Hearing loss among hypertensive patients

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Background
Hypertension is a leading cause of mortality and morbidity worldwide. Hypertensives have been observed to have elevated hearing thresholds in various studies.
Aims and objectives
The aims of this study were to assess the hearing thresholds of hypertensives in a tertiary hospital in Nigeria and compare it with nonhypertensive controls.
Patients and methods
This was a cross-sectional study conducted among hypertensives and age-matched and sex-matched controls from August 2015 to April 2016. A pretested questionnaire was used to obtain information on demographic and medical history. General physical examination and blood pressure measurements were done. Hearing thresholds were then measured with a diagnostic pure tone audiometer.
Data analysis
The pure tone average was calculated. Data analysis was done using the Statistical Package for Social Sciences, version 23.
Results
A total number of 104 participants were enrolled into the study. Fifty-two were hypertensives while the other 52 were nonhypertensive controls. The mean age of the participants was 49.1±10.3 years, with ages ranging from 34 to 85 years. There were 38 (36.5%) women and 66 (63.5%) men. Among the hypertensive participants, 20 (38.5%) had various degrees of hearing loss, whereas seven (13.5%) of the non-hypertensives had hearing loss (P=0.004, χ^2=8.45). The mean pure tone average (air conduction) among the hypertensive participants was 27.8±13.3 dB HL and 16.7±7.9 dB HL among the nonhypertensive control group. Among the hypertensives, 17 (32.7%) had mild hearing loss, while all seven (13.5%) patients in the nonhypertensive group had mild hearing loss.
Conclusion
This study has observed a 38.5% prevalence of hearing loss among hypertensives. It has shown an association between hypertension and hearing thresholds. All frequencies tested were observed to have elevated hearing thresholds among hypertensives as compared with the nonhypertensive control group.

Keywords:
hearing loss, hypertension, pure tone audiometry

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Introduction

Hypertension is a leading cause of morbidity and mortality worldwide [1,2]. A worldwide prevalence of 40% among adults aged 25 years and above was reported by the WHO in 2008 [3]. Two-thirds of the burden of hypertension is in the middle-income and low-income countries [1], with Africa having the highest prevalence of 46% [4]. Hypertension affects various systems in the body. It has been observed to contribute to the global burden of heart, kidney, and cerebrovascular disease [1]. Complications of hypertension account for 9.4 million deaths worldwide every year [1,5]. In Nigeria the prevalence of hypertension ranged from 9.3 to 50% in various studies conducted across the six geopolitical zones of the country [4].

Hearing loss is a hidden disability affecting about 360 million people worldwide based on WHO estimates [6,7]. The greatest burden of disabling hearing loss is also in low-income and middle-income countries, the worst hit regions being sub-Saharan Africa and Asia [7]. It is estimated that 50% of cases of hearing loss are preventable through prevention of exposure to risk factors, and prompt treatment of disease conditions that affect the hearing threshold of individuals [8]. Hearing loss may cause isolation, depression,

irritability, low self-esteem, and an overall reduction in the quality of life of individuals who are affected [9].

The association between hearing loss and hypertension is still being debated. Some authors have observed greater hearing deficits among hypertensives [10–14], while others have not observed any association between hearing loss and hypertension [15,16]. Hearing loss and noise exposure has been observed to cause hypertension in another study [17]. Several mechanisms leading to hearing loss among hypertensives have been hypothesized. Hypertension causes increased blood viscosity, leading to reduced blood flow through capillaries, and tissue hypoxia [18,19]. Another mechanism postulated is ionic changes in the cochlea leading to hearing loss [20]. Inhibition of the potassium pump in the stria vascularis, stops potassium influx to hair cells stopping depolarization [18]. The cochlear which is supplied by end arteries is adversely affected by any pathology that compromises the caliber of its blood vessels. This affects the supply of oxygen and nutrients. Hypertension, which predisposes to atherosclerosis, compromises the caliber of blood vessels [18,21]. Other authors have suggested that high systemic blood pressure causes hemorrhage within the cochlear, thereby compromising hearing [18]. Nigeria being the most populous black nation contributes significantly to the overall burden of hypertension and its complications in Africa. We have not identified any published work on hypertension and hearing loss in Nigeria. This study attempts to assess the hearing thresholds of hypertensives in a tertiary hospital in Nigeria and compare it with nonhypertensive controls.

