https://doi.org/10.1590/1980-549720210037

ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Spatial Analysis of Factors Associated with Hospitalizations for Ambulatory Care Sensitive Conditions among Old Adults in Minas Gerais State

Análise espacial dos fatores associados às internações por condições sensíveis à atenção primária entre idosos de Minas Gerais

Sara de Souza Silva[I], Letícia Cavalari Pinheiro[II], Antônio Ignácio de Loyola Filho[II,III]

ABSTRACT: ***Aim*:** To investigate the geographical variability and factors associated with hospitalizations for ambulatory care sensitive conditions (ACSC) among older adults living in the state of Minas Gerais. ***Methodology*:** This is an ecological study, based on data from the National Hospital Information System (SIH-SUS). Municipal rates of hospitalization for ACSC were compared to the state's average rate, and analysis of associated factors included sociodemographic characteristics, supply of health services and primary health care (PHC) activities. Data analysis was based on Bayesian spatial modeling. ***Results*:** Most municipalities in Minas Gerais (479 or 56.2%) had a rate of hospitalization for ACSC below the state average. After multivariate analysis, income (β = -0,0008; 95%CI: -0.0014 – -0,0002) and the Family Health Strategy coverage (β = -0.4269; 95%CI: -0.7988 – -0.1116) were negatively associated with the risk of hospitalization for ACSC, while the availability of hospital beds (β = 0.0271; 95%CI 0.0211 – 0.0331) was positively associated. The characteristics of PHC did not show any association with the rate of hospitalization for ACSC. ***Conclusion*:** the rates of hospitalization for ACSC in the elderly population were influenced by the PHC coverage, but also by external factors such as income and structure and provision of health services, indicating that the meeting of population health demands passes through actions that go beyond the health sector, including investment in the reduction of poverty and inequality and expansion of access to PHC.

***Keywords*:** Primary health care. Hospitalization. Aged. Ambulatory care. Ecological studies. Spatial analysis.

[I]Post-graduate Program in Public Health, René Rachou Institute, Fundação Oswaldo Cruz – Belo Horizonte (MG), Brazil.
[II]Center for Studies in Public Health and Aging, René Rachou Institute, Fundação Oswaldo Cruz – Belo Horizonte (MG), Brazil.
[III]Nursing School, Universidade Federal de Minas Gerais – Belo Horizonte (MG), Brazil.
Corresponding author: Antônio Ignácio de Loyola Filho. Avenida Augusto de Lima, 1.715, CEP: 30190-003, Belo Horizonte, MG, Brazil. E-mail: antonio.filho@fiocruz.br
Conflict of interests: nothing to declare – **Financial support:** Post-graduate Program in Collective Health at the René Rachou Institute, Fundação Oswaldo Cruz, and National Council for Scientific and Technological Development (CNPq) (Process: 305626/2018-3).

RESUMO: ***Objetivo*:** Investigar a variabilidade geográfica e os fatores associados à ocorrência de internações por condições sensíveis à atenção primária (ICSAP) entre idosos residentes no estado de Minas Gerais. ***Métodos*:** Trata-se de um estudo ecológico baseado nos dados do Sistema de Informações Hospitalares do Sistema Único de Saúde (SIH-SUS). As taxas municipais de ICSAP foram comparadas à taxa média do estado, e a análise dos fatores associados incluiu características sociodemográficas, de oferta de serviços de saúde e atividades próprias da atenção primária à saúde (APS). A análise dos dados baseou-se na modelagem espacial bayesiana. ***Resultados*:** A maioria dos municípios mineiros (479 ou 56,2%) apresentou uma taxa de ICSAP abaixo da taxa média estadual. Após a análise multivariada, a renda (β = -0,0008; IC95% -0,0014 – -0,0002) e a cobertura de Estratégia Saúde da Família (β = -0,4269; IC95% -0,7988 – -0,1116) associaram-se negativamente ao risco de ICSAP, enquanto a disponibilidade de leitos (β = 0,0271; IC95% 0,0211 – 0,0331) se associou positivamente. As características próprias da APS não apresentaram associação com a taxa de ICSAP. ***Conclusão*:** As taxas de ICSAP na população idosa foram influenciadas pela cobertura da APS e também por características externas a ela, como renda e oferta de serviços de saúde, indicando que o equacionamento das demandas de saúde populacionais passa por ações externas ao setor da saúde, como investimentos na redução da pobreza e da desigualdade, além da ampliação do acesso à APS.

Palavras-chave: Atenção primária à saúde. Hospitalização. Idoso. Assistência ambulatorial. Estudos ecológicos. Análise espacial.

INTRODUCTION

Hospitalizations for ambulatory care sensitive conditions (ACSC) are an indicator used to assess access to primary health care (PHC) and quality, since these health conditions include a set of diseases that can be prevented and controlled by timely and quality PHC[1]. In 2008, the Ministry of Health published the Brazilian List of ACSCs with 19 groups of causes of hospitalization, based on the evaluation of lists that already exist in Brazil and abroad[2].

International studies have shown that the rate of hospitalization for ACSCs is impacted by aspects related to PHC, and they are both general—relating to access, availability of services and primary care physicians—and specific—relating to continuous care[3-6]. In addition, these studies have also investigated whether the frequency of hospitalization for ACSC is affected by contextual socioeconomic characteristics such as the level of education and income of the population, area of residence and distance from health services, to mention some[3-5-5-11].

