



Sensorineural Hearing Loss among Hypertensive Patients Attending Cardiac Institute in Tanzania: A cross-sectional study

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Abstract

INTRODUCTION

Hypertension is among non-communicable diseases worldwide and it has been associated with sensorineural hearing loss. Almost 1.39 billion people (1 out of 4 adults) have hypertension and this figure is expected to increase. In Sub-Saharan Africa, hypertension is the leading cause of death and disability. Hypertension is associated with sensorineural hearing loss by compromising the blood supply in the cochlea.

MATERIALS AND METHODS

An assessment of the proportion and patterns of sensorineural hearing loss among hypertensive patients was conducted. 191 patients aged 18 years and above were recruited. History and physical examination including blood pressure, and otoscopy were done. Pure tone audiometry (PTA) was conducted.

RESULTS

Patients aged from 36 to 88 years with a mean age of 60 years and a standard deviation of 10. The patients aged between 61–76 years accounted for 85 (44.5%), whereas 29–44 and > 76 years accounted for 12 (6.3%) each. The female-to-male ratio was 1:1. Sensorineural hearing loss was detected in 144 (75.4%), commonly above 76 years of age which was 11 (91.7%). Mild sensorineural hearing loss was the most common degree revealed. There was no relationship between the degree of sensorineural hearing loss and the grades of hypertension (p-value of 0.113). No relationship between the duration of hypertension with the severity of hearing loss, p-value =0.369.

CONCLUSION

The prevalence of sensorineural hearing loss among hypertensive patients was 75.4%. The bilateral and mild degree was the commonest presentation. Increasing age was found to be associated with increased hearing loss. The duration and grade of hypertension were not related to the severity of hearing loss.

Keywords: Sensorineural, Hearing Loss, Hypertension, Cardiac Institute, Tanzania

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Introduction

Hypertension is among non-communicable diseases which are becoming an increasingly common health issue worldwide and studies associated it with sensorineural hearing loss. It has been estimated that 1.39 billion people (1 out of 4 adults) have hypertension and this figure is expected to increase due to lifestyle changes (1). In Sub-Saharan Africa, hypertension is the leading risk factor for premature death and disability,

approximately 74.7 million individuals have hypertension and it is expected to increase to 125.5 million individuals by 2025 (2).

In Tanzania, the nationally representative survey revealed the prevalence of hypertension was 26 % only 10% to 20% of patients with previously detected hypertension are, receiving treatment, and only 16% of those on treatment were adequately controlled (2,3). It has been seen that hypertension affects various systems in the body such as the heart,



kidney, and cerebral vascular disease, and an estimated 9.4 million deaths are related to the complications of hypertension (3,4).

World Health Organization (WHO), terms the patient to be hypertensive if the systolic blood pressure (SBP) is more than or equal to 140mmHg and diastolic blood pressure (DBP) of more or equal to 90mmHg, reading is taken at least in three different settings. WHO classifies hypertension into three grades as tabulated below (5) Table 1.

Most causes of hypertension are preventable and for those who have the disease, proper control can significantly reduce complications including hearing loss (6,7).

Hearing is a paramount sensation of human beings. It helps us to be aware of the surrounding environment and can alert any coming danger around us. Hearing serves as an essential means of communication, so any form of HL whether partial or complete can negatively impact the social interaction and general well-being of a person. Hearing loss (HL) in children significantly hampers their learning and developmental processes, notably affecting their acquisition of speech and language skills (8).

In 2019, the Global Burden of Disease (GBD) study, estimated that more than 1.57 billion people have some form of HL, and 35 million live with disability (9). The problem is higher in sub-Saharan Africa than in developed parts of the world. WHO estimates, suggest that the prevalence of hearing impairment (defined as Hearing loss >35 dB) for adults aged > 15 years old was 15.7% in Sub-Saharan Africa vs. 4.9% in high-income countries (10). Besides the lack of sufficient data on the prevalence of hearing impairment in Africa, still, the magnitude is still high compared to the developed world.

In Tanzania, most studies were conducted in children on the association between Sensorineural hearing loss and other risk factors, and few in adults (9). More studies are needed in adults to find the association between SNHL and associated risk factors.

WHO ranked SNHL as mild, moderate, moderately severe, severe, and profound as listed below:

- i. Mild for children: between 20 and 40 dB HL
- ii. Mild for adults: between 26 and 40 dB HL
- iii. Moderate: between 41 and 55dB HL
- iv. Moderate severe: between 56 and 70 dB HL
- v. Severe: between 71 and 90 dB HL
- vi. Profound: 91 dB HL or more

According to WHO, Individuals will be termed as having HL loss if presented with any form of alteration of the figure above from mild to profound HL (6,10).

