NOISE INDUCED HYPERTENSION AND PREHYPERTENSION IN PAKISTAN

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Abstract

The present study investigates the relationship of different sound levels with hypertension and prehypertension in Pakistani population. A cross sectional study was conducted to determine the prevalence of hypertension and prehypertension due to exposure of sound level ≤80 dBA (A weighted sound pressure level), 81-94 dBA and ≥95 dBA in November 11, 2005 to January 30, 2007. Sites were selected with stable sound ranges according to the above mentioned criteria. After selecting sampling sites, workers living in that area for at least 8 hours per day were categorized on the basis of blood pressure in groups called as normotensive, prehypertensive and hypertensive. Persons with diabetes, chronic bacterial or viral infections, alcohol addiction, kidney problems were excluded from the study. For getting homogenous groups, age range of 30-50 years was selected. Out of 566 samples, 90 excluded samples were consisted of 8% diabetic patients, 5% hepatitis C patients, 3% hepatitis B patients and 0% AIDS patients. Out of 476 participants, 389 samples were found with age 40±10 years. High noise increased the risks of hypertension (Odds ratio: 4.41; Confidence interval: 2.123-9,196) and prehypertension (Odds ratio: 3,809; Confidence Interval: 1,804-8,042) as compared to the normal sound level. However increased chances of hypertension (Odds ratio: 2,271; Confidence interval: 1,043-4,946) and prehypertension (Odds ratio: 3,028; Confidence Interval: 1,440-6,367) were observed on median noise exposure also. These findings suggest that sound level more than 81 dBA increases the chances for development of hypertension and prehypertension in Pakistani population.

KEY WORDS: noise, hypertension, prehypertension, Pakistan

Introduction

Previous decades have shown culmination of fields for industry and transportation making the human life prospered (1). Critical analysis reveals that progress achieved is on the cost of natural environment (1). Several types of pollution have also emerged out with this revolution. Among these types, noise pollution is the least discussed type (2). It prevailed in short time and now it seems impossible to escape its niche (3). It has no boundary and is also common in the developing countries like Pakistan (3).

Among cardiovascular diseases, hypertension has been the most discussed topic for its role as the risk factor of coronary heart disease and stroke (4, 5). During 1990 to 1994, the National Health Survey of Pakistan presented the horrifying image about prevalence of hypertension in Pakistan. Hypertension was found to affect 18% of adults >15 years and 33% of adults >45 years; however, <3% had their blood pressure (BP) controlled to 140/90 mm Hg or below (5). More than 70% of all hypertensive patients (85% in rural areas) in Pakistan were unaware of their disease despite the fact that average number of annual visits to the healthcare provider was 5,8 for women and 4,9 for men (6). Several epidemiological evidences indicate the role of noise in induction of hypertension (7, 8, 9). Due to lack of precedent research work about noise related prehypertension and hypertension in Pakistan, it is difficult to comment about the situation in epidemiological evidence against menacing impact of noise in the form of prehypertension and hypertension in Pakistani population. The present study deals with the investigation of drastic effects of noise pollution in the form of hypertension and prehypertension.

Material and Methods

Selection of sites

Audible continuous sounds associated with occupations were considered for the estimation of noise effects on blood pressure. Reason for selection of the occupational noise was its exposure to the workers for a specific period of time. After getting proper consent from concerned authorities, different working sites from Jhang Sadar and Lahore (cities in Pakistan) were visited thrice during November 11, 2005 to January 30, 2007 and three readings of A weighted sound intensity were recorded with the interval of five minutes on each visit by using TES-1351 digital sound level meter (TES Inc. Taiwan). Purpose was to find the sites with sound level range equal or below than 80 dBA, sites with in range of 81 – 94 dBA and sites with sound level equal or more than 95 dBA. Sites with sound level ranges deviating from the required criteria were not selected for the study. For surety of uniform sound level of the sampling site in whole working day, information was collected through questionnaire in face to face interview of each participant of the study.

Population studied

All procedures were in compliance with the declaration of Helsinki and the study protocol was approved by the Board of Advance studies and Research and ethical committee, University of the Punjab Lahore. The subjects were divided in three categories depending on the exposure of noise intensity at their work site; Normal sound level: workers exposed to the sound intensity ≤ 80 dBA ; Median noise: workers exposed to the sound intensity range 81- 94 dBA; High noise: workers exposed to the sound intensity ≥ 95 dBA. For avoiding samples with potential noise exposure at home, questionnaire was used during face to face interview of each participant of the study. Each category was further divided in normtensive, pre-hypertensive and hypertensive groups on the basis of blood pressure of the participants.

Sample collection

Sample collection was completed from November 11, 2005 to January 30, 2007 from different sites suitable for the study. After taking proper consent and completion of ethical criteria, male individuals (with a minimum length of exposure of eight hours per day for 5 years to the specific noise level) were selected for the study (10, 11).

