Predictors of 10-year mortality in a population of community-dwelling Brazilian elderly: the Bambuí Cohort Study of Aging

Determinantes da mortalidade em 10 anos de idosos brasileiros residentes na comunidade: Estudo de Coorte de Idosos de Bambuí

Maria Fernanda Lima-Costa [1]
Sergio Viana Peixoto [1]
Divane L. Matos [1]
Josélia O. A. Firmo [1]
Elizabeth Uchôa [1]

[1] *Núcleo de Estudos em Saúde Pública e Envelhecimento, Fundação Oswaldo Cruz/Universidade Federal de Minas Gerais, Belo Horizonte, Brasil.*

Correspondence
M. F. Lima-Costa
Núcleo de Estudos em Saúde Pública e Envelhecimento, Fundação Oswaldo Cruz/ Universidade Federal de Minas Gerais.
Av. Augusto de Lima 1715, 6º andar, Belo Horizonte, MG 30190-002, Brasil.
lima-costa@cpqrr.fiocruz.br

Abstract

We used data on 1,399 participants aged 60 and over from the Bambuí Cohort Study of Aging to examine predictors of mortality in a socioeconomically disadvantaged population. From 1997 to 2007, 599 participants died and 6.2% were lost to follow-up, leading to 12,415 person-years (pyrs) of observation. The death rate was 48.3 per 1,000 pyrs. Age (adjusted hazard ratio [HR] = 1.40), male gender (HR = 1.80), never married (HR = 1.78) or a widow (HR = 1.26), poor self-rated health (HR = 1.31), inability to perform four or more activities of daily living (HR = 3.29), number of cardiovascular risk factors (HR = 1.51 for two and HR = 1.91 for three or more), Trypanosoma cruzi *infection (HR = 1.27), and number of medications (HR = 1.06) were each significantly ($p < 0.05$) and independently associated with mortality. The* Mini-Mental State Examination *score showed a protective effect (HR = 0.96). Except* T. cruzi *infection, other predictors of mortality were highly consistent with those found in more affluent elderly populations.*

Mortality; Aged; Cohort Studies

Introduction

More than half (51%) of an estimated 59 million deaths that occurred globally in 2004 involved persons aged 60 years and over [1]. In the same period, 59% of total deaths in Brazil were of elderly persons (Departamento de Informática do SUS. Informações de saúde. http://www.datasus.gov.br, accessed on 07/Jul/2010). This proportion tends to increase with the aging of the population. As observed in most middle income countries [1], cardiovascular diseases are leading causes of death in elderly Brazilians, with stroke as the most frequent cause followed by ischemic heart disease [2].

Predictors of mortality in old age have received much attention in the last two decades. Research on the issue has focused on different domains, such as socio demographic characteristics, lifestyle, functioning, mental health and physical health. Life expectancy at birth is higher for females than for males and this advantage persists in old age [3,4,5,6,7,8]. Studies have documented a protective effect of having a spouse on the risk of mortality [8,9,10]. Self-rated health is a universal predictor of mortality in both young and older adults. Hazard ratios (HR) for all-cause mortality associated with poor self-rated health range between 1.5 and 2.0 [11]. There is also evidence that depressive symptoms predict mortality in old age. A meta-analysis of 17 cohort studies of elderly persons showed a crude relative risk of

dying associated with depression of 1.62 (95%CI: 1.44-1.82) [12].

Disability increases the risk of death. Population-based cohort studies have consistently reported increased risks of mortality associated with the inability of elderly persons to complete activities of daily living (ADL) and/or instrumental activities of daily living (IADL) [5,6,8,9,13,14]. Cognitive impairment or dementia is also associated with increased risks of mortality [5,13,15,16,17,18,19,20]. A review of population-based cohort studies showed that even mild levels of impairment predict subsequent death. A meta-analysis of six studies of dementia reported an age and sex adjusted odds ratio (OR) of 2.63 (95%CI: 2.17-3.21) [16].

We used data from 10 years of follow-up of the Bambuí Cohort Study of Aging to examine predictors of mortality in a socioeconomically disadvantaged elderly population.

Methods

Study area and population

The Bambuí Cohort Study of Aging has been conducted in Bambuí, a town of approximately 15,000 inhabitants, located in southeastern Brazil. The cohort study procedures have been described in detail elsewhere [21,22]. Briefly, the baseline cohort population consisted of all residents age 60 and over on January 1st, 1997 who were identified by means of a complete population census in the city. Of 1,742 older residents, 1,606 (92.2%) participated in the baseline survey, and 85.8% participated in other procedures (e.g. anthropometric measures, phlebotomy, electrocardiograms). Bambuí is a former endemic area for Chagas disease, an infectious disease caused by the protozoan *Trypanosoma cruzi*. The transmission of the infection by the insect vector was interrupted in the 1970s, but serologic evidence indicates that its prevalence remains high in the elderly due to a cohort effect [23]. The leading causes of death among elderly residents of Bambuí were stroke, Chagas disease and ischemic heart disease (death rates = 110, 61, and 42 per 100,000, respectively) [23].