Anatomy and physiology of the auditory system

The ear is the paired sensory organ consisting of the auditory and vestibular systems. The auditory system is divided anatomically and functionally into three regions: the external, middle, and inner ear. The auditory system is involved in the direction of sound while the vestibular system is involved with maintaining body balance. The external ear collects and directs sound waves through the ear canal to the tympanic membrane. The middle ear amplifies and transmits sound vibrations into the inner ear through the oval window. The inner ear consists of two main parts, the cochlear (organ of hearing) and the vestibular apparatus (organ of balance).

The cochlear is the organ of hearing. It is a coiled canal that contains receptor cells that respond to vibration transferred from the middle ear.

Table 1:
WHO HTN Grades

Blood pressure	Grade 1	Grade 2	Grade 3
SBP mmHg	140-159	160-179	≥180
DBP mmHg	90-99	100-109	≥110

The interior of the cochlear is divided into three regions; the Scala vestibule, the Scala tympani, and the cochlear duct (Scala media).

The scalars are tubular channels that follow the coiled curved curvature of the cochlear. At the cochlear tympani, sound vibrations are transformed into waves in the Scala vestibule which induces electrical impulses from the inner/outer hair cells. This induction involves encoding in terms of pitch and hinders, then transmitted to the brain via the cochlear nerve. Any disruption of this pathway will result in sensorineural deafness (11).

The Blood supply to the cochlear is complex. The arterial supply to the cochlear is the labyrinthine artery (internal auditory artery). It originates from the anterior inferior cerebellar artery (AICA) and follows the eighth cranial nerve in the internal auditory meatus, where it gives off the anterior vestibular artery to the vestibular apparatus and common cochlear artery which supplies the cochlear (12). The labyrinthine artery is an end-artery with little or no collateral blood supply to the cochlear. The labyrinthine artery that runs in the internal auditory meatus is not a single artery but several smaller arterioles, almost like an arterial plexus. Such a series of parallel small-calibre arteries attenuate rapid changes in blood flow and thus contribute to providing a smooth blood supply to the cochlear and the vestibular system (5,3).

Hypertension and sensorineural hearing loss

The incidence of sensorineural hearing loss (SNHL) in hypertension is due to the occurrence of inner ear damage due to high blood pressure in the vascular system, increased vascular viscosity, and ionic changes (14). High blood pressure in the vascular system and microcirculation that occur in hypertension include increased synthesis of connective tissue components, elastin, and collagen by smooth muscle cells that lead to the thickening of artery walls (arteriosclerosis). Smooth muscle cells in the blood vessel media also change, such as hyperplasia and hypertrophy. Tunica intima

artery in hypertension becomes thicker due to the increased size and height of endothelial cells. Due to these changes in the vascular system, high blood pressure can cause damage to the lining of the artery walls. In areas affected by damage can form fatty plaque. As high blood pressure persists, the more damage to the arterial wall, the more fatty plaque is formed, which reduces or stops the blood flow and can rupture and cause hemorrhage, this damage is not centred on one area of the body, but the whole body is also affected, including the ears (14). All living cells in the human body depend on the adequacy of oxygen and nutrient supply to maintain their function, and that supply depends on the integrity of the structure and function of the heart and blood vessels. Hypertension is the most common vascular disorder that can cause inner ear bleeding, leading to progressive or sudden hearing loss (14,15). Another vascular physiopathological mechanism described is the increase in blood viscosity caused by hyperlipidemia, whereby it reduces capillary blood flow to the cochlear and ends up reducing oxygen transport, causing tissue hypoxia, thus causing hearing loss (13,14).

Furthermore, Cochlear membranes can be damaged or torn due to hypertension. The cochlea or inner ear is formed from thin smooth membranes with fluid-filled spaces. The movement of the liquid causes sound waves. The electrical charge is created by the ear by actively storing a special electrolyte in the liquid-filled chambers. This active storage of electrolytes makes the difference in charge (+ or -) separated by a thin membrane. The difference in charge between spaces generates nerve impulses such as electricity that arise from the positive and negative poles of the battery. Tear off of the thin membrane can cause fluid mixing and loss of electrical charge, so it can not generate nerve impulses and cause hearing loss (12,13,16).