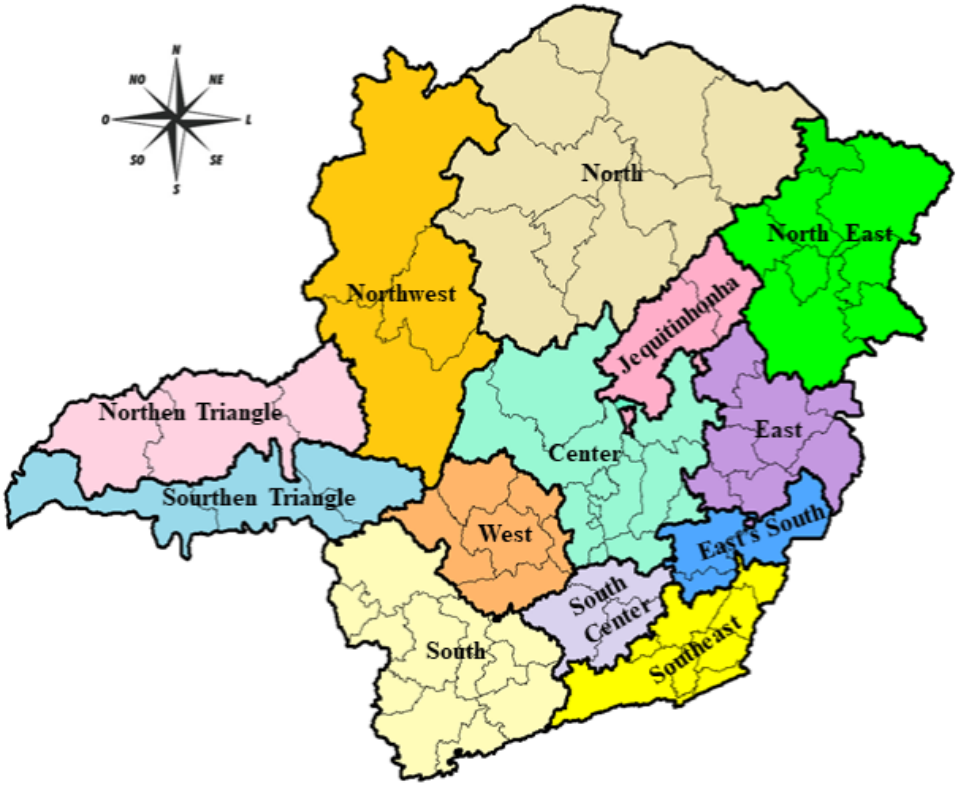
The national scientific production on the subject has been mostly centered on two main investigative strands. The first one has sought to establish a correlation between the evolution of rates of hospitalization for ACSC and the expansion of coverage of the Family Health Strategy (FHS)[12-15]. The second has investigated the determinants of hospitalizations for ACSCs, considering socioeconomic factors, structure and availability of health services in general, as well as specific attributes of PHC[16-21]. However, few of these studies have been conducted with the elderly population[13,16], the group that has the highest hospitalization rates in general[22].

Spatial analysis has been used in ecological studies because of the structure of dependence between areas and the random variation of the investigated event, which tends to increase as the area of analysis is reduced. These matters hinder the attempt to identify subpopulations that, despite the neighborhood, differ in terms of behavior of the health event[23]. Spatial analysis is present in several international analytical studies that have investigated the occurrence of hospitalizations for ACSC and factors associated[3-5,7,9,11,24], but, as far as it is known, there are no Brazilian studies on this subject with this approach.

In view of the exposed, this study aimed to verify the variability of hospitalizations for ACSC in the elderly population living in the municipalities of Minas Gerais and to analyze the determining factors using the Bayesian spatial modeling.

METHODS

The state of Minas Gerais, located in the Southeast Region of Brazil, is composed of 853 municipalities and, at the time of the study, was divided into 13 health macro-regions (Figure 1). In 2014, the estimated population was 20,733,996 inhabitants (12.5%



Source: Minas Gerais[25].

Figure 1. Macro-regions of Minas Gerais, according to the Minas Gerais Regionalization Master Plan, 2011.

of whom were 60 years old or more). In 2010, the human development index (HDI) for longevity was 0.838, indicating high life expectancy at birth, and the urbanization rate reached 85.3%; per capita income was R$ 749.69, the lowest in the Southeast Region, below the national average (R$ 793.87)[26]. In December 2014, 77% of the state's population was covered by the FHS[27] and the ratio bed of the Unified Health System (SUS)/inhabitant was 1.45/1,000, below the overall ratio for Brazil (1.59/1,000 inhabitants)[28].

This ecological study was based on data from Hospitalization Authorizations (HA) approved in 2014 and consolidated in the National Hospital Information System (SIH-SUS). The inclusion criteria were being between 60 and 79 years old and having the main diagnosis included in the Brazilian list of hospitalizations for ACSC[2]. Long-term hospitalizations (more than 45 days) were excluded, as these mainly fulfill administrative or accounting purposes[29].