Blood pressure measurement

Three visits were made for estimation of blood pressure at 8-11 am. On each visit, three BP readings were taken in accordance with recommendations of the American Heart Association (12). All BP assessments were performed with the participant in a sitting position. These readings were used to define group of individuals on the basis of blood pressure. Hypertension was defined according to the World Health Organization: a systolic BP ≥ 140 or a diastolic BP ≥ 90 (13). Prehypertension was defined as the systolic blood pressure between the range of 121 – 139 mmHg or diastolic blood pressure between the range of 81-89 mmHg (14). Normotensive individuals were defined to have systolic blood pressure ranges below 121 and diastolic blood pressure below 81mm Hg. Individuals using antihypertensive medication with history of hypertension were considered as hypertensive. This piece of information was obtained through face to face interview during sample collection.

Body mass index calculation

Body weight (BW) in kilogram (Kg) and height in meters (m) were recorded for all participants during first visit for sample collection. Height was measured, to the nearest 0.5 cm, without shoes, eyes looking straight ahead with a right - angle triangle resting on the scalp and against the wall. Weight was measured to the nearest 100 grams, without shoes (15). Body mass index (BMI) was calculated using the following equation; BMI= Body weight (Kg)/ Height $(m)^2$

Exclusion Criteria

Only males with the exposure of at least five continuous years to a specific noise level for eight hours per day were selected for the study. Any person infected with hepatitis B, C, HIV and chronic bacterial infections were excluded from the study. Conventional serological techniques were used for the detection of above mentioned viral infections. Hyperglycemic persons were also excluded from the study. Hyperglycemia was defined according to the WHO criteria (16). Persons with kidney problems and chronic bacterial infections were also excluded from the study. Information about kidney problems and chronic bacterial infections was collected via interview during first visit to the sites. Persons drinking alcohol were also excluded from the study. For exclusion of persons with viral infections, following diagnostic tests were performed:

Detection of viral infections

All blood samples were taken at 8-11 am. Blood samples were drawn by venipuncture of the cubital vein from each individual. 2 ml of blood was collected in plain tube for the separation of serum. Serum was separated by centrifugation. It was used for screening purpose. Qualitative tests were adopted for the detection of hepatitis B surface antigen, HCV and HIV by using one step device following the instructions of manufacturers (Acu- ®check).

Detection of blood sugar

Random sugar level of each individual was estimated using digital glucometer (Accu-Chek). Skin puncture was made by using sterile lancets after cleaning the finger with spirit swab. Blood drop was taken on the strip inserted in glucometer and the result was obtained from the screen of glucometer. A person was considered as diabetic, if random sugar level exceeded the value of 180 mg/ dL (16). Blood sugar of each participant of the study was measured during sample collection.

Statistical analysis

SPSS 13 for windows was used for statistical anlysis. Significant differences for all categories were estimated by using unpaired T test and Chi square test. Blood pressure was considered as grouping variable for the above mentioned tests. Odds ratio were calculated for the prediction of hypertension and prehypertension due to noise exposure. Normal sound level group was taken as reference. Data was adjusted for the age, weight, body mass index, smoking status and family history of hypertension before the estimation of odds ratio.

Results

Cross sectional study was conducted for the evaluation of noise effects on hypertension and prehypertension. Sites in Jhang and Lahore were selected during Novem-

Blood pressure group	Variables	Normal sound level group (n= 154)	Median noise group (n=112)	High noise group (n=123)
Normotensive	Number (%)	123 (79,9)	69 (61,6)	64 (52)
	Age (Years)	32,70±02,36	38,55±06,08*	34,70±05,25*
	Weight (Kg)	60,93±11,26	74,36±12,54*	58,45±10,34
	Height (m)	01,63±00,08	01,66±00,08*	01,61±00,07
	Body mass index	22,88±03,94	27,14±04,47*	22,55±03,76
	Current smoker (frequency): Yes/No	29/94	44/25†	28/36†
	Family history (Frequency): Yes/No	50/73	23/46†	32/32
Prehypertensive persons	Number (%)	16 (10,4)	25 (22,3)	29 (23,6)
	Age (Years)	33,31±03,32	40,36±06,30*	35,93±06,23
	Weight (Kg)	65,94±15,25	73,24±14,32	59,28±08,70
	Height (m)	01,65±00,07	01,64±00,09	01,59±00,07*
	Body mass index	24,21±04,53	27,29±04,58*	23,54±03,82
	Current smoker (frequency): Yes/No	5/11	10/15	12/17
	Family history (Frequency): Yes/No	14/2	9/16†	22/7†
Hypertensive persons	Number (%)	15 (9,7)	18 (16,1)	30 (24,4)
	Age (Years)	39,00±04,34	42,94±05,13*	37,53±06,27
	Weight (Kg)	75,80±13,91	77,83±12,19	64,80±11,46*
	Height (m)	01,65±00,04	01,62±00,06	01,60±00,08*
	Body mass index	27,76±04,45	29,50±03,88	25,42±04,38*
	Current smoker (frequency): Yes/No	4/11	5/13	16/14
	Family history (Frequency): Yes/No	12/3	6/11	16/14

All the data are shown as mean ± standard deviation. Comparison was made between groups exposed to different noise levels. * indicates the significant difference when compared with normal sound level group using unpaired T test. † indicates significant difference when compared with normal sound level group using chi square test.