Baseline data collection was performed from February to May, 1997, including standardized interviews, blood tests, blood pressure measurements and other procedures. Cohort members undergo annual follow-up visits, which consist of an interview and verification of death certificates. The Bambuí cohort study was approved by the Ethics Research Committee of the Oswaldo Cruz Foundation (Fundação Oswaldo Cruz), Brazil. Participants signed an informed consent and authorized death certificate verification.

Mortality data source

Deaths occurring between the study enrollment and December 31, 2007 were included in this analysis. Deaths were reported by next of kin during the annual follow-up interview and confirmed through the Brazilian Mortality Information System (SIM), with the permission of the Brazilian Ministry of Health (Ministério da Saúde). Death certificates were obtained for 98.9% of individuals. Death assigned to any cause was the outcome variable in this study.

Baseline measures

Baseline measures considered in this study included: socio-demographic characteristics (age, gender, number of complete years of schooling, and marital status), self-rated health, mental health (common mental disorders), functioning (cognitive function and ability to carry out ADL), conventional cardiovascular risk factors (systolic blood pressure, diabetes mellitus, smoking, and HDL cholesterol), the number of prescribed medications currently used, and *T. cruzi* infection. The presence of common mental disorders was defined as a score of five points or higher in the *12-item General Health Questionnaire*, as previously recommended for the study population [24]. Self-rated health was assessed by the answer to the question "*How would you rate your own health*" (very good, good, fair, poor). Cognitive functioning was assessed using a Portuguese version of the 30 item *Mini-Mental State Examination* (MMSE) [25]. ADL disability was defined by the report of much difficulty or inability to perform the following activities: feeding oneself, dressing oneself, bathing or showering, using the toilet, getting in and out of the bed to a chair, and walking across a room. Systolic blood pressure was defined by the mean of two out of three measures, by using standard protocol [26]. Diabetes mellitus was defined as a fasting blood glucose level equal or higher than 126mg/dL or current use of hypoglycemic medication. Current smokers were those who had smoked at least 100 cigarettes in their lifetimes and were still smokers. Fasting glucose and HDL cholesterol were determined at the Bambuí project laboratory with standardized enzymatic methods. The number of conventional cardiovascular risk factors were defined by the sum (yes = 1) of systolic blood pressure equal to or higher than 140mmHg, diabetes mellitus, smoking, and HDL cholesterol below the median (< 47mg/dL). Infection with *T. cruzi* was assessed

by three different assays: a hemagglutination assay (Biolab Mérieux, Rio de Janeiro, Brazil), and two enzyme-linked immunoabsorbent assays (Abbott Laboratories, USA, and Wiener Laboratories, Argentina). Current medication use was ascertained during the home interview by reviewing prescriptions and/or the medication packaging. Further details are described elsewhere [21,22].

Statistical analysis

The univariate analysis of the association between the explanatory variables and gender was based on the Pearson's chi square test, Student's t test and Mann-Whitney rank-sum test for differences between frequencies, means and medians, respectively. Kaplan-Meier estimates were used to compute cumulative survival probabilities by age and gender. The analysis of predictors of mortality was based on HR and 95%CI estimated using the Cox proportional hazards model after confirming that the assumption of proportionality among the hazards was met. Gender, schooling, conjugal status, self-rated health, common mental disorders, number of ADL disabilities, number of cardiovascular risk factors and *T. cruzi* infection were used as categorical measures in this analysis. Age was stratified into five year increments, the MMSE score was transformed into deciles (increments of ten percentile units), and the number of prescribed medications was a count variable. First we estimated the mutually adjusted association between socio-demographic variables and mortality, and then adjusted incrementally for: (1) self-rated health and common mental disorders, (2) MMSE score and ADL disability, and (3) other measures of health or future health (diseases and risk factors). All variables were maintained in the final adjusted model because no pairs exhibited collinearity. The significance of multiplicative interactions between gender and each explanatory variable on mortality was examined by using cross-product terms in Cox proportional regression models. Since there was no evidence of interaction for any study variable (p-values for interaction > 0.05), the analyses of predictors of mortality were carried out for both men and women with sex included as a covariate.