Patients and methods

Study design

This was a cross-sectional study conducted among hypertensives and an equal number of age-matched and sex-matched nonhypertensive controls attending the medical clinics of a tertiary health center, between August 2015 and April 2016. Institutional ethical approval was obtained and informed consent was taken from the participants before they were recruited into the study.

The inclusion criterion for the study group was physician-diagnosed hypertensives attending the medical clinics of the hospital for at least a year. Inclusion criterion for the control group was non-hypertensive adults (as evidenced by a normal blood pressure of <140/90 mmHg) attending the medical clinics of the hospital. Exclusion criteria included participants with a history of ear surgery performed in the past, history of exposure to loud sounds, history of cigarette smoking, history of use of ototoxic drugs, history of ear disease, patients being treated for any medical condition that may cause hearing loss, and an air-bone gap of equal to or greater than 10 dB. The participants were randomly selected to participate in the study.

Blood pressure measurement and medical history

A pretested interviewer-administered questionnaire was used to obtain information about the participants' biodata and medical history. Participants had general physical examination (including weight, height measurements). Blood pressure was measured on two occasions in the sitting position using a standard mercury sphygmomanometer (Accoson, Accoson North Ayrshire, UK) with an adult cuff size. The patient was seated on a chair with the back rested (not leaning forward), arm on the table, and both feet on the ground. Korotkoff sounds phases I and V were considered as the systolic and diastolic blood pressures, respectively, and recorded in mmHg. This was done after a 5-min rest using the right and left upper limbs. Two additional recordings were made using the limb with the higher value. The average was then calculated to give a representative value of the patient's blood pressure.

Pure tone audiometry

Both ears of the participants were examined (any obstructing wax observed during otoscopy was removed, after softening). Hearing thresholds were then measured in both ears using the Modified Hughson–Westlake method [22] at 250, 500, 1000, 2000, 4000, 6000, and 8000 Hz for air conduction and 500, 1000, 2000, and 4000 Hz for bone conduction using a Diagnostic Audiometer (Oscilla SM 960-D, Diagnostic Memory Audiometer, Otometrics, Taastrup, Denmark) in a sound isolated room, which satisfied the criteria of ISO 8253-1. Average of audiometric hearing thresholds at 500, 1000, 2000, and 4000 Hz for both air and bone conduction was determined, which was taken to be the pure tone average for both air and bone conduction. This was categorized in accordance to the WHO grades of hearing impairment as follows: normal hearing (<25 dB), mild hearing loss (26–40 dB), moderate hearing loss (41–60 dB), severe hearing loss (61–80 dB), and profound hearing loss (≥81 dB) [23]. The hearing thresholds for the better ear was used for further analysis in both patient and control groups.

Data analysis

Data analysis was done using the Statistical Package for the Social Sciences, version 23 (IBM – SPSS Inc., Chicago, Illinois, USA). The χ^2-test was used to determine the relationship between categorical variables and *t*-test was used to determine the relationship between quantitative variables. Linear regression was done to test for the association between variables. Data were presented using tables and charts. The level of significance was set at a *P* value of less than 0.05.

Results

A total number of 104 participants were enrolled into the study. Fifty-two were hypertensives while the other 52 were nonhypertensive controls. The mean age of the participants was 49.1±10.3 years, with ages ranging from 34 to 85 years. There were 38 (36.5%) women and 66 (63.5%) men. There was no statistically significant difference in age and sex of the two groups (Tables 1 and 2).

Among the hypertensive participants, 20 (38.5%) had various degrees of hearing loss, whereas seven (13.5%) of the non-hypertensives had hearing loss (P=0.004, χ^2=8.45). The mean pure tone average (air conduction) in the better ear among the hypertensive participants was 27.8±13.3 dB HL, and 16.7±7.9 dB HL among the nonhypertensive control group (Table 3). All hypertensive patients enrolled in this study were on antihypertensive medication.

Among the hypertensives, 17 (32.7%) had mild hearing loss, whereas all seven (13.5%) patients in the nonhypertensive group had mild hearing loss (Table 4). Hearing thresholds increased across the frequencies tested (Fig. 1).

Table 1 Demographics

	Hypertensives	Nonhypertensives	*P* value
Sex of participants			
Males	32	34	0.684
Females	20	18	
Age of participants (mean±SD) (years)	48.5±9.3	49.7±10.7	0.612

Table 2 Mean blood pressure values among participants

Blood pressure (mmHg)	Hypertensives (mean±SD)	Nonhypertensives (mean±SD)	Level of significance (*P*)
Systolic BP	142.7±10.3	112.3±11.4	0.000
Diastolic BP	82.7±12.4	79.6±10.3	0.003

BP, blood pressure.