TABLE 1. Base line characteristics of selected samples

Sound exposure	NT (n=222)	PH (n=62)	HT (n=60)	OR (95% CI) HT Vs NT	Association test p (χ^2) HT Vs NT	OR (95% CI) PH Vs NT	Association test p (χ^2) PH Vs NT	OR (95% CI) HT Vs PH	Association test p (χ^2) HT Vs PH
Normal sound level	105	13	13	Reference	0,000* (17,156)	Reference	0,571 (1,121)	Reference	0,001* (14,388)
Median noise	64	24	18	2,271 (1,043-4,946)		3,028 (1,440-6,367)		0,75 (0,280-2,002)	
High noise	53	25	29	4,41 (2,123-9,196)		3,809 (1,804-8,042)		1,16 (0,454-2,959)	

Abbreviations: NT=Normotensive; PH=Prehypertensive; HT=Hypertensive; N= number; OR=Odds ratio; CI=Confidence interval, * indicates significant difference,

TABLE 2. Results for odds ratio calculation and chi square test for assessment of noise effects on hypertension and prehypertension after adjusting data for age, weight, body mass index, smoking and family history of hypertension.

ber 11, 2005 to January 30, 2007. Sites with sound intensity ≤ 80 dBA were belonging to schools of Jhang and university of the Punjab Lahore Pakistan. Sound sources of these sites were the fans, labs, lecture halls and busy corridors with students and teacher sounds. Teachers and students were selected for the study. Sites with sound intensity range of 81-94 dBA were buses of transportation wing of University of the Punjab Lahore Pakistan. Sound sources of these sites were the traffic around the buses, the engine of buses and the passengers. Drivers and conductors were the participants of the study. High noise sites (sound intensity ≥ 95 dBA) were power loom factories situated in industrial area of Jhang. Sound sources of these sites were the power looms and workers. Persons with diabetes and viral infections like that of hepatitis B (HBV), hepatitis C (HCV) and human immunodeficiency virus (HIV) were excluded. Diagnostic kits were used to screen the samples. Out of 566, only 476 samples (84%) were free of viral infections under consideration. 90 samples (16%) were excluded due to presence of any positive results for HCV, HBsAg, HIV or diabetes. When same data was distributed among different noise categories, prevalence of HBsAg recorded was 3% in participants from sites with sound levels ≤ 80 dBA and ≥ 95 dBA each and 2% in participants from sites with sound level 81-94 dBA. For HCV, prevalence rate was 5% in sites with sound level ≤80 dBA and 81-94 dBA each and 6% in sites with sound intensity ≥95 dBA. Diabetic patients were 8% in all noise categories each. No person with positive result of anti HIV was found in any category. When data were rearranged for getting groups with age range 30-50 years, only 389 samples were found suitable for the analysis. 154 samples were collected from sites with sound level ≤ 80 dBA. 112 samples were taken from sites with sound level 81 – 94 dBA and 123 samples were taken from sites with sound levels ≥ 95 dBA. Base line characteristics of these samples are shown in Table 1. The distribution of samples on the basis of blood pressure in different types of noise categories indicates that out of 154 participants exposed to sound level ≤ 80 dBA, 79,9 % were normotensive, 10,4 % were prehypertensive and 9,7 % were hypertensive. In sites with 81-94 dBA, results were different. Out of 112 individuals, 61,6 % were normotensive, 22,3 % were prehypertensive and 16,1% were hypertensive. This difference exceeded in case of high noise areas with sound level ≥ 95 dBA. Out of 123 individuals, 52% were normotensive, 23,6 % were prehypertensive and 24,4 % were hypertensive. Results for odds ratio estimation and association test of prehypertension and hypertension with different sound levels were obtained after the adjustment of data for age, weight, body mass index, smoking and family history of hypertension. These are shown in Table 2. Significant association was observed between sound level exposure and hypertension and prehypertension. For hypertension, risks were 2,3 times high in case of 81-94 dBA exposure and 4,4 times high in case of exposure of sound with intensity ≥ 95 dBA as compared to ≤ 80 dBA sound exposure. Chances of prehypertension also increased with the increase in intensity of sound. The chances were 3,0 times high in 81-94 dBA category and 3,8 times high in case of ≥95 dBA category as compared to ≤ 80 dBA sound exposure.