Statistical analyses were conducted using Stata 11.0 statistical software (Stata Corp., College Station, USA). All p-values were 2-tailed ($\alpha = 0.05$).

Results

Of the 1,606 cohort subjects enrolled, 1,399 (87.1%) for whom complete data was available for all study variables were included in this analysis. Subjects were excluded from the analysis if biological measures, such as laboratory tests, blood pressure or anthropometric measures, were not performed (n = 111) or if data for any other study variable was missing (n = 4).

During a mean follow-up of 8.8 years, 599 participants died and 6.2% were lost to follow-up, leading to 12,415 person-years (pyrs) of observation. Those who were lost were younger than those followed [mean age (SD) = 67.4 (5.8) and 69.4 (7.5) years, respectively; p = 0.011]. Women and men were similarly represented in both groups (only 5.4% and 6.6% were lost, respectively; p = 0.227).

Table 1 shows the distribution of baseline characteristics of participants by sex. The mean age was 68.8 years (SD = 7), and 62% were women. Very low levels of schooling predominated (63.3%). Half (49.4%) of participants had a spouse. The prevalence of poor self-rated health, common mental disorders, any ADL disability, one or more conventional cardiovascular risk factors, and *T. cruzi* infection was 25.7%, 38%, 14.6%, 77%, and 37.7%, respectively. The median MMSE score was 26 (interquartile range: 23-28) and the median number of prescribed medications currently used was 3 (interquartile range: 1-4). Statistically significant differences between elderly men and women were found for most study variables, except mean age, high systolic blood pressure (140mmHg and over) and diabetes mellitus.

The overall mortality rate was 48.3 per 1,000 pyrs. As shown in Table 2, mortality rates increased from 28.8 per 1,000 in the youngest group (60-64 years) to 116.1 per 1,000 in the oldest group (80 years and over). There was an excess risk of mortality among men in relation to their counterpart women in all age groups. The difference between absolute risks ranged from 9.9 to 12.8 per 1,000 pyrs in the younger groups (60-64 years), and increased by 55.2 per 1,000 in those aged 75-79 years and 24.3 per 1,000 in those aged 80 years and over (Table 2).

As shown in Figure 1, there was a graded univariate association between baseline age and 10-year survival probability. Among those aged 60-69 and 70-79 years, gender difference on survival probability increased over time. Among those aged 80 years and over, gender differences on survival probability increased for some time, but converged at the end of the follow-up period.

Table 1

Distribution of baseline characteristics of participants by gender. The Bambuí Cohort Study of Aging, 1997.

Characteristics	Total (N = 1,399)	Males (n = 532)	Females (n = 867)	p-value *
Age, mean (SD)	68.8 (7.0)	68.4 (7.0)	69.0 (7.0)	0.163
Schooling less than 4 years (%)	63.3	60.0	65.6	0.023
Conjugal status (%)				< 0.001
Married/Live together	49.4	75.9	33.9	
Never been married	9.8	11.8	6.6	
Divorced/separated	5.2	5.5	5.1	
Widowed	35.1	12.0	49.3	
Self-rated health (%)				
Good or excellent	24.4	31.2	20.2	< 0.001
Reasonable	50.0	49.1	50.5	
Bad/Very bad	25.7	19.7	29.3	
Common mental disorders (%)	38.0	28.8	43.6	< 0.001
Mini-Mental State Examination score [median (IQR)]	26 (23-28)	25 (22-27)	26 (24-28)	< 0.001
Number of ADL disability (%)				0.039
0	85.5	88.0	84.0	
1	8.3	6.2	9.6	
2	3.7	4.3	3.2	
3	0.6	0.4	0.7	
4 or more	2.0	1.1	2.5	
Systolic blood pressure equal or higher than 140mmHg (%)	40.6	41.2	40.3	0.736
Diabetes mellitus (%)	14.9	13.4	15.8	0.210
HDL cholesterol bellow the median (< 47mg/dL) (%)	48.3	57.1	42.8	< 0.001
Current smoker (%)	17.2	28.8	10.0	< 0.001
Number of cardiovascular risk factors (%)				< 0.001
0	23.0	17.9	26.2	
1	41.2	36.1	44.4	
2	27.9	34.4	23.9	
3 or more	7.9	11.7	5.5	
Trypanosoma cruzi infection (%)	37.7	30.3	42.2	< 0.001
Number of prescribed medications [median (IQR)]	3 (1-4)	3 (2-5)	1 (0-3)	< 0.001

ADL: activities of daily living; IQR: interquartile range; SD: standard deviation.

