Rev Saúde Pública 2008;42(1)

Antônio I de Loyola Filho

Elizabeth Uchoa

Josélia O A Firmo

Maria Fernanda Lima-Costa

Influence of income on the association between cognitive impairment and polypharmacy: Bambuí Project

ABSTRACT

OBJECTIVE: To evaluate the prevalence of polypharmacy and the influence of income on the association between medication use and cognitive impairment among elderly people.

METHODS: Out of the 1,606 baseline members of the Bambuí cohort of elderly people, which started in 1997, 1,554 took part in the study. The Mini-Mental State Examination was applied to all the participants. The association between cognitive impairment and polypharmacy was tested by means of multivariate ordinal regression, performed for the whole population and for each of the income strata.

RESULTS: The prevalence of polypharmacy (two or more medications consumed) was 70.4% and the number of medications used presented an independent negative association with cognitive impairment (OR=0.72; 95% CI: 0.55;0.95). When this was stratified according to personal income (<2 minimum monthly salaries versus ≥ 2 minimum monthly salaries), a negative association was observed between medication use and cognitive impairment among elderly people with lower income (OR=0.64; 95% CI: 0.48;0.86), but not among those with higher income (OR=1.74; 95% CI: 0.81;3.74).

CONCLUSIONS: With regard to the association between cognitive impairment and number of medications consumed, the results indicate social inequality in the use of medications. It is possible that these elderly people are not consuming the medicines needed for appropriate treatment of their health problems.

KEY WORDS: Health of the elderly. Polypharmacy. Pharmacoepidemiology. Drug utilization. Cognitive impairment. Income.

Núcleo de Estudos em Saúde Pública e Envelhecimento. Fundação Oswaldo Cruz e Universidade Federal de Minas Gerais (UFMG). Belo Horizonte, MG, Brasil

Correspondence:
Antônio I. de Loyola Filho
Fundação Oswaldo Cruz
Av. Augusto de Lima, 1715 – sala 610
30190-002 Belo Horizonte, MG, Brasil
E-mail: aloy@cpqrr.fiocruz.br

Received: 9/20/2006
Reviewed: 4/18/2007
Approved: 7/30/2007

INTRODUCTION

Polypharmacy is more commonly defined as multiple consumption of medications, although there is no consensus in the literature regarding the quantity of medications needed to characterize this practice.[7,8,14] The basis for this definition is solely quantitative and it does not take into account the clinical pertinence of the use of these medications (for example, the presence of multiple diseases) or the adequacy of the proposed therapeutic regimen.[21]

In addition to comorbidity, the factors implicated in the genesis of polypharmacy include the number of doctors consulted, absence of questions during consultations concerning the medications in use and self-medication.[21] Side effects,

interactions and adverse drug reactions, difficulty in complying with prescriptions and excessive expenditure on healthcare are some of the undesirable consequences from polypharmacy.[21,22] These consequences are more likely to occur among the elderly, because of the anatomofunctional changes that accompany aging and modify the pharmacokinetics of medications.[22]

Multiple use of medications is more frequent among elderly people,[1] because of the high prevalence of chronic diseases during this phase of life.[2] In developed countries, population-based pharmacoepidemiological studies have shown that, among elderly people, the number of chronic diseases,[7,8,25] healthcare service usage,[7,8] being female[14] and being at a more advanced age[8,14] are related to multiple use of medications. In Brazil, a study carried out among elderly people living in the metropolitan region of Belo Horizonte[16] showed that there were significant independent associations between the consumption of three or more medications and female sex, older age group (80 years or over), having at least one chronic disease and having three or more medical consultations over the last 12 months. Among this same population, high consumption of medications (five or more) was associated with higher schooling levels (eight years or more) and the other variables mentioned above.

Cognitive impairment is frequent in old age,[20] and it may have negative repercussions on elderly peoples' functional capacity.[26] Individual characteristics, lifestyle habits, diseases and illnesses are factors that predispose elderly people to such impairment, but it may be exacerbated through the use of medications.[26] In such cases, cognitive impairment may result from polypharmacy or the use of certain classes of medications (anticholinergic, psychiatric and cardiovascular drugs, to cite a few).[18]

Population-based studies that have investigated associations between the use of medications and the presence of cognitive impairment among elderly people living in communities are scarce. Hidalgo et al[7] (1997) and Klarin et al[9] (2003) found among elderly people in Spain and Sweden respectively that a greater number of medications was consumed among those with cognitive impairment, but the associations did not remain significant after adjustment for other variables. On the other hand, among elderly people in Britain[20] and the United States,[5] the consumption of medications was lower among those who presented cognitive impairment. However, like in the studies cited earlier, the differences did not remain significant after adjustment for the other exploratory variables. Nonetheless, none of these studies investigated whether these associations might have been influenced by the socioeconomic situation of the elderly individuals and/or their families.

