The Effect of Distance on the Use of Emergency Hospital Services in a Spanish Region With High Population Dispersion

A Multilevel Analysis

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Background: There is geographic variability in the use of hospital emergency services. The effect of distance to the hospital on this variability is unknown.

Objectives: (a) To analyze the independent effect of distance on use of hospital emergency services; (b) to describe the variability among municipalities in use of hospital emergency services and to analyze how much of this variability is explained by distance.

Research Design: Weighted cross-sectional data from the 2003 Regional Health Survey of Castile and Leon were linked with municipal-level data from the 2001 Census, municipal health resources, and distance from municipality to hospital.

Subjects: Sample of 4281 adults residing in 179 municipalities of the region of Castile and Leon.

Measures: Using multilevel logistic regression models with random intercept, we analyzed the association between distance to hospital and use of hospital emergency services.

Results: The proportion of the sample using hospital emergency services in the last year was 14.4%. The multivariate analysis showed a significant inverse association between distance to hospital and use of emergency services (P = 0.001). Use of hospital emergency services varied widely across municipalities (variance 0.484; standard error, multilevel analysis).

Conclusion: Distance is a barrier to accessing hospital emergency services. The model explained 31.6% of the variability.

Key Words: emergency service, hospital, health services utilization, multilevel analysis

In recent years, many studies have explored the association between health, social, or environmental context and various health-related outcomes. Contextual characteristics such as unemployment level, poverty, environmental contamination, or access to health resources, among others, have been associated with health outcomes like birthweight, health status, prevalence of diseases, or mortality.

With respect to health services, there are conceptual models showing that both individual and contextual variables contribute to their use. The individual-level variables in this association have been widely documented in the scientific literature. However, a less-extensively explored aspect is how geographic context in the area of residence is associated with health services use independent of sociodemographic characteristics, health status, and socioeconomic level, among others. This is important, because people who live in the same municipality have common geographic access to health services. Various approaches using multilevel models have identified distance to health services as a barrier to accessing preventive programs, chronic hospital treatments, and primary physician care.

Information on the effect of distance on the use of emergency services is scarce, and has been derived primarily from ecological studies. For example, studies conducted in Spain 2 decades ago found an inverse association between the municipal rate of use of hospital emergency services (HES) and the distance from the municipality to the hospital. In the same line, a recently published study showed geographic variability in the use of HES in Spain, which did not seem to be explained by different patterns of morbidity in the population. The authors of this study suggest that the distance people have to travel to use HES could explain part of the geographic variability found.

In Spain, there are regions where a large percentage of the rural population lives in areas far from a hospital. Specifically, the Autonomous Community of Castile and Leon, with a population density of 27.13 inhabitants/km², is the largest European region with the highest population dispersion. About 50% of the population lives in municipalities with a public hospital, 37% lives over 25 km from their assigned hospital, and 21% lives more than 50 km.

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away. Contextual analyses in such regions, where there is wide variation in the variable “distance to the hospital,” make it possible to conduct an in-depth study of the effect of distance on the use of HES.

To date, no study has analyzed the effect of distance on HES use, taking into account both individual-level variables and variables related to the geographic and health context in which people live. Accordingly, the objectives of this study were a) to analyze the independent effect of distance on the use of HES; and b) to describe the variability across municipalities in the use of HES and analyze what part of this variability is explained by distance.

**METHODOLOGY**

Castile and Leon has 2,557,330 inhabitants distributed in 9 provinces and 2248 municipalities. The region is organized into 11 Health Areas and 248 Basic Health Zones. It has 14 public hospitals, at least 1 per Health Area, and 220 primary healthcare centers (PHC-E) that treat emergency consultations. Each municipality has an assigned hospital, called the reference hospital, and a PHC-E where emergency care is provided to cases not requiring diagnostic tests such as X-rays or laboratory tests. If the emergency to be treated requires diagnostic tests, the patient is stabilized in the PHC-E and then referred to the hospital.

With respect to financing, access to emergency services in the public health system is free and universal in Spain for anyone requiring emergency care.

