

## Birth cohort differences in hypertension control in a Brazilian population of older elderly: the Bambuí Cohort Study of Aging (1997 and 2008)

Diferenças de coorte por nascimento no controle da hipertensão entre idosos mais velhos: Estudo de Coorte de Idosos de Bambuí (1997 e 2008)

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### Abstract

*We examined for cohort differences in hypertension control between participants in the Bambuí Cohort Study of Aging of aging born 1916-1926 and 1927-1937. Participants included hypertensive elderly aged 71-81 at baseline (n = 313) and at 11th wave follow up (n = 484). Prevalence of hypertension awareness (70.9% and 81.2%, respectively), median medical appointments in previous 12 months (2 and 3, respectively) and antihypertensive drug use (74.4% and 90.7% respectively) increased significantly from older to younger cohort. However, prevalence of appropriately controlled hypertension among those treated (< 140/< 90mmHg) was similar in both cohorts (44.6% and 40.1%, p = 0.255). Multivariate analysis returned schooling as the only factor independently associated with appropriately controlled hypertension. Despite increased medical appointments and drug use in the recent cohort, the prevalence of appropriately controlled hypertension remained as low as in the older cohort.*

*Hypertension; Aged; Cohort Studies*

### Introduction

Worldwide, arterial hypertension is the main risk factor for mortality and the third most important cause <sup>1</sup> of years lived with disability. Prevalence of arterial hypertension is high in the overall population, and increases markedly with age. It is the most common chronic disease among older adults, with prevalence of 60% or more, both in high-income countries and in Latin America and the Caribbean <sup>2</sup>. The World Health Organization (WHO) estimated in 2002 that at least 50% of cardiovascular diseases and 75% of strokes result from high blood pressure <sup>3</sup>. Because of its high prevalence and severe consequences, efforts have been made worldwide to increase detection and control of existing arterial hypertension <sup>4,5,6,7</sup>.

Proper control of arterial hypertension is defined by systolic and diastolic pressures of less than 140 and 90 mmHg, respectively, among persons undergoing drug treatment. In the United States, results of the National Health and Nutrition Examination Survey (NHANES) showed that, in the overall population, prevalence of proper control of arterial hypertension increased among those undergoing treatment from 51% in 1988-94 to 69% in 2007 <sup>8</sup>. However, those observations were not corroborated in a more recent study based on the same survey, which found prevalence of appropriate control of arterial pressure among patients treated to be 44% for the period from 2005 to 2008 <sup>9</sup>. In Ontario, Canada, preva-

lence of proper control of arterial hypertension among patients treated was 66% in 2006, which is higher than observed in other population based surveys conducted in the early 1990s (12%)<sup>10</sup>. The studies above showed discrepant results for control of arterial hypertension among older adults as compared with younger adults. While the first United States study<sup>8</sup> found that, among patients 60 years old or older, controlled arterial hypertension was less prevalent than among young and middle-age adults, the second study<sup>9</sup> found better control of arterial hypertension in the older and middle-aged adult groups than among the youngest age group, which agrees with what was observed in Canada<sup>10</sup>. In middle-income countries, there is little information on appropriate control of arterial hypertension. One study in Mozambique (Africa) showed that, in 2005, in the overall population, 40% of hypertensive patients treated displayed appropriate arterial pressure levels<sup>11</sup>.

To our knowledge, there are no population-based studies examining trends in appropriate control of arterial hypertension among older adults in Brazil. One cross-sectional study conducted on the baseline of the cohort study of older adults in Bambuí, Minas Gerais State, showed prevalence of arterial hypertension to be 62%. Among the 919 participants with arterial hypertension, 704 (77%) knew they were hypertensive, 578 (63%) were using some anti-hypertensive drug and, of these, 225 (39%) displayed appropriately controlled arterial hypertension<sup>12</sup>.

The present study used baseline and 11<sup>th</sup> wave data on the Bambuí cohort mentioned above, in order to examine for birth cohort differences in prevalence of appropriate control of arterial hypertension among older elderly adults, and in associated factors.

