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RESEARCH ARTICLE

Blood pressure variations in textile mill middle-aged male workers exposed to noise

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ABSTRACT

Background: Continuous exposure to occupational noise may create physiological derangements of parameters pertaining to stress and anxiety of an individual's life. Controversial outcomes over the years from different studies made this a topic of debate. **Aims and Objective:** The aim of this study was to investigate the effect of noise exposure on blood pressure of textile mill workers depending on the intensity of noise. **Materials and Methods:** A total of 120 male textile mill workers were enrolled for the study. 30 workers from each section including weaving, spinning, packaging and administration section, of the textile mill on the basis of noise level, were selected. They were categorized into groups on the basis of high noise exposure and low noise exposure. The age group criteria for this study were 35-55 years. Blood pressure of this study population was estimated using sphygmomanometer using auscultatory method. Body mass index and heart rate were also noted. **Results:** Significant results were obtained in this study. 22.5% workers were found to be hypertensive in this study population. The maximum numbers of hypertensive were found in weaving section. 5.8% workers of the total study population were having isolated systolic hypertensive and isolated diastolic hypertensive. Systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and pulse pressure (PP) were found be significantly higher in high noise group (<0.05) compared to low noise group. Highest levels of SBP, DBP, MAP, and PP were found in weaving section with noise level between 95 and 100 db. Heart rate was also found to be significantly (<0.05) increased in high noise group. **Conclusion:** Continuous exposure to occupational noise may lead to adverse changes in blood pressure from mild risk to moderate risk depending on the intensity of noise. It may give lead to cardiovascular abnormalities, e.g., stroke and myocardial infarction. Occupational noise with higher intensity (>90 db) may be associated with hypertension.

KEY WORDS: Occupational Noise; Pulse Pressure; Mean Arterial Pressure; Cardiovascular Risk

INTRODUCTION

Noise pollution is a highly rated problem in developed countries but not very well implicated in developing countries.[1] Noise, an unwanted sound which is disagreeable or causing psychological or physiological damages to a person.[2] Noise is caused by acoustic waves of random intensities and frequencies.[3] Prolonged exposure to noise of a similar intensity can be harmful to the health of a person in various aspects. Adverse effects of noise may cause serious health issues in later stages.[4] There can be temporary or permanent adverse effect of noise exposure depending on the degree or intensity of that particular noise. Although hearing loss is one of the major problem caused by noise pollution, other effects, i.e., irritation, hypertension, headache, and sleep disturbances cannot be neglected.[5] Stress can also be the consequence of the appraisal of noise.[6]

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Cardiovascular abnormalities can be the consequence of stress, which might have resulted from short-term exposure to noise. Since stress has both direct and indirect effect which are responsible for developing coronary heart disease. Continuous stress due to high noise exposure may lead to cyclic vomiting syndrome changes as estimated by high blood pressure and stroke because stress leads to release of catecholamines which circulate and can result in rise of blood pressure and heart rate.[7] Slight changes in blood pressure of an individual may be the root cause for developing cardiovascular risk in coming future since heart attack, stroke, retinopathy, and a hypertensive renal failure are familiar in hypertensive population.[8] It has been observed that occupational noise can affect the blood pressure of an individual[9] but these results are still contradictory since a 7 years prospective cohort study did not find any risk of hypertension in noise exposure between 80 and 90 db,[10] and the relation between blood pressure and noise are still under debate.[11] Hence, the main objective of this was to investigate the effect of occupational noise on blood pressure of textile mill workers who were not the part of the population with a certain disorder.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Physiology, Santosh Medical College & Hospital, Ghaziabad, from June 2016 to October 2016. This study was ethically approved by the Institutional Ethical Committee of Santosh Medical College & Hospital, Ghaziabad. In total, 120 male workers from various sections of the textile mill were included for assessment of blood pressure.[12] All the workers have voluntarily participated. The written and oral consent was obtained from each participant. The age group criterion for this study population was 35-55 years.

