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Original articles

Noise and hypertension: study of their association among female teachers

Angelita de Paula Pimenta[1]
https://orcid.org/0000-0003-3486-9903

Ulisses Antônio Natividade[1]
https://orcid.org/0000-0001-9994-9061

Márcia Pimenta Ferreira[2]
https://orcid.org/0000-0002-9590-1973

Luiz Felipe Silva[1]
https://orcid.org/0000-0002-3174-9984

[1] Universidade Federal de Itajubá, Instituto de Recursos Naturais, Itajubá, Minas Gerais, Brasil.

[2] Universidade Federal de Minas Gerais, Escola de Educação Física, Fisioterapia e Terapia Ocupacional, Belo Horizonte, Minas Gerais, Brasil.

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ABSTRACT

Purpose: investigate the association of noise exposure with the occurrence of systemic arterial hypertension (SAH) among public school female teachers.

Methods: a cross-sectional, descriptive and observational study was conducted. A questionnaire elaborated by the researchers was applied to a random sample of 133 female teachers. Noise exposure dosimetry was used among the sample subjects. The non-conditional logistic regression technique was applied to identify significant variables and control confounding variables for the occurrence of SAH.

Results: the prevalence of hypertension found, in teachers, in this study, was 17.3%. However, the association between occupational noise exposure and the occurrence of hypertension was not verified. It was observed that smoking is a very relevant risk factor for hypertension, while the physical effort performed at work appeared as a protection factor.

Conclusion: although the variable "noise exposure dose" was not significant in the final model, it was found that the exposure values were above the limits, justifying the adoption of preventive measures.

Keywords: Hypertension; Occupational Noise; Occupational Exposure; Teachers

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Corresponding address:
Angelita de Paula Pimenta
Rua Elisa Felippeto Ricaldoni, 45
Apto 1103 - Bairro Castelo
CEP: 30840-410 - Belo Horizonte,
Minas Gerais, Brazil
E-mail: angelitapimenta@gmail.com

INTRODUCTION

Systemic arterial hypertension (SAH) is a multi-factorial clinical condition characterized by high and sustained levels of blood pressure (BP)[1]. Considered the most prevalent among cardiovascular diseases, systemic hypertension is also the main risk factor for stroke, heart attack and end stage renal disease[1,2]. Due to its high prevalence and low control, it has become a public health problem in Brazil and worldwide Due to its high prevalence, 40% worldwide, and low control, it has become a global public health problem, accounting for 9.4 million deaths per year (WHO, 2013)[2]. The number of hypertensive people in the world increased from 594 million in 1975 to 1 billion in 2015[3]. The prevalence of SAH, reported by medical diagnosis, in Brazil, for the population aged 18 years and over, was 21.4% in 2013. Among women, this value was 24.2% and among men, 18.3%[4].

Noise is a stressor and can lead to SAH. Noise causes slow progressive hearing loss, fatigue, irritability, noise sleep disorders etc[5]. Regarding epidemiology on this topic, publications and research can be found that report the occurrence of adverse effects resulting from excessive exposure to occupational noise, such as noise induced hearing loss (NIHL), hypertension and ischemic heart disease [5-7]. Continuous long-term exposure to noise above 85 dB(A) is associated with numerous health effects, including changes in blood pressure[4]. Many studies on non-auditory effects of noise exposure, above all the effect of noise exposure on arterial pressure, have been carried out [4, 8-10].

Exposure to noise in classrooms has contributed to the deterioration of teachers' health and quality of life, especially in basic education[11]. Teachers are a class of workers who are constantly exposed to the noise present in the classroom, from conversations between students who are inside and outside the class, those moving along the corridors, or those in gym activities, among others. Many of these professionals undergo strenuous working hours, increasing their exposure to noise and its effects. Moreover, teaching is a highly stressful activity in general, with obvious repercussions on physical, mental and professional performance[12].

This epidemiological study aimed to investigate the association of noise exposure with the occurrence of SAH, among female teachers.

