Rurality and avoidable hospitalization in a Spanish region with high population dispersion

Alfredo Borda-Olivas¹, Pablo Fernández-Navarro²,³, Laura Otero-García¹, Belén Sanz-Barbero¹,³

¹ National School of Public Health, Instituto de Salud Carlos III, Madrid, Spain
² National Center for Epidemiology, Instituto de Salud Carlos III, Madrid, Spain
³ CIBER Epidemiología y Salud Pública (CIBERESP), Spain

Correspondence: Alfredo Borda-Olivas, Escuela Nacional de Sanidad, Instituto de Salud Carlos III, Avda Monforte de Lemos 5, Pabellón 7, 28029 Madrid, Spain, tel: +34918222247, fax: +34913877862, e-mail: aborda@isciii.es

Background: This study analyses the association between rurality and local rate of avoidable hospitalizations in a Spanish region with high population dispersion. Methods: Ecological study using a municipality in the region of Castile and Leon (Spain) as the spatial unit of analysis. The variables used to operationalize rurality included the following: distance to hospital, population density, mean socio-economic level and percentage of the population aged >65 years. We calculated relative risk (RR) and 95% confidence intervals (CI) using the conditional autoregressive spatial model proposed by Besag, York and Mollié, with explanatory variables. Results: The number of avoidable hospitalizations was 9923 or 4.5% of all admissions. The age- and gender-adjusted avoidable hospitalization rate was 4.06 per 1000 persons. Spatial analysis showed that two variables, distance from municipality of residence to reference hospital and percentage of population aged >65 years were inversely associated with risk for avoidable hospitalization [RR = 0.996 (95% CI 0.993–0.999) and RR = 0.989 (95% CI 0.982–0.996), respectively]. Conclusions: It is important to determine whether these lower avoidable hospitalization rates reflect an adequate level of accessibility and quality of primary care health services for rural populations or, in the contrary, they reveal access barriers to hospital care.

Introduction

Avoidable hospitalizations (AHs), also known as hospitalizations for Ambulatory Care Sensitive Conditions (ACSC), refer to hospital admissions for conditions amenable to Primary Health Care (PHC) level management. Timely PHC services may reduce the risk of admission for these ailments by preventing the onset of a disease, treating an acute illness or managing a chronic condition.¹ Since the early 1990s, when the ACSC term was defined in the USA,¹² a large number of articles have been published in various countries, which have adopted the classifications included in the ACSC concept to each field of study.³,⁴ These studies have shown greater rates of AH associated with racial/ethnic inequality,⁵ poorer socio-economic status (SES)⁶,⁷ and lower access to health care.⁸,⁹ Studies examining AHs in Spain have also confirmed the inverse relationship between AH rates and SES.¹⁰,¹¹

Despite the importance of investigating equal access to health care in rural areas and the concern for their vulnerability, the research on AHs in relation to rurality is limited. Furthermore, in many of these studies, the rurality indicators have been included only as control variables in studies on health inequalities.¹² In the USA, larger AH rates have been found in rural populations¹³ except among Medicare beneficiaries (national health insurance program that covers Americans aged ≥65 years and younger people with disabilities).¹⁴ Findings in countries with universal coverage, such as Canada¹⁵,¹⁶ and Australia,¹⁷ have been contradictory. To our knowledge, no studies on AHs and rurality in Spain have been done so far, though research using certain rurality indicators as adjustment variables has also yield contradictory results.¹⁰,¹⁸,¹⁹

As one may expect, among the complexities of this field of research is that the definition of rurality itself is controversial. Traditionally, studies have used the number of inhabitants or population density to classify urban and rural areas. The Organization for Economic Co-operation and Development²⁰ defines a population density <150 inhabitants/km² as rural, whereas in Spain, the Rural Sustainable Development Act 45/2007,²¹ classifies as rural domain all administrative jurisdictions with a population <30,000 people with a population density <100 inhabitants/km². Further, this variable hinders the conceptualization of rurality by establishing a single valuation criterion, which, in general terms, may not be an accurate reflection of the social reality. Therefore, different empirical definitions have been created according to the field of study. Among the factors taken into account, we find the following: population density, absolute population numbers, distance to the province’s capital, infrastructure and public transportation services and type of economic activity, among others.¹²,²²,²³