## Methodology

### Area studied

The cohort study has been conducted in the town of Bambuí (population approximately 15,000), in Minas Gerais State. The cohort baseline was established in 1997, since when follow-up is performed annually on all participants by interview and death certificate review. Measurement of arterial pressure and other biological measures were taken at the baseline and at 2000, 2002 and 2008 follow-up. Further details are available in previous publications<sup>13,14</sup>.

When the cohort baseline was established, the town of Bambuí had one 62-bed hospital, 15 doctors (1 per 1,000 population), and a polyclinic

that offered 24-hour emergency care. In 2003, the Family Health Strategy (FHS) was introduced in the town, for which four teams were set up. In 2006, two further teams were added to the program, and drug distribution began under the FHS.

The Bambuí cohort study of older adults was approved (for initial procedures) by the Ethics Research Committee of the Oswaldo Cruz Foundation (Fundação Oswaldo Cruz – Fiocruz), Rio de Janeiro, and (for procedures not contemplated in the original project) by the Ethics Research Committee of the René Rachou Research Center of Fiocruz (Centro de Pesquisas René Rachou), Belo Horizonte. Baseline participants signed a free, informed consent form, which was renewed at all study follow-up points.

### Population studied

The population for the baseline cohort was identified by means of a complete census of the town performed in November and December 1996. Of the 1,742 residents aged 60 years or more on 1 January 1997, 1,606 participated at the baseline and 1,492 had their arterial pressure measured. Loss to follow-up in the first ten years was 6%<sup>13,14</sup>.

For the present study, all hypertensive participants aged from 71 to 81 years at the baseline and at 11<sup>th</sup> year follow-up were selected (that is, those born in 1916-1926 and in 1927-1937, respectively). Hypertension was considered to be given by systolic pressure  $\geq 140$ mmHg and/or diastolic pressure  $\geq 90$ mmHg, and/or anti-hypertensive drug use<sup>15</sup>.

### Measurements of arterial pressure and drug use

Three measurements of arterial pressure were taken at 2-minute intervals, after 5 minutes rest, with the individual seated and with the arm supported at heart level. These measurements were taken in a quiet, isolated room with controlled temperature. The first was taken after at least 30 minutes without drinking coffee or smoking. Arterial pressure was considered to be the mean of the second and third measurements<sup>15</sup>. The following instruments were used: Tycos 5097 sphygmomanometers (Welch Allyn Tycos 5097-30, Tycos, Arden, USA) and Littman Cardiology II stethoscopes (3M Medical Devices, St. Paul, USA). Arterial pressure was measured at Fiocruz advance post in Bambuí by trained technicians. The technicians' training included use of videos, double auscultation, and exercises to gauge inter- and intra-observer variability. The same procedures were followed in 1997 and 2008.

Use of drugs was ascertained by home interview, which included examining the drug packaging or medical prescription. Drugs were classified using the Anatomical Therapeutic Chemical Index (ATC/DDD Index)<sup>16</sup>. Drugs of the following drug classes were considered anti-hypertensives: diuretics (CO3), beta blocking agents (CO7), calcium channel blockers (CO8), agents acting on the renin-angiotensin system (CO9), and antihypertensives (CO2).

### **Other variables**

Other variables considered in this study were: age, sex, schooling (complete years), leisure-time physical activities, current smoking, number of medical appointments in the previous 12 months, history of medical diagnosis for arterial hypertension, and body mass index (BMI). Sufficient leisure-time physical activity was defined by the participant's reporting having performed exercises of any intensity for at least 20-30 minutes, three times or more a week in the previous 90 days. Tobacco use was defined as consumption of at least 100 cigarettes ever, and continuing with the habit at present. Participants were considered to know they suffered from hypertension if they reported having been so informed by a doctor. BMI was defined as weight over height squared. Further details are available in previous publications<sup>13,14</sup>.

Controlled arterial hypertension was defined by values of systolic and diastolic pressure of less than 140 and 90mmHg, respectively, among those using anti-hypertensive drugs<sup>15</sup>.

### **Data analysis**

Unadjusted analysis was based on the Pearson chi-square test, Student t-test and Mann-Whitney test for differences in frequencies, means and medians, respectively. Analysis of the factors associated with appropriate control of arterial hypertension was based on prevalence ratios (PRs) and 95% confidence intervals (95%CI) estimated by Poisson regression with robust variance. All analyses were performed using Stata 11.0 software (Stata Corp., College Station, USA).