METHODS

Ethical aspects

This study was submitted to the Ethics Committee of the Medicine School of Itajubá, and was approved on September 19, 2013, under number: 400817/2013.

Sample

A cross-sectional, descriptive and observational study was carried out in all 34 state public schools, with the population of 847 teachers, in Divinópolis, in the state of Minas Gerais, Brazil (33 of them located in an urban area and 1 in a rural one). The procedure for estimating the sample size was based on research by Moreira et al. (2011)[13], which revealed a prevalence of 7.14% of systemic arterial hypertension among female teachers.

Considering the 95% confidence level and absolute precision of five percentage points[14], the sample size resulted in 102 teachers. The value had to be increased by 10% to contemplate eventual losses or refusals and by 20% to account for confounding variables, resulting in a total of 133 female teachers, who were randomly selected, regardless of the schools they worked at. Even so, all of the schools, including the one in the rural area, were contemplated with at least one participant.

Only female teachers who were actively teaching were included in the research. The excluded ones were temporary female teachers, those working in a different function or those who were off work due to illness or on leave without pay.

Noise exposure assessment

In order to control the statistical error, the noise exposure assessment procedure was based on the sampling process by indications established by Brunn et al. (1986)[15]. According to these authors, the sufficient number of samples is set when an average confidence level of a set of measures presents a value equal to or below the error of the instrument (dosimeter) used. In this case, employee instrument error is ± 2 dB (A). The size of the sample submitted to the assessment of noise exposure was based on the work of Behar, Plener (1984)[16]. For this study, the values of T (ratio of the sample with the highest levels) and α (Probability of loss of individuals with the highest levels of exposure to noise) were established as being 0.1 and 0.05, respectively, resulting in 29 assessment procedures by dosimetry of teachers' exposure to noise. The 29 individual dosimetry assessments were made randomly, considering the teachers' sample group and the respective class schedules.

The noise exposure assessment procedure was carried out using a noise dosimeter of the brand Instrutemp, model DOS-500. The configuration of the instrument was set in accordance with the recommendation of the Occupational Hygiene Standard - 01 (NHO-01) (FUNDACENTRO, 2001)[17] establishing an exposure limit of 85 dB(A) for an eight-hour day with an exchange factor of three. The threshold level was set to 70 dB(A). The dosimetry procedure for each teacher was conducted over a period of 50 minutes, corresponding to the duration of one class.

The worker's exposure to sound levels is variable throughout the day and week. Therefore, the calculation of Normalized Exposure Level (NEL), according to the NHO-01 (FUNDACENTRO, 2001)[17], associated with a corresponding exposure of an eight-hour workday was carried out. Likewise, respecting the peculiarities presented in the teacher activity, the Weekly Exposure Level (WEL) was calculated, as adopted by the Directive of the European Economic Community (DCEE, 1986)[18]. The value of weekly exposure, converted to the value of the sound pressure in Pascal squared (Pa²), second Equation 1, was used to calculate the noise dose expressed by multiplying it by the time in function in weeks (Pa².weeks).

$$L_p = 10 \times \log p^2/(p_0^2) \qquad (1)$$

Where:
Lp: Sound level pressure, in dB, or the weekly exposure, in dB(A);
p: Sound pressure, in Pascal and
p_0: Sound pressure of reference or 2 x 10^{-5} Pa.

Questionnaire

A structured questionnaire, prepared by the authors based on the literature review, was applied to the sample female teachers in order to obtain data on sociodemographic, health and work aspects, on occupational noise exposure, and on risk factors for SAH, such as alcohol ingestion, smoking, sedentary lifestyle, skin color, and history of SAH in the family, among others. The questionnaire was based on the literature review. A pre-pilot application of the questionnaire was carried out with 25 teachers in order to test and adjust it. The questionnaire, after the free and informed consent form was signed by all the respondents, was applied between August and September of 2014 in reserved rooms of the schools. Waist circumference and height were measured with the aid of a tape measure. In order to measure body mass, a scale of the brand Omron, model HBF-214, was used.

The data analyzed data in this study were acquired by questionnaire application. Arterial hypertension, diabetes and auditory loss were reported by teachers that had already been submitted to medical diagnosis for these diseases.