Materials and Methods

This was a cross-sectional study conducted on hypertensive patients aged 18



years and above. This study was conducted at a Cardiac Institute (CI) in Tanzania. The institute is a National Specialized University Teaching Institute offering cardiovascular care, training, and research services in the United Republic of Tanzania. It receives referral patients from all over the country and East Africa. The hypertension clinic is conducted every day from Monday to Saturday and an average of 300 patients with hypertension are seen in a day. A total number of 191 patients were recruited. The inclusion criteria were all hypertensive patients aged 18 years and above and the exclusion criteria were all patients with pre-existing hearing loss before hypertension, renal failure, diabetes mellitus, temporal bone fracture and a history of using ototoxic drugs.

Data collection was done using a standard questionnaire, and history and physical examination were conducted and recorded. Blood pressure was measured using a proper cuff and Omron M3 automatic BP monitor and an otological examination were done by using a battery hand otoscope. Tuning fork tests were done using 512Hz Karl Storz stainless to all patients. Rinne's Test was done first followed by Weber's test in participants with unilateral sensorineural loss. All audiological measurements on hearing loss were performed in the quiet room. Using piano inventions, the clinical audiometer version 2013 assessed air and bone conduction. The audiometry was performed at the following different frequencies: 250HZ, 500, 1000, and 8000HZ, and each ear separately. Puretone audiometry (PTA) was performed at the

audiology clinic for those whose results showed SNHL. All the findings were recorded in the questionnaire.

The hearing loss was graded according to the World Health Organization (WHO) grading system criterion whereby;

- Mild for children: between 20 and 40 dB HL
- Mild for adults: between 26 and 40 dB HL
- Moderate: between 41 and 55dB HL
- Moderate severe: between 56 and 70 dB HL
- Severe: between 71 and 90 dB HL
- Profound:91 dB HL or more
- HL was classified as left, right, or bilateral (6,10).

Statistical analysis

Data collected were entered into a data collection form and assessed for completeness, accuracy, and consistency before analysis. Data analysis was carried out using SPSS software version 20.0. The mean was used as the measure of central tendency as the population was symmetrically distributed.

Ethical consideration

Ethical approval was sought from the Muhimbili University of Health and Allied Sciences Ethical Clearance Committee. All the patients willing to participate signed the informed consent and confidentiality was maintained.

Results

A total of 191 patients were included in the study. Age ranged from 36 to 88 years, with a mean age of 60 years and a standard deviation of 10.

Table 2:

Demographic Characteristics of the Study Participants (N = 191)

Variable		Frequency (N)	Percent (%)
Age group (years)	29 – 44	12	6.3
	45 – 60	82	42.9
	61 – 76	85	44.5
	>76	12	6.3
Total		191	100
Mean age in years (± SD)		60 ± 10	
Sex	Male	91	47.6
	Female	100	52.4
Total		191	100



There were 100 females and 91 males with a female-to-male ratio of 1:1. (Table 2). In this study, among 191 hypertensive patients studied, the proportion of sensorineural hearing loss was 144 (75.4%), and the majority of the patients were in the age group above 76 years by 11 (91.7%), followed by the age group between 29-44 years by 10 (83.3%), and the least affected group, aged between 45-60 years by 58 (70.7%). There was a difference in sensorineural hearing loss among the age groups, although it was not statistically

significant, p-value (0.431). Females were more affected 76 (76.0%) than males 68 (74.7%) however, it was not statistically significant-value = 0.868. (Table 3).

Regarding lateralization, bilateral sensorineural hearing loss was the most common presentation across all age groups, which accounted for 104 (72.2%) with the highest occurring in patients over 76 years 9 (81.8%), followed by 51 (76.9%) in the age group 61-76 years, and the least in the age group between 45-60 years by 58 (70.7%).

Table 3:

Proportion of sensorineural hearing loss according to age and sex (N=191)

Variables	Hearing Loss			
	Present N (%)	Absent N(%)	Total N (%)	
Age group(years)	29-44	10 (83.3)	2 (16.7)	12 (6.3)
	45-60	58 (70.7)	24 (29.3)	82 (42.9)
	61-76	65 (76.5)	20 (23.5)	85 (44.5)
	>76	11 (91.7)	1 (8.3)	12 (6.3)
	Total	144 (75.4)	47(24.6)	191(100)
Sex	Males	68 (74.7)	23 (25.3)	91 (47.6)
	Females	76 (76.0)	24 (24.0)	100 (52.4)
	Total	144 (75.4)	47 (24.6)	191 (100)

Table 4:

Lateralization of Sensorineural Hearing Loss According to Age and Sex (n = 144)