The dependent variable was the rate of hospitalization for ACSC (p/1,000), and the independent variables were grouped in three sets: sociodemographic, descriptors of provision of health services, and PHC activities. Sociodemographic variables included per capita income, urbanization rate[30] (both provided by the Brazilian Institute of Geography and Statistics – IBGE) and the municipal human development index (MHDI) for longevity[31] (provided by the United Nations Development Program – UNDP).

The variables relevant to the provision of health services were the percentage of the FHS coverage, the number of SUS beds per inhabitant (excluding obstetric and pediatric beds) and the proportion of elderly beneficiaries of health plans. Data related to the FHS coverage and the number of SUS beds/inhabitants were obtained from the National Registry of Health Establishments (CNES), while the National Supplementary Health Agency (ANS) was the source of data for coverage by plans health[28]. Finally, the variables of PHC activities included continued care, provision of educational and health promotion actions for the elderly, and clinical care at home if needed. For each of the activities, the percentage of FHS teams that performed them in each municipality was calculated. Data related to these activities were collected from the second cycle of the National Program for Improving Access and Quality in Primary Care (PMAQ-AB), between 2013 and 2014, involving 4,180 primary care teams in Minas Gerais (92.5% of the total at the time of the study)[32].

The selection of explanatory variables followed the theoretical model proposed by Nedel et al.[33], which considers sociodemographic factors, indicators of organization of health services and performance of the health system, such as the structure of PHC and its own activities.

The gross and smoothed rates of hospitalizations for ACSC among the elderly aged 60 to 79 years were calculated by municipality. To estimate the smoothed rate of a given area, the Poisson model proposed by Besag-York-Mollie (BYM) was used, which points out a spatial correlation structure between neighboring areas – in this case, bordering municipalities. This model is composed of two random effects, one that follows a standard normal distribution and the other with spatial correlation structure according to the autoregressive conditional model (ARCH)[34], which proposes a normal distribution with the mean equal to the average of the values of neighboring municipalities

and variance inversely proportional to the number of neighboring municipalities. The Markov Chain Monte Carlo (MCMC) sampling method was used to generate the distributions afterwards.

The Bayesian approach was chosen to minimize the great variability of rate of hospitalizations for ACSC in areas where the population is small, in addition to obtaining more realistic estimates and smoother maps, with easy visualization and interpretation from an epidemiological point of view[35,36].

All variables investigated were included in the multivariate analysis, given the model's parsimoniousness. The estimates of the coefficients were calculated with *a posteriori* means of the values estimated by the model simulations, and the 95% confidence intervals were used to identify the variables independently associated with the event. Estimates of the average impact on hospitalizations for ACSC due to variations in each covariate were given by the exponentials of the coefficients generated, since the model was the Poisson model. The Moran test was used to verify the presence or absence of spatial correlation of the residuals of the implemented models. A significant spatial correlation of the residues (p=0.0001) of a classic Poisson model adjusted to the data was identified, indicating that a spatially structured model would be more appropriate.

The relative risks were calculated by the ratios of hospitalizations for ACSC in each municipality and the average rate in Minas Gerais. Results less than 1 indicate municipalities with lower rates than the whole state, and greater than 1 reflected municipalities with higher rates compared to the whole state.

Of the total number of municipalities in the state, 48 (5.6%) had health teams that did not participate in the second cycle of the PMAQ-AB and, as a result, had missing data for the variables related to PHC activities. Data were input using binomial Bayesian models, as they were percentages, using the same BYM modeling. The dependent variables were those to be imputed, and the independent variables involved the other two sets, which did not have any missing data. The analyses were performed with the statistical software R 4.0.2.

The study did not require approval from the Research Ethics Committee because it used secondary data, which does not allow individual identification and that are fully accessible to the public.