The variables used in the analysis were coded. Regarding the categorical variables, that is, those that have more than two answer options, it was necessary to turn them into dummy variables during the inputting of variables into the software EPI-INFO version 3.51TM (2006)[19] for analysis.

Statistical analysis

In order to describe the association between the dependent variable, self-reported based on medical diagnosis, (hypertension – SAH) and the set of explanatory variables, the technique of multivariate unconditional logistic regression was carried out using the computer software Epi-Info 3.5.1TM[19]. The selected logistic regression method provides the calculation of Odds Ratio for the outcome, while controlling the other explanatory variables considered[20]. The construction of the model was guided by the criteria established by Hosmer and Lemeshow (1989)[21], in which the variables with $p \leq 0.20$ and $p \leq 0.05$, according to the likelihood ratio test, were selected in the univariate and multivariate analyses, respectively.

RESULTS

Sample characteristics

By applying the questionnaires among the 133 female teachers, a prevalence of hypertension of 17.3% was observed.

Table 1 shows the distribution of population by age, presence of companion, skin color and educational level. The average age was 42.7 ± 9.9 years old, with a minimum age of 22 and a maximum age of 59 years old.

Table 1. Distribution of sociodemographic variables among female teachers in state schools of Divinópolis, Minas Gerais, Brazil, in 2014

Variables	
Age (years) (means ± SD)	42.7 ± 9.9
- Marital status (%)	
Single or widow	41.0 (30.8)
Married or cohabiting	92.0 (69.2)
- Skin color (%)	
Black or brown	12.0 (9.0)
Others	121.0 (91.0)
- Educational level (%)	
High school	3.0 (2.3)
Higher Education and above	130.0 (97.7)
- Workplace	
Elementary School I	85.0 (64.0)
Elementary School II or High School	48.0 (36.0)

Table 2 shows the distribution of sample according to the variables related to health. Among the interviewed female teachers, 42.9% had a BMI above 25 $kg.m^{-2}$.

The distribution of the sample according to the variables related to work and noise exposure can be seen in Table 3.

Table 2. Distribution of variables related to lifestyle and health among female teachers in state schools of Divinópolis, Minas Gerais, Brazil, in 2014

Variables	
- Body Mass Index ($kg.m^{-2}$) (%)	
18.5 /- 25	76.0 (57.1)
≥ 25	57.0 (42.9)
- Waist circumference (above recommended) (%)	59.0 (44.4)
- Practitioner of physical activity (%)	69.0 (51.9)
- Smoking (%)	20.0 (15.0)
- Passive smoking (%)	17.0 (12.8)
- Alcohol intake (%)	16.0 (12.0)
- Coffee intake (%)	95.0 (71.4)
- Tea intake (%)	8.0 (6.0)
- Salt consumption (%)	25.0 (18.8)
- Systemic Arterial Hypertension (SAH) diagnosis (%)	23.0 (17.3)
- Systemic Arterial Hypertension (SAH) Family history (%)	64.0 (48.1)
- Noise-induced hearing loss (%)	6.0 (4.5)
- Diabetes diagnosis (%)	4.0 (3.0)

Table 3. Distribution of variables related to work and noise exposure among female teachers in state schools of Divinópolis, Minas Gerais, Brazil, in 2014

Variables	
- Feel insecure at work (%)	23.0 (17.3)
- Have autonomy at work (%)	104.0 (78.2)
- Have support from colleagues (%)	111.0 (83.5)
- Have supervisors' support (%)	112.0 (84.2)
- Extra-occupational noise exposure (%)	17.0 (12.8)
- Annoyed by noise at work (%)	49.0 (36.8)
- Annoyed by noise at home (%)	23.0 (17.3)
- Occupational exposure dose (Pa^2. Weeks) (means ± SD)	161.3 ± 111.8

From the analyzed sample, 55.3% have a daily workload from 4.5 to 9 h, 56.0% have seniority higher or equal to 10 years, and 64.7% work in Children School or Elementary School I.