The Spanish National Healthcare System is almost fully funded from taxes and predominantly within the public sector, and decentralized at the regional level. Provision is free of charge at the point of delivery, with some exceptions. PHC services are the entry point to the health care system; it is an integrated system composed of PHC centres and multidisciplinary teams. The main objective of the National Healthcare system is to provide universal...
and equal access to the population according to their needs, independently of their SES or geographic location. However, there are rural areas that differ from urban centres to the point of encountering barriers to health care access owing to lack of social and health services, low SES, low population density, greater population aging rates and distance to urban centres. Specifically, the Autonomous Community (AC) of Castile and Leon, a region in Spain with a population density of 27.13 inhabitants/km², is the largest European region with the highest population dispersion. The vast majority of its municipalities (97.6%) have a population <5000 inhabitants, and only 2.4% of municipalities have >100 inhabitants/km². In 2006, ~28% of the population lived in municipalities that were at a distance of >30 km (and 16% >60 km) from their assigned hospital. On top of this, 22.5% of the population were aged >65 years, being in Spain 16.7%.

The goal of this study is to describe AHs and to analyse their potential association with indicator variables of rurality, i.e., population density, distance from municipality to the hospital, SES and population aging, in an area with high population dispersion in the region of Castile and Leon.

Methodology

We performed an ecological study to examine AHs at the municipal level in the AC of Castile and Leon for the year 2006.

Geographic context

In 2006, Castile and Leon had a population of 2 557 330 inhabitants distributed in nine provinces and 2247 municipalities.

The region is organized into 11 Health Areas and 248 Basic Health Zones with 241 PHC centres, with these centres being the main primary care delivery units. Geographic areas with a population >50 inhabitants but no PHC centre are serviced by 3647 doctor’s offices. For towns having <50 inhabitants, house calls are available on request. Overall, the region has 14 public hospitals, and each municipality has an assigned PHC centre and an assigned hospital, called the reference hospital.

Data sources

Given the nature of the study, we extracted data from several sources. The number of AHs was obtained from the 2006 Minimum Information Data Set on Hospital Discharges (MIDS-HD) of Castile and Leon. The MIDS-HD is a registry containing all hospitalization events including demographic data (age, sex, place of primary residence and so on) and clinical data (primary and secondary diagnoses). Reporting hospitalization data to the registry is required for both public and private hospitals.

Distance from municipalities of residence to where the hospitals and PHC centres are located was calculated based on the 2004 Municipalities Map of Spain. Demographic and socio-economic data (SES, percentage population aged >65 years and percentage foreign population) were collected from the 2001 Population and Housing Census. The total population of the AC of Castile and Leon was obtained from the 2006 Municipal Census published by the National Institute of Statistics (INE in Spanish).

Supplementary figure S1 shows a map of Spain and a map of the AC Castile and Leon with health facilities.

Study variables

AHs were identified by matching the primary diagnosis found on the MIDS to a category from the International Classification of Diseases 9th Edition validated for Spain by Caminal et al. (Supplementary table S1).

The independent variables defining rurality include the following:

(i) Distance from municipality to the hospital in kilometres. The Euclidian distance was calculated from the centre of the municipality of residence to the centre of the municipality where the reference hospital was located using ArcView software;
(ii) Population density measured as the ratio of the number of inhabitants and the geographic area of the municipality, and subsequently categorized into tertiles;
(iii) Municipal socio-economic level was categorized into tertiles. This variable is provided by the National Institute of Statistics. SES is the result of combining data on occupation, activity and professional status. The measure of SES municipal is defined as the arithmetic mean of the class mark of households SES;
(iv) Population aged >65 years is defined as the proportion of people aged >65 years in the total population. These variables have been used in previous rurality studies and serve as adequate descriptions of the population of the AC of Castile and Leon.