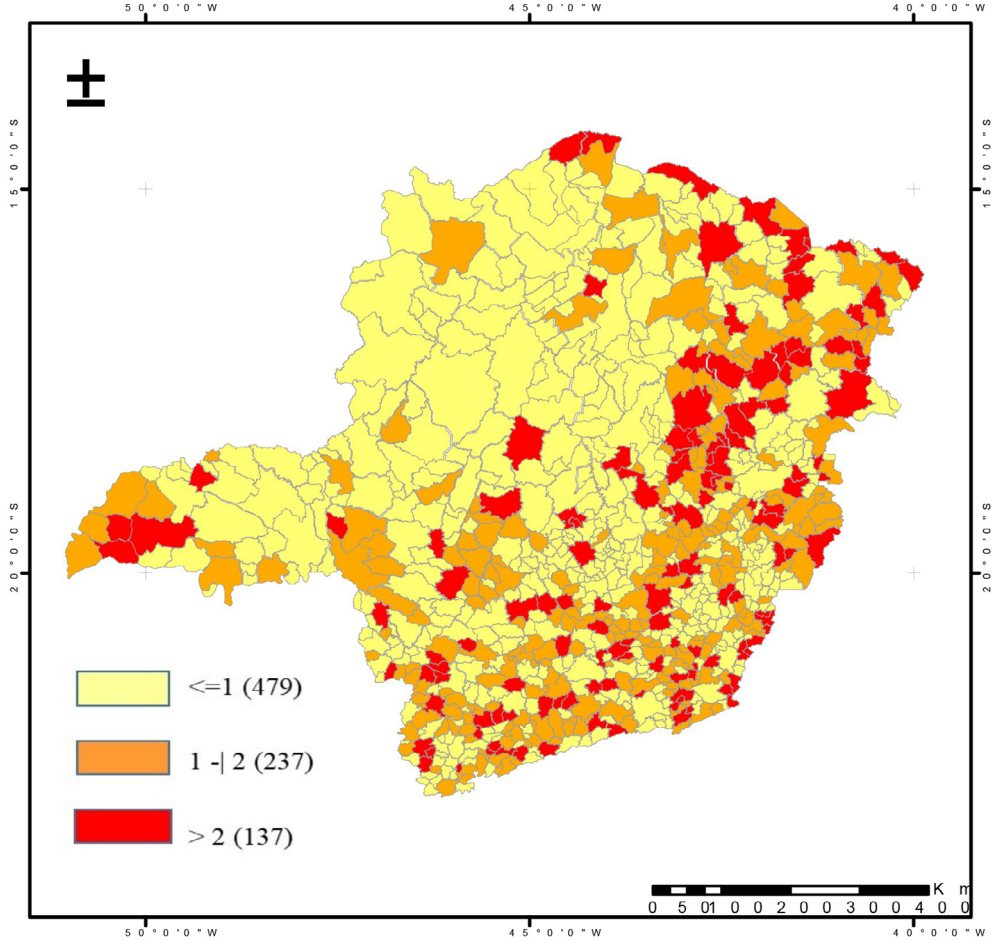
RESULTS

One in ten (10.2%) municipalities had an average per capita income below R$ 291.00 (situations considered to be of extreme poverty and vulnerability), while 76.4% of them had very high HDI-longevity (above 0.80), compatible with high life expectancy at birth. The average urbanization rate was 68%. With regard to the provision of health services, 743 (87.1%) municipalities had a high FHS coverage (above 70% of the population). Despite this, in 83.1% of them, the bed/inhabitant ratio was lower than that recommended by the Ministry of Health, 1.4/1,000 (excluding pediatric and obstetric beds). Regarding PHC

activities, of the 4,518 teams at the time of the study, 4,180 (92.5%) participated in the second evaluation cycle of the PMAQ-AB. On average, 88% of all PHC teams in the state conducted continuous-care consultations and 97.1% performed clinical care at home, but only 69.8% carried out educational and health promotion actions for the elderly.

The gross rate of hospitalization for ACSC for the state of Minas Gerais was 9.6/1,000. Figure 2 shows the spatial distribution of relative risk by municipality. Most municipalities (479 or 56.2%) had a relative risk of hospitalization less than or equal to 1; the Northwest (90.9%) and the North (84.9%) regions had the highest percentages of these municipalities. The municipalities with the highest relative risks (over 2) totaled 137 (16.1%), with the Jequitinhonha (41.2%) and Northeast (40.4%) regions achieving the highest proportion.

Table 1 shows the results of the multivariate analysis for factors associated with the rate of hospitalization for ACSC. Among the variables for the provision of health



HACSC: hospitalizations for Ambulatory Care Sensitive Conditions.

Figure 2. Distribution of municipalities according to the relative risks for HACSC among elderly people aged 69-79 years, Minas Gerais, 2014 (n = 853 municipalities).

Table 1. Result of Bayesian regression for socioeconomic factors, provision of health services and PHC activities associated with municipal HACSC rates, Minas Gerais, 2014 (n = 853 municipalities)*,**.

Variables	Mean	95%CI	
		LL	UL
Intercept (β)	-6.1197	-8.8237	-3.7680
Socio-demographic			
per capita income[a]	-0.0008	-0.0014	-0.0002
Health care provision			
SUS beds/1,000 inhabitants[a]	0.0271	0.0211	0.0331
FHS coverage[b]	-0.4269	-0.7988	-0.1116

*Model mutually adjusted by the variables described in the table, in addition to the human development index for longevity (HDI-longevity), urbanization rate, coverage % of the Family Health Strategy (FHS), % of elderly people covered by private health insurance, % of FHS teams that carry out continuous care, % of FHS teams that carry out educational and health promotion actions aimed at the elderly and % of FHS teams that carry out home care when necessary; ** the analysis covered all 853 municipalities in the state of Minas Gerais; PHC: primary health care; 95%CI: 95% confidence interval; LL: lower limit; UL: upper limit; significant at the level of p<0.05; HACSC: hospitalizations for Ambulatory Care Sensitive Conditions.

services, the FHS coverage (negatively) and SUS beds/inhabitant ratio were (positively) associated with the rate of hospitalization for ACSC. The multivariate analysis showed that the addition of one bed/1,000 inhabitants implies an average increase of 2.8% in the rate of hospitalization for ACSC, while a 10% increase in the FHS coverage results in a decrease of 4.2% in hospitalizations. Per capita income was shown to be negatively associated with the rate of hospitalization for ACSC after the multiple adjustment, so an increase of R$ 100.00 in the former represents a decrease of 7.7% in the latter.

DISCUSSION

Our results showed that the municipal rates of hospitalization for ACSC varied, with the majority of the municipalities presenting a rate lower than the state average. They also showed that these rates were lower in municipalities with higher income per capita and with greater coverage by the FHS and higher in municipalities with a higher number of SUS beds per inhabitant, but they did not vary due to the development of typical PHC actions.

