noise of aircrafts etc.[2] Noise has become a very important 'stress factor' in the environment of man.[1] The term 'Noise Pollution' has been recently coined to signify the vast cacophony of sounds that are being produced in the modern life, leading to health hazards.[1] In order to grasp what the sound of a particular level is like, the noise levels associated with a number of activities are shown in Table-1.[3]

Noise has many effects on the exposed population.[3] Loud noise is known to affect the function of various physiological activities.[4] The basic aim of the study was to observe the effect of exposure to short-term noise on systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), pulse pressure (PP) and heart rate (HR).

Table-1: Noise Levels of Everyday Activities

Sound level (dB)	Activity
30–50	Private office
50–65	General Office
60–70	Speech
70–90	Average traffic
90	Raised voice – shouting
>120	Painful to the ears

MATERIAL AND METHODS

One hundred and seventeen medical students (both male and female) were selected as subjects. The subjects were 18–23 years old. The subjects with normal blood pressure (BP) and heart rate were chosen for the study. Normal blood pressure in this study was considered as 100–125 mm Hg (systolic) and 60–90 mm Hg (Diastolic),[5–7] and normal heart rate was from 60–100 beats per minute.[6] The subjects with any hearing abnormality were excluded from the study. The audiometer was used to test the auditory acuity of each subject. The subjects selected for the study were themselves control group by exposing them to experimental condition, without production of noise.

Sound of 90-dB intensity was produced for 10 minutes, at the frequency of 4000 Hz. The blood pressure and heart rate were checked before exposure

to noise; after 1, 5 and 9 minutes after the start of production of noise and then at three minutes interval, till it returned to normal. The results were analyzed by Student's *t*-test.

Noise was produced by audiometer for 10 minutes in soundproof room in ENT department of Khyber Teaching Hospital, Peshawar. The sound was of 4000 Hz and 90 dB loud.

RESULTS

One hundred and seventeen subjects were selected for the study. Sixty-one (52.14%) of the subjects were male and 56 (47.86%) were female.

The systolic BP increased in 67 subjects (57.26%), decreased in 24 subjects (20.51%), and was not affected in 26 subjects (22.22%). The diastolic BP increased in 83 subjects (70.94%), and decreased in 14 subjects (11.96%). There was no effect on diastolic BP in 20 subjects (17.09%). The Pulse Pressure increased in 40 subjects (34.19%). It decreased in 52 subjects (44.44%), while it was not affected in 25 individuals (21.37%). The Mean Arterial Pressure increased in 86 subjects (73.50%). It decreased in 19 subjects (16.24%); while there was no effect in 12 subjects (10.26%). The heart rate increased in 104 (88.89%) subjects. It decreased in 4 (3.42%) and it was not affected in 9 (7.69%) subjects.

Analysis of rise in blood pressure and heart rate is summarized in Table-2. Once the blood pressure and heart rate was increased, it took some time to come back to the resting value (Figure-1 and Figure-2).

Table-2: Quantitative Analysis of rise in BP and HR

Subjects	SBP (mm Hg)	DBP (mm Hg)	PP (mm Hg)	MAP (mm Hg)	HR
Maximum rise (Male)	19	27	13	21	20
Maximum rise (Female)	23	20	18	19	12
Maximum fall (Male)	15	23	17	18	2
Maximum fall (Female)	15	12	22	2	4
Average rise (Male)	2.285	2.765	-0.34	2.568	10.399
Average rise (Female)	2.640	3.739	-0.5622	1.827	6.124
Average rise (Both Sexes)	2.462	3.064	-0.429	2.157	8.938

