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A Hierarchical Model to Study the Factors Associated with Hypertension: A Population-Based Study in Brazilian Elderly

Lydia Katharina Guedes Gama Santos[1], Sandra Rêgo de Jesus[2]

[1]Medical student and Scientific Initiation Scholar, Multidisciplinary Health Institute, Federal University of Bahia, Vitória da Conquista, Bahia, Brazil.
[2]Associeted Professor, Multidisciplinary Health Institute, Federal University of Bahia, Vitória da Conquista, Bahia, Brazil.

Corresponding Author: Lydia Katharina Guedes Gama Santos

ABSTRACT

Systemic arterial hypertension is one of the most widespread pathologies in the world and the main risk factor for cardiovascular diseases; it has been pointed out as one of the main causes of death and disability among the elderly. This study aimed to identify the factors associated with self-reported arterial hypertension in the elderly living in the north-eastern Brazil. This was a population-based cross-sectional study with a sample of 6,793 older adults (≥ 60 years of age) living in the capitals of the north-eastern Brazil. The explanatory variables were grouped according to a hierarchical conceptual model defined previously to assist in the description of self-referred hypertension. Poisson regression was used, and the prevalence ratios with their respective 95% confidence intervals were estimated. The prevalence of self-reported hypertension was 57.92% (95% CI: 57.84 – 58.01). The factors that increased the prevalence by more than 20% were: female gender (PR=1.22; 95%CI: 1.13 - 1.33), black skin color (PR=1.27; 95%CI: 1.16 - 1.40), age 75 or older (PR=1.21; 95% CI: 1.10 - 1.32), overweight (PR=1.40; 95% CI: 1.25 - 1.56) and diabetes diagnosis (PR=1.33; 95% CI: 1.25 - 1.42). Married elderly, with low schooling and those who evaluated the health status as poor also significantly increased the prevalence of self-reported hypertension. The high prevalence of hypertension among the elderly and the associated factors identified in this study are of fundamental importance to assist in the development of preventive programs and in the formulation of public policies to address them.

Key words: Hypertension; health of the elderly; epidemiological surveys

INTRODUCTION

Systemic Arterial Hypertension (SAH) is one of the most widespread pathologies in the world and the main risk factor for cardiovascular diseases. In Brazil, this condition is endemic in all states and its occurrence is related to age, socioeconomic level, living conditions and habits[1]. In this context, SAH stands out as a disease of important social and economic relevance, since it presents high occurrence and, consequently, great social impact on public health, economy and quality of life [2].

Hypertension also stands out because it affects a large number of people and is one of the most disabling diseases of today, besides being responsible for a significant part of deaths in Brazil [3]. The profile of people affected by hypertension found in literature matches the profile of the general population[1], the results highlight women, in which the diagnosis is related to the highest demand in Basic Health Units (BHS), people aged 60 or over, brown, overweight, alcoholics, smokers and people with physical activity and inadequate consumption of fruit [4].

Thus, it is perceived that the prevalence of SAH is more significant in socioeconomically disadvantaged populations [4], bringing social inequality as an important factor when thinking about prevention through changes in living and eating habits. Moreover, stress and lifestyle are related to the prevalence of the disease, since these can be related to food choices [5]. Therefore, it is also necessary to consider that SAH does not need to be standardized according to the advanced age group, given its vast possibility of prevention. In this circumstance, hypertension should be seen as a major challenge for the health care network to monitor and control cases [6].

It is known that aging is characterized as a dynamic process, progressive and irreversible, closely linked to biological, psychic and social factors [3]. This process increases the incidence of Chronic Noncommunicable Diseases (NCD) associated with disabilities and functional incapacities and may influence the well-being and quality of life of the elderly [6]. In this sense, knowing the factors associated with hypertension in the elderly, is extremely important to develop strategies to intervene in the affected population by promoting preventive actions[7].

In Brazil, some studies have investigated this subject in the elderly. However, most studies have limited comparability, due to the local scope and differences in issues and methods, making it difficult to use them as a decision tool for public health. For the elderly population ≥60 years old, studies in specific locations have shown prevalence of hypertension higher than 45%. [6,8]. In view of the above, the present study aims at identifying factors associated to self-reported arterial hypertension in elderly residents in the north-eastern Brazil.