The present study had the aim of evaluating the prevalence of polypharmacy and the influence of income on the association between the use of medications and cognitive impairment, among elderly people.

METHODS

This study was conducted in the city of Bambuí (15,000 inhabitants), situated in the State of Minas Gerais. The life expectancy of the population of the municipality of Bambuí in 1997 was 70.2 years and the human development index (HDI) was 7.0. Low schooling levels (42.6% of the population aged 25 years or over presented less than four years of schooling) and low income levels (46.0% had an income of less than 0.5 minimum monthly salary) predominated. Cardiovascular diseases were the principal cause of mortality and the second greatest cause of hospitalization.[13]

The Bambuí Project is a population-based cohort study among elderly people living in the city of the same name. The participants were identified by means of a complete census of the city that was carried out by the team of investigators. All the people living in the city aged 60 years or over on January 1, 1997, were invited to participate in the study. Among the 1,742 residents within the age range considered, 1,606 participated in the baseline cohort that was constituted in 1997. Further details can be obtained in a previous study.[13] All participants in the Bambuí baseline cohort who underwent the Mini-Mental State Examination (MMSE) and for whom there was information on their use of medications were selected for the present study.

The dependent variable was the number of medications consumed over the last 90 days. The participants were asked about the medications consumed over this period, and the information was confirmed by checking the packaging of the medications mentioned. For cases in which the elderly individual selected was unable to answer the questionnaire because of health problems or incapacity (90/1,606; 5.6%), responses given by someone with whom the individual had a personal relationship (a close informant) were used.[13] The name and dosage of the medications were used in identifying them. After identification, the medications were broken down into their active agents and classified on the basis of their chemical formulations. The classification was based on the Anatomical Therapeutic Chemical Index (ATC/DDD Index), which was developed by the World Health Organization Collaborating Centre for Drug Statistics Methodology[a] and is recommended for comparisons with international studies. The total consumption of medications was categorized as 0, 1, 2-4 and 5 or more. Polypharmacy was defined as the consumption of two or more medications, such that consumption of

[a] World Health Organization. Collaborating Centre for Drug Statistics Methodology. Disponível em: http://www.whocc.no/atcddd/indexdatabase/ [Acesso em fev/2005]

2-4 medications was called minor polypharmacy and the consumption of five or more medications was called major polypharmacy.[1]

The presence of cognitive impairment was determined by means of the MMSE,[3] adapted for Brazil. In this, instead of the season of the year, individuals are asked about the period of the day; in the questions about spatial orientation, the district, address and room in the house replace respectively the county, hospital and floor. Instead of the series of multiples of seven, individuals are asked to sequentially add five, starting from 25, or alternatively to spell the name "Maria" (very common in Brazil), back-to-front. For individuals who do not know how to read, two modifications are introduced: a figure "with closed eyes" is presented and the individual is asked to do the same as the figure is doing; and the individual is asked to say a phrase, instead of writing it.[23] The MMSE scores were dichotomized: elderly people with no schooling and a score < 19 and those with some schooling and score < 23 were considered positive for the presence of cognitive disorder (code 1); and the remainder were considered negative (code 0).[6]

The other independent variables included: 1) sociodemographic characteristics; 2) health condition; and 3) healthcare service usage. The sociodemographic characteristics considered were sex, age (continuous variable), schooling (completed years), conjugal situation and monthly personal income (in Brazilian minimum monthly salaries, MMS, at that time). The health condition indicators were the number of chronic diseases diagnosed by a doctor, as self-reported by the individual ("Has any doctor or health professional ever told you that you have one or more of the following diseases: hypertension, coronary disease, arthritis/rheumatism, diabetes or Chagas disease?"), and incapacity to perform at least one out of three activities of daily living, without help from another person (eating, having bath and/or moving between rooms on the same floor of the house) The indicators for healthcare service usage included the number of medical consultations attended over the 12 months preceding the interview and the history of hospitalization over the same period. These variables were included in the study because of their epidemiological importance and because they are traditionally associated with the use of medications in pharmacoepidemiological studies.

Univariate analyses were performed to investigate associations between: 1) the characteristics of the study population and polypharmacy; and 2) the consumption of certain classes of medications and positive results from the MMSE. The association between cognitive impairment and polypharmacy was tested by means of multivariate ordinal regression, carried out for the whole population and for each of the income strata (< 2 MMS and ≥ 2 MMS). The ordinal regression model was equivalent to a set of binary logistic regressions totaling the number of event-variable categories minus one. It assumed the premise of proportional odds, i.e. it generated a constant association measurement across the response-variable categories. The model made it possible to pick up the ordered nature of the response variable and its underlying continuity attribute, thereby minimizing information loss in the categorization.[17] In the multivariate analyses, the associations between cognitive impairment and use of medications were initially adjusted for sex and age, and the final model was constructed by introducing the other sociodemographic variables, the variables indicating health condition and those for health service usage (introduced en bloc), independent of the presence or absence of any significant association in univariate analysis. The variables that presented associations at the level of $p<0.05$ in the final model were considered to be independently associated with the use of medications. An approximation of the maximum likelihood ratio test was used to check the premise of proportionality of the odds. To test the association between the consumption of certain classes of medications and positive results from the MMSE, in the whole population and in each of the income strata, logistic regression taking a significance level of 5% was used. All the analyses were done using the Stata statistical package, version 7.0.