### **Results**

The arterial pressure of 93.3% of cohort participants (492/459) was measured in 1997, and 92.9% (576/620) in 2008. In both years, no statistically significant differences ( $p > 0.05$ ) were observed in age and sex between those who had their arterial pressure measured and those who did not. Preva-

lence of arterial hypertension ( $\geq 140/\geq 90$ mmHg and/or treatment) increased from 68.2% in 1997 to 84% in 2008 ( $p = 0.029$ ).

The study participants' characteristics are shown in Table 1. The two cohorts did not differ in mean age or the proportion of women. In the more recent cohort (born 1927-1937), as compared with the previous one (born 1916-1926), significant increases were observed in the proportion of those with 4 years' or more schooling, and of those with sufficient leisure-time physical activity, in addition to an increase in mean BMI and median number of medical appointments in the previous 12 months. Prevalence of smoking use halved (from 16% to 8.9%). Among the older adults of the more recent cohort, there was a greater prevalence of those who knew they were hypertensive than in the earlier cohort (81.2% against 70.9%) and of those who used anti-hypertensive drugs (90.7% against 74.4%).

Table 2 shows the values of systolic and diastolic pressure by birth cohort and sex. In joint analyses for both sexes, no statistically significant differences ( $p > 0.05$ ) were observed between the cohorts in prevalence of arterial pressure controlled at levels below 140/90mmHg (44.6% and 40.1%, respectively) or at levels below 160/100mmHg (76.8% and 74.9%, respectively), or in mean systolic pressure (143.4mmHg and 145.6mmHg, respectively). These results were observed consistently among men and women. Mean diastolic pressure was lower in the more recent cohort (79.5 mmHg) than in the older cohort (82.5mmHg); and that decrease was observed among the men, but not among the women. Table 3 shows the results of multivariate analysis of the factors associated with appropriate control of arterial hypertension stratified by birth cohort. Only four or more years' schooling showed an independent association with appropriate control of arterial hypertension, and that association was observed consistently in the two cohorts (PR = 1.34; 95%CI: 1.00-1.79 and PR = 1.26; 95%CI: 1.00-1.58, respectively). Sex, leisure-time physical activity, current smoking use, BMI and number of medical appointments in the previous 12 months showed no significant associations with appropriate control of arterial hypertension [PR (95%CI)], ranging from 0.89 (0.68-1.17) to 1.26 (0.90-1.76) in the older cohort, and PR adjusted for sex (95%CI) ranging from 0.85 (0.54-1.34) to 1.28 (0.87-1.87) in the recent cohort.

Table 1

Characteristics of study participants, by birth cohort. The Bambuí Cohort Study of Aging, 1997 and 2008.

Characteristics	Cohort	
	1916-1925 (n = 313)	1927-1937 (n = 484)
Age [mean (SD)]	75.1 (3.1)	75.1 (3.0)
Female	65.5	66.7
Four or more years' schooling	29.8	38.0 *
Leisure-time physical activity in previous 90 days	12.5	27.1 **
Current smoking	16.0	8.9 ***
BMI (kg/m <sup>2</sup> ) [mean (SD)]	25.2 (4.9)	26.1 (5.3) *
Number of medical appointments in previous 12 months, median (P25-P75)	2 (1-4)	3 (2-5) **
Aware hypertensive	70.9	81.2 **
Regular use of anti-hypertensive drug	74.4	90.7 **

BMI: body mass index; SD: standard deviation; P25 and P75: 25 and 75 percentiles, respectively.

\*  $p < 0.05$ ;

\*\*  $p < 0.001$ ;

\*\*\*  $p < 0.01$ .

Note: results in percentages, except where indicated.

Table 2

Mean systolic and diastolic pressure values, by birth cohort and sex. The Bambuí Cohort Study of Aging, 1997 and 2008.

