Hypertension and Clustering of Cardiovascular Risk Factors in a Community in Southeast Brazil - The Bambuí Health and Ageing Study

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Objective - *A population-based prospective study was analysed to: a) determine the prevalence of hypertension; b) investigate the clustering of other cardiovascular risk factors and c) verify whether older differed from younger adults in the pattern of clustering.*

Methods - *The data comprised a representative sample of the population of Bambuí, Brazil. Multiple logistic regression was used to investigate the independent association between hypertension and selected factors.*

Results - *A total of 820 younger adults (82.5%) and 1494 older adults (85.9%) participated in this study. The overall prevalence of hypertension was 24.8% (SE=1.4 %), being higher in women (26.9±1.5%) than in men (22.0± 1.7%) (p=0.033). Hypertension was positively and significantly associated with physical inactivity, overweight, hypercholesterolemia hyperglycemia and hypertriglyceridemia. The coexistence of hypertension with 4 or more of these risk factors occurred 6 times more than expected by chance, after adjusting for age and sex (OR=6.3; 95%CI: 3.4-11.9). The pattern of risk factor clustering in hypertensive individuals differed with age.*

Conclusion - *Our results reinforce the need to increase detection and treatment of hypertension and to approach patients' global risk profiles.*

Keywords: hypertension, cardiovascular risk factors, prevalence

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Epidemiological data show that hypertensive individuals are remarkably different from normotensive persons in more than just high blood pressure (BP). A tendency exists for hypertension to occur in combination with other lifestyle, metabolic, and anthropometric factors, all independently associated with increased risk of cardiovascular diseases (CVD). According to data from the Framingham Heart Study, less than 20% of hypertension occurs in the absence of 1 or more risk factors, including high triglycerides and LDL cholesterol levels, reduced HDL cholesterol levels, glucose intolerance, hyperinsulinemia, obesity, and left ventricular hypertrophy [1].

Cardiovascular diseases are the leading cause of death in Brazil, accounting for 34% of all deaths in 1990-94 [2], and the main cause of hospitalisation in those aged ≥60 in 1996 [3]. The country's population is ageing very rapidly, and the social and economic burden associated with CVD is likely to grow. Until recently, CVD were supposed to be a problem of adults living in the large metropolitan areas of Brazil. However, around 27 million Brazilians live in urban areas of small municipalities, and little is known about their risk profile. We investigated hypertension as a risk factor syndrome in younger and older adults living in a small municipality in Southeast Brazil that was also formerly an endemic area for Chagas' disease [4,5].

We analysed data from the baseline of the Bambuí Health and Ageing Study (BHAS), which comprises a community survey and an ongoing prospective study designed to identify predictors of adverse health events in older adults [4]. The objectives of this study are: a) to describe BP levels and the prevalence of hypertension in the adult population living in a community in Southeast Brazil, b) to compare hypertensive and normotensive individuals in relation to the presence of other cardiovascular risk factors including metabolic, anthropometric, and lifestyle factors, and c) to verify whether older adults differ from younger adults in the overall pattern of risk factor clustering.

Methods

Bambuí is located in West Minas Gerais State, in Southeast Brazil. The municipality had around 20,000 inhabitants in 1996, of which 73% were living in the urban area. Agriculture and commerce are the main economic activities of the municipality. Life expectancy increased from 59.9 in 1970 to 70.2 years in 1991. Cardiovascular diseases (ICD-9: 390-459) were the primary cause of death in Bambuí in 1991 (34%) and the second cause of hospitalisations in the public sector in 1993 (18,5%). In Bambuí, even though transmission of *Trypanosoma cruzi* has now been interrupted, the prevalence of the infection is very high among the aged due to a cohort effect [5].

Participation in the study was voluntary, and a signed copy of an informed consent was obtained from all participants.

The BHAS includes an initial baseline survey and follow-up activities. Complete censuses were carried out for identification of participants. All residents aged ≥60 years (n=1742) and a nonreplaceable simple probabilistic sample of adults aged 18-59 years were selected for interview and examinations. The sample size of adults (1020/8899 inhabitants) was sufficient to estimate a prevalence of risk factors = 0.50, with a confidence interval = 0.95, losses = 0.20, and precision = 0.03.

In the present study, the baseline cohort data (≥60 years) and the cross-sectional study data (18-59 years) were analysed. Interviews, physical measurements, blood samples, and blood tests of all participants were accomplished between January and August 1997. Further details of the methods used to conduct the study have been published elsewhere [4].