This study had been approved by the ethics committee of Fundação Oswaldo Cruz, and all of the participants signed an informed consent statement.

RESULTS

There were 1,554 participants in this study, corresponding to 96.8% of the membership of the baseline cohort of elderly people in Bambuí. Among these, female sex (60.2%), couples living together (49.4%), low schooling level (64.8% had completed fewer than four years of schooling) and low income level (72.8% had a monthly income <2 MMS) predominated. The mean age was 69.2 years (SD=7.3) and the proportion of the elderly people who fulfilled the criteria for positive classification as cases of cognitive impairment was 17.4%.

The prevalence of medication use among the participants in the study was 85.7% (1,332/1,554) and 70.4% were consuming two or more medications: 44.8% consuming 2-4 medications (minor polypharmacy) and 25.5% consuming five or more medications (major polypharmacy). The following variables presented significant associations ($p<0.05$) with medication consumption: cognitive impairment, sex, age, conjugal situation, number of chronic conditions diagnosed, incapacity to perform at least one activity of daily living and number of medical consultations and history of hospitalizations over the last 12 months (Table 1).

Table 1. Results from univariate analysis on the association between the number of medications consumed and the sociodemographic characteristics, health condition indicators and healthcare service usage indicators. Bambuí, Southeastern Brazil, 1997.

Characteristic	Number of medications (%)				OR*
	0 (N=223)	1 (N=251)	2-4 (N=723)	5 (N=409)	(95% CI)
Cognitive impairment**					
No	76.6	82.5	83.5	84.6	1.00
Yes	23.4	17.5	16.5	15.4	0.76 (0.60;0.97)
Sex					
Male	65.3	56.7	35.3	23.2	1.00
Female	34.7	43.3	64.7	76.8	3.18 (2.61;3.87)
Age group (years)					
60-69	70.3	63.3	57.3	52.8	1.00
70-79	24.8	29.2	30.2	34.3	1.41 (1.15;1.74)
≥ 80	5.0	7.5	12.5	12.9	1.83 (1.36;2.47)
Conjugal situation					
Married/consensual partnership	61.7	55.8	47.1	42.7	1.00
Widowed	22.5	25.8	38.7	43.2	1.84 (1.50;2.26)
Single/separated	15.8	18.3	14.2	14.1	1.12 (0.85;1.46)
Number of years of schooling completed					
None	35.1	30.4	31.1	32.8	1.00
1 – 3	32.9	33.8	32.5	32.8	1.00 (0.80;1.26)
≥ 4	32.0	36.4	36.4	34.3	1.03 (0.82;1.29)
Personal income in minimum monthly salaries of that time***					
< 2	71.8	67.1	74.0	74.8	1.00
≥ 2	28.2	32.9	26.0	25.3	0.84 (0.69;1.03)
Number of chronic conditions diagnosed by a doctor****					
None	55.4	38.8	21.3	7.1	1.00
1	30.2	49.6	38.5	29.8	3.13 (2.45;3.99)
≥ 2	14.4	21.7	40.2	63.1	8.04 (6.23;10.38)
Incapacity to perform at least one activity of daily living*****					
No	98.7	97.5	93.8	89.4	1.00
Yes	1.4	2.5	6.2	10.6	2.84 (1.92;4.18)
Number of medical consultations over last 12 months					
None	48.7	40.8	12.6	2.8	1.00
1-2	36.9	37.5	40.1	26.0	4.20 (3.22;5.47)
3-4	9.9	13.8	24.4	28.8	9.87 (7.26;13.42)
≥ 5	4.5	7.9	22.8	42.4	18.15 (13.26;24.84)
Hospitalization over the last 12 months					
No	90.5	87.5	79.0	63.4	1.00
Yes	9.5	12.5	21.0	36.4	2.83 (2.25;3.57)

* OR 95% CI, estimated by the ordinal regression method
** Based on the score obtained from the Mini-Mental State Examination
*** Minimum monthly salary = R$ 120 (at that time, R$ 1 = US$ 1)
**** Arthritis/rheumatism, Chagas disease, coronary disease, diabetes and/or hypertension
***** At least one among the activities of eating, getting dressed and moving around in the home

Table 2 presents the results from the multivariate analysis on the association between cognitive impairment and the consumption of medications, for the whole population of this study. After adjusting for all the variables included in the model (Model 2), cognitive impairment presented an independent negative association with polypharmacy. All the variables listed in the table (except for conjugal situation and schooling from

Table 2. Results from multivariate analysis on the association between cognitive impairment, number of medications consumed and other variables. Bambuí, Southeastern Brazil, 1997.

