

Hearing Loss due to Noise Exposure and its Relationship with Hypertension in Peruvian Workers

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Abstract:

Introduction: Noise-induced hearing loss has been implicated in the genesis of several chronic conditions; however, its behavior concerning hypertension still raises doubts about it.

Objective: to determine the association between hearing loss due to exposure to noise and the presence of hypertension in a sample of Peruvian workers.

Methods: Cross-sectional analytical study. Secondary analysis of the occupational database of a Medical center in Lima, Peru. Hypertension was measured by self-report and clinical method. Hearing loss was classified as none, mild, moderate and severe. For the regression analysis, Poisson was performed with robust variance, obtaining crude (PRc) and adjusted (PRA) prevalence ratios.

Results: We worked with a total of 1987 participants. The prevalence of hypertension was 15.40% and hearing loss was 36.39%. For the multivariate regression analysis, a statistically significant association with hypertension was found in those with mild hearing loss (PRA=1.52; CI95% 1.06–2.10), moderate (PRA=2.70; CI95% 1.93–3.76) and severe (PRA=3.82; 95% CI 2.56–5.96), compared to those without hearing loss.

Conclusions: Hearing loss due to exposure to occupational noise was associated with the presence of hypertension. Although this study is only a first overview of the relationship that both variables could have, it is recommended to continue promoting policies and awareness campaigns to prevent hearing loss in workers, and thus avoid complications related to it in the long term.

Keywords: Hearing loss, obesity, hypertension, occupational health (Source: MeSH NLM).

1. INTRODUCTION

Occupational noise is one of the most common occupational hazards in the workplace worldwide [1]. So then hearing loss is the main adverse health effect caused by exposure to noise at work [2]. Also, is the most prevalent occupational disease in the United States [3] turning into the third occupational disease, accounting for 16.7% of all occupational illnesses in China [4]. Therefore, hearing loss is an occupational health problem [5].

Noise-induced hearing loss has been implicated in the genesis of several conditions such as sleep disorders, myocardial infarction, cancer, and digestive disorders [6-8]. It has also been suggested that it can alter metabolism and increase the risk of obesity [9]. However, although some studies have found a relationship between this and the presence of Arterial hypertension (AHT) [10-13], other reports do not present clear results regarding this issue [14].

In Peru, there is no evidence of this issue. Given that knowing the behavior of these characteristics could contribute to another reason to avoid its development in order to prevent long-term cardiovascular complications [15,16].

So then, the present study aims to determine the relationship between hearing loss due to exposure to noise and the presence of AHT in a sample of Peruvian workers.

2. MATERIALS AND METHODS

2.1. Type and Design of Research

The present study is observational, analytical, cross-sectional. Secondary analysis of the occupational database of a healthcare center in Lima, Peru.

2.2. Population and Sample

The population was made up of workers who attended their occupational evaluation during the period from 2016 to 2020 at a medical center in Lima, Peru. The workers belonged to the administrative, operator, foreman, bricklayer, security guard, teacher, among others.

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All workers who received evaluation and medical attention in the established period, who have been evaluated by audiometry, and have all the requested results were included. Pregnant women were excluded because they presented different criteria to define hypertension and those who were undergoing treatment for hearing loss. Sampling was non-probabilistic consecutive.

The records of the workers who have been evaluated since the established period were requested from the health center. In that amount of time, approximately 10,000 subjects were evaluated. Given the positive response, it was specified that only the data of the people who had all the variables of interest would be delivered. In this way, the total sample was 1987 workers.

Since we worked with all the subjects that were in the database and met the selection criteria, we proceeded to calculate the statistical power. According to the literature reviewed [20], an exposed/unexposed ratio of 1 was assumed, the prevalence of hypertension in patients with hearing loss of 15% versus the prevalence of hypertension in patients with normal hearing of 5%, and a confidence interval of 95%, a statistical power of 100% was obtained.

2.3. Variable Definition

The outcome variable was hypertension, which was defined according to one of these conditions: 1) systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg; and/or 2) self-report of previous hypertension or use of antihypertensive medication.