Other explanatory variables included were as follows: (i) Foreign population—percentage of non-Spain nationals of the total population and (ii) Distance from the municipality to the PHC centre calculated in kilometres from the centre of the municipality of residence to the centre of the municipality where the reference PHC centre was located. Bivariate collinearity between the independent variables was analysed. Variables with a correlation coefficient ≥0.60 were not included in the multivariate model (Supplementary table S2).

Statistical analysis

First, the AHs reported in the region of Castile and Leon during 2006 were identified based on the MIDS-HD. After stratifying the population into 5-year groups, we calculated the age- and sex-adjusted rates of AH for each municipality. Rates were standardized by the direct method using the 2006 Spanish Standard population as reference. Expected cases were calculated based on the AHs age- and sex-standardized rates calculated for the population of Castile and Leon. To examine the association between the indicator variables of rurality and the AHs, we calculated a relative risk and its 95% confidence interval using the Bayesian conditional autoregressive spatial model proposed by Besag, York and Mollie (BYM) with explanatory variables. The BYM model is a spatial Poisson model, used in ecological studies, that considers observed cases as the dependent variable and the expected cases as the offset, in addition to two random-effects terms that take into account contiguity (spatial term) and the heterogeneity among municipalities.

\[
O_i \sim Po(\mu_i = E_i \lambda_i)
\]

\[
\log(\lambda_i) = \sum_j \beta_j x_{ij} + h_i + b_i \Rightarrow \log(E_i) = \sum_j \beta_j x_{ij} + h_i + b_i
\]

\[
h_i \sim Normal(\mu_h, \sigma_h)
\]

\[
b_i \sim Car.Normal(\eta_i, \tau_b)
\]

\[
\tau_b \sim Gamma(a, \beta)
\]

\[
\gamma_i \sim Gamma(\alpha, \beta)
\]

where \(\lambda_i\) is the relative risk in the area \(i\); \(O_i\) is the number of observed cases of AHs in the municipality \(i\); \(E_i\) are the expected cases and \(x_{ij}\) are the indicator variables of rurality and other control variables; \(h_i\) is the term of heterogeneity among municipalities; and \(b_i\) is the spatial term.

Integrated nested Laplace approximations (INLAs) were used as a tool for Bayesian inference. For the purpose, we used R-INLA with the option of Gaussian estimation of the parameters, a package available in the R environment. A total of 2247 towns were included, and the spatial data on municipal contiguities were obtained by processing the official INE maps. The results of the model were included in a geographic information system to plot...
municipal maps that depicted smoothed standardized AH rates (SHR) and smoothed relative risk (RR) estimates.

Results

In 2006, there were 221 214 hospital admissions in Castile and Leon. Most of these patients (90%; 218 600 hospitalizations) were Castile and Leon residents. Of the 218 600 hospital admissions, 48.6% were male and 51.4% were female patients. The majority (71%; 155 263 cases) were admitted as emergencies. Mean patient age was 55.4 years [standard deviation (SD) = 25.4; median = 61.2; 25th/75th percentile = 35.7–76.5; range = 0–106.6], mean hospital stay was 7 days (median = 5 days; 25th/75th percentile = 2–9 days; range = 0–598).

The number of AHs was 9922. This figure corresponds to 0.39% of the population of Castile and Leon and to 4.5% of all 2006 hospital admissions in the region; it translates into a total of 86 431 hospitalization days. Of these AHs, 98.6% (9787 cases) were emergency admissions. Regarding the age distribution, 17.7% were aged <15 years and 58.9% were aged >65 years. Male cases (55.1%) were significantly over-represented.