Variable	Model 1 OR (95% CI)*	Modelo 2 OR (95% CI)**
Disfunção cognitiva***		
No	1,00	1,00
Yes	0,82 (0,64;1,06)	0,72 (0,55;0,95)
Sex		
Male	1,00	1,00
Female	3,10 (2,54;3,78)	2,18 (1,72;2,75)
Age (in years)	1,03 (1,02;1,05)	1,03 (1,02;1,05)
Conjugal situation		
Married/consensual partnership		1,00
Widowed		1,00 (0,78;1,27)
Separated/divorced		0,92 (0,69;1,23)
Schooling in completed years		
None		1,00
1-3		1,21 (0,95;1,54)
≥ 4		1,42 (1,09;1,83)
Monthly personal income in minimum monthly salaries****		
< 2		1,00
≥ 2		1,39 (1,09;1,77)
Number of chronic conditions diagnosed by a doctor*****		
None		1,00
1		2,49 (1,93;3,22)
≥ 2		4,61 (3,49;6,10)
Incapacity to perform at least one activity of daily living******		
No		1,00
Yes		1,96 (1,26;3,06)
Number of medical consultations over the last 12 months		
None		1,00
1-2		2,56 (1,94;3,38)
3-4		5,32 (3,84;7,36)
≥ 5		8,23 (5,84;11,61)
Hospitalization over the last 12 months		
No		1,00
Yes		1,55 (1,20;2,00)

* OR 95% CI, obtained by ordinal regression and adjusted for sex and age
** OR 95% CI, obtained by ordinal regression and adjusted for the variables described in column 1 (1,550 individuals participated in this analysis)
*** Evaluated using the Mini-Mental State Examination (see methodology section)
**** MMS = R$ 120 (at that time, R$ 1 = US$ 1)
***** Hypertension, arthritis/rheumatism, Chagas disease, coronary disease or diabetes
****** At least one among the activities of eating, getting dressed and moving around in the home

one to four years) remained significantly associated with polypharmacy.

The final results from the multivariate analyses according to income strata are in Table 3. In the social stratum of lower income (<2 MMS), a significant negative association was observed between cognitive impairment and polypharmacy (OR=0.64; 95%CI: 0.48;0.86). In the higher stratum (income ≥2 MMS), the direction of this association was positive, but it was not significant (OR=1.74; 95%CI: 0.81;3.74). The association pattern for polypharmacy was similar in the two strata: the differences were in the incapacity to perform activities of daily living (significant positive association in

Table 3. Result from multivariate analysis on the association between cognitive impairment, number of medications consumed and other variables, stratified according to monthly personal income. Bambuí, Southeastern Brazil, 1997.

Variable	Monthly income in minimum monthly salaries < 2 MMS OR (95% CI)*	Monthly income in minimum monthly salaries ≥ 2 MMS OR (95% CI)*
Cognitive impairment**		
No	1.00	1.00
Yes	0.64 (0.48;0.86)	1.74 (0.81;3.74)
Sex		
Male	1.00	1.00
Female	2.37 (1.79;3.13)	1.59 (0.99;2.54)
Age (in years)	1.03 (1.01;1.04)	1.05 (1.02;1.08)
Conjugal situation		
Married/consensual partnership	1.00	1.00
Widowed	1.01 (0.77;1.33)	1.22 (0.72;2.08)
Single/separated	0.98 (0.71;1.37)	0.89 (0.48;1.63)
Schooling in completed years		
None	1.00	1.00
1-4	1.23 (0.94;1.61)	1.24 (0.66;2.33)
≥ 4	1.36 (1.01;1.83)	1.87 (1.03;3.41)
Number of chronic conditions diagnosed by a doctor***		
None	1.00	1.00
1	2.46 (1.80;3.38)	2.54 (1.62;3.99)
≥ 2	4.10 (2.94;5.73)	6.63 (3.92;11.19)
Incapacity to perform at least one activity of daily living****		
No	1.00	1.00
Yes	2.55 (1.56;4.17)	0.58 (0.20;1.72)
Number of medical consultations over last 12 months		
None	1.00	1.00
1-2	3.05 (2.17;4.29)	1.75 (1.07;2.86)
3-4	6.30 (4.27;9.31)	3.60 (1.98;6.54)
≥ 5	9.89 (6.59;14.83)	5.30 (2.65;10.61)
Hospitalization over the last 12 months		
No	1.00	1.00
Yes	1.54 (1.15;2.06)	1.69 (0.99;2.90)

* OR 95% CI, estimated by the ordinal regression method; 1,128 individuals with income <2 MMS and 422 individuals with income ≥ 2 MMS participated in this analysis.
** Based on the score obtained from the Mini-Mental State Examination
*** Arthritis/rheumatism, Chagas disease, coronary disease, diabetes and/or hypertension
**** At least one among the activities of eating, getting dressed and moving between the rooms on the same floor
Number of medications used : "0"; "1"; "2-4" or "≥ 5".

the lower income stratum and non-significant negative association in the higher income stratum) and absence of statistical significance for the associations found for female sex and history of hospitalization in the higher income stratum.

