

The Bambuí Cohort Study of Aging: methodology and health profile of participants at baseline

Estudo de Coorte de Idosos de Bambuí: metodologia e perfil de saúde dos participantes

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Abstract

The cohort study was initiated in 1997 to investigate the incidence and predictors of health outcomes in an elderly population with low socioeconomic level. The eligible population consisted of all 1,742 residents in Bambuí, Minas Gerais State, Brazil, aged 60 years and over (1,606 participated). During 10 years of follow-up, 641 participants died and 96 were lost, leading to 13,739 person-years of observation. The baseline health profile of participants revealed a double burden of diseases with high prevalence of chronic non-transmissible diseases and widespread Trypanosoma cruzi infection. The most common health condition was hypertension (61.5%), followed by chronic knee or hand symptoms (43.6%), common mental disorders (38.5%), T. cruzi infection (38.1%), and insomnia (36.7%). In general, the baseline prevalence of mental symptoms and cardiovascular diseases or risk factors was comparable to those found in populations in high income countries.

Aging; Health of the Elderly; Health Profile; Cohort Studies

Introduction

Population aging has gained global dimension as a result of an impressive reduction in mortality and fertility during the 20th century. Over the past 40 years, the global average life expectancy increased from 50 to 66 years, representing an increase of 4 years per decade ¹. Life expectancy has increased much faster in middle and low income countries. In Latin America and the Caribbean, for example, life expectancy between 1960 and 1999 increased 24%, while in high income countries from the Organization for Economic Co-Operation and Development (OECD), the corresponding change was 12% ¹. Like the rest of the world, Brazil is an aging society. In the last decade, the number of elderly increased by 36%. This growth was 2.5 times higher than the 14% growth in the younger population ².

This demographic change has a significant impact on the population's health conditions, with important repercussions for the health system. Aged societies have a greater burden of chronic diseases and disabilities that, in turn, require greater spending on equipment, medication and skilled human resources, modifying and increasing the demand for medical and social services ². As has been emphasized by the World Health Organization (WHO) ³, promoting active aging might mitigate this impact. Socioeconomic conditions, physical environment, individual characteristics (such as biological, psychological and genetic factors), lifestyle and health service provision, as well

as gender and cultural factors, are all determinants of active aging³.

Most literature on aging has been produced in rich countries into their own socio-demographic characteristics¹. Since the determinants of active aging might be affected by local conditions, particularly in populations with low socioeconomic status, it may not be appropriate to apply results from international studies into our midst without local studies.

The Bambuí Cohort Study of Aging was designed and developed to investigate the incidence and predictors of cognitive decline, functional dependence, falls, death, and use of health services, among others, in an elderly Brazilian population with low socioeconomic level. The study has a multi-disciplinary scope, and includes epidemiology, statistics, anthropology, geriatrics, gerontology, infectology, psychiatry and genetics. In the present article, we describe the methodology of this population-based study and the baseline health profile of participants.

Methodology

Study area

The cohort study has been conducted in Bambuí city, located in the State of Minas Gerais, in Southeastern Brazil, with a population of 15,000. The choice of the study area was based on four main criteria: (1) low migration rate (to reduce losses to follow-up over time); (2) socio-demographic characteristics; (3) mortality profile; (4) feasibility of the study in terms of co-operation of residents and facilities for follow-up.

The population of the municipality of Bambuí had remained stable during the three decades that preceded the beginning of the study (around 20,000 inhabitants from 1970 to 1991). During this period, life expectancy at birth increased from 59.9 to 70.2 years, while infant mortality decreased from 92.8 to 48.4 deaths per 1,000 live births, characterizing a population in demographic transition. Low levels of schooling and low income predominated (42.6% of the population aged 25 and over has had less than four years of schooling, and the proportion of poor residents was 46%). The Human Development Index (HDI) was 0.70⁴.