MATERIAL AND METHODS

This is a population-based cross-sectional study that used data on the population aged 60 and over, living in the capitals of the north-eastern Brazil, collected in 2017 by system of Vigilância de Fatores de Risco e Proteção para Doenças Crônicas por Inquérito Telefônico (VIGITEL - Surveillance of Risk Factors and Protection for Chronic Diseases by Telephone Survey). The VIGITEL system has been performed annually by the Ministry of Health since 2006, in 26 Brazilian capitals and the Federal District. This system uses probabilistic samples of the adult population (≥ 18 years old) living in domiciles served by at least one fixed telephone line. To compensate for the bias of not universal fixed telephone coverage, post-stratification weights calculated by the "rake" method are used [9]. These weights seek to match the socio-demographic distributions of the sample in each city to the estimated distribution for the total adult population of the city. The post-stratification weight of each individual in the VIGITEL sample is used to generate all the estimates provided by the system for each of the 27 cities.

The VIGITEL data collection instrument addresses demographic and socioeconomic characteristics of individuals, characteristics of the pattern of diet and physical activity associated with the occurrence of NCD, weight and height referred, frequency of consumption of cigarettes and alcoholic beverages, self-assessment of health status, reference to previous medical diagnosis of hypertension and diabetes, among other subjects[9].

For this investigation, the prevalence of self-reported hypertension was considered as an outcome variable according to the positive answer to the question "Has any doctor ever told you that you have high blood pressure?

The explanatory variables were: gender (male, female), age group (60 to 64, 65 to 69, 70 to 74 and ≥ 75 years), marital status (single, married/united, widowed and separated/divorced), race/skin color (white, brown, black or yellow/indigenous), education (0 to 4, 5 to 8 and 9 or more years of study), possession of health plan (yes or no), smoking (non-smoker, ex-smoker and

current smoker), physical inactivity in the areas of "leisure", "work", "displacement" and "domestic activities" (yes, no), consumption of alcoholic beverages (yes, no), recommended consumption of fruits and vegetables - five or more servings a day (yes, no), referred diabetes (yes, no) and poor evaluation of health status (yes, no). The body mass index was classified as low weight (< 22 Kg/m2), eutrophic (22 to 27 Kg/m2) and overweight (> 27 Kg/m2)[10].

Since the study outcome is not a rare event, overestimation of Odds Ratios (OR) may be observed as compared with the Prevalence Ratios (PR). Therefore, rather than using logistic regression, multivariate Poisson regression models were defined with robust variance.[11, 12]. In all analyses we considered the effect of sample design for analysis of surveys based on complex designs of the Stata 15.0 program.

The statistical analysis was performed according to a predefined conceptual model (Figure 1). The model defined two hierarchical levels: the first level (distal) included only one block with all the variables of demographic/social-economic factors and the second level (proximal) included two blocks, one for behavioral variables (lifestyle) and another for health condition variables. Univariate and multivariate analyses were performed through Poisson regression with robust variance. The variables that presented P ≤0.05 in the univariate analyses were included in the next stage, which was an intra-block multivariate analysis.

Finally, the set of significant variables (P≤0.05) of the multivariate analysis in each block was inserted in the hierarchical analysis, following the order defined in the conceptual structure. The variables of level 1 were first introduced in the hierarchical model and the variables of level 2 were then introduced, since the effect of the variables at the distal level can be mediated by the variables at the proximal level. All the variables of the blocks of level 2 were introduced together as we postulate that they operate at the same level. Since we were interested in the effect of the variables at the distal level (even if they are mediated by the proximal variables), our final estimate for the effect of the distal variables is that before the introduction of the proximal variables, while the estimates of the effect of the variables at the proximal level should be made after the introduction of the variables at the distal level in the model, excluding the variables with P>0.05