**Data Sources**

The individual-level data analyzed were taken from the 2003 Regional Health Survey of Castile and Leon, which targets the population aged 16 and over. This survey is representative of the region of Castile and Leon. The complete microdata file was extracted from the 2003 National Health Survey, provided by the Ministry of Health and Consumer Affairs. The effective sample for Castile and Leon was 97.9% of the theoretical sample. The sampling frame consisted of all noninstitutionalized persons residing in Spain. Multistage stratified sampling was used. The first-stage units were the census sections, grouped into strata based on the size of the municipality. The sections were selected within each stratum with probability proportional to size. The second-stage units were the primary residences, which were selected with equal probability within each section by systematic sampling with random start. Finally, 1 individual aged 16 years or over was randomly selected within each household. The survey was administered in person, and answered by the respondent. Only when the person selected could not directly provide the information owing to communication problems, illness, or disability was it permitted to obtain the questionnaire information from another person residing in the household who was sufficiently informed and able to do this. The questionnaires were applied in the different co-official languages in Spain and have been translated into English.

The municipal-level variables on unemployment and percentage of households without a vehicle were obtained from the 2001 Population and Housing Census published by the National Institute of Statistics.

Information on the hospital corresponding to each municipality included in the survey (reference hospital), as well as the presence or absence of a PHC-E in the municipality, was obtained from the Guide for Health Planning in Castile and Leon. Road distances, measured in travel time, were obtained from the Web server of the Territorial Information System of the regional government of Castile and Leon. The application for the calculation of distances uses the MRServer library as the map server and MapRutas LT Server (v.SDT2008) as the engine for calculation of routes.

**Variables**

**Dependent Variable**

The dependent variable analyzed is the use of hospital emergency services in the last 12 months. Respondents were asked “In the past 12 months, have you had to use any emergency service for some problem or disease?” Those who replied affirmatively were asked “With regard to the last time you used an emergency service in these past 12 months, what type of service was it?” They were considered to have used public hospital emergency services when they replied that they had used a social security hospital.

Those who had been hospitalized were asked the reason for the last admission. Women whose last admission was for a birth were excluded.

**Individual-level Variables**

The sociodemographic variables used were sex and age. The indicator of socioeconomic level was mean household income per month. This variable was collected in 8 categories in the survey and subsequently regrouped into 3 categories: up to 900€, 900 to 1800€, and more than 1800€. Given the large number of persons for whom household income was unknown (29.6%), an additional category was created for these “missing values.”

The variable used to reflect health status was the presence of one or more diagnosed chronic diseases. This was determined by asking respondents if a physician had diagnosed them with any of a list of 27 chronic diseases. The replies were grouped into 2 categories: no chronic disease versus chronic disease.

People who stated they had used an emergency hospital service were asked how they accessed the service (referred by physician vs. own initiative).

**Contextual Variables**

Distance was collected as a continuous variable and subsequently categorized into tertiles. Municipalities with a hospital were assigned the distance from the center of the municipality to the hospital. For municipalities without a hospital, the distance was calculated from the center of the municipality of residence to the center of the municipality where the reference hospital was located. The cut-off points were: tertile 1: up to 7 minutes; tertile 2: 8 to 34 minutes; tertile 3: over 34 minutes.
The percentage of households without a vehicle and the unemployment rate were collected in the census as continuous variables and subsequently categorized into tertiles. The cut-off points are shown in Table 1.

### Statistical Analysis

We first made a descriptive study with an analysis of frequencies. To quantify the independent effect of distance to the hospital on the use of HES, we then performed a 2-level regression analysis. Persons (first level) were nested within municipalities of residence (second level).

### Fixed-effects Analysis

We analyzed the association between use of HES and the individual-level and contextual variables. Odds ratios (OR) and their 95% confidence intervals (CI) were obtained from the β coefficients (standard errors) in the fixed part of the model. The variables that were statistically significant in the univariate model were used to construct a random intercept multivariate model with forward selection of variables. The likelihood ratio test was used to compare models to determine the combination of variables with the best fit. Sex and percentage of households in the municipality without a vehicle were introduced into the model despite their lack of statistical significance owing to their epidemiological importance.

### Bivariate Collinearity

Bivariate collinearity between the independent variables was analyzed by calculating Spearman’s ρ correlation coefficient. Variables with a correlation coefficient equal to or greater than 0.60 were not included together in the multivariate model.

### Random-effects Analysis

We calculated the variability in the use of HES between second-level units (municipalities). To determine whether use of HES was more similar between persons in the same municipality than between persons from different municipalities, we calculated the intraclass correlation coefficient (ICC), which is the percentage of the total variability that is due to differences between municipalities, as follows: \( ICC = \frac{V_m}{V_m + V_i} \times 100 \), where \( V_m = \) variance between municipalities and \( V_i = \) individual variance. As the dependent variable is dichotomous, the ICC was calculated using the method of Snijders and Bosker, where \( V_i = \pi^2/3 \).