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

Adjusted HR for 10-year mortality by baseline characteristics are shown in Table 3. In the fully adjusted analysis, age (HR = 1.40; 95%CI: 1.32-1.47 for each increment of five years), male gender (HR = 1.80; 95%CI: 1.47-2.21), had never been married (HR = 1.78; 95%CI: 1.34-2.35) and being widowed (HR = 1.26; 95%CI: 1.03-1.56), poor self-rated health (HR = 1.31; 95%CI: 1.02-1.69), inability to perform four or more ADL (HR = 3.29; 95%CI: 2.17-5.00), number of cardiovascular risk factors (HR = 1.51; 95%CI: 1.20-1.92 for two and HR = 1.91; 95%CI: 1.40-2.62 for three or more), *T. cruzi* infection (HR = 1.27; 95%CI: 1.06-1.52), and number of prescribed medications (HR = 1.06; 95%CI: 1.02-1.20 for increases of one additional medication) were all positively and independently associated with subsequent mortality. The MMSE score showed a graded protective effect (HR = 0.96; 95%CI: 0.93-0.99) for each increase in units of 10 percentiles. With few exceptions (schooling and common mental disorders), adjustments for other variables had little or no impact on the associations initially found.

Table 2

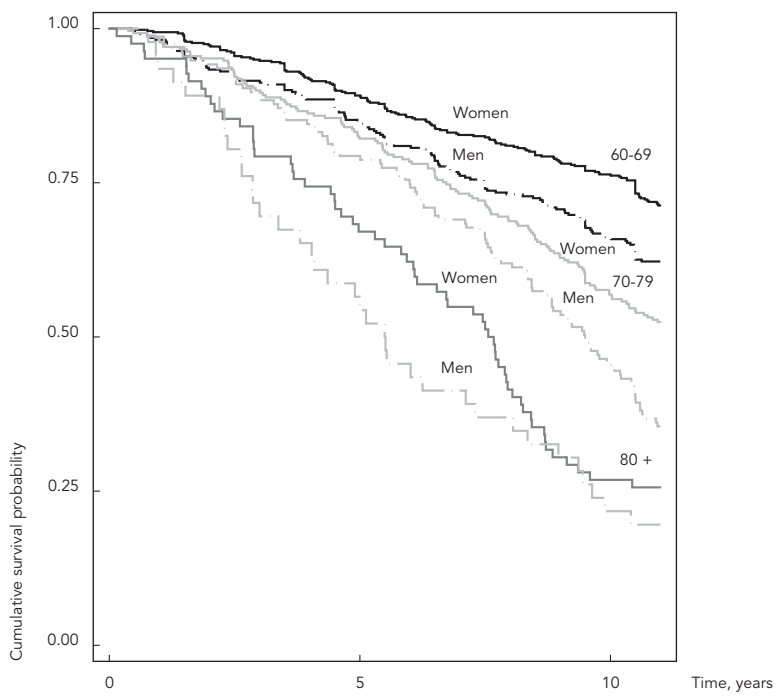
10-year mortality rates by age and sex. The Bambuí Cohort Study of Aging, 1997-2007.

Age (years)	Total		Males		Females		Difference between males and females (deaths rates per 1,000 pyrs)
	Number of deaths	Deaths rates per 1,000 pyrs	Number of deaths	Deaths rates per 1,000 pyrs	Number of deaths	Deaths rates per 1,000 pyrs	
60-64	133	28.8	66	36.3	67	23.9	12.4
65-69	140	41.8	59	50.1	81	37.3	12.8
70-74	123	52.6	50	58.9	73	49.0	9.9
75-79	105	82.9	50	119.9	55	64.7	55.2
80 and over	98	116.1	37	132.3	61	108.0	24.3
Overall	599	48.3	262	57.7	337	42.8	14.9

pyrs: person-years at risk.

Figure 1

Kaplan-Meier survival estimates by age group (60-69 years, 70-79 years and 80+ years) and gender. The Bambuí Cohort Study of Aging, 1997-2007.



Discussion

In this community-based cohort study conducted in a well defined elderly population during ten-year follow-up, increasing age, male gender, absence of a spouse, poor self-rated health, lower cognitive functioning, ADL disability, number of cardiovascular risk factors, number of medications and *T. cruzi* infections were each significantly and independently associated with mortality.

Table 3

Adjusted hazard ratios for ten-year mortality by baseline characteristics. The Bambuí Cohort Study of Aging, 1997-2007.