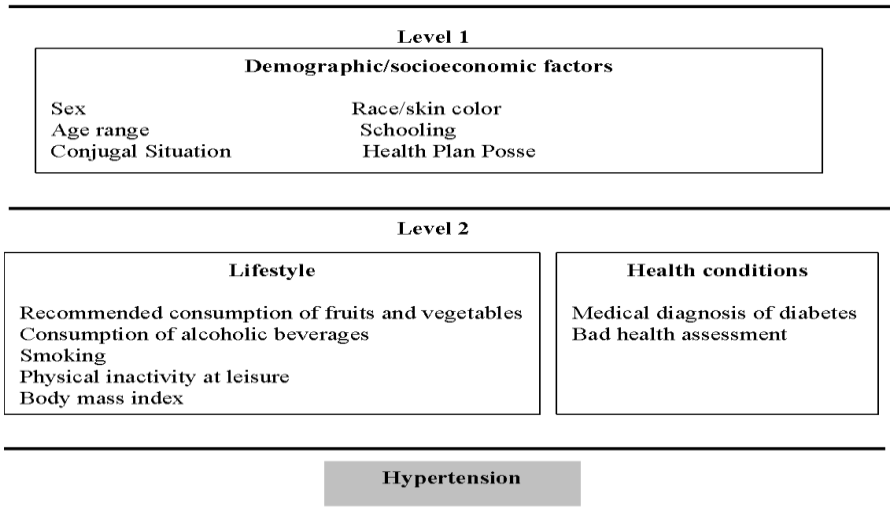

Figure 1 - Hierarchical model proposed for factors associated with hypertension in the elderly.

The variables in the multivariate model within each level and the variables of the proximal level were kept in the final model when they presented a P≤ 0.05.

The VIGITEL Project was approved by the National Commission of Ethics in Research for Human Beings of the Ministry of Health (Opinion 2.100.213/2017 - CAAE: 65610017.1.0000.0008). The Informed Consent Term was replaced by the verbal consent at the time of telephone contact with the interviewees.

RESULTS

In 2017, for the 9 capitals of the north-eastern Brazil, VIGITEL conducted 18,382 interviews with adults (≥18 years), indicating a participation rate of 71.75%, ranging from 71.16% in Recife to 72.60% in Salvador.

Among the 18,382 individuals surveyed, 6,793 were elderly. The prevalence of self-reported hypertension among elderly people in the Northeast was 57.92% (95% CI: 57.84 - 58.01), being lower among elderly people living in Fortaleza (50.78%; 95% CI: 50.60 - 60.96). Prevalence of self-reported systemic arterial hypertension higher than 60% were observed for elderly residents in Maceió (63.89%; 95% CI: 63.60-64.18), Natal (62.94%; 95% CI: 62.65-63.23), Salvador (61.08%; 95% CI: 60.91-61.25) and Teresina (61.09%; 95% CI: 60.77-61.41) (Table 1).

Table 1 - Prevalence of hypertension according to the capitals of the north-eastern Brazil. VIGITEL, 2017.

Capitals	Prevalence (%)	95% CI
Aracaju	58.18	57.81 – 58.55
Fortaleza	50.78	50.60 – 60.96
João Pessoa	53.81	53.49 – 54.12
Maceió	63.89	63.60 – 64.18
Natal	62.94	62.65 – 63.23
Recife	59.32	59.11 – 59.52
Salvador	61.08	60.91 – 61.25
São Luís	54.58	54.23 – 54.92
Teresina	61.09	60.77 – 61.41
Total	**57.92**	**57.84 – 58.01**

95% CI: 95% Confidence Interval

Table 2 - Prevalence and prevalence ratio of hypertension according to the level 1 variables in the block of factors demographic and socioeconomic. VIGITEL, Brazil, 2017.

Level 1	Frequency (%)	Prevalence (%)	PR[a]	95% CI	PR[b]	95% CI
Sex						
Male	39.12	52.00	1.00		1.00	
Female	60.88	61.73	1.19	1.11-1.27	1.23	1.14-1.33
Age group						
60 to 64 years	38.06	51.66	1.00		1.00	
65 to 69 years	20.87	60.17	1.16	1.07-1.27	1.16	1.06-1.27
70 to 74 years	18.03	60.94	1.18	1.08-1.29	1.19	1.08-1.31
>= 75 years	23.04	63.88	1.24	1.14-1.34	1.22	1.11-1.34
Conjugal Situation						
Single	13.21	52.70	1.00		1.00	
Married/stable unit	58.52	57.02	1.08	0.98-1.19	1.14	1.03-1.27
Widower	19.70	63.73	1.21	1.09-1.34	1.09	0.97-1.22
Separated/divorced	8.57	58.85	1.11	0.98-1.27	1.13	0.98-1.30
Breed / Skin Color						
White	43.55	54.39	1.00		1.00	
Black	13.30	70.43	1.29	1.18-1.42	1.27	1.16-1.40
Parda	40.59	57.73	1.06	0.99-1.14	1.08	1.00-1.16
Yellow/indigenous	2.56	60.32	1.11	0.91-1.35	1.05	0.86-1.28
Schooling (years of study)						
>= 9 years	34.07	52.53	1.00		1.00	
From 5 to 8 years	24.93	58.13	1.11	1.02-1.20	1.06	0.96-1.16
From 0 to 4 years	41.00	62.28	1.19	1.11-1.27	1.12	1.04-1.22
Possession of health plan						
Yes	43.01	55.74	1.00		1.00	
No	56.99	59.70	1.07	1.01-1.14	1.05	0.98-1.13