The results from the analysis of associations between the consumption of certain classes of medications and cognitive impairment, adjusted for sex and age, are described in Table 4. Table 5 presents the results from the same analysis for income strata. Considering level 1 classification (anatomical), the consumption of all the medication classes investigated was lower among the elderly people with cognitive impairment, although the differences were not statistically significant. Considering the therapeutic/pharmacological classification, presence of cognitive impairment was positively and significantly associated with the use of digoxin-based

Table 4. Results from analysis of the association between consumption of certain selected classes of medications and cognitive impairment, adjusted for sex and age. Bambuí, Southeastern Brazil, 1997.

Class of medications*	Cognitive impairment**		OR (95% CI)****
	Yes (%)***	No (%) ***	
Alimentary tract and metabolism*****	28.9	33.1	0.78 (0.60;1.06)
Antihistamines H2	4.8	3.9	1.13 (0.59;2.16)
Alimentary tract with anticholinergic action	1.5	1.6	0.70 (0.23;2.15)
Cardiovascular system*****	54.4	57.3	0.99 (0.75;1.31)
Digoxin-based cardiac therapy	20.4	13.9	1.72 (1.21;2.46)
Methyldopa-based antihypertensives	7.8	7.9	1.17 (0.70;1.94)
ACE inhibitors******	3.7	9.0	0.40 (0.20;0.78)
Musculoskeletal system*****	11.9	16.6	0.79 (0.53;1.19)
Non-steroidal anti-inflammatory drugs	3.0	5.0	0.68 (0.32;1.45)
Central nervous system*****	45.2	48.6	0.95 (0.72;1.26)
Benzodiazepines*******	17.4	19.7	0.95 (0.67;1.37)
Analgesics	12.2	16.8	0.78 (0.52;1.17)
Anticonvulsants	8.9	5.9	1.61 (0.98;2.65)
Antipsychotics	5.9	3.5	2.08 (1.13;3.82)
Antiparkinsonians	2.6	2.0	1.19 (0.50;2.85)
Tricyclic antidepressives	2.2	7.6	0.34 (0.15;0.80)

* Classification in accordance with the Anatomical Therapeutic Chemical Index (ATC)
** Based on the score obtained from the Mini-Mental State Examination, adjusted for schooling level
*** % of users of the class of medications
**** OR 95% CI, estimated by logistic regression and adjusted for sex and age
***** Level 1 of the ATC classification
****** Angiotensin-converting enzyme
******* Except for anticonvulsants

cardiac therapy and the use of antipsychotic drugs, and negatively and significantly associated with the use of angiotensin-converting enzyme (ACE) inhibitors and tricyclic antidepressives.

The results from the stratified analysis showed that there were differences in the association pattern between the two strata. For most of the medications, the consumption was lower among the elderly people with cognitive impairment and lower income (and significantly so for ACE inhibitors and tricyclic antidepressives), although the consumption of digoxin-based medications and antipsychotic drugs presented a significant positive association. Among the elderly people with higher income, on the other hand, the consumption was greater for most classes of medications, and all the significant associations that were observed (for cardiovascular medications, digoxin-based cardiac therapy drugs and methyldopa-based antihypertensives) were positive.

DISCUSSION

The prevalence of polypharmacy observed in the present study was greater than what has been found in some studies conducted in developed countries.[8,25] On the other hand, the prevalence of major polypharmacy was lower than what has been observed in European countries,[8,9,25] while it was greater than what has been observed in Hong Kong[27] and in the metropolitan region of Belo Horizonte.[16] Differences regarding sociodemographic characteristics, cultural traits, morbidity patterns and healthcare service usage patterns may underlie the variations in medication consumption between different populations. However, the possibility that methodological differences may partially explain the variation observed cannot be dismissed. The Bambui study included prescribed and non-prescribed drugs and the question on medication consumption covered the last 90 days. This may partially explain the greater prevalence observed there, in comparison with studies that solely considered prescribed medications[8,25] or that used shorter time windows, such as one week[27] or a fortnight.[16]

In the present study, the variables indicating health conditions and healthcare service usage, and some sociodemographic characteristics, were considered to be *a priori* confounding variables in relation to investigating the association between polypharmacy and cognitive impairment. The greater usage of medications among women confirmed the findings from another Brazilian study.[16] Both the variables indicating health conditions and those for healthcare service usage presented strong and independent associations with the number of

Table 5. Results from analysis of the association between consumption of certain selected classes of medications and cognitive impairment,* stratified according to income and adjusted for sex and age. Baseline cohort, Bambuí, Southeastern Brazil, 1997.