Baseline characteristics	HR (95%CI)			
	Model 1	Model 2	Model 3	Model 4
Age (for each increment of 5 years)	1.42 (1.35-1.50)	1.42 (1.34-1.49)	1.39 (1.32-1.47)	1.40 (1.32-1.47)
Men (vs. women)	1.64 (1.36-1.97)	1.78 (1.48-2.15)	1.73 (2.42-2.10)	1.80 (1.47-2.21)
Schooling less than 4 years (vs. higher)	1.21 (1.02-1.44)	1.18 (0.99-1.41)	1.05 (0.86-1.27)	1.01 (0.82-1.24)
Conjugal status (vs. married/live together)				
Never married	1.65 (1.25-2.17)	1.70 (1.29-2.24)	1.67 (1.27-2.21)	1.78 (1.34-2.35)
Divorced/Separated	1.57 (1.11-2.21)	1.47 (1.04-2.08)	1.45 (1.02-2.05)	1.34 (0.95-1.91)
Widowed	1.26 (1.02-1.55)	1.26 (1.03-1.55)	1.27 (1.03-1.57)	1.26 (1.03-1.56)
Self-rated health (vs. good/excellent)				
Reasonable		0.94 (0.76-1.15)	0.90 (0.72-1.11)	0.83 (0.67-1.03)
Bad/Very bad		1.70 (1.35-2.14)	1.50 (1.18-1.91)	1.31(1.02-1.69)
Presence of common mental disorders (vs. absence)		1.20 (1.01-1.43)	1.15 (0.96-1.37)	1.13 (0.94-1.35)
Mini-Mental State Examination score (in increments of 10 percentile units)			0.95 (0.92-0.97)	0.96 (0.93-0.99)
Numbers of ADL disability (vs. none)				
1			1.07 (0.81-1.42)	1.01 (0.76-1.34)
2			1.23 (0.84-1.81)	1.05 (0.71-1.56)
3			1.77 (0.82-3.81)	1.28 (0.59-2.80)
4 or more			3.36 (2.22-5.10)	3.29 (2.17-5.00)
Number of cardiovascular risk factors (vs. none)				
1				1.04 (0.88-1.38)
2				1.51 (1.20-1.92)
3 or more				1.91 (1.40-2.62)
Trypanosoma cruzi infection (vs. no)				1.27 (1.06-1.52)
Number of prescribed medication (count)				1.06 (1.02-1.20)

ADL: activities of daily living; Model 1: mutually adjusted for socio-demographic variables (age, sex, schooling and conjugal status); model 2: mutually adjusted for socio-demographic variables plus self-rated health and common mental disorders; Model 3: mutually adjusted for socio-demographic variables, self-rated health, common mental disorders plus functioning (*Mini-Mental State Examination* score and ADL disability); Model 4: mutually adjusted for socio-demographic variables, self-rated health, common mental disorders, functioning plus other measures of health (number of cardiovascular risk factors, *T. cruzi* infection and prescribed medications).

Among the variables considered in the present analysis, only level of schooling and common mental disorders did not show an independent effect on mortality. The study population had small differences in the schooling level, and this might explain the absence of association between this variable and the outcome in our study. However, most population-based cohort studies of elderly persons have not shown an association between schooling and mortality. The absence of an association was observed in different settings and contexts, such as large urban areas in Brazil [5] and in India [15], in Mexican Americans residing in different cities of the United States [19], in Taiwanese elderly [10] and in Danish nonagenarians [13]. In our study, an initial association between low schooling level and increased risk of mortality was found, but the hazard ratio lost statistical significance after adjustments for self-rated health and common mental disorders. Common mental disorders were found to be a predictor of mortality in our study in the analysis adjusted by socio-demographic variables and self-rated health. But this association disappeared after adjustments for cognitive functioning and ADL disability.

Cohort studies have documented a positive relationship between marriage and longer life expectancy [8,9,10], but this association was not replicated by others [13,15,19]. Two of the above mentioned studies categorized conjugal status into four groups, and used "having been widowed" [13] or "unmarried elderly" [15] as the reference category. We also categorized conjugal status in four groups, but we used "having a spouse" as the

reference category. Both "had never been married" and "being widowed" were found to be independent predictors of mortality in this analysis.

Self-rated health is well established as a universal predictor of mortality [11,27]. Self-ratings of health represents a key measure of health status, and reflects the states of the human body and mind [27]. In the Bambuí cohort population, the perception of one's own health was multidimensional in structure, reflecting socioeconomic conditions, social support, health status (mainly mental health), and access to/use of health services. This structure resembles the definition of health adopted by the World Health Organization (WHO): an individual's physical, mental, and social well-being [28]. In the present study, poor self-rated health was a predictor of mortality, and the association remained significant even after adjustments for demographic characteristics, mental health, functioning, and other measures of health and future health status.