Individual dosimetry

The procedure revealed that the average of the exposure values and the confidence interval of the samples were 87.2 ± 1.7 dB(A).

The equivalent noise level (LAeq) exceeded 85 dB(A) in 69% of the performed procedures. From the average of the equivalent noise level, it was observed the normalized exposure level (NEL), exceeds the limit of 85 dB(A), from an estimated exposure of six hours per day. The weekly exposure level (WEL) reaches the limit of 85 dB(A) with five days of work comprising six classes a day.

According to teachers' reports, during dosimetry, noise from traffic, as well as others from external sources, were not perceived within the classroom.

No significant differences were found between the noise values in the classroom during dosimetry performance. Similar noise values were found in classes of Physical Education, Portuguese, Mathematics, Biology, among others, even in different educational levels. The mean value found was 86.7 dB(A) with a standard deviation of 4,7 dB(A).

The noise exposure dose had a mean value of 161.3 ± 111.8 Pa^2. weeks, with the maximum value of 344 Pa^2. weeks.

Analysis of the variables

The Table 4 shows the univariate analysis results, showing the significant explanatory variables in the process, ie those with $p < 0.20$, the Odds Ratios (OR) and Confidence Intervals (95% CI) values.

Table 4. Univariate analysis (crude) of explanatory variables significant in the occurrence of hypertension among female teachers in state schools of Divinópolis, Minas Gerais, Brazil, in 2014

Variable	Crude analysis		
	OR	CI $_{95\%}$ [b]	p value
Smoker			
Non smoker	1		
Smoker	7.69	2.69 – 22.00	< 0.01
Age			
22 /- 52	1		
52 /- 59	4.21	1.59 – 11.13	< 0.01
Skin color			
White	1		
Black/Brown	4.09	1.17 – 14.30	0.04
Waist (above recommended)			
No	1		
Yes	2.81	1.10 – 7.19	0.03
Autonomy			
No	1		
Yes	2.26	0.85 – 6.03	0.11
Salt consumption			
No	1		
Yes	2.24	0.80 – 6.21	0.13
Marital status			
Single or widow	1		
Married or cohabiting	0.41	0.13 – 1.31	0.11

In the most appropriate regression model, based on the maximum likelihood ratio test, ie the one with p value <0.05, the significant variables were: smoking, age and marital status. The Table 5 presents the explanatory variables cited, with the both values of the Odds Ratios (OR) and Confidence Intervals (CI95%).

Table 5. Multivariate analysis (adjusted) of explanatory variables in the occurrence of hypertension among female teachers in state schools of Divinópolis, Minas Gerais, Brazil, in 2014

Variable	Adjusted analysis		
	OR	CI $_{95\%}$	p
Smoking			
Non smoker	1		
Smoker	9.34	2.75 – 31.71	< 0.001
Age (years)			
22 /– 52	1		
52/ – 59	2.96	1.01 – 8.65	0.048
Marital status			
Single or widow	1		
Married or cohabiting	0.25	0.06 – 1.00	0.050

DISCUSSION

Teachers' work has been characterized as stressful, due to inadequate work organization, which has a limited autonomy and lack of social support. In addition, the daily work, represented by the intense noise and some precarious relationships in the activity, have contributed to the development of stress[11]. This configuration of the teacher's work led to hypothesize that the presence of noise, a stressor, even if not at such intense levels as typically found in industry, could be associated with the occurrence of SAH among teachers.

The prevalence of SAH observed among female teachers higher than that found in a study with university female teachers,[13] where the value was of 7.14%. However, the results were lower than the values found in a study with Basic Education female teachers, in which the prevalence of SAH was of 20.1% [22].

Despite noting noise levels in the classroom above the permissible for an eight-hour workday, the variable "noise exposure" analyzed either as categorical or continuous did not present significance in the occurrence of hypertension, which is a result that contrasts with other studies developed in this subject [4-8]. Attarchi et al.[23] have shown that hypertension rate, systolic mean and diastolic BP were higher among shift workers that were exposed to noise higher than the permissible limit of 85 dB(A). Excessive exposure of female teachers to noise in the workplace requires appropriate control measures to prevent associated risks.