The spatial analysis showed an important geographic variation in municipal hospitalization rates for ACSC. Minas Gerais has a high number of municipalities, and they are different from each other in a series of characteristics such as territorial extension, population density, level of socioeconomic development and health service provision, configuring itself as a geographically heterogeneous state[37]. Thus, the attempt to identify a more homogeneous profile occurs in a regional perspective.

The municipalities with the lowest relative risks of hospitalization for ACSC were predominant in the North and Northwest regions, which had higher indicators of primary health care services at the time of the study[37]. On the other hand, municipalities with high relative risks were more frequent in the Northeast and Jequitinhonha regions, characterized by worse socio-demographic indicators such as low occupancy and income rates and greater social vulnerability[38].

The municipalities in Minas Gerais with the highest coverage by the FHS presented lower risk for hospitalization. The negative association between ACSC rates and the FHS coverage was seen in different populations. A study analyzed approximately 60 million adult hospitalizations (≥20 years) by SUS across Brazil and showed that increased FHS coverage was associated with reduced rates of hospitalization[15], which was also found in a metropolis in the South Region of the country[39]. In another study focusing on hospitalizations of the elderly, the rate related to ACSC was negatively correlated with greater coverage by the FHS and with a greater number of medical consultations in primary care[13]. Similarly, international studies have reinforced the importance of access to PHC[3] and the availability of primary care physicians[5] in reducing the rates of hospitalization for ACSC.

The FHS was implemented as an instrument for the expansion, improvement and strengthening of PHC in Brazil and has positively impacted the access and use of health services, improving the efficiency of SUS and the health condition of the assisted populations[40]. Several health actions provided for in the FHS (identification of patients by community health agents, intervention groups, longitudinal care, among others) enhance the diagnosis and adequate management of chronic health conditions such as hypertension and diabetes. Elderly people are frequently affected by these conditions, which are among the main causes of hospitalization for ACSC[13]. Our results reinforce the understanding that PHC plays an important role in reducing the burden of demand for hospital care by the elderly.

As pointed in this investigation, national[21] and international[4,5,9] studies have associated the occurrence of hospitalization for ACSC to the greater availability of hospital beds. An explanatory hypothesis is that the greater offer of hospital beds would facilitate access to the tertiary level of care, inducing an excess of hospitalizations disconnected from the real needs of the population, as pointed out by the Law of Roemer[41]. In the light of the results related to the FHS coverage, the greater availability of hospital beds indicates that the provision of health services may play different and opposite roles in relation to hospitalization for ACSC: inhibiting them by providing timely PHC or enhancing them through the greater supply of healthcare services. hospital beds, configuring, in the latter case, a possible inappropriate use of health services[5,42] and generating distortions in health care[43].

Among the sociodemographic factors investigated, only per capita income was shown to be associated with the risk of hospitalization for ACSC: municipalities with lower per capita income had a higher risk. The influence of different socioeconomic indicators

on this occurrence is well documented in the scientific literature[5,7,8,10]. Worse socioeconomic conditions are barriers to access health services and supplies and hinder the adoption of healthy lifestyle habits[43]. Low-income individuals use health services less and usually do so mostly to treat the disease, not for routine exams or prevention[44]. Thus, our results show the influence of factors external to PHC and the existence of inequality in health regarding hospitalizations for ACSC, confirming the rightness to prioritize socioeconomically disadvantaged populations in expanding coverage by the FHS.

No associations between PHC activities and risk of ACSC were found in this study. The investigated activities are selected indicators of the PMAQ-AB, in its second cycle, module II, referring to the work process of the PHC teams. A cohort study involving 1,200 adult users of public PHC services residing in Porto Alegre (RS)[19] found no association between the quality of PHC and hospitalization for ACSC. In Belo Horizonte (MG), it was investigated whether characteristics of health care provided by the FHS (continuity, scope and coordination) would be associated with the rate of hospitalization[18], and no association was found between any of these characteristics. In both studies, the attributes of the FHS were assessed using the PCATool, an instrument that prioritizes users' perception about the quality of services.

We found a single nationwide study[17] which used data from the PMAQ-AB to assess the impact of the FHS teams' work process on the rate of hospitalizations for ACSC, addressing referrals to specialized consultations, home visits and matrix support from the Expanded Nucleus of Family Health as determinants. Only matrix support was found to be associated in univariate analysis, but it did not remain independently associated after multiple adjustment. Our results were similar, although we considered different indicators.

From the perspective of the logic of comprehensive care present in PHC, it is possible that the absence of association is an indication that PHC actions impact ACSC when they are developed jointly, and not by one or the other, in isolation. From the methodological point of view, the absence of association may be a consequence of the distribution of explanatory variables, which in some cases varied very little between the municipalities, as occurred with the realization of a consultation for continued care and with clinical care at home when needed. Another important point is that the data reflect health care experiences related to PHC teams, which does not allow assessing the degree of adherence to the guidelines for the treatment and management of the care proposed by them, by the elderly person or their guardian (family member or caregiver). Finally, it is worth mentioning the possibility of ecological fallacy, which does not differ the participants in terms of exposure and event due to absence of individual measures; perhaps associations are identifiable at the individual level.