Among the predictors of mortality in old age, low cognitive functioning and dementia have been one of the most consistently reported risk factors [5,13,15,16,17,18,19,20]. However, the definition of the exposure variable varies in important ways between studies, making precise comparisons difficult. As an example, three studies conducted in the past decade used the MMSE score as a measure of cognitive functioning. One of these compared the highest score with the lowest [5], a second compared the lowest quintile with higher values [18], and the third had considered changes over time [17]. We computed hazard ratios for baseline 10 percentiles unit increments of the MMSE, and found an inverse and graded association between this measure and the risk of mortality.

Limitations in the ability to perform ADL or IADL have been reported to be consistent predictors of mortality in the elderly [5,6,8,9,13,14]. We found a very strong association between baseline ADL disability and mortality, and this association showed a J shaped pattern. Persons with four or more impaired functions had a three-fold higher risk of death than those without any ADL limitations, and this association remained highly significant even after adjustments for several potential confounding factors.

Although we collected data on a large number of biological measures [21,22], in the present analysis we used those related to the leading causes of death in the study area, that is, cardiovascular diseases and Chagas disease [23]. Cardiovascular risk factors and diseases are leading causes of death worldwide, particularly in middle and old age [1]. Furthermore, it is well established that the concomitance of risk factors increases the risk of cardiovascular events [29]. Our results are consistent with the body of knowledge on this issue.

The health profile of the study population is characterized by the concomitance of degenerative conditions that predominates in most elderly populations worldwide, and a highly prevalent parasitic disease [22], characterizing a population in epidemiological transition. Chagas disease is endemic to South and Central American countries with about 8 million infected [30]. Since the early 1990s, successful multi-country interventions have been undertaken to interrupt the transmission of the infection by insect vectors, and Brazil has been declared free of the transmission caused by the main vector *Triatoma infestans* [30]. Chagas disease in old age is an emerging issue in this context. The aging of the population, together with a cohort effect observed in endemic areas where the household insect transmission has been interrupted, will lead to increases in the number of older adults who are already infected by *T. cruzi* [21]. This effect was first described in Bambuí [23], where the interruption of the transmission anteceded by several decades that of the rest of Brazil. The consequences of the disease in the elderly are impressive. An earlier cross-sectional study showed that infected elderly in Bambuí were more likely to report worse self-rated health, to have stayed in bed recently, to use more prescribed medications, and to be hospitalized independently of other relevant factors [23]. Another cross-sectional study showed a strong and graded relationship between *T. cruzi* infection and cognitive impairment, which is biologically plausible [31]. A recent cohort study showed that *T. cruzi* infection is a predictor of all-cause mortality among the elderly Bambuí cohort independent of age, sex and conventional cardiovascular risk factors [32]. Furthermore, *T. cruzi* infection is an independent predictor of deaths to stroke, probably in a causal pathway [33]. Thus, *T. cruzi* infection was included as a health parameter in the present study, and this variable was considered as a potential confounding factor for the association between other explanatory variables and mortality. As expected, infection with *T. cruzi* was found to be an independent predictor of mortality in this analysis.

As commented elsewhere [21,22], 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-ups, and the ongoing measurements of several outcome variables, including mortality. Nonetheless, this study has some limitations. Although we have

collected information at the follow-up visits for several explanatory variables used in the present analysis, we used only those obtained at baseline. This research strategy was adopted to allow comparisons of results with previous studies on the issue. This strategy has two main consequences: first, our results are subject to the effects of regression to the mean that tend to underestimate the strength of the associations found [34]; second, changes in exposure status over time were not captured. With regard to *T. cruzi* infection, changes of infection status overtime is unlikely for two reasons: first, the transmission of the infection was interrupted in the study area decades ago [23] and incident cases are not expected; second, as the safety and the benefit of the treatment of chronic infection in old age remains uncertain [35], no cohort participants were treated with anti-trypanosomal medication at baseline or at the follow-ups.

In this cohort study with more than 12,000 pyrs of observation, we modelled the predictors of mortality in a population of socioeconomically disadvantaged elderly, and with double burden of non-communicable diseases and a parasitic chronic infection. With exception of an increased risk associated with *T. cruzi* infection, other predictors of mortality were highly consistent with those found in more affluent elderly populations in Brazil [5] and other countries [6,8,9,10,11,13,14,16,17,18,19,20]. Our results support the hypothesis that most predictors of mortality in old age do not vary across populations.