The hearing loss variable due to exposure to noise was measured according to the polyclinic audiometry test report. This was classified into does not have, mild, moderate, and severe hearing loss. This classification was based on the clinical practice guideline for the medical evaluation of workers in activities with noise exposure [17].

Covariates were gender (male vs female); categorized age (18 to 29 years old, 30 to 60 years old, and 61 to 65 years old); occupation (field and office work); time at work (0 to 5 years, 6 to 10 years and 11 years and over); body mass index (BMI), divided into normal weight (BMI from 18.50 to 24.99), overweight (BMI from 25 to 29.99) and obesity (BMI ≥ 30); hypercholesterolemia (cholesterol ≥ 200 mg/dl);

hypertriglyceridemia (triglycerides ≥ 150 mg/dl) and hyperglycemia (glucose ≥ 100 mg/dl).

2.4. Procedure

Workers go to the medical center to pass the evaluation process. This may be for the purpose of entering the company, periodic evaluation, or termination of employment. First, everyone undergoes an anthropometric evaluation, where trained nursing staff measures their weight, abdominal waist, and height.

Then, they go through the laboratory where a blood sample is taken by venipuncture, which was processed to take glucose, triglyceride, and cholesterol. From there, if the company requested it, the worker went to a booth for the audiometry evaluation. Finally, he is evaluated by the occupational doctor, who asks him about his pathological and family history, and then performs the corresponding physical examination. SBP and DBP were measured on the right arm in a sitting position with the right arm supported at chest level. Three measurements were made, at least 5 minutes apart, using an oscillometric device (brand: Omicron), the pressure result was given by the average of the last two measurements of both pressures.

All information placed in the medical record is recorded by the medical center staff in an electronic database. There was no need to blind said person, since the data that is collected daily is not carried out for the purpose of a specific investigation.

2.5. Statistical Analysis

The data was delivered in Excel 2016. We proceeded with data cleaning and coding of categorical variables. Then, the STATA version 17 program was used for statistical analyses. The description of the categorical variables was made using absolute and relative frequencies.

For the bivariate analyses, according to the presence of hypertension, the chi-square test of independence was used. For the regression analysis, Poisson was performed with robust variance, obtaining crude prevalence ratio (PRc) and adjusted prevalence ratio (PRa) for the aforementioned covariates.

2.6. Ethical Aspect

Written permission for the use of the database was obtained. These were anonymous, and access to the

study material was limited to the principal investigators. The risks were minimal since no study worker was in contact with them. Furthermore, permission was obtained from the Research Ethics Committee of the Ricardo Palma University School of Medicine (Committee Code: PG005–2022).

3. RESULTS

We worked with a total of 1987 participants. The prevalence of hypertension was 15.40%. The prevalence of hearing loss was 36.39%. The male sex was made up of 59.64%. 74.48% had fieldwork, while 22.24% had 11 years or more in the job Table 1.

In the bivariate analysis, there was no association for the variables sex ($p=0.087$), occupation ($p=0.714$), hypercholesterolemia ($p=0.298$), hypertriglyceridemia ($p=0.139$). On the other hand, there were statistically significant associations between hypertension arterial and age, time at work, Body mass index, hyperglycemia and hearing loss see Table 2.

In the multivariable Poisson regression analysis, a statistically significant association was found to present AHT, for those with mild hearing loss ($PRa=1.52$; CI95% 1.06–2.10), moderate ($PRa=2.70$; CI95% 1.93–3.76) and severe ($PRa=3.82$; CI95% 2.56–5.96), compared to those without hearing loss Table 3.

4. DISCUSSION

The present study found an association between hearing loss due to exposure to noise and the presence of hypertension. The 36.93% of the workers evaluated had hearing loss. As far as is known, this is the first study in Peru that evaluates this fact.

Globally, several studies have found that hearing loss is directly related to several cardiovascular diseases [6], including an increased risk of death from these conditions in the long term [18].