Exclusion Criteria

1. Workers with cardiovascular complaints as suggested by history
2. Working hours of the workers more than 8 h in a day excluding lunch
3. Workers having diabetes mellitus and any renal disorder
4. Workers having any hearing problem or diseased ear
5. Persons having history of hypertension or taking antihypertensive drugs
6. Individuals suffering from noise-induced hearing loss
7. Smokers, alcoholics, and tobacco consumers.

Inclusion Criteria

Only textile mill workers, working for at least 5 years, were included and not having any cardiovascular abnormalities or noise-induced hearing loss.

METHODS

All the parameters were followed in the morning before the work shift to reduce the influence of diurnal rhythm and effects of acute exposure to noise.

1. Classification of workers: All the workers are categorized into two groups: Group I included 90 workers and Group II included 30 workers.[13]
2. Classification of Groups: All the sections of this textile mill were categorized into groups on the basis of sound level in that particular section. Group I was termed as high noise area in which sound level was >70 db. While Group II was termed as low noise area with sound level <50 db.[14] Sound level in each section was measured using noise dosimeter (Table 1).
3. Calculation of body mass index (BMI): BMI was calculated by dividing weight of an individual with the square of the height of that individual. Weight and height of an individual was measured in kilogram and meter, respectively.[15]
4. Measurement of blood pressure: Blood pressure was measured using sphygmomanometer using auscultatory method.[16,17]
   a. Systolic blood pressure (SBP): SBP is the maximum pressure exerted during systole.
   b. Diastolic blood pressure (DBP): DBP is the minimum pressure exerted during diastole.
   c. Pulse pressure (PP): PP was also calculated after obtaining SBP and DBP, by the following formula:
      PP=SBP−DBP
   d. Mean arterial pressure (MAP): After measuring SBP and DBP, MAP was calculated by given equation:
      MAP=DBP+1/3PP
   e. Heart rate: It was measured after measuring the blood pressure. Workers were made to sit in relax position. Forearm was slightly pronated and wrist slightly flexed. The radial artery was palpated with tips of three fingers. Index finger is toward heart varies pressure on artery and middle finger feel the pulse and distal finger prevent reflux of pulsation. Rate of pulse was measured in beats per minute.[18]
5. Evaluation of blood pressure: Normal range for blood pressure was 120/80 mmHg, where 120 mmHg is systolic pressure and 80 mmHg is diastolic pressure. Persons having blood pressure more than 140/90 mmHg was termed as hypertensive. Workers having SBP between 120 mmHg and 140 mmHg and DBP between 80 mmHg and 90 mmHg were termed as prehypertensive.[19] Isolation in SBP above 140 mmHg along with DBP below or equal to 80 mmHg was referred as Isolated systolic hypertensive[20] while elevation in diastolic pressure above the 90 mmHg and systolic pressure within or below 120 mmHg was termed as isolated diastolic hypertension.[21]

Statistical Analysis

All the variables were expressed in mean ± standard deviation. An unpaired Student's *t*-test was used for differentiation of variables between the groups. For differentiation of various sections of high noise area one-way ANOVA was performed. $P < 0.05$ was considered statistically significant. A statistical software IBM-Statistical Package for Social Science version 23.0 for windows was used for statistical analysis.

RESULTS

There was no statistical difference in age and BMI of the textile mill workers when compared on the basis of groups. While on the basis of sections, a significant difference was observed in BMI of the textile mill workers. The systolic pressure was higher in Group I when compared to Group II. Similarly, diastolic pressure was elevated in workers, working high noise area compared to those working in low noise area. The results were highly significant (<0.001). The MAP was comparatively higher in high noise area workers (Figure 1). The PP was also lower in workers working in low noise area compared to those working in high noise area. The findings were highly significant (<0.001) between the groups. Increased heart rate was found in Group I when compared to Group II, and this difference was highly significant (Table 2). The high noise group has three sections; weaving, spinning, and packaging. In which SBP, DBP, MAP and PP were significantly different among the sections (<0.001). The levels of blood pressure variables were highest in weaving and lowest in packaging sections. These similar findings were observed in heart rate also (Table 3). In this study population, there were 22.5% workers with hypertension and the highest percentage (40%) of hypertensive people was observed in weaving section while in administration section there was no worker was suffering from hypertension. Workers with ISH were present only in weaving and spinning section, while workers with IDH were reported in high noise areas (Table 4).