The following information obtained in the BHAS baseline survey questionnaire was used in this analysis: 1) social and demographic characteristics (age, sex, personal and family income, graduation level, marital status), 2) lifestyle characteristics (physical activities, smoking and drinking habits), and 3) clinical aspects (use of antihypertensive medication). The interview lasted about 90 minutes and was performed at home. Neither interviewer nor interviewee knew about the objectives of this study at the time of the interview.

Health professionals especially trained for this project took BP and physical measurements of all participants at the local health service. BP was measured 30 or more minutes after the last caffeine intake or cigarette smoked. Systolic and diastolic BP (SBP and DBP) were recorded as the first and fifth Korotkoff sounds, respectively. Three measures were taken after 5 minutes of initial rest and subsequently at 2-minute intervals. In this study, BP was considered as the arithmetic mean of the second and third measurements [5]. The nutritional indicator used was body mass index (BMI = weight/square height), and measures were taken by specially trained health technicians, using standard equipment [4].

Blood samples were collected after for 12 hour fasting. Plasma levels of glucose, total cholesterol, HDL cholesterol, and tryglicerides were determined using an automated analyser (Eclipse Vitalab, Merck, The Netherlands). LDL cholesterol was estimated using the Friedewald equation [6]. Consequently, information on LDL cholesterol was regarded as missing for levels of triglycerides equal to or greater than 400mg/dL. The presence of *T. cruzi* antibodies was detected using an indirect hemaglutination test and an enzyme linked immunoabsorbent assay (Biolab and Abbott Brazil, respectively).

Hypertension was defined as DBP ≥90mmHg, or SBP ≥140mmHg or current use of antihypertensive medication for management of hypertension, at the time of interview [7]. We determined 4 study subjects were hypertensive by asking them and also by checking to antihypertensive medications at their homes. If both were affirmative, the subject was classified as having hypertension irrespective of the blood pressure obtained.

Estimates were weighted to allow for the difference in sampling probability of participants aged 18-59 years (younger adults) and those aged ≥60 years (older adults) and to represent the total urban adult population. Descriptive statistics were used to fully explore the data. One sample *t* test was used for comparisons between means and design-based Pearson's chi-square test for proportions.

To investigate the tendency of hypertension to cluster with other cardiovascular risk factors, we created a risk factor score to rank individuals according to the number of other known risk factors for CVD existing at the time of the survey. The following factors and cut-off points were used to build up this risk factor score: 1) BMI ≥25kg/m^2, 2) total cholesterol ≥240mg/dL and/or LDL-cholesterol >160mg/dL, 3) HDL-cholesterol <50mg/dL in males or <45 mg/dL in females, 4) triglyceride >150mg/dL, 5) blood glucose ≥126mg/dL, 6) current smoker, and 7) physical inactivity (walking or doing some other kind of exercise less than once per week and a self-report of having a sedentary life). The final risk factor score varied from 0 to 4, with 0 meaning no exposure to these factors, 1 being the exposure to any 1 factor and 2, 3, and 4 being exposure to any combination of 2, 3, or 4 or more of these factors, respectively.

The magnitude of the association between hypertension and independent variables was investigated using multiple logistic regression [8]. The analysis was carried out using Stata Statistical Software [9].

Results

The total number of participants in this study was 820 individuals aged 18-59 years (82.5% of the selected sample) and 1494 individuals aged ≥60 years (85.9% of residents).

The prevalence of hypertension in the adult population of Bambuí was 24.8% (SE: 1.14), being higher in women (26.9±1.5%) than in men (22.0±1.7%) (p=0.033). Figure 1 shows the prevalence of hypertension according to sex and age group. The prevalence of hypertension increased with age for males and females up to age group 60-69 years, and was much lower for very old (≥80 years) males than females in the same age group (43% *vs.* 68%, respectively).

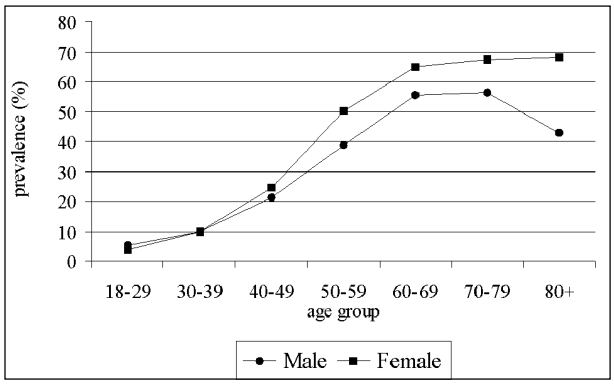

Fig. 1 - Prevalence of hypertension in the urban adult population of Bambuí according to sex and age group. BHAS, 1996-97.