Resumo

*Foram utilizadas informações de 1.399 participantes (≥ 60 anos) do Estudo de Coorte de Idosos de Bambuí, para examinar os determinantes da mortalidade em uma população com nível socioeconômico baixo. Entre 1997 e 2007, 599 participantes faleceram e 6,2% foram perdidos para acompanhamento, resultando em 12.415 pessoas-ano de observação. A taxa de mortalidade foi de 48,3 por mil pessoas-ano. Idade (*hazard ratio *ajustada [HR] = 1,40), sexo masculino (HR = 1,80), ser solteiro (HR = 1,78) ou viúvo (HR = 1,26), pior autoavaliação da saúde (HR = 1,31), incapacidade para realizar quatro ou mais atividades da vida diária (HR = 3,29), número de fatores de risco cardiovascular (HR = 1,51 para dois e HR = 1,91 para três ou mais), infecção pelo* Trypanosoma cruzi *(HR = 1,27) e número de medicamentos (HR = 1,06) apresentaram associações significantes (p < 0,05) e independentes com o evento. O escore do* Mini-Exame do Estado Mental *mostrou efeito protetor (HR = 0,96). Exceto a infecção pelo* T. cruzi*, os outros preditores da mortalidade foram consistentes com o observado em populações idosas com melhor situação socioeconômica.*

Mortalidade; Idoso; Estudos de Coortes

Contributors

M. F. Lima-Costa contributed to the conception and design, acquisition of data, analysis and interpretation of data, drafting the article, and final review of the version to be approved. S. V. Peixoto, D. L. Matos, J. O. A. Firmo and E. Uchôa collaborated on conception and design, acquisition of data, revision of the manuscript, and approval of the version to be published.

Acknowledgments

The authors acknowledge the financial support provided by FINEP, CNPq and FAPEMIG.

References

1. World Health Organization. The global burden of disease: 2004 update. Geneva: World Health Organization; 2008.
2. Lima-Costa MF, Matos DL. Tendências das condições de saúde e uso de serviços de saúde da população idosa brasileira: 20 anos de Sistema Único de Saúde. In: Departamento de Análise de Situação de Saúde, Secretaria de Vigilância em Saúde, Ministério da Saúde. Saúde Brasil 2008: 20 anos de Sistema Único de Saúde (SUS) no Brasil. Brasília: Ministério da Saúde; 2009. p. 385-406.
3. Kinsella K, Gist YJ. Gender and aging: mortality and health. http://www.census.gov/ipc/prod/ib98-2.pdf (accessed on 08/Jul/2010).
4. Crimmins EM, Hayward MD, Saito Y. Differentials in active life expectancy in the older population of the United States. J Gerontolol B Psychol Sci Soc Sci 1996; 51:S111-20.
5. Ramos LR, Simões EJ, Albert MS. Dependence in activities of daily living and cognitive impairment strongly predicted mortality in older urban residents in Brazil: a 2-year follow-up study. J Am Geriatr Soc 2001; 49:1168-75.
6. Fried LP, Kornmal RA, Newman AB, Bild DE, Mittelmark MB, Polak JF, et al. Risk factors for 5-year mortality in older adults: the Cardiovascular Health Study. JAMA 1998; 279:585-92.
7. Korten AE, Jorm AF, Jiao Z, Letenneur L, Jacomb PA, Henderson AS, et al. Health, cognitive, and psychosocial factors as predictors of mortality in an elderly community sample. J Epidemiol Community Health 1999; 53:83-8.
8. Simons LA, McCallum J, Friedlander Y, Simons J. Predictors of mortality in the prospective Dubbo study of Australian elderly. Aust N Z J Med 1996; 26:40-8.
9. Scott WK, Macera CA, Cormman CB, Sharpe PA. Functional health status as a predictor of mortality in men and women over 65. J Clinl Epidemiol 1997; 50:291-6.
10. Liu X, Hermalin A, Chuang YL. The effect of education on mortality among older Taiwanese and its pathways. J Gerontol B Psychol Sci Soc Sci 1998; 53:S71-82.
11. DeSalvo KB, Bloser N, Reynolds K, He J, Muntner P. Mortality prediction with a single general self-rated health question. A meta-analysis. J Gen Intern Med 2006; 21:267-75.
12. Cuijpers P, Smit F. Excess mortality in depression: a meta-analysis of community studies. J Affect Disord 2002; 72:227-36.