Regression analysis (with mean hearing threshold as the dependent variable, and presence of hypertension as the independent variable) showed that the presence of hypertension was positively associated with hearing loss (P=0.000). The presence of hypertension in a patient increases the pure tone average by 10.0 dB HL from this data. The data also shows that 17.9% of the variability of hearing threshold is due to hypertension alone.

Systolic blood pressure was found to be associated with pure tone average in this study (P=0.000), and for every 1 mmHg rise in systolic blood pressure, a 0.29 dB increase in hearing threshold is expected. Regression analysis also shows that 13.7% of the variability of pure tone average is due to changes in systolic blood pressure (Table 5).

Discussion

This study observed a 38.5% prevalence of hearing loss among hypertensives. We observed an association between hearing threshold and hypertension, following regression analysis (P<0.05). Agarwal *et al.* [12] in a case–control study of hearing loss among hypertensives carried out among hypertensives and a control group observed a 36.7% prevalence of hearing loss among the participants with grade I hypertension. They observed a progressively higher prevalence, with increase in the grade of hypertension [12]. Their study also found a statistically significant association between hypertension and hearing loss [12]. Their observations agree with the findings in this study. A higher prevalence of hearing loss among hypertensives (61%) was however observed by Marchiori *et al.* [24]. They found hypertension to be an independent risk factor for hearing loss after multivariate analysis [24].

Table 3 Mean pure tone average (air conduction) among participants

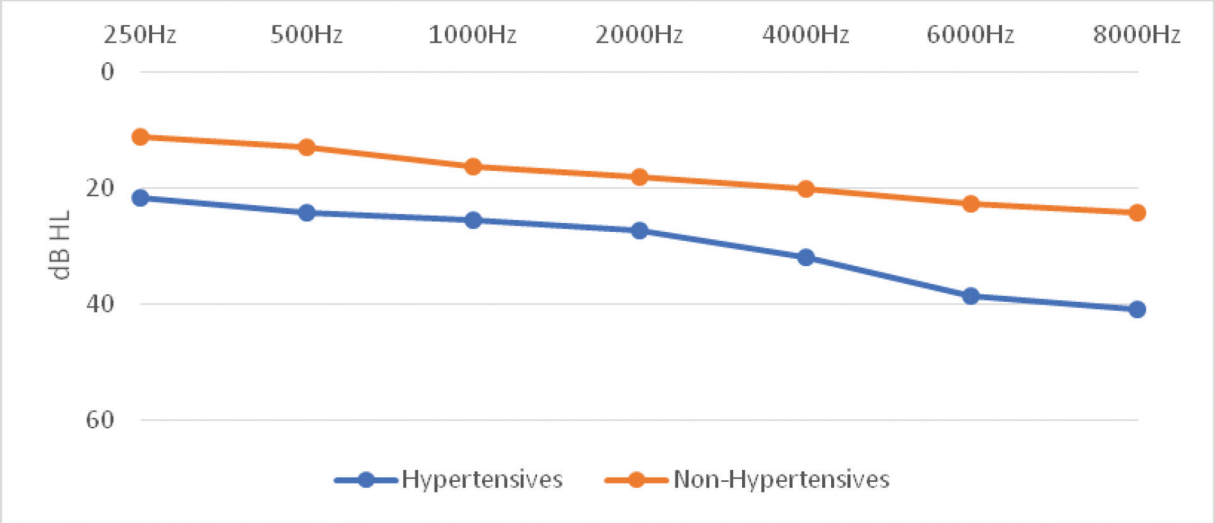
	Hypertensives (mean±SD)	Nonhypertensives (mean±SD)
Mean pure tone average (dB HL)	27.8±13.3	16.7±7.9
Level of significance (*P*)	0.000	

Table 4 Degree of hearing loss

Degree of hearing loss (WHO)	Hypertensives [*n* (%)]	Nonhypertensives [*n* (%)]
Normal	32 (61.5)	45 (86.5)
Mild	17 (32.7)	7 (13.5)
Moderate	3 (5.8)	NA

NA, not applicable.

Figure 1



Mean hearing thresholds across tested frequencies among participants.

Table 5 Simple linear regression analysis of systolic blood pressure and pure tone average

	Coefficient	*t*	*P* value
Constant	−19.00	1.957	0.053
Systolic blood pressure (mmHg)	0.29	4.018	0.000*

R^2=0.137. *Significant.