The leading causes of death among elderly residents of Bambuí were stroke, Chagas disease, ischemic heart disease, and chronic obstructive pulmonary disease (death rates = 110, 61, 42 and 19 per 100,000, respectively). Chagas disease is caused by the protozoan *Trypanosoma cruzi*.

Bambuí is one of the oldest known endemic areas for this parasitic disease. Intensive use of insecticides interrupted the transmission of the infection decades ago. However, it was anticipated that the infection had remained highly prevalent among elderly residents, who had acquired the infection in their youth, because there was no safe and effective treatment for chronic *T. cruzi* infection in the elderly⁵. This was another reason for the choice of the study area. Most epidemiological studies of ageing have focused on non-communicable diseases and, to our knowledge, no previous population-based cohort study had examined the consequences of the double burden of non-communicable diseases and a parasitic chronic infection in old age. Finally, the existence of a satellite campus of the Oswaldo Cruz Foundation (Fundação Oswaldo Cruz) in the study area [Emmanuel Dias Center for Advanced Studies (Posto de Estudos Avançados Emmanuel Dias)] was important to provide logistical support for the fieldwork. Further details are described in previous publications^{4,5}.

Study population

The eligible population for the cohort study consisted of all residents of Bambuí aged 60 years and over on January 1, 1997. The study population was identified by a complete census in the city conducted by the research team between November and December, 1996.

Baseline survey

The baseline survey was conducted in 1997, and involved the following operational steps: home interview; field clinic visit (for blood collection, anthropometric measurements, blood pressure measurements, and electrocardiogram); laboratory tests (biochemical and hematological analyses that were performed at the central laboratory in Belo Horizonte); and samples storage (serum, plasma, buffy-coat and DNA aliquots were stored in freezers at -80°C).

The baseline questionnaire included information on: social and demographic characteristics (age, sex, ethnicity, recent history of migration, conjugal status, schooling, spouse's schooling, religion, living arrangements, personal and household income, occupational history and current occupation); psychosocial factors (social support and social network, life events, and selected psychological traits); lifestyle (smoking, alcohol consumption, dietary habits, and physical activity); self-reported health conditions (self-rated health and prior medical diagnosis for selected diseases or conditions); physical symp-

toms (angina pectoris, intermittent claudication, chronic hand and knee symptoms and stroke); mental symptoms (common mental disorders, insomnia, daytime sleepiness, and sleep habits); reproductive health history; functioning (cognition function and ability to perform activities of daily living and instrumental activities of daily living); falls; use of health services and use of medications.

Biochemical analyses (fasting glucose, blood creatinine, urea, total protein, albumin, uric acid, calcium, phosphorus, magnesium, total cholesterol, HDL cholesterol, LDL cholesterol and triglycerides) were determined with standardized enzymatic methods, using automated equipment (Eclipse Vitalab; Merck, Netherlands). Hematological analyses were performed using an electronic counter (Coulter Counter T890; Beckman Coulter, Miami, USA). Infection with *T. cruzi* was assessed by three different assays performed concurrently: a hemagglutination assay (Biolab Mérieux, Rio de Janeiro, Brazil), and two enzyme-linked immunoabsorbent assays (Abbott Laboratories, Abbott Park, USA and Wiener Laboratories, Rosario, Argentina). Other assays performed using the stored baseline aliquots included plasma B-type natriuretic peptide (MEIA/AxSYM; Abbott Laboratories, Abbott Park, USA), highly sensitive C-reactive protein (Siemens, Germany), and apolipoprotein E genotyping. Genome wide scanning (~1 million single nucleotide polymorphisms – SNPs) of the study population is in process, as part of the Epigen-Brazil consortium, and these data will be incorporated to the cohort dataset in the future ⁵.