Forty-two percent of younger and 51% of older adults were classified as having stage I hypertension (SBP=140-159 or DBP=90-99) [7]. A slightly higher proportion of younger adults (20%) than older adults (13%) were classified as having stage 2 (SBP=160-179 or DBP=100-109), and similar percentages as having stages 3 or 4 hypertension (SBP≥180 or DBP≥110) (11% and 13%, respectively). Ageing was also associated with an increasing severity in levels of BP, expressed by higher levels of mean SBP with increasing age in men and women, with a slight decrease in the mean level for very old men (≥80 years) (Figure 2). The mean levels of both SBP and DBP were lower in women during early adulthood than in men. Pulse pressure (SBP minus DBP) was highest for very old (≥80 years) women (Figure 2).

Isolated systolic hypertension (ISH), defined as SBP ≥140mmHg and DBP <90mmHg, regardless of medication status, was found in 18.9% of the individuals with hypertension. This proportion was around 1% up to age 40-49 years increasing sharply thereafter (7.9%, 12.9%, 21.7%, and 20.7% in age groups 50-59, 60-69, 70-79, and ≥80 years, respectively). Defining ISH as SBP≥160mmHg and DBP<95mmHg reduced the overall prevalence of ISH to 4.9%, being 9.3% among the older and 1.4% among younger adults.

The results of the logistic regression analysis on the association of hypertension with socio-demographic characteristics and lifestyles are presented as raw and after adjustment for age and sex (Table I). Current smoking and inactivity remained associated with hypertension status after adjustment for age and sex, with prevalences being lower in current smokers and higher in inactive persons. BMI ≥25kg/m^2 and ≥30kg/m^2 were highly associated with hypertension before and after adjustment for age and sex. Hypertension status was not statistically associated with schooling or family income after adjustment for age and sex.

All metabolic factors (total cholesterol, HDL and LDL-cholesterol, triglycerides, and glucose) were significantly associated with hypertension status before and after adjustment for age and sex. The association between *T. cruzi* infection and hypertension found in the univariate analysis disappeared after adjustment for age and sex (Table II).

The average number of linked metabolic and lifestyle risk factors for CVD increased with age, in both hypertensive and normotensive persons. However, the average number of risk factors was higher for individuals with hypertension at in all age groups compared (1.32, 1.57, and 1.98 in normotensive persons aged 18-39, 40-59, and ≥60 years vs. 2.03, 2.13, and 2.31 in hypertensive persons in the same age groups). In hypertensive individuals, only 6% of younger and 8% of older adults were not simultaneously exposed to