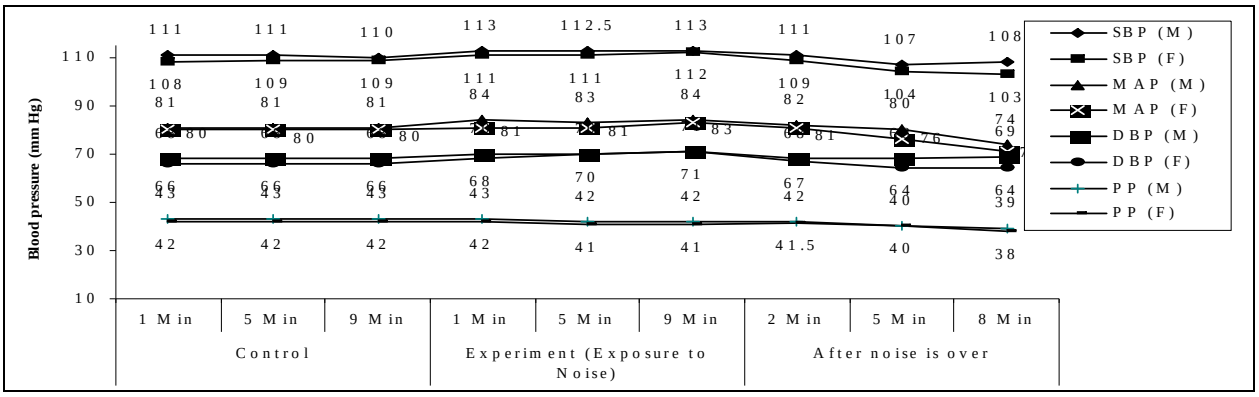

Figure-1: Blood Pressure at different times during procedure.

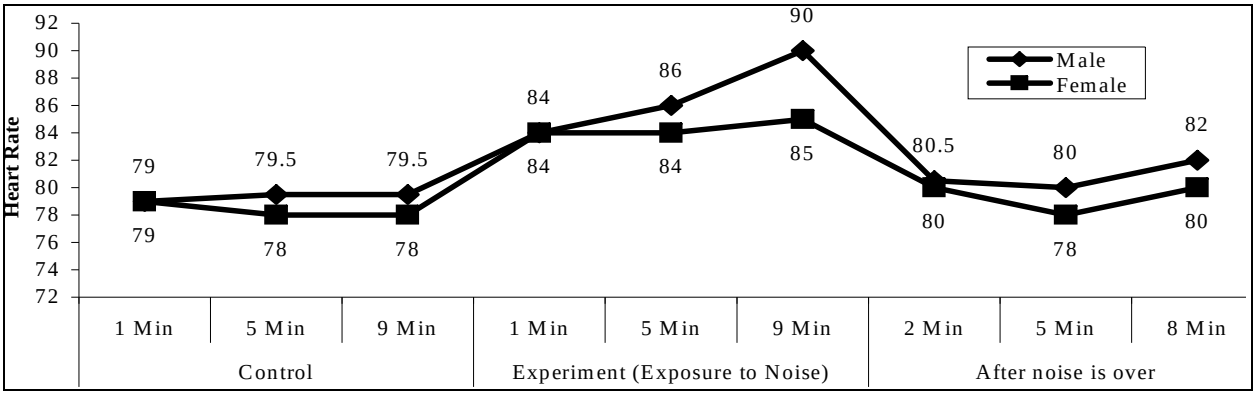

Figure-2: Heart Rate at different times during the procedure.

DISCUSSION

In 1970, Occupational Health Safety and Health Act established occupational noise exposure standards; an employee may receive in a working day.[8] According to this standard 90 dB is the maximum permissible noise level of exposure, without the use of ear protectors for 8 hours per day.

When noise levels at different busy locations in Peshawar were studied by Akhtar[2], it was found that average road traffic noise levels in Peshawar were between 87–98.5 dB, the most frequent level being above 90 dB. Blood pressure and heart rate increased in most of the subjects, although it decreased in few subjects and not affected in many subjects. The diastolic blood pressure was affected is more number of subjects than the systolic blood pressure (83 subjects vs. 67 subjects). The heart rate was affected in even more number of subjects. It increased is 88.89% of the subjects. It can be seen from Table-2 and Figure-1 & 2 that the increase in blood pressure due to noise occurred in relatively more number of females as compared to males, while the increase in heart rate was observed in more number of males as compared to females; however, the difference was statistically insignificant.

Average rise in systolic blood pressure, diastolic blood pressure, pulse pressure , mean arterial and Heart Rate was 2.462 mm Hg, 3.064 mm Hg, 0.42 mm Hg, 2.157 mm Hg and 8.938 ($p<0.05$). Therefore it can be seen that there was a significant rise in systolic and diastolic blood pressure and heart rate when the noise was produced.