Variables	All Cohorts		Male Cohorts		Female Cohorts	
	1916-1926 (n = 233)	1927-1937 (n = 439)	1916-1926 (n = 65)	1927-1937 (n = 138)	1916-1926 (n = 168)	1927-1937 (n = 301)
	Systolic pressure and diastolic pressure < 140 and < 90mmHg (%)	44.6	40.1	49.2	44.2	42.9
Systolic pressure and diastolic pressure < 160 and < 100mmHg (%)	76.8	74.9	72.3	78.3	78.6	73.4
Mean systolic pressure in mmHg (SD)	143.4 (22.7)	145.6 (21.8)	143.1 (25.6)	143.8 (20.4)	143.5 (21.6)	146.4 (22.4)
Mean diastolic pressure in mmHg (SD)	82.5 (12.1)	79.5 (12.0) *	83.5 (12.3)	80.8 (11.3)	82.0 (12.0)	79.0 (12.2) *

SD: standard deviation.

\*  $p < 0.01$ .

## Discussion

The results of this study show that, in the two cohorts studied, no changes occurred in the prevalence of appropriate control of arterial hypertension among hypertensive older adults using anti-hypertensive drugs. On the other hand,

awareness of being hypertensive and use of medication for arterial hypertension were observed to increase significantly in the recent cohort in comparison to the earlier cohort.

To complement this, our analysis considered other indicators of success in controlling arterial hypertension among those in treatment. These

Table 3

Multivariate analysis of factors associated with appropriate control of arterial pressure (systolic pressure < 140mmHg and diastolic pressure < 90mmHg) stratified by birth cohort. The Bambuí Cohort Study of Aging, 1997 and 2008.

Variables	1916-1926 cohort			1927-1937 cohort		
	Treated	Appropriate control		Treated	Appropriate control	
		n (%)	PR (95%CI)		n (%)	PR (95%CI)
Sex						
Male	65	32 (49.2)	1.00	138	61 (44.2)	1.00
Female	168	72 (42.9)	0.87 (0.64-1.18)	301	115 (38.2)	0.86 (0.68-1.09)
Schooling (years)						
0-3	160	64 (40.0)	1.00	272	99 (36.4)	1.00
≥ 4	72	39 (54.2)	1.34 (1.00-1.79) *	167	77 (46.1)	1.26 (1.00-1.58) **
Leisure-time physical activity in previous 90 days						
No	201	91 (45.3)	1.00	324	133 (41.1)	1.00
Yes	32	13 (40.6)	0.85 (0.54-1.34)	115	43 (37.4)	0.89 (0.68-1.17)
Current smoking						
No	203	87 (42.9)	1.00	401	157 (39.2)	1.00
Yes	30	17 (56.7)	1.28 (0.87-1.87)	38	19 (50.0)	1.26 (0.90-1.76)
BMI (kg/m <sup>2</sup> )						
< 25	102	42 (41.2)	1.00	186	70 (37.6)	1.00
≥ 25	123	59 (48.0)	1.18 (0.87-1.59)	239	97 (40.6)	1.08 (0.85-1.38)
Number of medical appointments in previous 12 months						
< 3	112	50 (44.6)	1.00	172	66 (38.4)	1.00
≥ 3	121	54 (44.6)	1.01 (0.76-1.35)	267	110 (41.2)	1.08 (0.85-1.37)

BMI: body mass index; PR: prevalence ratio; 95%CI: robust 95% confidence interval adjusted for all variables listed in the table.

\*  $p = 0.047$ ;

\*\*  $p = 0.048$  (Wald's test).

indicators included mean systolic and diastolic pressure measurements, and arterial pressure controlled to levels below 160/100mmHg. Mean systolic pressure was similar in the two cohorts, as was prevalence of arterial pressure controlled to below the level mentioned above. However, among men (but not women), diastolic pressure values were observed to decline significantly. This result is consistent with previous observations that it is easier to reduce diastolic pressure values than systolic pressure values<sup>15</sup>. It is important to remember that among older adults it is systolic pressure rather than diastolic pressure that is most strongly associated with increased risk of cardiovascular events<sup>17,18,19</sup>.

Control of arterial pressure can be affected by factors such as lack of access to health services, cost of treatment, poor adherence to medication, adverse effects of drugs, inertia of the doctor responsible, non-compliance with treatment standards, unsuitable education of doctors and patients, and

health-related behavior<sup>20</sup>. In this study, successful control of arterial hypertension does not seem to have been determined by access to health services and to treatment, given that the number of medical appointments showed no association with the event, and in 2008 the proportion of hypertensive patients treated stood at 91%. Health-related behavior (tobacco use and physical activity) and BMI also showed no association with appropriate control of arterial hypertension in either cohort. Only schooling showed an association with appropriate control of arterial hypertension in both the more recent and the earlier cohorts.