The most frequent causes of AHs were infectious events such as pneumonia (45% of cases) followed by gastroenteritis (17%). Table 1 shows the number of hospital admissions by type of AH.

Table 1 Frequency by cause of AHs in the AC of Castile and Leon, 2006

<table>
<thead>
<tr>
<th>Causes of hospitalization</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia</td>
<td>4546</td>
<td>45.81</td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>1688</td>
<td>17.01</td>
</tr>
<tr>
<td>Hypertensive cardiovascular disease</td>
<td>1208</td>
<td>12.17</td>
</tr>
<tr>
<td>Heart failure</td>
<td>988</td>
<td>9.96</td>
</tr>
<tr>
<td>Acute diseases of respiratory tracts</td>
<td>778</td>
<td>7.84</td>
</tr>
<tr>
<td>Metabolic disorders of fluid and electrolyte balance</td>
<td>252</td>
<td>2.54</td>
</tr>
<tr>
<td>Perforated appendix</td>
<td>250</td>
<td>2.52</td>
</tr>
<tr>
<td>Others</td>
<td>213</td>
<td>2.14</td>
</tr>
</tbody>
</table>

N, frequency; %, percentage.

More than half (53.8%; 1210) of municipalities did not report any AH. The average rate for AH per municipality was 4.8 hospitalizations per 1000 inhabitants (SD = 12.3; 25th/75th percentile = 0–5.4). Age- and sex-adjusted AH rate using the Spanish Standard population as reference was 4.06 hospitalizations per 1000 inhabitants. Table 2 describes AH rates, populations and variables included in the analyses.

Figure 1 depicts the smoothed SHR and the smoothed RR under the BYM model. Although not clearly, the smoothed SHR map shows a more aggregated in the northwest and central areas. The smoothed RR maps show increased risk in the northwest areas and reduced risk in the south.

Table 2 Population, rates and variables included in the analysis of AHs in the AC of Castile and Leon, 2006

<table>
<thead>
<tr>
<th>Population/Rates of AH</th>
<th>Total</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>p25</th>
<th>p75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>2 520 424</td>
<td>1121.7</td>
<td>9558.8</td>
<td>215</td>
<td>106</td>
<td>488</td>
</tr>
<tr>
<td>Crude rate</td>
<td>–</td>
<td>4.8</td>
<td>12.3</td>
<td>0</td>
<td>0</td>
<td>5.4</td>
</tr>
<tr>
<td>Adjusted rate</td>
<td>–</td>
<td>4.1</td>
<td>5.3</td>
<td>2.8</td>
<td>1.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Observed</td>
<td>9908</td>
<td>4.4</td>
<td>36.2</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Expected</td>
<td>9914</td>
<td>4.4</td>
<td>33.6</td>
<td>1.1</td>
<td>0.6</td>
<td>2.4</td>
</tr>
<tr>
<td>Standardized ratio of AH</td>
<td>–</td>
<td>1.0</td>
<td>2.5</td>
<td>0</td>
<td>0</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Continuous variables

<table>
<thead>
<tr>
<th>Distance from municipality to the hospital (km)</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>p25</th>
<th>p75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from municipality to the PHC (km)</td>
<td>42.2</td>
<td>23.3</td>
<td>39.4</td>
<td>24.4</td>
<td>56.8</td>
</tr>
</tbody>
</table>

Categorical variables

<table>
<thead>
<tr>
<th>Population density (inhab/km²)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower tertile (&lt;5.2)</td>
<td>748</td>
</tr>
<tr>
<td>Middle tertile (5.2–10.9)</td>
<td>749</td>
</tr>
<tr>
<td>Upper tertile (&gt;10.9)</td>
<td>750</td>
</tr>
</tbody>
</table>