Concerning hypertension, multiple research works have found similar results. The study by Chang *et al.* [19] was a cross-sectional study involving 790 workers in an aircraft factory; this showed that workers with high-frequency hearing loss also had an increased risk of hypertension. In turn, it suggests that high-frequency hearing loss is a good biomarker for prolonged exposure to occupational noise.

Similarly, Kuang *et al.* [20] found that hearing loss was associated with elevated blood pressure levels

and the risk of hypertension. Ni *et al.* [6] reported that SBP and DBP in the group of workers with hearing loss were higher than in the group with normal hearing. Another older study, which recruited black workers, reported that hearing loss is associated with higher mean blood pressure and hypertension [21].

Table 1: Characteristics of the Workers' Sample

Characteristics	n (%)
Sex	
Femenine	802 (40.36)
Masculine	1185 (59.64)
Categorized age	
18 to 29 years old	637 (32.06)
30 to 60 years old	1118 (56.27)
61 to 65 years old	232 (11.68)
Occupation	
Field work	1480 (74.48)
Office work	507 (25.52)
Time at work	
0 to 5 years	1222 (61.50)
6 to 10 years	323 (16.26)
11 years or more	442 (22.24)
Hypercholesterolemia	
No	1593 (80.17)
Yes	394 (19.83)
Hypertriglyceridemia	
No	1512 (76.09)
Yes	475 (23.91)
Hyperglycemia	
No	1602 (80.62)
Yes	385 (19.38)
Categorized BMI	
Normal weight	1028 (51.74)
Overweight	626 (31.50)
Obesity	333 (16.76)
Hearing loss	
No	1264 (63.61)
Mild hearing loss	485 (24.41)
Moderate hearing loss	163 (8.20)
Severe hearing loss	75 (3.77)
Hypertension	
No	1681 (84.61)
Yes	306 (15.40)

Table 2: Bivariate Analysis with the Presence or Not of Hypertension

Characteristics	Arterial Hypertension		p*
	Yes	No	
	n (%)	n (%)	
Sex			
Femenine	692 (86.28)	110 (13.72)	0.087
Masculine	989 (83.46)	196 (16.54)	
Categorized age			
18 to 29 years old	636 (99.84)	1 (0.16)	0.033
30 to 60 years old	929 (83.09)	189 (16.91)	
61 to 65 years old	152 (65.52)	80 (34.48)	
Occupation			
Field work	1029 (83.25)	207 (16.75)	0.714
Office work	652 (86.82)	99 (13.18)	
Time at work			
0 to 5 years	1087 (88.95)	135 (11.05)	< 0.001
6 to 10 years	254 (78.64)	69 (21.36)	
11 years or more	240 (76.92)	102 (23.08)	
Categorized BMI			
Normal weight	978 (95.14)	50 (4.86)	< 0.001
Overweight	533 (85.14)	93 (14.86)	
Obesity	170 (51.05)	163 (48.95)	
Hypercholesterolemia			
No	1341 (84.18)	252 (15.82)	0.298
Yes	340 (86.29)	54 (13.71)	
Hypertriglyceridemia			
No	1269 (83.93)	243 (16.07)	0.139
Yes	412 (86.74)	63 (13.26)	
Hyperglycemia			
No	1399 (87.33)	203 (12.67)	< 0.001
Yes	282 (73.25)	103 (26.75)	
Hearing loss			
No	1167 (92.33)	97 (7.67)	< 0.001
Mild hearing loss	367 (75.67)	118 (24.33)	
Moderate hearing loss	109 (66.87)	54 (33.13)	
Severe hearing loss	38 (50.67)	37 (49.33)	

*Performed with the chi-square test of independence.