The present study has some limitations resulting from the use of secondary data. The data are collected and consolidated by SIH-SUS, an information system that prioritizes the accounting-administrative logic in the generation of information and obeys budgetary and physical ceilings. It is possible that not all hospitalizations have been

reported, especially those with diagnoses whose financial reimbursements are lower. In addition, as the system only informs SUS-funded hospitalizations, the generalization of results for the entire elderly population in the state of Minas Gerais is impaired, since SIH-SUS does not cover information on hospitalizations in private hospitals or paid for by others sources. However, it is worth remembering that 73% of the state's population is SUS-dependent, which gives robustness to the results[28].

A degree of uncertainty in the estimates produced by the study is plausible, due to the need for data input to analyze the variables related to PHC. In this case, information for these variables was not available in 5.6% of the municipalities analyzed (they did not participate in the second cycle of the PMAQ-AB). Also important to mention that residual confusion cannot be ruled out, since the presence of multicollinearity required the adoption of a more parsimonious explanatory model. Finally, the design of the study (cross-sectional) does not allow attributing the character of causality to the associations identified.

On the other hand, the robustness of the study derives from the scope of data, which represent all hospitalizations (n=21,357) in the state of Minas Gerais financed by SUS in 2014. In addition, the Bayesian regression model circumvented some problems, such as the inclusion of municipalities with small populations, which could cause great variability in the rates. More than three quarters (78.3%) of the municipalities in the state of Minas Gerais are small, that is, have less than 20 thousand inhabitants[26]. The use of the Bayesian spatial model provided the smoothing of the estimated rates of hospitalizations due to the spatial dependence between adjacent areas. This approach minimized the instability of rates resulting from the low frequency of hospitalization for ACSC in small municipalities, eliminating much of the randomness not associated with risk factors and overcoming the political-administrative divisions between areas[35].

In summary, this study showed that the rates of hospitalization for ACSC in the elderly population were influenced by characteristics external to PHC, specifically socioeconomic factors and the provision of services. The variability observed for these rates at the municipal level attests to the relevance of health diagnoses and planning of the provision of local health services, albeit in line with guidelines defined at higher management levels. Our study also shows that addressing population health demands involves actions external to the health sector, including investments in poverty reduction, especially in less socioeconomically developed municipalities, aiming to minimize health inequalities stemmed from the synergism between income and precarious health.

Finally, our study highlights the importance of expanding the FHS coverage, as a mechanism for effective universal access to PHC, in order to minimize the burden of population disease and the demand for health services, especially at the tertiary level. The expansion of access to PHC is a considerable challenge to Brazilian society, given the current context, in which a policy of fiscal austerity and restrictions on public health financing prevails, reducing social protection mechanisms and reinforcing inequality[45].