[a] *Crude prevalence ratio;*
[b] *Prevalence ration from the intra-block multiple regression;*
95% CI: 95% Confidence Interval.

Table 2 shows the prevalence and prevalence ratio of hypertension according to sociodemographic factors (level 1 variables). The highest prevalence of hypertension among females (61.73%), widowers (63.73%), those who declare themselves black (70.43%), those with 0 to 4 years of schooling (62.28%) and those without a health plan (50.70%) is verified. The prevalence of SAH among the elderly

presents a tendency to increase with age, being the prevalence of 63.88% for the age group of 75 years or more.

All socio-demographic factors were significantly associated with hypertension in the univariate analysis, (P<0.05). The elderly who declare themselves black had a higher prevalence of hypertension when compared to white (PR=1.27; 95% CI: 1.16 - 1.40), even after adjusting for intra-bloc factors. In the intra-block multivariate analysis, except for the health plan, all variables remained significantly associated with hypertension with P<0.05 (Table 2).

Table 3 shows the prevalence and prevalence ratio of hypertension according to lifestyle factors and health conditions (level 2 variables)There is a higher prevalence of hypertension among the elderly who responded "no" to regular consumption of fruits and vegetables (58.63%); for those who consume alcohol (59.23%), for non-smokers (59.06%), for those with physical inactivity (62.45%), in those who are overweight (66.57%), in those who reported having diabetes (76.34%) and in those who evaluated their health status as poor (70.98%).

Most lifestyle factors and health conditions were associated with hypertension in univariate analyses (with a P <0.05), with the exception of the variable related to regular consumption of fruits and vegetables. The elderly with overweight presented higher prevalence of hypertension (PR=1.37; 95% CI: 1.24 - 1.52), even after adjustment by intra-bloc factors. Similarly, a 39% higher prevalence of hypertension was found in elderly who reported medical diagnosis of diabetes (PR=1.39; 95% CI: 1.31 - 1.47). In the intra-block multivariate analysis, the following variables remained with P<0.05: smoking (PR= 0.74; 95% CI: 0.62-0.88), physical inactivity (PR=1.08; 95% CI: 1.01-1.14), body mass index (PR=1.37; 95% CI: 1.24-1.52), and poor health status evaluation (PR= 1.15; 95% CI: 1.05-1.27).

Table 3 - Sample distribution, prevalence and prevalence ratio of hypertension according to the level 2 variables in the block of factors lifestyle and health conditions. VIGITEL, Brazil, 2017.

Level 2	Frequency (%)	Prevalence (%)	PR[a]	95% CI	PR[b]	95% CI
Regular consumption of fruits and vegetables						
Yes	35.05	56.61	1.00		1.00	
No	64.95	58.63	1.04	0.97-1.10	1.03	0.97-1.10
Consumption of alcoholic beverages						
No	77.48	59.23	1.00		1.00	
Yes	22.52	53.43	1.11	1.03-1.20	1.04	0.96-1.12
Smoking						
Non-smoker	57.69	59.06	1.00		1.00	
Current smoker	5.36	42.17	0.71	0.59-0.86	0.74	0.62-0.88
Former smoker	36.95	58.44	0.99	0.93-1.05	0.98	0.92-1.04
Physical inactivity						
No	67.16	55.71	1.00		1.00	
Yes	32.84	62.45	1.12	1.06-1.19	1.08	1.01-1.14
Body mass index						
Low weight	16.26	46.19	1.00		1.00	
Strophic	41.64	53.77	1.16	1.05-1.30	1.16	1.04-1.29
Overweight	42.09	66.57	1.44	1.30-1.60	1.37	1.24-1.52
Diabetes						
No	77.33	52.52	1.00		1.00	
Yes	22.67	76.34	1.45	1.37-1.53	1.39	1.31-1.47
Bad health assessment						
No	92.78	56.91	1.00		1.00	
Yes	7.22	70.98	1.25	1.13-1.37	1.15	1.05-1.27

[a] *Crude Prevalence ratio;*
[b] *Prevalence ration from the intra-block regression;*
95% CI: 95% Confidence Interval.