Three measures of blood pressure were performed using a standard protocol ⁶. These measures were taken by using mercury sphygmomanometers with the appropriate size cuff (Tycos 5097-30; Tycos, Arden, USA) and standardized stethoscopes (Littman Cardiology II; 3M, St. Paul, USA). Anthropometric measures (weight, height, arm circumference, wrist circumference, waist circumference, hip circumference, triceps skinfold and demi-span) were also performed using standard equipment (CMS Weighing Equipment Ltd., London, UK). Twelve-lead electrocardiograms (ECGs) (Hewlett Packard MI700A; Hewlett Packard, Palo Alto, USA) were digitally recorded at rest. ECGs were analyzed at the ECG Reading Center EPICARE (Wake Forest University, Winston-Salem, USA) and classified according to the Minnesota code criteria ⁵.

The interviews were carried out in participants' homes and lasted about 90 minutes. Each interview was completed in one or two visits (within a one week interval) depending on the respondent's need for rest. Blood collection was

performed after twelve hours of recommended fast. Blood collection and examinations were performed at the field clinic or at home when there was a health limiting condition. All of the interviewers and health technicians were trained and certified before examinations ^{4,5}.

Follow-up

The main outcome variables include major geriatric conditions, such as cognitive decline, functional dependence and falls, death, and use of health services. Cohort members undergo annual follow-up visits in the participant's home, which consist of an interview (selected questions of the baseline questionnaire), and ascertaining vital status. Deaths were reported by next of kin during the annual interview and confirmed by verification of a death certificate or by consulting the Mortality Information System (SIM), with the permission of the Brazilian Ministry of Health (Ministério da Saúde). The cause of death was coded according to the International Classification of Diseases, 10th Revision (ICD-10).

Other procedures were repeated in selected years (2000, 2002 and 2008), depending on the availability of funds, using the same methodologies employed at baseline. Training and certification of the field workers was repeated at each follow-up visit. Table 1 summarizes the procedures performed at baseline and at each follow-up visit.

Variables included in the present analysis

Baseline measures considered in the present analysis included: socio-demographic characteristics (age, conjugal status, years of residence in Bambuí city, schooling, religion, monthly personal income); general health conditions (self-rated health, activities of daily living disability, and chronic knee or hand symptoms); cardiovascular risk factors and diseases (hypertension, diabetes mellitus, stroke, intermittent claudication, current smoking, and body mass index); mental health (common mental disorders, insomnia, daytime sleepiness, *Mini-Mental State Examination* score – MMSE) and *T. cruzi* infection. Activities of daily living disability were defined by the report of much difficulty or inability to perform at least one of the following activities: feeding oneself, bathing or showering and/or using the toilet. Hypertension was defined by systolic blood pressure equal to or higher than 140mmHg and/or diastolic blood pressure equal to or higher than 90mmHg or treatment. Diabetes mellitus was defined as a fasting blood glucose level equal to or higher than 126mg/dL or treatment.

Table 1

Procedures performed at baseline and follow-up visits. The Bambuí Cohort Study of Aging.

Visit	Year(s)	Information obtained
Baseline	1997	Interview, anthropometric measures, blood pressure measures, electrocardiogram, blood collection, blood tests and samples for storage
Follow-up	1998-2008	Interview and vital status verification
Follow-up	2000, 2003, 2008	Anthropometric measures and blood pressure measures
Follow-up	2003, 2008	Electrocardiogram
Follow-up	2008	Blood collection, blood tests and samples storage

Current smokers were those who had smoked at least 100 cigarettes in their lifetimes and were still smokers. Body mass index (BMI) was defined by the weight divided by the height squared (kg/cm²). The presence of common mental disorders was defined as a score of 5 points or higher in the *12-item General Health Questionnaire*, as previously recommended for the study population⁷. Cognitive functioning was assessed using a Portuguese version of the 30 item MMSE⁸. Current medication use was ascertained during the home interview by reviewing prescriptions and/or the medication packing. Symptoms of stroke⁹, intermittent claudication¹⁰, insomnia¹¹, daytime sleepiness¹² and chronic knee or hand symptoms¹³ were assessed as reported elsewhere. Further details are in Lima-Costa et al.⁵.