Class of medications**	Monthly income in minimum monthly salaries***	
	< 2 MSS OR (95% CI)****	≥ 2 MSS OR (95% CI)****
Alimentary tract and metabolism*****	0.75 (0.54;1.05)	1.28 (0.58;2.83)
Antihistamines H2	1.09 (0.50;2.37)	2.42 (0.70;8.34)
Alimentary tract with anticholinergic action	0.76 (0.23;2.44)	-
Cardiovascular system*****	0.93 (0.68;1.28)	2.47 (1.05;5.79)
Digoxin-based cardiac therapy	1.55 (1.05;2.28)	3.85 (1.13;13.12)
Methyldopa-based antihypertensives	0.93 (0.53;1.63)	3.20 (1.01;10.14)
ACE inhibitors*****	0.40 (0.18;0.89)	0.86 (0.25;3.00)
Musculoskeletal system*****	0.74 (0.47;1.17)	1.66 (0.63;4.38)
Non-steroidal anti-inflammatory drugs	0.63 (0.28;1.44)	1.05 (0.13;8.43)
Central nervous system*****	0.96 (0.70;1.30)	0.97 (0.44;2.14)
Benzodiazepines******	0.90 (0.61;1.35)	1.56 (0.64;3.85)
Analgesics	0.85 (0.55;1.31)	0.57 (0.16;1.98)
Anticonvulsants	1.63 (0.93;2.87)	2.02 (0.62;6.61)
Antipsychotics	2.04 (1.06;3.93)	1.61 (0.19;13.49)
Antiparkinsonians	1.06 (0.37;2.98)	2.42 (0.45;13.13)
Tricyclic antidepressives	0.34 (0.13;0.86)	0.54 (0.07;4.24)

* Based on the score obtained from the Mini-Mental State Examination, adjusted for schooling level
** Classification in accordance with the Anatomical Therapeutic Chemical Index (ATC)
*** MMS = R$ 120 (at that time, R$ 1 = US$ 1)
**** OR 95% CI, estimated by logistic regression and adjusted for sex and age.
***** Level 1 of the ATC classification
****** Angiotensin-converting enzyme
******* Except for anticonvulsants

medications consumed, thus corroborating a pattern that has been found to be consistent across different populations.[7,8,16] The magnitude and independence of these associations prove the importance of these variables for explaining the use of medications. This consequently attests to the pertinence of including them in the study for adjustment purposes.

The consumption of medications was significantly lower among the elderly people in Bambuí who were classified as positive for cognitive impairment. Similar results have been found in developed countries,[5,20] although in those countries the association did not remain significant after adjusting for confounding variables. Elderly people with cognitive impairment more frequently present chronic health problems[28] and functional limitations,[20] and thus it is plausible to expect a higher frequency of polypharmacy among them. Hanlon et al[5] (1996) expressed concern that lower consumption of medications among elderly people with cognitive impairment might constitute underuse of medications, because doctors had failed to prescribe adequate drug therapy, influenced by knowledge of their patients' cognitive status. Knowing that elderly people with abnormal cognitive function are more likely not to comply with a therapeutic regimen,[19] doctors perhaps become more parsimonious in their prescriptions.

Among the classes of medications investigated in the present study, only tricyclic antidepressives and ACE inhibitors (negative associations), and digoxin-based cardiac therapy and antipsychotic drugs (positive associations), were associated with the presence of cognitive impairment. With regard to ACE inhibitors, Klarin et al[9] (2003) found similar results among elderly people in a rural community in Sweden. Since the medication classes investigated are considered to induce cognitive impairment,[18] one likely explanation for lower use of some of them is that this expresses greater precaution among doctors with regard to prescribing them, fearful of possible negative effects on their patients' cognition levels. On the other hand, these patients would not be receiving adequate pharmacological treatment for their health problems.[9] Among elderly people with cognitive impairment, health problems may go unnoticed by health professionals because the patients are unable to adequately describe their symptoms.[5,9] On the other hand, the positive association between the use of digoxin and antipsychotics and cognitive impairment is a matter of concern, since both of these

medications have been correlated with the occurrence of this problem. The appearance of neurological disorders has been associated with toxic doses of digoxin and with the use of antipsychotics, and in both cases this occurs more frequently among elderly people.[18] Deeper investigations are needed for better understanding of the association between the use of these medications and cognitive impairment among this population.

The analyses stratified according to income showed differences in the association between the use of medications and cognitive impairment.