The results from the final multivariate hierarchical analysis are presented in Table 4. The variables that increased the prevalence of hypertension by more than 20% in the elderly were: female gender (PR=1.22; 95% CI: 1.13 - 1.33),

black skin color (PR= 1.27; 95% CI: 1.16 - 1.40), age 75 or older (PR=1.21; 95% CI: 1.10 - 1.32), overweight (PR=1.40; 95% CI: 1.25 - 1.56) and medical diagnosis of diabetes (PR=1.33; 95% CI: 1.25 - 1.42). It is also observed higher prevalence of hypertension among married elderly (PR=1.14; 95% CI: 1.02-1.27), in those with schooling ≤ 4 years of study (PR=1.16; 95%CI: 1.07-1.25) and in those who evaluated the health status as poor (PR=1.14; 95%CI: 1.02-1.26). In contrast, the elderly smokers had a significantly lower prevalence (PR=0.76; 95% CI: 0.63 - 0.92), i.e., the prevalence of self-reported hypertension was 24% lower in elderly smokers.

Table 4 - Prevalence ratio derived from hierarchical multiple regression on the factors associated with hypertension. VIGITEL, Brazil, 2017.

Levels	PR	95% CI
Level 1*		
Sex		
Male	1.00	
Female	1.22	1.13-1.33
Age group		
60 to 64 years		
65 to 69 years	1.16	1.06-1.27
70 to 74 years	1.18	1.08-1.30
>= 75 years	1.21	1.10-1.32
Conjugal Situation		
Single	1.00	
Married/stable unit	1.14	1.02-1.27
Widower	1.08	0.97-1.21
Separated/divorced	1.13	0.98-1.30
Breed / Skin Color		
White	1.00	
Black	1.27	1.16-1.40
Parda	1.09	1.01-1.17
Yellow/indigenous	1.09	0.90-1.32
Schooling (years of study)		
>= 9 years	1.00	
From 5 to 8 years	1.08	0.98-1.18
From 0 to 4 years	1.16	1.07-1.25
Level 2**		
Smoking		
Non-smoker	1.00	
Current smoker	0.76	0.63-0.92
Former smoker	0.98	0.91-1.05
Body mass index		
Low weight	1.00	
Strophic	1.16	1.03-1.31
Overweight	1.40	1.25-1.56
Diabetes		
No	1.00	
Yes	1.33	1.25-1.42
Bad health assessment		
No	1.00	
Yes	1.14	1.02-1.26

PR: Prevalence ratio;95% CI: 95% Confidence Interval.

DISCUSSION

The prevalence of hypertension in the elderly was 57.92% and showed variation in the capitals of the north-eastern Brazil. The prevalence of hypertension in the elderly found in this region corroborates with results found in other studies conducted in Brazil [16-18] in which relate the higher prevalence of NCDs with the advancement of age [4, 6-8], taking into account that the natural process of aging brings with it the accumulation of risk factors increasing the prevalence from this age group [3,4,6]. In some studies it was possible to observe the prevalence of the diagnosis of hypertension in at least half of the population from 55 years of age showing that the prevalence of hypertension and its complications and limitations increase with advancing age[1, 13].

In this study the results showed that the factors associated with hypertension in elderly north easterners were: female gender, age advancement, married marital status/stable union, black skin color, low schooling, overweight, diabetes, being a smoker and assessing the health status as bad. In this analysis, the prevalence of self-reported hypertension was influenced by factors of all hierarchical levels, with overweight and diabetes increasing by more than 30% the prevalence of SAH. The results of this study are reinforced with similar findings in different contexts and with different methodologies that reported the factors associated with hypertension.