SD, standard deviation; p25, percentile 25; p75, percentile 75; N, frequency; PHC, primary health care.
In contrast, Sanmartin and Khan\textsuperscript{15} in Canada, as well as Nayar et al.,\textsuperscript{13} in every age group,\textsuperscript{13} in both pediatric and adult populations, report greater AH rates in rural areas. Similar findings are reported by Cloutier-Fisher et al.,\textsuperscript{16} in Canada and Ansari et al.,\textsuperscript{17} in Australia. In contrast, Sanmartin and Khan\textsuperscript{15} in Canada, as well as Nayar et al.,\textsuperscript{13} did not detect significant differences among beneficiaries of the US health insurance program Medicare. The heterogeneity in results may be explained by contextual differences (demographic, geographic and socio-economic) of the environments under study as well as differences in organization and access to health services. Thus, for instance, Gusmano et al.,\textsuperscript{7} comparing Manhattan and Paris, found larger AH rates in Manhattan, which are explained by the differences in access to health services between the two cities. Other reasons for the variability in results could be related to differences in methodology across studies, especially regarding operationalization of the main dependent and independent variables, i.e. the definition of AH and the empirical definition of rurality.

In Spain, Megan et al.,\textsuperscript{10} did not find a relationship between AHs and travel time from the municipality of residence to the hospital or PHC centre using data from the Madrid region. However, our findings confirm the results of Caminal et al.,\textsuperscript{19} in Catalonia and Bermudez-Tamayo et al.,\textsuperscript{18} in Andalucia regarding decreasing AH rates, as distance between municipality of residence and reference hospital increases. Caminal et al.,\textsuperscript{19} also find an inverse relationship between AHs and percentage of the population aged >65 years. In relation to population density, we did not find a statistically significant association between population density and AHs. This suggests that in the study area, the population density is not an indicator of rurality in relation to the use of health services. The availability of primary care resources depends on the number of inhabitants, not of the population density. It is important to take into account that the population density was classified into tertiles owing to the high population dispersion of the AC of Castile and Leon with only 2.4% of its municipalities including >100 inhabitants/km\textsuperscript{2}.

Potential explanatory factors of our findings may be associated with health care services, patients characteristics and geographic context. First, there is evidence that greater access to primary care services is associated to lower AH rates. In the region under study, 96.1% of the municipalities have a doctor’s office or a PHC centre and, thus, theoretically, high access to PHC. Second, older populations and chronic disease patients, prevalent groups in the rural milieu, engage in regular and frequent primary care visits. Thus, one may argue that the high accessibility to primary care and the regular monitoring of the most vulnerable populations, elderly and chronic patients, may contribute to our lower AH rates. Finally, regarding the environment, lower AH rates may reflect the access barriers to hospital services that rural populations experience. Specifically, the long distances to a hospital may encourage higher use of PHC services thus reducing AH rates.\textsuperscript{10} Recent published research in the same region found an inverse association between distance to and use of emergency services so that increased distance from the municipality of residence to the hospital reduced the use of emergency services.\textsuperscript{11} An additional potential explanation regarding this inverse association could be that PHC physicians in rural areas are more inclined to address and successfully manage situations that would warrant admission in a hospital environment.\textsuperscript{29}

These findings should be interpreted in the context of the study’s limitations. First, the analysis is based on secondary data, the MIDS-HD, which excludes patient identifiers and, thus, impedes the deletion of duplicate records, e.g. re-admissions. Second, the

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**Table 3 Variables associated with AHs**