In the poorer stratum, elderly people with cognitive impairment presented a significantly lower prevalence of polypharmacy and had lower consumption of the medications investigated. On the other hand, in the higher income stratum, cognitive impairment was positively associated with polypharmacy (without reaching significance) and, among the elderly people with cognitive impairment, there was higher consumption of most of the medications investigated. In the study population, the poorer individuals presented worse state of health (number of chronic diseases and incapacity to perform at least one activity of daily living) and they used the healthcare services more (number of medical consultations and history of hospitalizations). As stated earlier, all these variables presented positive associations with polypharmacy, and this allows it to be supposed that the medication needs were greater among the population stratum of lower income. In this light, the results are of concern, since they indicate that inequality relating to the use of medications exists among this population. In Brazil, there is unequal availability of medications, since pharmaceutical care remains marked by deficiencies in the public sector with regard to the storage, distribution and dispensing of medications, while these are predominantly available in private pharmacies. Thus, access to and use of medications is conditional on the funding capacity, which is greater among individuals with higher income.[4] Expenditure on medications has a significant weight in the budget of the elderly population in Brazil. Half of them receive ≤ 1 minimum monthly salary and spend an average of 23% of this income on purchasing medications.[11] Abandonment of treatment with medications because of their cost occurs frequently.[10] All the indications are that Bambuí reproduces this Brazilian pattern, since the relationship between use of medications and socioeconomic situation has appeared in other studies developed there. Income was positively associated with the use of prescribed medications,[15] and the elderly people of lower socioeconomic level presented greater difficulty in obtaining them, which they ascribed to financial problems.[12] References to difficulties in funding expenses due to medications among this population were also observed in a study with qualitative methodology.[24] Thus, two questions can be raised: 1) whether, among the elderly people in Bambuí, medical prescriptions should be differentiated not only as a function of doctors' knowledge of patients' cognitive state, as suggested by Hanlon et al[5] (1996), but also as a function of socioeconomic level; and/or 2) whether, under pressure because of adverse economic conditions, poorer elderly people with cognitive impairment might be consuming lower quantities of medications than those that would be necessary for treating their health problems.

The present investigation is the first Brazilian population-based study developed with the aim of finding out whether there is any association between cognitive impairment and the use of medications. It is also the first Brazilian pharmacoepidemiological study to investigate whether socioeconomic conditions would influence this association, if it were to exist. All the methodological care required for ensuring information quality was taken, such as standardization of the data collection instrument, training for interviewers and census identification of participants, among other measures.[13]

However, the cross-sectional nature of the present study did not enable clarification of the time relationships between cognitive impairment and the use of medications. It can also be envisaged that insufficiency of statistical power in the higher-income stratum (N=422) may not have allowed confirmation of a positive association between cognitive dysfunction and polypharmacy, although this was suggested by the magnitude of the association measurement and the respective confidence interval (OR=1.74; 95%CI: 0.81;3.74).

In conclusion, the present study showed that in Bambuí, the elderly people classified as presenting cognitive impairment consumed less medication than did those who were considered not to have such impairment. Income had an important role in this association, since the lower consumption of medications among elderly people with cognitive impairment in the lower-income stratum did not have correspondence in the higher-income stratum, where this consumption was greater. Longitudinal studies are needed in order to establish the time relationships between cognitive impairment and the use of medications, and thus to provide better understanding of the importance of medication consumption in the genesis of cognitive impairment. Furthermore, such studies would also enable investigation of whether the health problems of elderly people with cognitive impairment are receiving adequate treatment with medications.