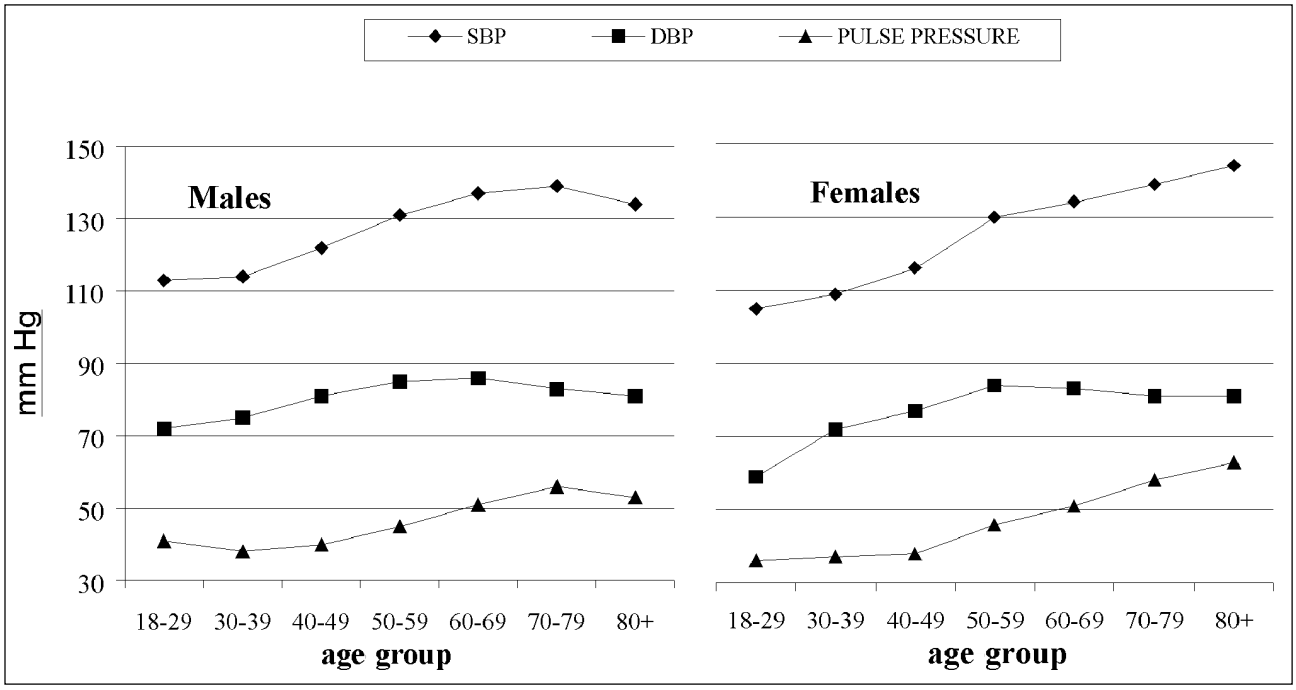

Fig. 2 - Mean systolic and diastolic blood pressures and pulse pressure by age for men and women 18 years of age and over. BHAS, 1996-97.

Table I - Association between hypertension and selected conditions before and after adjustment for sex and age group. BHAS, 1996-97

Factor	Hypertension		Odds ratio	Adjusted
	No (n=1256)	Yes (n=1058)	(95% CI)	(95% CI)
Sex				
Male	570	377	1.00	1.00
Female	686	681	1.30 (1.02- 1.67)	1.30 (0.96-1.75) [1]
SLiteracy (years)				
None	206	323	1.00	1.00
1-3	288	339	0.62 (0.43-0.90)	1.03 (0.68-1.56)
4-7	427	302	0.26 (0.18-0.37)	0.75 (0.49-1.15)
8+	335	94	0.12 (0.08-0.18)	0.62 (0.36-1.05)
Family monthly income (minimum wage)				
<2	288	299	1.00	1.00
2-3.99	464	387	0.64 (0.47-0.88)	0.87 (0.59-1.29)
4-5.99	237	167	0.58 (0.40-0.84)	0.97 (0.61-1.55)
6-9.99	133	104	0.52 (0.33-0.82)	0.93 (0.54-1.61)
10+	116	93	0.56 (0.35-0.89)	0.85 (0.49-1.48)
Smoking				
Never	671	642	1.00	1.00
Ex-smoker	344	175	0.51 (0.37-0.64)	0.93 (0.63-1.36)
Current smoker	241	241	1.16 (0.86-1.58)	0.60 (0.41-0.88)
Physically active[3]				
No	256	361	1.00	1.00
Yes	1000	697	0.34 (0.26-0.45)	0.59 (0.41-0.84)
Body mass index (kg/m2)				
<25	766	434	1.00	1.00
25-29	355	410	2.69 (2.05-3.52)	2.82 (2.02-3.94)
≥ 30	107	184	4.30 (2.99-6.20)	4.29 (2.75-6.70)

[1] Odds ratio adjusted for age; [3] Physically active: walking or doing other kinds of exercise at least once per week or self-report of moderate/intense level of activity in daily life.

Table II - Association between hypertension and selected laboratory examinations, raw and after adjustment for sex and age group. BHAS, 1996-97

Factor	Hypertension		Odds ratio	Adjusted Odds ratio
	No (n=1256)	Yes (n=1058)	(95%CI)	(95% CI)
Cholesterol (mg/dL)				
<200	632	269	1.00	1.00
200-239	358	359	2.74 (2.03-3.69)	1.51 (1.06-2.14)
≥240	266	430	5.28 (3.85-7.24)	1.89 (1.27-2.82)
HDL Cholesterol ≥45 (men) or ≥50mg/dL (women)				
Yes	682	522	1.00	1.00
No	572	534	1.32 (1.04-1.68)	1.46 (1.07-1.99)
Triglycerides (mg/dL)				
<150	931	593	1.00	1.00
≥150	323	463	2.51 (1.94-3.24)	2.03 (1.49-2.75)
Blood glucose (mg/dL)				
<126	1191	916	1.00	1.00
≥126	63	140	4.75 (2.89-2.78)	1.86 (1.08-3.22)
Serology for T. cruzi				
Negative	997	691	1.00	1.00
Positive	251	359	4.05 (3.01-5.46)	1.11 (0.77-1.59)

the metabolic and lifestyle risk factors considered in this study. The corresponding figures in normotensive individuals were 23% and 10%, respectively. Conversely, the proportion of persons exposed to 3 or more risk factors was 31% and 42% in hypertensive individuals aged 18-59 and ≥60 years, respectively and 15% and 33% in normotensive persons in the same age groups.