DISCUSSION

Noise at the workplace or occupational noise can be harmful to health in a long term since it may create several associated risk with exposure to noise. A meta-analysis has shown that continuous exposure to noise can contribute to the prevalence of cardiovascular disease.[22] Blood pressure seems to be highly affected as far as noise exposure is concerned,[23] since in this study noise creates more alterations in blood pressure of the textile workers working in high noise area compared to those working in low noise area. A cross-sectional study from china suggested that there may be positive association between occupational noise and hypertension after dividing workers in the noisy

Table 1: Noise level in different sections of textile mill

Sections	Noise levels in db
Weaving	95-100
Spinning	90-95
Packaging	70-80
Administration	40-50

Table 2: Difference of blood pressure variables between Group I and Group II

Variables	Group I (90)	Group II (30)	*P* value
Age	40.36±2.59	39.86±3.00	0.419
BMI	24.83±2.94	25.43±2.94	0.334
SBP	131.91±13.73	116.23±7.39	<0.001
DBP	85.68±9.27	75.83±5.38	<0.001
MAP	100.93±10.12	89.26±5.40	<0.001
PP	46.13±8.98	40.40±5.70	0.001
Heart rate	82.03±10.92	74.80±4.72	<0.001

All variables were expressed in mean±standard deviation. $P<0.05$ was considered statistically significant. BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, PP: Pulse pressure

Table 3: Difference of blood pressure variables among the sections of high noise area

Variables	Weaving	Spinning	Packaging	*P* value
Age	40.73±2.82	39.60±2.48	40.76±2.35	0.140
BMI	24.72±2.69	25.94±2.90	23.81±2.93	0.017
SBP	138.70±13.95	133.16±9.39	123.86±13.41	<0.001
DBP	88.70±9.21	86.30±6.77	82.06±10.48	0.018
MAP	105.00±9.46	101.90±7.47	95.90±11.18	0.001
PP	49.66±11.63	46.86±6.29	41.86±6.36	0.002
Heart rate	84.83±12.31	83.63±11.66	77.63±6.93	0.022

All variables were expressed in mean±standard deviation. $P<0.05$ was considered statistically significant. BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, PP: Pulse pressure

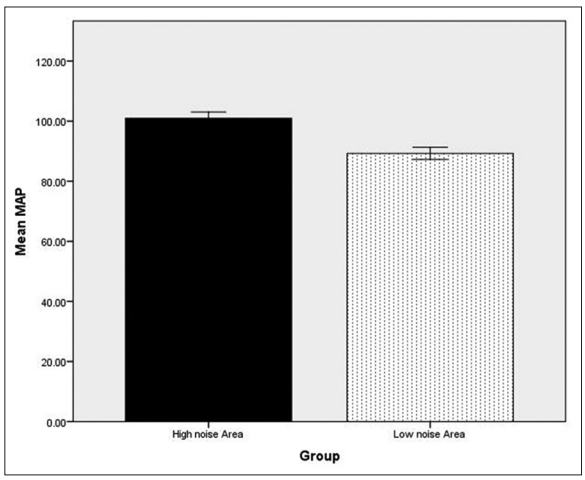

Figure 1: Presentation of mean arterial pressure between high and low noise area workers

Table 4: Cross tabulation between blood pressure range and different sections

Sections	N	PH	H	ISH	IDH	Total
Weaving	04	05	12	06	03	30
Spinning	04	13	09	01	03	30
Packaging	15	08	06	-	01	30
Administration	23	07	-	-	-	30
Total	46	33	27	07	07	120