The statistical analysis was based on the Pearson's chi square, Student's t test or Man-Whitney rank sum test for differences between frequencies, means and medians, respectively. These analyses were performed using Stata statistical software, version 11.0 (Stata Corp., College Station, USA). All p values were two tailed ($\alpha = 0.05$).

Ethics

The original study proposal of the Bambuí Cohort Study of Aging was approved by the Ethics Research Committee at the Fiocruz in Rio de Janeiro. Procedures not described in the initial project were reviewed and approved by the Ethics Research Committee of the René Rachou Research Center of Fiocruz (Centro de Pesquisas René Rachou) in Belo Horizonte, Minas Gerais. Participants signed an informed consent at baseline and at each subsequent visit and authorized death certificate and medical records verification.

Results

From a total of 1,742 residents aged 60 years and over, 1,606 (92.2%) participated in the baseline interview. Blood collection and other examinations were performed in 85.8% of the eligible elderly. Table 2 shows selected baseline socio-demographic characteristics of cohort participants. The mean age (SD) was 69.3 (7.5) years, and female sex predominated (56.3%). The distribution of socio-demographic variables revealed a stable population in terms of migration (87.5% had lived in Bambuí city for at least 10 years), predominance of very low schooling levels (65.3% had less than 4 years of schooling), and predominance of low personal income (73.4% earned less than twice the Brazilian minimum monthly salary). One third of cohort members (35.4%) were widowed. Cohort members overwhelmingly identified themselves as Catholics (94.3%). Most socio-demographic characteristics were similarly distributed among elderly men and women, except conjugal status (widows were much more frequent than widowers), and monthly household income (lower among women).

Table 3 presents the baseline prevalence of selected chronic diseases or conditions among cohort participants. The most common condition was hypertension (61.5%), followed by chronic knee or hand symptoms (43.6%), common mental disorders (38.5%), *T. cruzi* infection (38.1%), and insomnia (36.7%). Self-rated health was reported as bad or very bad by 27.2% and activities of daily living disability was reported by 7.9% of participants. Women were more likely to report worse self-rated health, chronic knee and hand symptoms and mental symptoms (common mental disorders, insomnia and daytime sleepiness). The mean BMI and the prevalence of hypertension and *T. cruzi* infection were also higher in women. Current smoking and inter-

Table 2

Selected baseline socio-demographic characteristics of cohort members by sex. The Bambuí Cohort Study of Aging.

Characteristics	Total (N = 1,606)	Women (n = 904)	Men (n = 642)	p-value *
Age [mean (SD)]	69.3 (7.5)	69.5 (7.5)	69.0 (7.3)	0.212
Conjugal status (widowed) (%)	35.4	50.3	13.1	< 0.001
Has lived in Bambuí city for at least 10 years (%)	87.5	87.6	87.3	0.249
Less than 4 years of schooling (%)	65.3	66.8	63.1	0.129
Religion (catholic) (%)	94.3	93.8	95.2	0.236
Monthly personal income in Brazilian minimum wages ** (%)				
None	8.5	13.6	0.8	
Less than 2.0	64.9	68.8	59.0	
Equal to or higher than 2.0	26.7	17.6	40.3	< 0.001

SD: standard deviation.

* p-value: Pearson's chi square and Student's t tests for differences between frequencies and means, respectively;

** Minimum wage: US\$120 at the time the baseline study was conducted.

Table 3

Baseline health status of cohort members by sex. The Bambuí Cohort Study of Aging.