		Lateralization			Total n (%)	p-value
		Right n. (%)	Left n (%)	Bilateral n (%)		
Age group(years)	29-44	1 (10.0)	2 (20.0)	7 (70.0)	10 (6.9)	0.843
	45-60	7 (12.5)	12 (21.4)	37 (67.3)	56 (38.9)	
	61-76	5 (7.5)	11 (16.4)	51 (76.9)	67 (46.5)	
	>76	0 (0.0)	2 (18.2)	9 (81.8)	11 (7.6)	
	Total	13 (9.0)	27(18.8)	104 (72.2)	144 (100)	
Sex	Males	5 (7.5)	16 (23.9)	46 (68.7)	67 (46.5)	0.317
	Females	8 (10.4)	11 (14.3)	58 (75.3)	77 (53.5)	
	Total	13 (9.0)	27 (18.8)	104 (72.2)	144(100)	

Table 5:

Degree of Sensorineural Hearing Loss According to Age and Sex (n =144)

		Degree of sensorineural hearing loss					Total n (%)	P-Value
		Mild n (%)	Moderate n (%)	Moderately severe n(%)	Severe n(%)	Profound n (%)		
Age group(yrs)	29-44	6 (60.0)	1 (10.0)	0 (0.0)	0 (0.0)	3 (30.0)	10 (6.9)	0.001
	45-60	45 (80.4)	7 (16.4)	2 (3.6)	2 (3.6)	0 (0.0)	56 (38.9)	
	61-76	53 (79.1)	11 (13.4)	1 (1.5)	2 (3.0)	0 (0.0)	67 (46.5)	
	>76	4 (36.4)	6 (54.5)	1 (9.1)	0 (0.0)	0 (0.0)	11 (7.6)	
	Total	108 (75.0)	25 (17.4)	4 (2.8)	4 (2.8)	3 (2.1)	144 (100)	
Sex	Male	44 (65.7)	15 (22.4)	2 (3.0)	3 (4.5)	3 (4.5)	67 (46.5)	0.074
	Female	64 (83.1)	10 (13.0)	2 (2.6)	1 (1.3)	0 (0.0)	77 (53.5)	
	Total	108 (75.0)	25 (17.4)	4 (2.8)	4 (2.8)	3 (2.1)	144 (100)	



Females were more affected 58 (75.3%) than males 46 (68.7%). The difference between lateralization by age group and gender was not statistically significant, with p-values (0.8430 and (0.317) respectively. (Table 4).

Mild sensorineural hearing loss was the most common degree of hearing loss revealed in this which was detected in 108 (75.0%) with the highest occurring in 45 patients (80.4%) in the age group 45–60 years with a p-value = 0.001 which was statistically significant. Females were more affected by 64 (83.1%) than males by 44 (65.7%) with a p-value (0.074). Table 5. Mild sensorineural hearing loss was the most common degree of hearing loss across all grades of hypertension which was 108(75.0%), with the highest occurring in 30 (81.1%) in controlled hypertension, followed by 62 (77.5%) in grade 1, 10 (71.4%) in grade 3, and the least was 6(46.2%) in grade2. However, this difference is not statistically significant with a p-value (0.113) see Table 6.

Mild sensorineural hearing loss was the most common degree of hearing loss across all durations of hypertension by 108(75.0%), with the highest occurring at 65 (79.3%) in < 5 years, 17(68%) in 5 - 10 years, and 26 (70.3%) in > 10 years. However, this difference is not

statistically significant p-value (0.369) see Table 7.

Discussion

This study revealed that the majority of hypertensive patients were aged 61-76 years with a mean age of 60 years. These findings are closely related to that conducted by Mishra who found the mean age of hypertension to be 54 years. Females were more predominant which were 100 (52.4%). Several other studies reported females being more commonly affected than males (5,17).

The findings from this study revealed that the proportion of sensorineural hearing loss among hypertensive patients was 144(75.4%) which showed a possible link between hypertension and hearing loss. These findings are similar to other studies which revealed the same link (1). The most affected age groups were 29- 44 years 10 (83.3%), followed by the age group 61-76 years 65 (76.5%) which had similar findings to the study done by S. Senniappan *et al* who found the most affected group of 61-70 years (18). Nevertheless, this study revealed that females were more affected compared to males 100(52.4%).