N: Normal, PH: Prehypertensive, H: Hypertensive, ISH: Isolated systolic hypertensive, IDH: Isolated diastolic hypertensive

group (≥90 db) and nonnoisy group (≤70 db) in support to this study.[24] There were 22.5% workers were found to have hypertension especially in the section where the noise level was between 90 and 100 db. This result was supported by other studies.[25,26] Chang et al. also suggested that hypertension may be associated with exposure to occupational noise level >80 db.[27] Moreover, a study based on sawmill workers also reported that noise exposure >85 db was positively associated with hypertension.[28] There was significant changes in systolic and DBP among the textile mill workers from various sections. This result was supported by the Fezil et al., when they observed significant changes in SBP and DBP of spinning mill workers before and after exposing to noise.[29] Attarchi et al. also matched our study by observing consistant increase in blood pressure with increasing intensity of noise in different groups and further suggested that cardiovascular risk and blood pressure assessment should be regularly monitored along with auditory measurement.[30] Kalantary et al. also reported increased level of blood pressure in workers after exposing to noise in support to this study.[31] Moreover, in support to our study, there was high prevalence of increased SBP and DBP in female workers of textile mill when exposed to high level of noise which can be formed into hypertension with continuous exposure of noise.[32] There was the high impact of noise on SBP since in the high noise area the level of SBP was higher when compared to low noise area group. When compared on the basis of the noise intensity, the high level of SBP was observed in weaving section with noise level between 95 and 100 db. Ismaila and Odusote supported these findings while observing the significant difference in SBP and suggested that workers should not be exposed more than 89 db since high intensity of noise can increase the SBP.[33] The study has concluded that isolated SBP better predicts risk than the elevation in DBP.[34] Noise create alteration in SBP compared to DBP since there was more number of workers in weaving section having ISH compared to IDH. Although chronic noise exposure independently increases SBP,[35] Lesnik and Makowiec-Dabrowska observed noise exposure >70 db can increase the DBP.[36] In this study, there was significant difference was observed in DBP between high noise exposed group and low noise exposed group. MAP is considered to be perfusion pressure through each tissue bed. Increased MAP is an important component of vascular overload and cardiovascular risk. An association between systolic, diastolic, and mean pressure may provide assessing risk of cardiovascular abnormalities.[37] Another study has suggested that measuring MAP may be more accurate in cardiovascular risk assessment compared to other blood pressure indices.[38] There increased level of MAP was observed in workers working in high noise area compared to those working in low noise area. Gadhave et al. also reported the similar findings matched with this study that the significant effect of noise on systolic, diastolic, MAP, and PP may lead to various cardiovascular abnormalities, e.g., hypertension and myocardial infarction.[39] Moreover, PP, an arithmetic difference between SBP and DBP, has also been considered to be an independent factor for assessing coronary risk.[40] The stiffness of large arteries and aorta are reflected by PP.[41] In addition, SBP and DBP along with heart rate seems to be positively associated with noise exposure.[42] In this study, elevated level of PP and heart rate was observed in high noise area group compared to low area group, and this level was highest in workers working in weaving section. Singhal S et al. also matched our study by observing similar findings in terms of elevated level of SBP, DBP, MAP, PP, and heart rate in high noise area group.[43]

CONCLUSION

The outcome of this study specifies that increasing intensity of noise increases the blood pressure of workers of the textile mill. This continuous exposure of high intensity of noise may be harmful in a long manner. It may give rise to various cardiovascular diseases, e.g., hypertension, heart attack, and myocardial infarction. Consistent increase in MAP and PP may predict coronary risk along with systolic and diastolic pressure. Hence, this study recommends that blood pressure should be routinely checked up along with other parameters to avoid the risk of developing cardiac abnormalities in textile mill workers. More studies should be conducted with large sample size to confirm this fact in textile workers.