When the blood pressure and heart rate was analyzed only in those subjects in whom the blood pressure and heart rate increased, it was seen that the average rise in systolic blood pressure was 5.61 mm Hg, while the average rise in diastolic blood pressure and heart rate was 6.71 mm Hg and 13.45 respectively. ($p<0.005$).

Our results are comparable with most other studies performed in other countries. Herbold *et al* investigated the association between blood pressure and exposure to road traffic noise in 30-69 years age group and found positive association between exposure to road traffic noise and high blood pressure.[9] In 1989, Harrison and Kelly (USA) found significant cardiovascular reactivity among the older group as compared to younger people.[10] The noise selected by them was of 80 dB intensity.

In Poland, Lesnik *et al* evaluated the changes in hemodynamic parameters caused by noise of 70 dB.[11] They found that noise resulted in increase in ejection volume and diastolic blood pressure. Kristal-Boneh *et al* (United States) showed positive association between noise and heart rate but they did not find any association with blood pressure.[12] In Japan, Swada investigated the extent of blood pressure elevation during noise exposure in young males and found significant or almost significant rise in mean arterial pressure, systolic blood pressure and diastolic blood pressure.[13] Baker *et al* in United States did not find significant association between noise and blood pressure/heart rate.[14] A study was performed by Melamed *et al* in Israel to see whether noise exposure level and job complexity interact to affect changes in blood pressure levels and job satisfaction.[15] Results showed that among workers exposed to high noise, those with complex jobs showed increases in blood pressure that were more than double shown by those with simple jobs. Under low noise exposure, there was a small increase in blood pressure for workers with complex jobs but about a 3-fold increase in workers with simple jobs.[15] Rosenlund carried out a research comparing two groups of people living near or far from the Stockholm Arlanda Airport.[16] It was found that living under an airport flight path may boost a person's high blood pressure, risk by as much as 80%. Rosenlund reported that people exposed to average aircraft noise of 55 decibels or higher were 60% more likely to report having been diagnosed with high blood pressure. Those with exceeding 72 decibels were 80% more likely to report a high blood pressure diagnosis. Overall, 14% of people exposed to less noise had high blood pressure, compared with 20% of those who regularly faced noise levels of 55 decibels or higher.[16]

In Netherlands, Elise *et al* performed a Meta-analysis on the association between noise exposure and blood pressure and ischaemic heart disease.[17] With respect to the association between noise exposure and blood pressure, small blood pressure differences were evident. Their meta-analysis showed a significant association for both occupational noise exposure and air traffic noise exposure and hypertension. They estimated relative risks per 5dB noise increase of 1.14 (1.01–1.29) and 1.26 (1.14–1.39), respectively. In cross-sectional studies, road traffic noise exposure increases the risk of myocardial infarction and total ischaemic heart disease.[17] Because of the limitations in exposure characterization, adjustment for important confounders, and the occurrence of publication bias, Elise *et al* suggested further studies in this regard.

Evans *et al*, in Austria, performed the study in children and found that systolic blood pressure increased due to noise exposure.[18]

The actual mechanism responsible for increase is blood pressure and heart rate is not yet completely understood but a few facts are known. Peripheral vascular resistance increases and

baroreflex sensitivity is not suppressed during intermittent noise exposure.[13] Fisher an Tucker proved that rise in blood pressure in rats due to noise exposure was sympathetically mediated.[19] There is increased urinary excretion of epinephrine, nor-epinephrine, dopamine and cortisol is the subjects exposed to high levels of noise.[20] Bergomi *et al* also detected impairment of some sensory functions.[20] Evans *et al* observed that there is increased 8 hour overnight urinary cortisol in children living in noisy environment.[18] Based on all these preliminary findings it may be suggested that noise may be related to a marked activation of the neuroendocrine system, resulting in increase in blood pressure and heart rate.

Finally, in order to prevent or at least minimize the health hazards due to noise exposure, it is recommended that maximum allowable duration of exposure to noise should be reviewed and strictly followed; legislation for control of noise should be constituted and strict policy be adapted to enforce the concerned laws; efforts should be made to control the noise at the source, to control the transmission of noise and to protect the exposed persons; there should be permanent arrangements for regular measurements of noise levels at different locations in cities and factories and health education regarding noise control should be given due importance.

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