The raw and sex and age-adjusted odd ratios (OR) for each level of the risk scores are given in Table III. A clear and steep upward trend exists in the sex and age-adjusted OR for being hypertensive with increasing risk factor scores, with a highly significant x^2 for linear trend. The magnitude of the age-adjusted OR for risk factor scores was similar for men and women. Inclusion of educational level in the multivariate analysis had a negligible effect on the OR for risk factor score and was not kept in the final analysis.

The pattern of risk factor clustering in hypertensive individuals differed significantly with age (χ^2=10.05, P=0.0

Table III - Odds ratios for hypertension according to the score of other cardiovascular risk factors, raw and after adjustment for age and sex. BHAS, 1996-97

Risk factor score[1]	Hypertension		Odds-ratio	Age-adjusted Odds-ratio
	Yes (%) (n=1026)	No (%) (n=1223)	(95% CI)	(95% CI)
Zero	76	208	1.00	1.00
One	222	395	2.54(1.60-4.06)	2.48 (1.49-4.13)
Two	305	334	3.52 (2.22-5.58)	2.87 (1.72-4.80)
Three	245	197	6.09 (3.73-9.94)	4.33 (2.48-7.55)
Four or more	178	89	10.71 (6.15-18.65)	6.33 (3.38-11.86)

[1] : Risk factor score: defined as the sum of any combination of the following factors: 1) BMI ≥25kg/m², 2) total cholesterol ≥240mg/dL and/or LDL-cholesterol >160mg/dL, 3) HDL-cholesterol <50 mg/dL in males or <45 mg/dL in females, 4) triglyceride >150mg/dL, 5) blood glucose ≥ 126mg/dL, 6) current smoker, and 7) physical inactivity.

40), inactivity (χ^2=8.77, *P*=0.003), hyperglycemia (χ^2=7.83, P=0.005), and hypercholesterolemia (χ^2=28.61, P<0.001) being more common in older adults and overweight (χ^2=15.51, p<=0.001) being more common in younger adults.

Discussion

This study found that about 1/4 of the population in this community is hypertensive. Most adults had stage 1 hypertension, but over 28% had BP levels beyond 160/100mmHg (stages 2, 3, or 4), and this proportion was highest in older men (around 40%). The prevalence of hypertension in the older population living in this community is very high (61.5%), and surprisingly close to that described for the American population in the same age group [10].

The overall prevalence of hypertension in this study community is similar to that found in São Paulo, the largest Brazilian city with over 10 million inhabitants [11], and smaller than that found in other studies in the country [11-13]. Discrepancies in the age range and sex distribution among the study populations in these surveys are likely to account for such differences. The variation in the prevalence of hypertension with age in both sexes is very similar to prevalence curves described in cross-sectional studies in Brazil [14,15] and in other countries [16-18].

The increase in pulse pressure with age observed in this community has been associated with ISH, and predicted CVD in a continuous graded fashion at all levels of BP in the Framingham Study [19]. The prevalence of ISH is seldom mentioned in Brazilian studies, perhaps because it is much more common in older age groups, and none of the studies on hypertension were designed to study older adults. We found a much lower prevalence of ISH among hypertensive older adults in Bambuí (26.7%) than observed in the older adults participating in the Framingham Study (65-75%) and the US population aged ≥60 years (65%) [19,20]. The rise in SBP with advancing age is attributed to loss of arterial compliance and this process is unlike that of atherosclerosis, which underlies the preponderance of CVD observed in older people [16]. Combined systolic and diastolic hypertension, which predominates in this study community, seems to carry only a marginally greater risk than ISH [20]. The low prevalence of ISH may be partly explained by the younger age of older adults in this community as compared with Americans studied, but it is also likely to express population differences in prevalence of risk factors affecting systolic and diastolic BP levels.