REFERENCES

1. Baloye DO, Palamuleni LG. A comparative land use-based analysis of noise pollution levels in selected urban centers of Nigeria. Int J Environ Res Public Health. 2015;12(10):12225-46.
2. Jamir L, Nongkynrih B, Gupta SK. Community noise pollution in urban India: Need for public health action. Indian J Community Med. 2014;39(1):8-12.
3. Akhtar NH. Noise-induced hearing loss in traffic police constables. J Coll Physicians Surg Pak. 1996;6(5):265-8.
4. Mead MN. Noise pollution: The sound behind heart effects. Environ Health Perspect. 2007;115(11):A536-7.
5. Savale PA. Effect of noise pollution on human being: Its

prevention and control. J Environ Res Dev. 2014;8(4):1026-36.
6. Stansfeld SA, Matheson MP. Noise pollution: Non-auditory effects on health. Br Med Bull. 2003;68(1):243-57.
7. Stansfeld S, Haines M, Brown B. Noise and health in the urban environment. Rev Environ Health. 2000;15(1-2):43-82.
8. Mayet J, Hughes A. Cardiac and vascular pathophysiology in hypertension. Heart. 2003;89(9):1104-9.
9. de Souza TC, Périssé AR, Moura M. Noise exposure and hypertension: Investigation of a silent relationship. BMC Public Health. 2015;15:328.
10. Stokholm ZA, Bonde JP, Christensen KL, Hansen AM, Kolstad HA. Occupational noise exposure and the risk of hypertension. Epidemiology. 2013;24(1):135-42.
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. Dadoniene J, Zagminas K, Berzanskyte A. Introduction to Research Methodology. Vilniaus: Universiteto Leidykla Vilnius; 2013. p. 38.
13. Martinez-Abrain A. Is the 'n = 30 rule of thumb' of echological field studies reliable? A call for the greater attention to the variability in our data. Anim Biodiveres Conserv. 2014;37(1):95-100.
14. Noise Background Report. Available from: https://www.sanjoseca.gov/DocumentCenter/Home/View/511. [Last accessed on 2016 Dec 10].
15. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. Int J Obes. 1985;9(2):147-53.
16. Jain AK. Manual of Practical Physiology. 2nd ed. New Delhi: Arya Publication; 2003. p. 148-53.
17. Sahu D, Bhaskaran M. Palpatory method of measuring diastolic blood pressure. J Anaesthesiol Clin Pharmacol. 2010;26(4):528-30.
18. Palatini P. Recommendations on how to measure resting heart rate. Medicographia. 2009;31:414-9.
19. National High Blood Pressure Education Program. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Bethesda, MD: National Heart, Lung, and Blood Institute, (US); 2004, Auguest. Classification of Blood Pressure. Available from: https://www.ncbi.nlm.nih.gov/books/NBK9633. [Last accessed on 2016 Dec 10].
20. Basile JN. Systolic blood pressure: It is time to focus on systolic hypertension—especially in older people. BMJ. 2002;325(7370):917-8.
21. Midha T, Lalchandani A, Nath B, Kumari R, Pandey U. Prevalence of isolated diastolic hypertension and associated risk factors among adults in Kanpur, India. Indian Heart J. 2012;64(4):374-9.
22. Van Kempen EE, Kruize H, Boshuizen HC, Ameling CB, Staatsen BA, de Hollander AE. The association between noise exposure and blood pressure and ischemic heart disease: A meta-analysis. Environ Health Perspect. 2002;110(3):307-17.
23. Powazka E, Pawlas K, Zahorska Markiewicz B, Zejda JE. A cross sectional study of occupational noise exposure and blood pressure in steelworkers. Noise Health. 2002;5:1522.
24. Wang S, Qin Q, Liu L, Han L, Chen Y. A cross-sectional study on the effects of occupational noise exposure on hypertension or cardiovascular among workers from automobile manufacturing company of Chongqing, China. J Biomed Sci Eng. 2013;6:1137-42.