In relation to socio-demographic factors, women presented a higher prevalence of hypertension, corroborating with findings from other studies of chronic diseases in the elderly in Brazil[1, 4, 6, 8, 13, 15, 17, 33], this finding is explained by greater zeal on the part of women for health issues and, consequently, greater demand for health services[1, 8, 13]. It is also observed that the elderly married or with stable union presented higher prevalence of hypertension, this finding may be related to a positive influence of women in their spouses in the search for health services,

moreover, it is found in the literature that among individuals who have never assessed the pressure, men presented a higher proportion[1, 13] strengthening the argument of lower demand for health services by men.

Elderly people with black skin color presented higher prevalence of hypertension, as has been observed in other studies[8, 17, 20]. Regarding schooling, it was possible to observe a higher prevalence of hypertension in older people with fewer years of study, corroborating the findings of other studies[1,7,8,13,21]. Skin color is an important determinant of social inequality and linked to low schooling reveals a group in vulnerable socioeconomic situation[8, 20, 27], and may be related to the presence of chronic diseases[17], taking into account access to health services, medical care or access to medication for long-term treatment [26, 27]. In addition, access to information assists in healthier choices and habits in everyday life, and can be considered a social determinant of health and disease conditions. Therefore, low schooling and black skin color are factors of iniquity in the access to hypertensive care practices, demanding more and more affirmative public policies to address inequalities[17, 26, 27, 29, 33].

Smoking presented an inverse and significant association with the prevalence of hypertension. This result corroborates with other studies performed with the elderly [17, 36]. The negative association of smoking with hypertension has been attributed to the fact of reverse causality, i.e., abandonment of this habit due to health problems. Considering that in this study the prevalence of hypertension was lower among the elderly smokers, it is believed that this fact may indicate the follow-up of blood pressure levels. The increase in demand for health services to control blood pressure levels results in a greater number of recommendations and educational interventions that encourage smoking cessation [36]. Although non-smoking is not related to the reduction in blood pressure, it alone remains one of the main risk factors for cardiovascular disease and therefore cessation should be recommended in both primary and secondary prevention [36].

The findings of this article are reinforced with the results found in other studies in which diabetes also showed association with hypertension among the elderly, the prevalence of hypertension was significantly higher among the elderly who reported having diabetes. Results of clinical research indicate that about 70% of diabetics have hypertension, and the coexistence of hypertension and diabetes significantly increases the risk of developing cardiovascular diseases and other comorbidities[40].

Regarding the nutritional status, it was observed a higher prevalence of hypertension in the elderly with overweight, the relationship between overweight and SAH has already been portrayed in the literature [1, 4, 7, 8, 21, 33, 37-39]. The prevalence of obesity may increase with age, since overweight is determined by the decrease in basal metabolism rate, which may occur as a consequence of the loss of muscle mass, natural of senility [37]. Overweight can also result in changes in other pathophysiological mechanisms such as insulin resistance, hyperinsulinemia and increased reabsorption of sodium and water due to kidney changes [38], adding to the accumulation of risk factors for chronic non-communicable diseases [33, 37].

The self-perception of poor health was associated with the higher prevalence of SAH, this result corroborates what was found in another study[35]. The perceived health condition is permeated by several socio-demographic and economic factors such as income, education, living habits and presence of comorbidities[42], so the result found can be explained by the accumulation of diseases accentuated with age, and the relationship of hypertension with other diseases [3, 32, 35, 36, 38]. Thus, the set of these morbidities and, as a consequence, the need for prolonged rigid drug control, increased attendance at medical appointments, may

contribute to a worse perception of health status [32, 35, 42].

The results of this study should be interpreted with some limitations. It is a transversal study, which evaluates only association between variables, without the possibility of defining a causal relationship. Another limitation is the use of self-reported hypertension, although the use of this measure has shown to be a recommended indicator in population-based studies with large samples like this [21,28]. Despite these limitations, the methodology used in this study responded to the objectives and the associations found were compatible with other studies.

CONCLUSION

The results of this study showed that the prevalence of hypertension in the elderly of the north-eastern Brazil was over 57%, portraying an important public health problem in Brazil that needs to be addressed with attention. The advancement of age, black skin color, low schooling, overweight and the report of medical diagnosis of diabetes were associated with the higher prevalence of hypertension among the elderly in the year 2017, evidencing that the problem is even more impactful in certain subgroups of society. The high prevalence of hypertension among the elderly and the associated factors identified in this study are important to assist in the development of preventive programs and in the formulation of public policies to confront it in this region.

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