At the second level, the proportion of variance explained (PVE) by the different models was calculated as follows: \( PVE = \frac{V_0 - V_1}{V_0} \times 100 \), where \( V_0 = \) second-level variance of the null model, and \( V_1 = \) second-level variance of the adjusted model.

A slope analysis was performed, with no random effect found.

### TABLE 1. Description of the Sample

| Distance From Municipality to Hospital | Up to 7 min Away n (%) | 8–34 min Away n (%) | More Than 34 min Away n (%) | Total n (%) |
|--------------------------------------|------------------------|---------------------|-----------------------------|-------------|
| Individual variables                 |                        |                     |                             |             |
| Sex                                  |                        |                     |                             |             |
| Women                                | 751 (51.62)            | 734 (52.62)         | 676 (47.17)                 | 2161 (50.46) |
| Men                                  | 706 (48.52)            | 659 (47.24)         | 757 (52.83)                 | 2122 (49.54) |
| Age                                  |                        |                     |                             |             |
| 15–34 y                              | 485 (33.33)            | 426 (30.54)         | 357 (24.91)                 | 1268 (29.61) |
| 35–54 y                              | 494 (33.95)            | 471 (33.76)         | 432 (30.15)                 | 1397 (32.62) |
| 55 y or over                          | 477 (32.78)            | 498 (35.70)         | 644 (44.94)                 | 1619 (37.80) |
| Presence of chronic disease          |                        |                     |                             |             |
| No                                   | 718 (49.35)            | 703 (50.39)         | 690 (48.15)                 | 2111 (49.29) |
| Yes                                  | 738 (50.72)            | 691 (49.53)         | 742 (51.78)                 | 2171 (50.79) |
| Income/month                         |                        |                     |                             |             |
| Up to 900€                           | 239 (16.43)            | 377 (27.03)         | 504 (35.17)                 | 1120 (26.15) |
| 900–1800€                            | 414 (28.45)            | 516 (36.99)         | 430 (30.01)                 | 1360 (31.75) |
| Over 1800€                           | 238 (16.36)            | 193 (13.84)         | 102 (7.12)                  | 533 (12.44)  |
| NA                                   | 564 (38.76)            | 308 (22.08)         | 395 (27.56)                 | 1267 (29.58) |
| Municipality-level variables         |                        |                     |                             |             |
| PHC-E center in municipality         |                        |                     |                             |             |
| No                                   | 24 (1.65)              | 493 (35.34)         | 723 (50.45)                 | 1240 (28.95) |
| Yes                                  | 1432 (98.42)           | 900 (64.52)         | 710 (49.55)                 | 3042 (71.02) |
| % of households without a vehicle    |                        |                     |                             |             |
| Up to 31%                            | 621 (42.68)            | 731 (52.40)         | 136 (9.49)                  | 1488 (34.74) |
| 31–35%                               | 561 (38.56)            | 420 (30.11)         | 387 (27.01)                 | 1368 (31.94) |
| More than 35%                        | 274 (18.83)            | 243 (17.42)         | 908 (63.36)                 | 1425 (33.27) |
| Unemployment rate                    |                        |                     |                             |             |
| <10%                                 | 617 (42.41)            | 300 (21.51)         | 514 (35.87)                 | 1431 (33.41) |
| 10%–13%                              | 564 (38.76)            | 451 (32.33)         | 353 (24.63)                 | 1368 (31.94) |
| >13%                                 | 274 (18.83)            | 644 (46.16)         | 566 (39.50)                 | 1484 (34.65) |
| Total                                | 1455 (100.00)          | 1395 (100.00)       | 1433 (100.00)               | 4283 (100.00) |

2003 Regional Health Survey of Castile and Leon.

% indicates percentage; n, frequency; PHC-E, primary health care center with emergency services.
Weighted coefficients for the region of Castile and Leon were used in all the analyses. The Stata software package, version 11.00, was used to perform the analyses. The parameters were estimated by maximum likelihood with adaptive quadrature using the gllamm program.