25. Hwang BF, Chang TY, Cheng KY, Liu CS. Gene-environment interaction between angiotensinogen and chronic exposure to occupational noise contribute to hypertension. Occup Environ Med. 2012;69:236-42.
26. Koskinen HL, Kauppinen T, Tenkanen L. Dual role of physical workload and occupational noise in the association of the metabolic syndrome with risk of coronary heart disease: Findings from the Helsinki Heart Study. Occup Environ Med. 2011;68:666-73.
27. Chang TY, Liu CS, Young LH, Wang VS, Jian SE, Bao BY. Noise frequency components and the prevalence of hypertension in workers. Sci Total Environ. 2012;416:89-96.
28. Sbihi H, Davies HW, Demers PA. Hypertension in noise-exposed sawmill workers: A cohort study. Occup Environ Med. 2008;65:643-6.
29. Fezil M, Narmadha MP, Benson B. Influence of occupational noise on insulin, blood glucose, homocysteine, blood pressure and heart rate. Int J Pharm Clin Sci. 2013;3(2):14-9.
30. Attarchi M, Dehghan F, Safakhah F, Nojomi M, Mohammadi S. Effect of exposure to occupational noise and shift working on blood pressure in rubber manufacturing company workers. Ind Health. 2012;50:205-13.
31. Kalantary S, Dehghani A, Yekaninejad MS, Omidi L, Rahimzadeh M. The effects of occupational noise on blood pressure and heart rate of workers in an automotive parts industry. ARYA Atheroscler. 2015;11(4):215-9.
32. Ni CH, Chen ZY, Zhou Y, Zhou JW, Pan JJ, Liu N, et al. Associations of blood pressure and arterial compliance with occupational noise exposure in female workers of textile mill. Chin Med J (Engl). 2007;120(15):1309-13.
33. Ismaila SO, Odusote A. Noise exposure as a factor in the increase of blood pressure of workers in a sack manufacturing industry. BJBAS. 2014;3:116-21.
34. Onat A, Ceyhan K, Erer B, Basar O, Uysal O, Sansoy V. Systolic, diastolic, and pulse pressures as coronary risk factors in a population with low cholesterol levels: A prospective 10-year evaluation. Clin Cardiol. 2003;26(2):91-7.
35. Lee JH, Kang W, Yaang SR, Choy N, Lee CR. Cohort study for the effect of chronic noise exposure on blood pressure among male workers in Busan, Korea. Am J Ind Med. 2009;52(6):509-17.
36. Lesnik H, Makowiec-Dabrowska T. Hemodynamic reactions to monotonous work performed in silence and in noise of 70 dB (A). Pol J Occup Med. 1989;2(1):51-61.
37. Chemla D, Antony I, Zamani K, Nitenberg A. Mean aortic pressure is the geometric mean of systolic and diastolic aortic pressure in resting humans. J Appl Physiol. 2005;99:2278-84.
38. Avanzini F, Alli C, Boccanelli A, Chieffo C, Franzosi MG, Geraci E, et al. High pulse pressure and low mean arterial pressure: Two predictors of death after a myocardial infarction. J Hypertens. 2006;24:2377-85.
39. Gadhave PK, Gadhave KC, Dighe UC. Cardiovascular parameters as an appraisal to the stress caused due to clamorous work-place environments in metal machining units. Proceedings of the World Congress on Engineering. Vol. 1. 2014. p. 615-7.
40. Malone AF, Reddan DN. Pulse pressure. Why is it important? Perit Dial Int. 2010;30:265-8.
41. Strandberg TE, Pitkala K. What is the most important component of blood pressure: Systolic, diastolic or pulse

pressure? Curr Opin Nephrol Hypertens. 2003;12(3):2937.
42. Lusk SL, Gillespie B, Hagerty BM, Ziemba RA. Acute effects of noise on blood pressure and heart rate. Arch Environ Health. 2004;59(8):392-9.
43. Singhal S, Yadav B, Hashmi SF, Muzammil M. Effects of workplace noise on blood pressure and heart rate. Biomed Res. 2009;20(2):122-6.

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