Table 6:

Degree of Sensorineural Hearing Loss in Relation to the Grade of Hypertension (N =144)

Degree of Sensorineural Hearing Loss							
Grade of HTN	Mild n (%)	Moderate n (%)	Moderately severe n (%)	Severe n(%)	Profound n (%)	Total n (%)	P-Value
Controlled	30 (81.1)	5 (13.5)	1 (2.7)	1 (2.7)	0 (0.0)	37 (25.7)	0.113
Grade 1	62 (77.5)	12 (15.0)	2(2.5)	2 (2.5)	2 (2.5)	80 (55.6)	
Grade 2	6 (46.2)	5 (38.5)	1 (7.7)	1 (7.7)	0 (0.0)	13 (9.0)	
Grade 3	10 (71.4)	3 (21.4)	0 (0.0)	0 (0.0)	1 (7.1)	14 (9.7)	
Total	108 (75.0)	25 (17.4)	4(2.8)	4 (2.8)	3 (2.1)	144 (100)	

Table 7:

Degree of Sensorineural Hearing Loss in Relation to the Duration of Hypertension from the Time of Diagnosis (n =144)

Degree of sensorineural hearing loss							
Duration of HTN(years)	Mild n (%)	Moderate n (%)	Moderately severe n (%)	Severe n(%)	Profound n (%)	Total n (%)	P-Value
<5	65 (79.3)	9 (11.0)	3 (3.7)	3 (3.7)	2 (2.4)	82 (56.9)	0.369
5-10	17 (68.0)	7 (28.0)	0 (0.0)	0 (0.0)	1 (4.0)	25 (17.4)	
>10	26 (70.3)	9 (24.3)	1 (2.7)	1 (2.7)	0 (0.0)	37 (25.7)	
Total	108 (75.0)	25 (17.4)	4 (2.8)	4 (2.8)	3 (2.1)	144 (100)	



Other previous studies reported males were more prevalent than females, due to the number of males enrolled in the study being more compared to females (17,19).

Bilateral sensorineural hearing loss was the most common presentation among hypertensive patients comparable to findings revealed that 104(72.2%) had bilateral sensorineural hearing loss. These findings are similar to the study done in Japan in 2019, which also reported bilateral sensorineural hearing loss being the most common presentation (19). Regarding age, this study revealed that the most commonly affected age group was above 76 years by 9 (81.8%) which is similar to the study done in Japan and Nigeria which reported bilateral involvement is more common in those aged 60 years and above (19). It was also revealed that the most affected group was between 50- 55 years. In addition, in this study, females were more commonly affected, 77(53.5%) which is different from the studies done in Japan and Nigeria which revealed males being more affected than females (19).

Mild sensorineural hearing loss was found to be the most common degree of sensorineural hearing loss accounting for 108(75.0%), followed by moderate SNHL 25(17.4%). This finding is similar to the study done in Kenya in 2014 which also revealed mild SNHL being the commonest degree of hearing, followed by moderate SNHL, 10(76.9%) and 2(15.4) respectively. The most affected age group was 45-60 years accounting for 45(80.4%) which is similar to the study done in Kenya (5). Moreover, this study found that females were more affected than males. This concurred with previous studies which had similar findings (17).

Mild sensorineural hearing loss was the most common presentation across all the grades of hypertension being 108 (75.0%). There was a slight difference between increasing grades of hypertension and severity of hearing loss however, the difference was not statistically significant. These findings are similar to several other studies which revealed mild sensorineural

hearing loss being the commonest presentation (5,17,19). A study done in India and Nigeria revealed the possible relationship between progressive hearing loss and the grades of hypertension (20,21)

It was also found that mild sensorineural hearing loss was the most common degree of HL in all durations of hypertension which accounted for 108(75.0%) with the highest occurring at the duration of fewer than five years 65 (79.3%). This finding is similar to the study done by S. Senniappan *et al* which showed no statistical significance between the duration of hypertension and the risk of worsening SNHL (18) also, P-Vemanna *et al*, did a study of hearing impairment among essential hypertensive patients and revealed no statistical significance between the duration of hypertension and increasing severity of the hearing loss. In contrast to this, another study by Agarwal *et al* (21,22), reported a relationship between the duration of hypertension and increasing severity of SNHL, the study reported that patients with a mean duration of 9 years of hypertension have worse SNHL as compared to the mean duration of 5 years.

Conclusion

Sensorineural Hearing loss is prevalent among hypertensive patients. Mild sensorineural hearing loss was the most common degree of hearing loss, and bilateral presentation was the most commonly identified. Advancement of age was found to be associated with increased SNHL, but gender was not found to contribute to hearing loss. Furthermore, the duration and grade of Hypertension were not observed to increase the severity of hearing loss.

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