REFERENCES

1. Homar JC, Matutano CC. La evaluación de la atención primaria y las hospitalizaciones por ambulatory care sensitive conditions. Marco conceptual. Atención Primaria 2003; 31(1): 61-5. https://doi.org/10.1016/S0212-6567(03)70662-3
2. Alfradique ME, Bonolo PF, Dourado MIC, Lima-Costa MF, Macinko J, Mendonça CS, et al. Internações por condições sensíveis à atenção primária: a construção da lista brasileira como ferramenta para medir o desempenho do sistema de saúde (Projeto ICSAP–Brasil). Cad Saúde Pública 2009; 25(6): 1337-49. https://doi.org/10.1590/S0102-311X2009000600016
3. Huang Y, Meyer P, Jin L. Spatial access to health care and elderly ambulatory care sensitive hospitalizations. Public Health 2019; 169: 76-83. https://doi.org/10.1016/j.puhe.2019.01.005
4. Kim J, Kang H-Y, Lee K-S, Min S, Shin E. A Spatial Analysis of Preventable Hospitalization for Ambulatory Care Sensitive Conditions and Regional Characteristics in South Korea. Asia Pac J Public Health 2019; 31(5): 422-32. https://doi.org/10.1177/1010539519858452
5. Kim AM, Park JH, Yoon TH, Kim Y. Hospitalizations for Ambulatory Care Sensitive Conditions as an indicator of access to primary care and excess of bed supply. BMC Health Serv Res 2019; 19(1): 259. https://doi.org/10.1186/s12913-019-4098-x
6. Barker I, Steventon A, Deeny SR. Association between continuity of care in general practice and hospital admissions for ambulatory care sensitive conditions: cross sectional study of routinely collected, person level data. BMJ 2017; 356: j844. https://doi.org/10.1136/bmj.j84
7. Mazumdar S, Chong S, Arnold L, Jalaludin B. Spatial clusters of chronic preventable hospitalizations (ambulatory care sensitive conditions) and access to primary care. J Public Health 2020; 42(2): e134-41. https://doi.org/10.1093/pubmed/fdz040
8. Dimitrovová K, Costa C, Santana P, Perelman J. Evolution and financial cost of socioeconomic inequalities in ambulatory care sensitive conditions: an ecological study for Portugal, 2000–2014. Int J Equity Health 2017; 16(1): 145. https://doi.org/10.1186/s12939-017-0642-7
9. Weeks WB, Ventelou B, Paraponaris A. Rates of admission for ambulatory care sensitive conditions in France in 2009–2010: trends, geographic variation, costs, and an international comparison. Eur J Health Econ 2016; 17(4): 453-70. https://doi.org/10.1007/s10198-015-0692-y
10. Lugo-Palacios DG, Cairns J. Using ambulatory care sensitive hospitalisations to analyse the effectiveness of primary care services in Mexico. Soc Sci Med 2015; 144: 59-68. https://doi.org/10.1016/j.socscimed.2015.09.010
11. Mobley LR, Root E, Anselin L, Lozano-Gracia N, Koschinsky J. Spatial analysis of elderly access to Primary Care services. Int J Health Geogr 2006; 5: 19. https://doi.org/10.1186/1476-072x-5-19
12. Maia LG, Silva LA, Guimarães RA, Pelazza BB, Pereira ACS, Rezende WL, et al. Internações por condições sensíveis à atenção primária: um estudo ecológico. Rev Saúde Pública 2019; 53: 2. https://doi.org/10.11606/S1518-8787.2019053000403
13. Marques AP, Montilla DER, Almeida WS, Andrade CLT. Hospitalization of older adults due to Ambulatory Care Sensitive Conditions. Rev Saúde Pública 2014; 48(5): 817-26. https://doi.org/10.1590/S0034-8910.2014048005133
14. Rodrigues-Bastos MR, Campos EMS, Ribeiro LC, Bastos-Filho MG, Bustamante-Teixeira MT. Internações por condições sensíveis à atenção primária, Minas Gerais, 2000 e 2010. Rev Saúde Pública 2014; 48(6): 958-67. https://doi.org/10.1590/S0034-8910.2014048005232
15. Macinko J, Oliveira VB, Turci MA, Guanais FC, Bonolo PF, Lima-Costa MF. The Influence of Primary Care and Hospital Supply on Ambulatory Care–Sensitive Hospitalizations Among Adults in Brazil, 1999–2007. Am J Public Health 2011; 101(10): 1963-70. https://doi.org/10.2105/ajph.2010.198887
16. Soares AMM, Mendes TCO, Lima KC, Menezes MM. Causes for hospitalization of elderly individuals due to primary care sensitive conditions and its associated contextual factors. Rev Assoc Med Bras 2019; 65(8): 1086-92. https://doi.org/10.1590/1806-9282.65.8.1086
17. Araújo WRM, Queiroz RCS, Rocha TAH, Silva NC, Thumé E, Tomasi E, et al. Structure and work process in Primary Care and Hospitalizations for Sensitive Conditions. Rev Saúde Pública 2017; 51: 75. https://doi.org/10.11606/s1518-8787.2017051007033
18. Mendonça CS, Leotti VB, Dias-da-Costa JS, Harzheim E. Hospitalizations for Primary Care Sensitive Conditions: association with socioeconomic status and quality of family health teams in Belo Horizonte, Brazil. Health Policy Planning 2017; 32(10): 1368-74. https://doi.org/10.1093/heapol/czx103
19. Gonçalves M, Hauser L, Prestes IV, Schmidt MIS, Duncan BB, Harzheim E. Primary health care quality and hospitalizations for ambulatory care sensitive conditions in the public health system in Porto Alegre, Brasil. Fam Pract 2016; 33(3): 238-42. https://doi.org/10.1093/fampra/cmv051