Variables	Total *	Female *	Male *	p-value **
General health conditions				
Self-rated health (bad/very bad) (%)	27.2	30.3	22.3	< 0.001
Activities of daily living disability (%)	7.9	8.5	6.9	0.222
Chronic knee or hand symptoms (%)	43.6	49.2	35.2	< 0.001
Cardiovascular risk factors and diseases				
Hypertension (%)	61.5	66.0	65.6	< 0.001
Diabetes mellitus (%)	14.5	15.7	12.8	0.129
Stroke (%)	4.0	4.2	3.8	0.676
Intermittent claudication (%)	2.5	1.0	4.8	< 0.001
Current smoking (%)	18.7	10.2	31.5	< 0.001
Body mass index in kg/cm ² [mean (SD)]	25.1 (5.0)	25.9 (5.3)	23.9 (4.1)	< 0.001
Mental health				
Common mental disorders (%)	38.5	43.8	30.3	< 0.001
Insomnia in previous 30 days (%)	36.7	43.8	26.0	< 0.001
Daytime sleepiness in previous 30 days (%)	13.0	15.7	8.8	< 0.001
MMSE score [median (IQR)]	26 (22-28)	26 (23-28)	24 (21-27)	< 0.001
Trypanosoma cruzi infection (%)	38.1	42.4	31.3	< 0.001

IQR: interquartile range; MMSE: Mini-Mental State Examination; SD: standard deviation.

* The number of participants varies due to missing values;

** p-value: Pearson's chi square, Student's t and Mann-Whitney rank sum tests for differences between frequencies, means and medians, respectively.

mittent claudication were more frequent among elderly men, and the MMSE score (a measure of cognitive functioning) was lower in this group. The prevalence of activities of daily living disability and diabetes mellitus was similar in both sexes.

From 1997 to 2007, during a mean follow-up of 8.6 years, 641 (39.9%) participants died and 96 (6%) were lost to follow-up, leading to 13,739 person-years of observation. Death certificates were obtained for 618 individuals (96.4%). Those who were lost were more likely to be younger.

Losses to follow-up were not associated with sex, schooling, hypertension, diabetes mellitus, stroke, intermittent claudication, current smoking and body mass index (Table 4).

Discussion

The research strategies achieved a high response rate at baseline and maintained high retention rates after ten years of onset. These were accomplished due to a series of factors. An anthropological study that preceded the field work was useful in guiding how the research team approached the community and in preparing the materials used to advertise the project ⁴. Research activities were almost continuous, allowing regular contact with cohort members. Thus, changes of address and deaths were promptly captured. As the study was conducted in an aged population, samples collec-

tion and biological measures were performed at home when the participant was unable to go to the field clinic. Further, a good relationship with the community was probably the most important factor in sustaining high participation.

Strengths of the Bambuí Cohort Study of Aging include the fact that it is a long term population-based cohort study with high response rates at baseline and minimal loss of participants to follow-up, the standardized and systematic measurement of parameters at baseline and at follow-up visits, and annual monitoring of several outcome variables. The study also has limitations. Due to budget constraints, blood collection was performed at baseline and only 11 years later. Thus, whatever changes occurred during this time interval were not captured. All participants received their examination results at the baseline and at follow-up and were encouraged to seek medical attention when necessary. To avoid this

Table 4

Follow-up rates according to age, sex and cardiovascular risk factors and diseases. The Bambuí Cohort Study of Aging.

Characteristics	Baseline participants (n) *	Followed-up (%)	p-value **
Age (years)			
60-69	933	92.8	
70 +	673	95.7	0.017
Sex			
Female	964	94.6	
Male	642	93.2	0.227
Hypertension			
No	575	93.7	
Yes	919	94.1	0.761
Diabetes mellitus			
No	1,275	94.0	
Yes	217	93.6	0.779
Stroke			
No	1,433	93.8	
Yes	60	98.3	0.147
Intermittent claudication			
No	1,448	94,1	
Yes	37	94,6	0.892
Current smoking			
No	1,306	94.0	
Yes	300	94.3	0.801
Body mass index $\geq 25\text{kg}/\text{cm}^2$			
No	748	92.7	
Yes	703	95.0	0.061

Note: subjects known to have died were considered as traced.

* The number of participants varies due to missing values;

** p-value: Pearson's chi square.

becoming a source of bias, selected exposure indicators (e.g. lifestyle and treatment) have been monitored in the annual follow-up interviews.