Discussion

The present research work deals with the investigation of effects of different sound levels on human health in the form of hypertension and prehypertension in population of Pakistan. Exclusion criteria were designed on the basis of previous reports which have shown that viral infections of HCV, HBsAg and HIV infections can raise the blood pressure (17-19). Diabetes is also the major factor causing induction of hypertension (20). If samples are not categorized on the basis of affecting factors for hypertension, potential stratification may result in contradictory findings. Such stratifications are not suitable for genetic association studies of complex traits (21). In the present study, prevalence of HBV, HCV and HIV was estimated in persons belonging to different professions concerning with specific range of sound levels. Results indicated that percentage of HBV and HCV was same in all types of samples. Prevalence of viral diseases was not associated with sites differentiated on the basis of sound level. In Pakistan, seroprevalence of HCV was reported 5,31% in 47,000 individuals of Islamabad (22). In northern areas of Pakistan, 4% of healthy participants were positive for anti-HCV antibodies (23). Situation is more critical in the rural and under developed areas where factors responsible for the spread of blood borne infections are common (24). Present findings suggest presence of 5% positive population of anti HCV in group exposed to sound ≤ 80 dBA and 81-94 dBA and 6% for subjects exposed to sound ≥ 95 dBA. One percent more prevalence rate in ≥ 95 dBA group might be due to the fact that samples were illiterate or less educated. While in case of ≤ 80 dBA group, participants were educated. Samples from group exposed to 81-94 dBA were though less educated but their occupational dealing was with the educated persons belonging to university of the Punjab. This interaction might have given them awareness about viral diseases and the cure for avoiding these problems. For HBV, 3% participants were positive for anti HBsAg belonging to ≤ 80 dBA and ≥ 95 dBA group. In case of 81-94 dBA exposure, only 2% were positive for HBsAg. Akhtar and coworkers reported 2,46% positive persons for HBsAg while screening 203 samples belonging to the students and employees of university of the Punjab Lahore Pakistan (25). Comparatively different findings of their studies might be due to the different timing of sample collection. As students return to their home after completing their educational session, exact epidemiological information for viral diseases is difficult. The situation concerning HIV is also comparable. Unawareness, low literacy rate, and practice of homosexuality are the major factors responsible for the increased prevalence of HIV. All of these factors are found common in northern part of Pakistan (24). Moreover, the major bulk of HIV cases in Pakistan is comprised of deported migrant workers from the Gulf States, a significant proportion of whom are residents of Northern Pakistan (25). A complete absence of HIV cases in our studied population was, therefore, astonishing. The reason of no detection of HIV positive case in this survey may be the limited number of population. For getting clear picture about prevalence rate of HIV, study based on large number of samples is needed (24). In past, several studies were conducted for the elucidation of noise effects on hypertension. Sources of noise pollution belonged to either community or occupation (11, 26). Noise more than 85 dB is responsible for increased risk of hypertension (11). The present study involved the occupational noise. It showed strong association between noise and hypertension. Risk of prehypertension and hypertension increased with the increase in intensity of sound. Exposure of sound level more than 95dBA resulted in more risk of prehypertension and hypertension as compared to the exposure of 81dBA- 94dBA. Jarup et al has also stated the increased risk of hypertension in persons exposed to aircraft noise (10). Same trend was observed for the road traffic noise also (26). Though it has become established fact that noise causes hypertension but exact pathway is still unknown. For the investigation of mechanism of noise induced hypertension, detailed study is needed at cellular and molecular level. The present study lacks the information about dietary salt intake, physical activity of subjects, and exposure to organic solvents therefore its findings are limited. However, present results are sufficient to claim that sound level more than 81 dBA can increase the risk of hypertension and prehypertension in Pakistani population.

Conclusion

It can be concluded from the present study that noise pollution elevates the blood pressure in the Pakistanis. Chances of hypertension and prehypertension are associated with the intensity of the sound exposed to the persons. Risks of prehypertension and hypertension are increased on the exposure of sound level more than 81 dBA and are further enhanced with the elevation in intensity of the sound. Multifactorial traits like hypertension and prehypertension are difficult to study due to the involvement of several confounders. This study is also restricted due to the same factors. Nevertheless the present findings are reliable enough to describe the drastic effects of noise on blood pressure irrespective of these limitations.

Authors' contributions

This research paper is part of PhD research work of Syed Kashif Nawaz. It was completed under the supervision of Professor Dr. Shahida Hasnain. Present rules of university of the Punjab Lahore allow the students to publish their part of Ph.D thesis without any permission from university administration.

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Competing Interests

None declared.

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