13. Nybo H, Petersen HC, Gaist D, Jeune B, Andersen K, McGue M, et al. Predictors of mortality in 2,249 nonagenarians – the Danish 1905-Cohort Survey. J Am Geriatr Soc 2003; 51:1365-73.
14. Blazer DG, Hybels CF, Pieper CF. The association of depression and mortality in elderly persons: a case for multiple, independent pathways. J Gerontol A Biol Sci Med Sci 2001; 56:M505-9.
15. Jotheeswaran AT, Williams JD, Prince MJ. Predictors of mortality among elderly people living in a south Indian urban community; a 10/66 Dementia Research Group prospective population-based cohort study. BMC Public Health 2010; 10:366.
16. Dewey ME, Saz P. Dementia, cognitive impairment and mortality in persons aged 65 and over living in the community: a systematic review of the literature. Int J Geriatr Psychiatry 2001; 16:751-61.
17. Bassuk SS, Wypij D, Berkman LF. Cognitive impairment and mortality in the community-dwelling elderly. Am J Epidemiol 2000; 151:676-88.
18. Ansley KJ, Luszcz MA, Giles LC, Andrews GR. Demographic, health, cognitive, and sensory variables as predictors of mortality in very old adults. Psychol Aging 2001; 16:3-11.
19. Nguyen HT, Black SA, Ray LA, Espino DV, Markides KS. Cognitive impairment and mortality in older Mexican Americans. J Am Geriatr Soc 2003; 51: 178-83.
20. Nitrini R, Caramelli P, Herrera Jr. E, Castro I, Bahia VS, Ahghinah R, et al. Mortality from dementia in a community-dwelling Brazilian population. Int J Geriatr Psychiatry 2005; 20:247-53.
21. Lima-Costa MF, Firmo JOA, Uchôa E. Cohort profile: the Bambui (Brazil) Cohort Study of Aging. Int J Epidemiol 2010; [Epub ahead of print].
22. Lima-Costa MF, Firmo JOA, Uchôa E. The Bambuí Cohort Study of Aging: methodology and health profile of participants at baseline. Cad Saúde Pública 2011; 27 Suppl 3:S327-35.
23. Lima-Costa MF, Barreto SM, Guerra HL, Firmo JOA, Uchôa E, Vidigal PG. Ageing with *Trypanosoma cruzi* infection in a community where the transmission has been interrupted: the Bambuí Health and Ageing Study (BHAS). Int J Epidemiol 2001; 30:887-93.
24. Costa E, Barreto SM, Uchôa E, Firmo JOA, Lima-Costa MF, Prince M. Is the GDS-30 better than the GHQ-12 for screening depression in elderly people in the community? The Bambui Health Aging Study (BHAS). Int Psychogeriatr 2006; 18:493-503.
25. Castro-Costa E, Fuzikawa C, Ferri C, Uchôa E, Firmo J, Lima-Costa MF, et al. Dimensions underlying the Mini-Mental State Examination in a sample with low-educational levels: the Bambui Health and Aging Study. Am J Geriatr Psychiatry 2009; 17:863-72.
26. The fifth report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (JNC V). Arch Intern Med 1993; 153:154-83.
27. Jilha M. What is self-rated health and why does it predict mortality? Towards a unified conceptual model. Soc Sci Med 2010; 69:307-16.
28. Lima-Costa MF, Firmo JOA, Uchôa E. A estrutura da auto-avaliação da saúde entre idosos: Projeto Bambuí. Rev Saúde Pública 2004; 38:827-34.
29. Kannel WB. Risk stratification in hypertension: new insights from the Framingham Study. Am J Hypertens 2000; 13(1 Pt 2):3S-10S.
30. World Health Organization. Reporte sobre la enfermedad de Chagas. Buenos Aires: Pan American Health Organization/World Health Organization; 2007.
31. Lima-Costa MF, Castro-Costa E, Uchôa E, Firmo JOA, Ribeiro AL, Ferri CP, et al. A population-based study of the association between *Trypanosoma cruzi* infection and cognitive impairment in old age (The Bambui Study). Neuroepidemiology 2009; 32:122-8.
32. Lima-Costa MF, Peixoto SV, Ribeiro AL. Chagas disease and mortality in old age as an emerging issue: 10 year follow-up of the Bambui population-based cohort study (Brazil). Int J Cardiol 2010; 41:362-3.
33. Lima-Costa MF, Matos DL, Ribeiro AL. Chagas disease predicts 10-year stroke mortality in community-dwelling elderly (The Bambuí Cohort Study of Aging). Stroke 2010; 145:2477-82.
34. Bland JM, Altman DG. Statistics notes: some examples of regression towards the mean. BMJ 1994; 309:780.
35. Bern C, Montgomery SP, Herwaldt BL, Rassi Jr. A, Marin-Neto JA, Dantas RO, et al. Evaluation and treatment of Chagas disease in the United States: a systematic review. JAMA 2007; 298:2171-81.

Submitted on 24/Aug/2010
Final version resubmitted on 19/Jan/2011
Approved on 21/Feb/2011