One explanation for the association between more schooling and appropriate control of arterial hypertension may be improved understanding and assimilation of medical prescription and its importance<sup>21,22</sup>. The association with schooling observed in this study is consistent with previous observations made among participants in

the Bambuí cohort of older adults. A qualitative study showed that people were generally clear about the need for treatment to control arterial pressure. However, although most of the participants reported that they followed the treatment, it was clear from their accounts that many of them did not follow their medical prescription correctly. Overall, it was clear from the accounts that the absence of symptoms led many of them to feel they were not ill, and accordingly to underestimate the importance of continuing to use the medication. Thus, medication was often interrupted and resumed only with the advent of symptoms which, in their view, indicated increased arterial pressure<sup>23</sup>. Such behavior may explain, at least partially, the persistence of poor pressure control in the population studied.

This study has advantages and limitations. The advantages include the population base and the standardization of methods and data collection at the baseline and 11<sup>th</sup> year follow-up. One further advantage was the low level of participant loss to follow-up, which reduced the likelihood of non-participation bias. Meanwhile, the response rate for arterial pressure measurements was slightly higher in the 1997 survey (93%) than in 2008 (88%), and that may in some way affect

the estimated prevalence of appropriate control of arterial hypertension. However, a sensitivity analysis showed that the results obtained would not be affected even if all non-participants in the 2008 survey had appropriately controlled arterial pressure ( $p = 0.196$ ; details not shown). Lastly, it must be emphasized that this study was conducted using the population of the Bambuí cohort of older adults, and the results may not be generalizable to other elderly populations.

Lack of success in controlling arterial pressure at appropriate levels, in spite of advances in drug therapy and access to treatment, is a phenomenon that has recently been termed the “hypertension paradox”<sup>24</sup>. The persistence of low levels of controlled arterial hypertension in this study occurred in a context of improved schooling, health-related behavior, awareness of the condition of being hypertensive, use of anti-hypertensive drugs, and number of medical appointments. These results show that these improvements were not enough to increase appropriate control of arterial hypertension in the population studied. The results underline the need for complementary measures – possibly to increase adherence to treatment – in order to improve control of existing arterial hypertension.

## Resumo

*Foram examinadas diferenças de coorte entre nascidos em 1916-1926 e em 1927-1937 no controle da hipertensão entre participantes do Estudo de Coorte de Idosos de Bambuí. Foram utilizados dados dos participantes hipertensos com 71-81 anos de idade da linha de base ( $n = 313$ ) e do 11º ano de seguimento ( $n = 484$ ). A prevalência dos que sabiam ser hipertensos (70,9% e 81,2%, respectivamente) e a mediana de consultas médicas nos últimos 12 meses (2 e 3, respectivamente) e do uso de drogas anti-hipertensivas (74,4% e 90,7%, respectivamente) aumentaram significativamente na coorte recente em comparação à antiga. Entretanto, a prevalência do con-*

*trole adequado da hipertensão entre tratados ( $< 140/ < 90\text{mmHg}$ ) foi semelhante nas duas coortes (44,6% e 40,1%;  $p = 0.255$ ). Na análise multivariada, a escolaridade foi o único fator independentemente associado ao controle adequado da hipertensão arterial. Apesar do aumento de consultas médicas e do uso de medicamentos na coorte mais jovem, a prevalência do controle adequado da hipertensão permaneceu tão baixa quanto o observado na coorte mais velha.*

*Hipertensão; Idoso; Estudos de Coortes*

## Contributors

J. O. A. Firmo conceived the project, participated in data collection, analysis and interpretation, drafted the article and approved the final version. S. V. Peixoto and A. I. Loyola Filho participated in the analysis, interpretation of results and critical analysis of the article. E. Uchôa and M. F. Lima-Costa contributed to project conception, data collection, and critical review and final approval of the article.

## Acknowledgments

To FINEP, CNPq and FAPEMIG for funding this study.

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Submitted on 29/Nov/2010

Final version resubmitted on 05/Apr/2011

Approved on 09/May/2011