<table>
<thead>
<tr>
<th>Variables</th>
<th>RR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from municipality to the hospital (km)</td>
<td>0.996</td>
<td>(0.993-0.999)</td>
</tr>
<tr>
<td>Lower tertile (&lt;5.2)</td>
<td>1.000</td>
<td>1.000-1.000</td>
</tr>
<tr>
<td>Middle tertile (5.2-10.9)</td>
<td>0.980</td>
<td>(0.974-0.986)</td>
</tr>
<tr>
<td>Upper tertile (&gt;10.9)</td>
<td>0.961</td>
<td>(0.953-0.969)</td>
</tr>
<tr>
<td>Municipal socio-economic level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower tertile (&lt;0.86)</td>
<td>1.000</td>
<td>1.000-1.000</td>
</tr>
<tr>
<td>Middle tertile (0.86-0.98)</td>
<td>0.949</td>
<td>(0.938-0.961)</td>
</tr>
<tr>
<td>Upper tertile (&gt;0.98)</td>
<td>0.928</td>
<td>(0.916-0.941)</td>
</tr>
<tr>
<td>Population aged &gt;65 years</td>
<td>0.989</td>
<td>(0.982-0.996)</td>
</tr>
<tr>
<td>Foreign population</td>
<td>1.012</td>
<td>(0.983-1.041)</td>
</tr>
<tr>
<td>Distance from the municipality to the PHC (km)</td>
<td>0.992</td>
<td>(0.984-1.001)</td>
</tr>
</tbody>
</table>

RR, relative risk; 95% CI, 95% confidence interval. Results of the regression model. AC of Castile and Leon, 2006.
Conflicts of interest

Contrary, whether they reflect access barriers to hospital care. Quality of PHC services enjoyed by rural populations or, in the need of further study, however, to ascertain whether these municipal level are associated with lower AH rates. It is essential municipality of residence to the hospital and older populations at to AHs more accurately. Therefore, this study indicates that both longer distances from the municipality of residence to the hospital and older populations at the municipal level are associated with lower AH rates. It is essential and in need of further study, however, to ascertain whether these lower AH rates are a reflection of an adequate accessibility and quality of PHC services enjoyed by rural populations or, in the contrary, whether they reflect access barriers to hospital care.

Supplementary Data

Supplementary data are available at EURPUB online.

Conflicts of interest: None declared.

Acknowledgements

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Key points

We examined aspects of the rural population in NHS with universal coverage. Also, we performed spatial analysis to account for neighbouring municipalities and variability of municipal-level data.

Findings suggest that the rural areas could have adequate access and quality of PHC services. In particular, the residence in municipalities with longer distances to the hospital, and older populations, would benefit from policies or programmes that provide accessible PHC.

Further research is required to ascertain whether these findings reflect an adequate PHC or whether they reflect barriers to access of hospital care for rural populations.

References

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13 Laditka JN, Laditka SB, Probst JC. Health care access in rural areas: evidence that hospitalization for ambulatory care-sensitive conditions in the United States may increase with the level of rurality. Health Place 2009;15:731–40.
Background: As liver cancer incidence and mortality remain high in many parts of Europe, a more comprehensive response is required to reduce the burden. Expert stakeholders should be involved in the design of responses because they have important insights about potentially effective responses and will be affected by policy changes. We aimed to prioritize liver cancer control strategies based on European liver cancer stakeholders’ views of which strategies would have the greatest impact in a comprehensive liver cancer control plan. Methods: One hundred liver cancer clinical, policy and advocacy stakeholders from France, Germany, Italy, Spain and Turkey were surveyed. Respondents completed 12 conjoint choice tasks in which they chose which of two subsets of 11 strategies would have the greatest impact in their country. Results: All strategies were considered likely to have a positive impact (P < 0.01). The highest priority strategy was monitoring of at-risk populations, followed by centres of excellence, clinical education, multidisciplinary management, national guidelines, measuring social burden, public awareness, risk assessment and referral, research infrastructure and access to treatments. Conclusions: Canvassing stakeholder views through a conjoint analysis survey provided a robust quantitative prioritization that can complement traditional qualitative consultation processes. The prioritized strategies provide a logical starting point for decision makers considering developing national plans or collaborative efforts to achieve comprehensive liver cancer control in Europe.

Introduction
Liver cancer is the second most common cause of cancer death among men and the sixth among women worldwide. Incidence is relatively high in southern and western Europe, and incidence and mortality increased in many European countries over the past 30 years, with a possible plateau or slight decline more recently. Risk factor profiles are changing, with fluctuations in alcohol...