Table 3: Crude and Adjusted Poisson Regression Analysis with Robust Variance for the Association between Hearing Loss and Hypertension

Characteristics	Crude Analysis			Adjusted Analysis *		
	R _{Pc}	CI 95%	p	R _{Pa}	CI 95%	p
Hearing loss						
No	Ref.			Ref.		
Mild	3.17	2.48-4.06	<0.001	1.82	1.42-2.33	<0.001
moderate	4.31	3.23-5.77	<0.001	2.70	1.93-3.76	<0.001
Severe	6.43	4.77-8.67	<0.001	3.82	2.56-5.69	<0.001

*Adjusted for sex, categorized age, time at work, job title, body mass index, hypercholesterolemia, hyperglycemia, and hypertriglyceridemia.

**significant p-value <0.05.

PRC: Crude prevalence ratio. RPa: Adjusted prevalence ratio.

95% CI: Confidence interval at 95%.

Tomei *et al.* [22] studied, in 2013, 79 farmers and 64 controls. A significant prevalence of HT was detected in farmers with reduced addition, compared to those without. In the work of Wang *et al.* [23], a total of 267,766 occupational workers exposed to noise were recruited, and they concluded that patients with hypertension present a substantial increase in hearing loss compared to patients without this condition. The study by Gan *et al.* [10] reached the same conclusion, the evidence was consistent to support associations between hearing loss and elevated blood pressure levels, but not with occupational noise. Nawaz *et al.* [24], in a study of 300 participants from the Jinnah Sindh Medical University, found that hypertension was positively correlated with hearing loss, although it was not specifically in the working population.

However, other studies have found no association. Samelli *et al.* [25] conducted a cross-sectional analysis of 900 Brazilians belonging to the Brazilian Longitudinal Study of Adult Health (ELSA-Brazil). Although it found that hearing thresholds were worse in participants with hypertension, after adjusting for confounding variables, no statistically significant association was found. This difference with the present study may be due to the fact that we worked with a heterogeneous population, while the rest of the research has been directed exclusively at workers.

4.1. Interpretation of Results

Hearing loss is associated with short-term and long-term changes in heart rate, cardiac output, and increased peripheral vascular resistance, and chronically elevated stress-related hormones such as epinephrine, norepinephrine, and corticosteroids [26]. In this way, a lasting elevation of the sympathetic and endocrine systems will be produced, which would affect blood pressure levels [27].

Furthermore, it has been found that hearing loss causes an increase in oxidative stress, an increase in the inflammatory state, sedentary lifestyle, and lack of physical activity [28]. The participation of intermediary factors should also be mentioned, such as atherosclerosis, which can be found in hypertension and reduce blood flow to the cochlea by hardening or constricting the internal auditory artery [29].

Although this study is only the first overview of the relationship between hearing loss and hypertension, it is important to consider that workers are constantly exposed to occupational noise. Therefore, it should be

tried that they do not develop this condition or that it worsens. This can be achieved through the use of occupational controls, such as periodic evaluations, increased screening of those already with hearing loss, audiometric monitoring, proper use of hearing protection, worker education, and programs to reduce other factors that may also be related to hearing loss. further development of hearing loss [16].

4.2. Study Limitations

The study has limitations. First, the design was cross-sectional, which cannot reveal the causal relationship and adequately evaluate the associations, so a prospective cohort study is needed to validate the results in the future; however, it can give us a first scope of the behavior of these variables. Second, although some confounding factors were adjusted in the present study, some individual factors for hypertension were not considered, such as smoking, alcohol consumption, psychosocial and nutritional factors, which could overestimate the results; however, it is not believed that this could lead to a non-significant association with respect to hearing loss. Third, data on noise intensity in the workplace and non-occupational noise exposure of workers, such as the use of headphones on the way to work and at home, which are very important for loss, were not collected. hearing, which should be taken into account in future research.

5. CONCLUSION

Hearing loss due to exposure to occupational noise is associated with the presence of hypertension. Although this study is only a first overview of the relationship between these variables, it is recommended to continue promoting policies and awareness campaigns to prevent hearing loss in workers, and thus avoid complications related to this in the long term.

COMPETING OF INTEREST

The authors declare have no conflict of interest.

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AUTHORSHIP CONTRIBUTIONS

The authors participated in the genesis of the idea, project design, data collection and interpretation, analysis of results and preparation of the manuscript of this research work.

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