20. Castro ALB, Andrade CLT, Machado CV, Lima LD. Condições socioeconômicas, oferta de médicos e internações por condições sensíveis à atenção primária em grandes municípios do Brasil. Cad Saúde Pública 2015; 31(11): 2353-66. https://doi.org/10.1590/0102-311X00126114
21. Pazó RG, Frauches DO, Molina MCB, Cade NV. Modelagem hierárquica de determinantes associados a internações por condições sensíveis à atenção primária no Espírito Santo, Brasil. Cad Saúde Pública 2014; 30(9): 1891-902. https://doi.org/10.1590/0102-311X00099913
22. Loyola Filho AI, Matos DL, Giatti L, Alfradique ME, Peixoto SV, Lima-Costa MF. Causas de internações hospitalares entre idosos brasileiros no âmbito do Sistema Único de Saúde. Epidemiol Serv Saúde 2004; 13(4): 229-38. https://doi.org/10.5123/S1679-49742004000400005
23. Carvalho MS, Souza-Santos R. Análise de dados espaciais em saúde pública: métodos, problemas, perspectivas. Cad Saúde Pública 2005; 21(2): 361-78. https://doi.org/10.1590/S0102-311X2005000200003
24. Magan P, Otero A, Alberquilla A, Ribera JM. Geographic variations in avoidable hospitalizations in the elderly, in a health system with universal coverage. BMC Health Serv Res 2008; 8: 42. https://doi.org/10.1186/1472-6963-8-42
25. Minas Gerais. Secretaria de Estado de Saúde. Diretoria de Regionalização e estudos assistenciais [Internet]. Belo Horizonte: Secretaria de Estado de Saúde [accessed on Out. 2020] Available from: https://www.saude.mg.gov.br/parceiro/regionalizacao-pdr2
26. Instituto Brasileiro de Geografia e Estatística (IBGE). Consulta estados [Internet]. Brasil: IBGE [accessed on Feb. 2020]. Available from: https://cidades.ibge.gov.br/brasil/mg/panorama
27. Brasil. Ministério da Saúde. Departamento de Atenção Básica. Histórico de Cobertura. Consulta de dados [Internet]. Brasil: Ministério da Saúde [accessed on Jan. 2020]. Available from: https://egestorab.saude.gov.br/paginas/acessoPublico/relatorios/relHistoricoCoberturaAB.xhtml
28. Brasil. Ministério da Saúde. DATASUS. Consulta de dados [Internet]. Brasil: Ministério da Saúde [accessed on Jan. 2020]. Available from: http://www2.datasus.gov.br/datasus/index.php?area=02
29. Portela MC, de Andrade Schramm JM, Pepe VLE, Noronha MF, Pinto CAM, Cianeli MP. Algoritmo para a composição de dados por internação a partir do sistema de informações hospitalares do sistema único. Cad Saúde Pública 1997; 13(4): 771-4. https://doi.org/10.1590/S0102-311X1997000400020
30. Instituto Brasileiro de Geografia e Estatística (IBGE). Censo Demográfico Brasileiro de 2010. Rio de Janeiro: Instituto Brasileiro de Geografia e Estatística; 2012.
31. Instituto de Pesquisa Econômica Aplicada (IPEA). Índice de Desenvolvimento Humano Municipal Brasileiro [Internet]. Brasília: PNUD, Ipea, FJP; 2013. Available from: https://onedrive.live.com/view.aspx?cid=124653557C0404EC&authKey=%21AGvg%2D0FawRuMMj4&resid=124653557C0404EC%2123008&ithint=%2Epdf&open=true&app=WordPdf
32. Brasil. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Nota metodológica da certificação das equipes de atenção básica participantes do Programa Nacional de Melhoria do Acesso e da Qualidade da Atenção Básica. Brasília: PMAQ-QB; 2015.
33. Nedel FB, Facchini LA, Bastos JL, Martín-Mateo M. Conceptual and methodological aspects in the study of hospitalizations for ambulatory care sensitive conditions. Ciênc Saúde Coletiva 2011; 16(Supl. 1): 1145-54. https://doi.org/10.1590/S1413-81232011000700046
34. Besag J, Yokr JC, Mollié A. Bayesian image restoration, with two applications in spatial statistics. Ann Inst Stat Math 1991; 43: 1-59.
35. Assunção RM, Barreto SM, Guerra LH, Sakurai E. Mapas de taxas epidemiológicas: uma abordagem bayesiana. Cad Saúde Pública 1998; 14(4): 713-23. https://doi.org/10.1590/S0102-311X1998000400013
36. Bernardinelli LMC, Montomoli C. Empirical bayes versus fully bayesian analisys of geographical variation in disease risk. Stat Med 1992; 11(8): 983-1007. https://doi.org/10.1002/sim.4780110802
37. Ferreira Júnior S, Diniz JS. Desigualdades na oferta municipal de serviços da atenção primária no estado de Minas Gerais: uma análise dinâmica entre os anos de 2007 e 2012. In: Anais do XI Encontro Nacional de Economia da Saúde: saúde, desenvolvimento e território; & VI Encontro de Economia da Saúde da América Latina e Caribe; 2014; Rio de Janeiro. Rio de Janeiro: ABRES; 2014.
38. Oliveira LP, Costa EPVSM, Ribeiro Filho V. Uma análise da vulnerabilidade social das microrregiões geográficas do estado de Minas Gerais, Brasil. Geo UERJ 2017; (30): 58-75. https://doi.org/10.12957/geouerj.2017.29321
39. Costa JSD, Pattussi MP, Morimoto T, Arruda JS, Bratkowski GR, Sopelsa M, et al. Tendência das internações por condição sensível à atenção primária e fatores associados em Porto Alegre, RS, Brasil. Ciênc Saúde Coletiva 2016; 21(4): 1289-96. https://doi.org/10.1590/1413-81232015214.15042015
40. Macinko J, Mendonça CS. Estratégia Saúde da Família, um forte modelo de Atenção Primária à Saúde que traz resultados. Saúde Debate 2018; 42(N. Esp. 1): 18-37. https://doi.org/10.1590/0103-11042018s102

41. Delamater PL, Messina JP, Grady SC, WinklerPrins V, Shortridge AM. Do More Hospital Beds Lead to Higher Hospitalization Rates? A Spatial Examination of Roemer's Law. PLoS One 2013; 8(2): e54900. https://doi.org/10.1371/journal.pone.0054900
42. Castro MSM, Travassos C, Carvalho MS. Efeito da oferta de serviços de saúde no uso de internações hospitalares no Brasil. Rev Saúde Pública 2005; 39(2): 277-84. https://doi.org/10.1590/S0034-89102005000200020
43. Roos LL, Walld R, Uhanova J, Bond R. Physician visits, hospitalizations, and socioeconomic status: ambulatory care sensitive conditions in a Canadian setting. Health Serv Res 2005; 40(4): 1167-85. https://doi.org/10.1111/j.1475-6773.2005.00407.x
44. Neri M, Soares W. Desigualdade social e saúde no Brasil. Cad Saúde Pública 2002; 18(Supl.): S77-87. https://doi.org/10.1590/S0102-311X2002000700009
45. Santos IS, Vieira FS. Direito à saúde e austeridade fiscal: o caso brasileiro em perspectiva internacional. Ciênc Saúde Coletiva 2018; 23(7): 2303-14. https://doi.org/10.1590/1413-81232018237.09192018

Received on: 11/25/2020
Revised on: 01/15/2021
Accepted on: 01/20/2021

Authors' contributions: All authors participated equally in the study design, conception, data analysis, writing and final review of the paper.