As a consequence of higher life expectancy, elderly women outnumber elderly men in most nations and this numerical advantage increases with age¹⁴. As expected, women predominated among the Bambuí cohort participants. Women were more likely to be widowed and to report lower monthly income than did men. Gender differences on health conditions were also found. Women were more likely than men to have chronic hand and knee symptoms, hypertension, higher body mass index, mental symptoms, *T. cruzi* infection, and to rate their health as poor. Men were more likely than women to have intermittent claudication and lower MMSE score. Interestingly, the directions of the above mentioned sex differences – with few exceptions – were similar as those observed in European and North American elderly populations¹⁵.

The health profile of the cohort members revealed a double burden of disease, that is, a high prevalence of chronic non-transmissible diseases and widespread *T. cruzi* infection. *T. cruzi* infection is related to poor socioeconomic circumstances in early life. The main source of infection is a bloodsucking triatomine insect that colonizes poor households. Most individuals in endemic areas acquire the infection before the age of 20¹⁶. The transmission of this infection was interrupted in the study area decades before the beginning of the cohort study, but the prevalence of *T. cruzi*

infection remained high among elderly residents through the operation of a cohort effect¹⁷. The prevalence of hypertension, diabetes mellitus, intermittent claudication and chronic knee or hand symptoms were comparable of those found in populations in rich countries^{13,18,19}. Also, a high median level of total cholesterol was found, possibly reflecting dietary patterns of the Bambuí residents, with high lipid consumption, and low intake of fiber, vitamins, and minerals²⁰. The prevalence of current smokers in the study population was similar to that observed in the United States for older adults with lower levels of schooling in the same period²¹. The prevalence of depressive symptoms²², common mental disorders²³, insomnia¹¹ and excessive daytime sleepiness¹² were similar to – or even higher than – those in other elderly populations. Furthermore, elderly residents of Bambuí were less optimistic about their own health than the overall elderly Brazilian population surveyed in the same period²⁴. The prevalence of activities of daily living disability (eating, dressing or bathing) was similar as that of Brazilian elderly in the corresponding period²⁴.

At the time this paper was prepared, the Bambuí study had produced more than 70 scientific publications. The findings have led to a better understanding of the aging process in the context of poor socio-economic circumstances, and in addition, have provided new insights on the impact of the epidemiological transition on this process⁵.

Resumo

O estudo de coorte foi iniciado em 1997 para examinar a incidência e os determinantes de eventos em saúde em uma população idosa com baixo nível socioeconômico. Todos os 1.742 residentes na cidade de Bambuí, Minas Gerais, Brasil, com idade ≥ 60 anos foram elegíveis para o estudo (1.606 participaram). Durante dez anos de seguimento, 641 participantes faleceram e 96 foram perdidos, resultando em 13.739 pessoas-anos de observação. O perfil de saúde dos participantes revelou carga dupla de doenças com alta prevalência de doenças crônicas não transmissíveis e da infecção

pele Trypanosoma cruzi. A condição de saúde mais frequente foi hipertensão (61,5%), seguida por dores articulares crônicas (43,6%), sintomas mentais comuns (38,5%), infecção pelo T. cruzi (38,1%) e insônia (36,7%). Em geral, as prevalências de sintomas mentais e de doenças cardiovasculares ou fatores de risco para as mesmas foram comparáveis às observadas entre idosos em países de alta renda.

Envelhecimento; Saúde do Idoso; Perfil de Saúde; Estudos de Coortes

Contributors

M. F. Lima-Costa participated on the conception and design, acquisition of data, analysis and interpretation of the data, drafting the article, and final approval of the version to be published. J. O. A. Firmo and E. Uchôa contributed to the conception and design, acquisition of data, revision of the article, and final approval of the version to be published.

Acknowledgments

To the FINEP, CNPq and FAPEMIG for financial support.

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Submitted on 06/Dec/2010

Final version resubmitted on 21/Feb/2011

Approved on 28/Feb/2011