REFERENCES

1. Bjerrum L, Søgaard J, Hallas J, Kragstrup J. Polypharmacy: correlations with sex, age and drug regimen. *Eur J Clin Pharmacol.* 1998;54(3):197-202.
2. Desai MM, Zhang P, Hennessy CH. Surveillance for morbidity and mortality among older adults - United States, 1995-1996. *MMWR Morb Mortal Wkly Rep.* 1999;48(SS08):7-25.
3. Folstein MF, Folstein SE, McHugh PR. "Mini-Mental State": a practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res.* 1975 12(3):189-98.
4. Guerra Jr AA, Acúrcio FA, Gomes CAP, Miralles M, Girardi SN, Werneck GAF, et al. Disponibilidade de medicamentos essenciais em duas regiões de Minas Gerais, Brasil. *Rev Panam Salud Publica.* 2004;15(3):168-75.
5. Hanlon JT, Landerman LR, Wall WE Jr, Horner RD, Fillenbaum GG, Dawson DV, et al. Is medication use by community-dwelling elderly people influenced by cognitive function? *Age Ageing*. 1996;25(3):190-6.
6. Herrera Jr E, Caramelli P, Nitrini R. Estudo epidemiológico populacional de demência na cidade de Catanduva - Estado de São Paulo - Brasil. *Rev Psiq Clin.* 1998;25(2):70-3.
7. Hidalgo JLT, Diaz RC, Olano CF, Gallego MR, Casalderrey CF, Puime AO. Factores associados al consumo de medicación crônica em personas ancianas. *Med Clin (Barc).* 1997;108:572-6.
8. Jörgensen T, Johansson S, Kennerfalk A, Wallander MA, Svärdsudd K. Prescription drug use, diagnoses, and healthcare utilization among the elderly. *Ann Pharmacother.* 2001;35(9):1004-9.
9. Klarin I, Fastbom J, Wimo A. A population-based study of drug use in the very old living in a rural district of Sweden, with focus on cardiovascular drug consumption: comparison with an urban cohort. *Pharmacoepidemiol Drug Saf.* 2003;12(8):669-78.
10. Lebrão ML, Laurenti R. Saúde, bem-estar e envelhecimento: o estudo SABE no Município de São Paulo. *Rev bras Epidemiol.* 2005;8(2):127-41.
11. Lima-Costa MFF, Barreto SM, Firmo JO, Uchoa E. Socioeconomic position and health in a population of Brazilian elderly: the Bambuí Health and Aging Study (BHAS). *Rev Panam Salud Publica.* 2003;13(6):387-94.
12. Lima-Costa MFF, Barreto SM, Giatti L. Condições de saúde, capacidade funcional, uso de serviços de saúde e gastos com medicamentos da população brasileira: um estudo descritivo baseado na Pesquisa Nacional por Amostra de Domicílios. *Cad Saude Publica.* 2003;19(3):735-43.
13. Lima-Costa MFF, Uchoa E, Guerra HL, Firmo JOA, Vidigal PG, Barreto SM. Estudo de Bambuí sobre saúde e envelhecimento: metodologia e resultados preliminares de coorte de estudo de idosos no Brasil. *Rev Saude Publica.* 2000;34(2):126-35.
14. Linjakumpu T, Hartikainen S, Klaukka T, Veijola J, Kivelä SL, Isoaho R. Use of medications and polypharmacy are increasing among the elderly. *J Clin Epidemiol.* 2002;55(8):809-17.
15. Loyola Filho AI, Uchoa E, Firmo JOA, Lima-Costa MFF. Estudo de base populacional sobre o consumo de medicamentos entre idosos: Projeto Bambuí. *Cad Saude Publica*. 2005;21(2):545-53.
16. Loyola Filho AI, Uchoa E, Lima-Costa MFF. Estudo epidemiológico de base populacional sobre uso de medicamentos entre idosos na Região Metropolitana de Belo Horizonte (MG). *Cad Saude Publica*. 2006;22(12):2657-67.
17. Manor O, Matthews S, Power C. Dichotomous or categorical response? Analysing self-rated health and lifetime social class. *Int J Epidemiol.* 2000;29(1):149-57.
18. Moore AR, O'Keeffe ST. Drug-induced cognitive impairment in the elderly. *Drugs Aging*. 1999;15(1):15-28.
19. Okumo J, Yanagi H, Tomura S. Is cognitive impairment a risk factor for poor compliance among Japanese elderly in the community? *Eur J Clin Pharmacol*. 2001;57(8):589-94.
20. Rait G, Fletcher A, Smeeth L, Brayne C, Stirling S, Nunes M, et al. Prevalence of cognitive impairment: results from the MRC trial of assessment and management of older people in the community. *Age Ageing.* 2005;34(3):242-8.
21. Rollason V, Vogt N. Reduction of polypharmacy in the elderly: a systematic review of the role of the pharmacist. *Drugs Aging.* 2003;20(11):817-32.
22. Rozenfeld S. Prevalência, fatores associados e mal uso de medicamentos entre idosos: uma revisão. *Cad Saude Publica*. 2003;19(3):717-24.
23. Seabra MLV, Concílio GV, Villares JB, Carlini EA. Avaliação do teste Mini-Mental State em voluntários e pacientes brasileiros. *Rev ABP-APAL.* 1990;12(1/4):1-7.
24. Uchoa E, Firmo JOA, Costa MFFL. Envelhecimento e saúde: experiência e construção cultura. In*:* Minayo MCS, Coimbra Jr CEA, organizadores. Antropologia, saúde e envelhecimento. Rio de Janeiro: Fiocruz, 2002; p.25-35.
25. Veehof LJG, Stewart RE, Haaijer-Ruskamp FM, Jong BM. The development of polypharmacy. A longitudinal study. *Fam Pract.* 2000;17(3):261-7.
26. Verbrugge LM, Jette AM. The disablement process. *Soc Sci Med.* 1994;38(1):1-14.
27. Woo J, Ho SC, Yuen YK, Lau J. Drug use in an elderly Chinese population: prevalence and associated factors. *Gerontology.* 1995;41(2):98-108.
28. Yen YC, Yang MJ, Shih CH, Lung FW. Cognitive impairment and associated risk factors among aged community members. *Int J Geriatr Psychiatry.* 2004;19(6):564-9.

Funded by Financiadora de Estudos e Projetos (Finep – Procedure no. 6694009-00) and by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq – Procedure no. 520337/96-4).
Article based on doctoral thesis of AI Loyola Filho, which was presented within the Postgraduate Public Health Program of the UFMG School of Medicine, in 2006.