Hypertension was not associated with any of the socio-demographic variables in this study after adjustment for age and sex. Some Brazilian studies have found an association between hypertension and educational level [13,15,21], but they were conducted in large cities with greater socio-economic contrasts than our study community, where agriculture is the main economic activity. In this community, educational level decreases with age. About 24% of younger and 64% of older participants have less than 4 years of graduation. This fact may have reduced the ability to detect any possible association with educational level in our study.

Regarding the comparison of hypertensive and normotensive individuals, the results are worrisome: only 7% of hypertensive individuals were not exposed to other metabolic or lifestyle risk factors. All metabolic factors investigated were associated with hypertension independently of age and sex. These findings agree with previous investigations on the tendency of hypertension to occur concomitantly with other metabolic disorders [3]. The importance of this clustering relates to its great impact on the risk of CVD. Lipoproteins greatly affect the impact of hypertension on atherogenesis, and high cholesterol (especially HDL cholesterol) and triglyceride levels markedly influence the risk of hypertension-induced coronary disease. Similarly, the risk of coronary artery disease is also greatly increased by coexisting glucose intolerance [19]. Smoking was associated with a lower prevalence of hypertension. This finding agrees with other cross-sectional studies in the country [15] and elsewhere [19], and is probably explained by the worse survival of hypertensive smokers and lifestyle changes induced by disease.

Lack of regular physical activity was also related to a high prevalence of hypertension in other studies [13,15,22.] It is now accepted that exercise plays a direct and etiological role in BP levels and should be part of a global approach to treatment of hypertension. Exercise seems to have a protective effect on premature death and coronary artery disease even when started late, regardless of patients' age and how long they have been sedentary [23].

The association between BMI and hypertension has been observed in other cross- sectional studies in Brazil [13,15]. Strong epidemiological evidence exists that overweight increases the risk of hypertension and CVD, independent of age or levels of plasma glucose and serum cholesterol. Obesity, particularly abdominal adiposity, has been found to promote insulin resistance, which is related to hypertension in a graded fashion [1].

In our study, the combined prevalence of selected metabolically linked risk factors increased as the population aged, both in hypertensive and normotensive individuals, but prevalences were greater in those with hypertension in all age groups and differences were wider in younger adults. After adjustment for age and sex in the regression analysis, we found that the prevalence of hypertension increased directly with the number of risk factors examined. Because hypertension is variably hazardous depending on the number and severity of associated risk factors [1], the very high prevalence of coexisting risk factors in hypertensive individuals in this community has important public health and therapeutic implications. The use of a simple score, such as the one used in this study, allows classification of hypertensive individuals according to their global risk profile. The coexistence of hypertension with 4 or more lifestyle and metabolically linked risk factors was 6 times higher than expected by chance, after taking age and sex into account. It is no longer appropriate to consider reduction in hypertension as the sole goal of antihypertensive therapy [19-21].

Our results indicate that differences in multivariate risk profile of hypertensive individuals are less striking in older

adults when compared with younger ones. However, the high prevalence of metabolic disorders and inactivity in the aged and the high proportion of older individuals with overt CVD tend to magnify the impact of apparently small differences in risk profile on morbidity and mortality. In this community, around 20% of older adults had symptoms or a previous medical diagnosis of CVD.

In the BHAS, all efforts were made to avoid bias: encouraging participation, collecting information double blinded, assessing the reliability of the data gathered, standardised procedures and instruments, and exhaustive training of field work and laboratory teams. The participation rate was high, and older and younger participants were similar to the town population regarding sex, age, marital status, monthly family income, and education[4]. However, because of the cross-sectional nature of the data, one cannot discard the possibility of survival bias: 1) older participants are survivors (i.e., those exposed to risk factors have a higher probability of dying prematurely); 2) older participants are noninstitutionalised (i.e., those living in the community tend to be healthier). No institution for older adults exists in Bambuí. At any rate, a survival bias in this study would tend to reduce the magnitude of the associations found, favouring the direction of our results.

In conclusion, the high prevalence of hypertension and the clustering of CVD risk factors in hypertensive individuals in this community indicate the need not only to increase detection and control of hypertension in this community, but also to direct treatment to improve individuals' global risk profiles. Around 27 million Brazilians live in small towns like the one investigated in this study, and very little is known about their health conditions. Because we have no reason to suppose that the population of Bambuí differs from those of other towns of similar size, it is reasonable to inquire about the extension and implications for health care services of the cardiovascular risk profile pictured in this study.

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