We found the mean hearing threshold among hypertensives to be 27.8±13.3 dB HL, with elevated mean hearing thresholds across all frequencies tested. Tan *et al.* [13], in a cross-sectional study in a University Medical Centre in Malaysia observed that mean hearing thresholds were higher in all frequencies tested on both sides among hypertensives compared with the control group. They found these differences to be significant at 2 kHz and above [13]. Their findings were similar to the findings in this study. The study by Tan and colleagues was among hypertensives with features of hypertensive retinopathy. They found a strong relationship between hypertension and hearing loss among those participants with hypertensive retinopathy [13]. Esparza *et al.* [25] in a study on hypertension and inner ear dysfunction among 42 participants also observed that participants with hypertension showed deterioration of hearing thresholds at high frequencies further corroborating the findings in this study. They also found that the degree of retinal vascular compromise correlated with the hearing threshold at 8 kHz [25]. Similar microangiopathic pathological processes is believed to affect both the retina and the cochlea, and as such patients referred for evaluation of their eyes ought to also be sent for auditory evaluation. Other studies among hypertensives have also observed elevated hearing thresholds at higher frequencies [26,27].

Mild hearing loss was the most common degree of hearing loss in this study. This agrees with the findings in a study conducted among 154 hypertensives and equal number of controls [24]. They found mild hearing loss to be the most common degree of hearing loss observed among hypertensives [24]. Agarwal *et al.* [12] also observed mild hearing loss to be the most commonly observed degree of hearing loss. Mondelli and Lopes [14] in a retrospective study on the relation between arterial hypertension and hearing loss observed among participants with hearing impairment and hypertension, a 13.34% prevalence of mild hearing loss, 56.66% prevalence of moderate hearing loss, and 16.67% prevalence of severe hearing loss. This is in disagreement with the findings in this study. Mild hearing loss is often overlooked or not detected by patients. They are only likely to self-report and thus leave records for a retrospective review when their hearing acuity starts to deteriorate beyond the mild degree.

The mean systolic blood pressure among hypertensives in this study was 142.7±10.3 mmHg. Systolic blood pressure was observed to be positively associated with hearing threshold in this study (*P*=0.000). Gates *et al.* [27] in a study on the relation of hearing in the elderly to cardiovascular disease and risk factors found systolic blood pressure to be related to hearing loss among women. They did not observe any relationship between systolic blood pressure and hearing loss among men nor diastolic blood pressure and hearing loss among both

men and women [27].While this study investigates the effect of hypertension on hearing thresholds, other authors have reported a relationship between hypertension and hearing loss, but with hearing loss being a risk factor for hypertension [11,17,28]. Narlawar *et al*. [28] in a study among 770 workers in an iron and steel company in India observed that hearing loss and hypertension were common among workers exposed to noise, with hypertension being a likely cause of hearing loss. Chang *et al*. [17], in a cross-sectional study of 790 participants, studied the effect of hearing loss on hypertension, and observed a higher prevalence of hypertension among participants with hearing loss.

Other authors however have not observed any relationship between hypertension and hearing loss [15,16,29]. Baraldi *et al*. [16] studied hearing loss and hypertension among 70 elderly individuals in Sao Paulo and observed no difference in hearing thresholds of the study and control groups. They selected participants whose blood pressure has been controlled. This might have affected their results. In a prospective study of cardiovascular risk factors and hearing loss among 3488 men, hypertension was not significantly associated with the risk of hearing loss [29]. Torre *et al*. [15] in a study of cardiovascular disease and cochlear function in older participants did not observe any association between hypertension and cochlear impairment. Both studies were on multifactorial risk factors (hypertension, diabetes mellitus, BMI, dyslipidemia, and cigarette smoking). This may have not allowed the effect of hypertension to be independently assessed as it was done in this study. The limitation of our research is the fact that it is not a population-based study. However, this can serve as a pilot study for a bigger population-based study.

Conclusion

This study has observed a 38.5% prevalence of hearing loss among hypertensives. It has shown an association between hypertension and hearing loss. All frequencies tested were observed to have elevated hearing thresholds among hypertensives as compared with normal thresholds in the control group. Mild hearing loss was the most common degree of hearing loss observed. We recommend regular audiologic assessment for hypertensive patients.

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Conflicts of interest

There are no conflicts of interest.

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