This study showed that age has an important influence on the occurrence of hypertension. This study showed that age has an important influence on the occurrence of hypertension, in line with other studies which reveal that with advancing age, a non-modifiable risk factor, there is a propensity to develop hypertension[22].

Passos et al.[24] affirm that there is a clear trend of increase in blood pressure with age, since a significant increase in blood pressure with age was verified, from 2.3% in the age group of 20-29 years old to 46.9% among those between 60 and 69 years old. Studies show that the prevalence of SAH increased progressively and significantly with age up to 69 years old, reaching 70.0% among those over 70 years[25].

Smoking was considered a significant variable for the occurrence of SAH in the final model. There are many reports that identify the cardiovascular system as one of the major target organs for problems due to smoking[26]. Nicotine's main acute effects on the cardiovascular system are peripheral vasoconstriction, blood pressure and heart frequency increasement[27]. Those reports state that nicotine generates the activation of sympathetic nervous system, along with heart frequency, blood pressure and myocardial contractility with the reduction of oxygen in forward vessels and the myocardium[27]. Either active or passive exposure to smoking causes damage to heart and blood vessels, although pathological mechanisms of damage may differ with regard to the type of action but not for that is concerning chemical toxics responsible of the alterations[28]. In this study, smoking behaved as a significant variable associated with hypertension.

Smoking, reported as a habit for 15.0% of the respondents, has been confirmed as a risk factor for numerous diseases, especially cardiovascular, cancer and respiratory diseases. This study showed that female teachers who smoke, adjusted for age and marital status, have a major probability of developing SAH. Any action in favor of smoking control must be carried out beyond the individual dimension, seeking to understand the social, political and economic variables that contribute to the smoking habit[29].

Marital status was another significant variable for the occurrence of hypertension in the final model. Corroborating the results of this study, other research show that married women generally have lower morbidity and mortality[30,31] In contrast, recent studies have shown that women who stay single instead of getting married, or who get divorced instead of staying married, are especially likely to be healthy[32]. Marital status have indirect influences on health outcomes, including hypertension through health risk behaviors and stress, and direct influences on cardiovascular, endocrine, immune, neurosensory, and other physiological.

This study took into account the occurrence of hypertension reported by the respondents who claimed having been diagnosed or to be using medication for hypertension. Thus, the information bias should be taken into account because there is no validation through diagnosis, or medical and hospital records.

The findings in observational studies are often distorted from different sources of bias[33]. An exposure assessment was undertaken during the development of its activities. However, the simple fact that the teacher is carrying a dosimeter in the classroom can interfere with the natural behavior of the students. Additionally, any shortcomings in the tools and technical errors of measurement can produce systematic errors in the measurement of exposure or in the outcomes.

The recovery of exposure to noise can suffer from bias, which would result in a value away from reality and therefore can influence the results of the study. Another relevant factor is the fact that the information regarding the risk factors for SAH were obtained from reports of the participants.

Finally, there is the bias of the healthy worker or of the survivor. The identification of this bias in this study is related to the inclusion of only active teachers, thus not including retired teachers or those on leave due to illness and accidents at work[34].

It is suggested that further research be conducted in order to look into this issue, exceeding the limits of this study, in order to undo this association.

CONCLUSION

This study aimed to investigate the association between noise exposure and SAH, a topic still little investigated in the working conditions of teachers. Based on the results, the association has not been verified. The prevalence of hypertension among female teachers in this study was lower than the value found at the national level and higher than that observed among university female teachers. The female teachers on their working day are exposed to excessive noise levels, justifying the adoption of preventive measures. Smoking, being above the median age of the sample, showed to be risk factors, while living with a partner represented protection against the occurrence of hypertension, among female teachers.

Because noise exposure is considered a consolidated health risk factor in the epidemiological literature and hypertension is one of the main diseases in the modern world, both should be evaluated in a risk prevention and health promotion process, seeking to contribute for teachers' quality of life.

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