RESULTS

The weighted sample was composed of 4281 persons, grouped into 179 municipalities. These municipalities are home to 73.8% of the population aged 16 and over in Castile and Leon. In the 12 months before data collection, 22.6% of those interviewed had used some emergency service. The last emergency service used for 14.4% of respondents was a social security hospital, versus 0.9% who had used a private hospital.

Some 26.2% of public HES consultations were referred by a physician, whereas 73.8% were due to the patient’s own initiative. Referrals were more frequent with increasing distance from the municipality of residence to the hospital. The percentage of physician-referred use of HES was 19% for people living in a municipality that was up to 7 minutes from the hospital (tertile 1), and 39% for those living in a municipality over 34 minutes from the hospital (tertile 3).

Table 1 describes the municipalities according to distance from the hospital. It can be seen that people living in municipalities farthest from the hospital are older and have lower socioeconomic level, less availability of private transportation, and less availability of PHC-E centers.

Table 2 shows the frequency of HES use in the last 12 months, by distance to the hospital. The percentage of HES use decreases with increasing distance from the municipality of residence to the hospital (17.1% vs. 12.3%).

Table 3 shows the results from the “fixed effects” part of the multilevel models. The full model shows that the probability of HES use increases among people with chronic diseases ($P < 0.001$) and those who live in municipalities with a high unemployment rate ($P = 0.034$). The probability of HES use decreases with increasing age ($P = 0.027$), is lower among persons who live in a municipality that has a PHC-E center ($P < 0.001$), and decreases with increasing distance from the municipality of residence to the hospital ($P < 0.001$). As compared with people who live in municipalities with a hospital, those living in municipalities that are 8 to 34 minutes from the hospital have a probability 0.60 times lower of using HES [OR = 0.60 (95% CI: 0.40-0.91)], and those who live in municipalities over 34 minutes from the hospital have a probability 0.49 times lower of using these services [OR = 0.49 (95% CI: 0.32-0.75)].

Table 4 provides summary results from the “random effects” multilevel models that examined the relative contribution of individual-level and contextual characteristics.

### TABLE 2. Percentage of Use of Hospital Emergency Services in the Last 12 Months

| Distance From Municipality to Hospital | Up to 7 min Away | 8–34 min Away | More Than 34 min Away | Total |
|----------------------------------------|-----------------|--------------|----------------------|-------|
| **Individual variables**               |                 |              |                      |       |
| Sex                                    |                 |              |                      |       |
| Women                                  | 126 (16.78)     | 105 (14.31)  | 88 (13.02)           | 319 (14.8) |
| Men                                    | 124 (17.56)     | 88 (13.35)   | 88 (11.62)           | 299 (14.1) |
| Age                                    |                 |              |                      |       |
| 15–34 y                                | 86 (17.73)      | 57 (13.38)   | 44 (12.32)           | 187 (14.75) |
| 35–54 y                                | 72 (14.57)      | 56 (11.89)   | 43 (9.95)            | 171 (12.25) |
| 55 y or over                           | 91 (19.08)      | 81 (16.27)   | 89 (13.82)           | 261 (16.13) |
| Presence of chronic disease            |                 |              |                      |       |
| No                                     | 88 (12.26)      | 74 (10.53)   | 70 (10.14)           | 232 (11.0) |
| Yes                                    | 161 (21.82)     | 119 (17.22)  | 106 (14.29)          | 386 (17.8) |
| Income/month                           |                 |              |                      |       |
| Up to 900€                             | 44 (18.41)      | 55 (14.59)   | 66 (13.10)           | 166 (14.8) |
| 900–1800 €                             | 80 (19.32)      | 66 (12.79)   | 46 (10.70)           | 192 (14.1) |
| Over 1800 €                            | 36 (15.13)      | 29 (15.03)   | 6 (5.88)             | 71 (13.3) |
| NA                                     | 89 (15.78)      | 43 (13.96)   | 57 (14.43)           | 189 (14.9) |
| **Municipal-level variables**          |                 |              |                      |       |
| PHC-E center in municipality           |                 |              |                      |       |
| No                                     | 3 (12.50)       | 90 (18.26)   | 104 (14.38)          | 197 (13.8) |
| Yes                                    | 246 (17.18)     | 103 (11.44)  | 72 (10.14)           | 421 (16.0) |
| % of households without a vehicle      |                 |              |                      |       |
| Up to 31%                              | 115 (18.52)     | 103 (14.09)  | 14 (10.29)           | 420 (13.7) |
| 31%–35%                                | 91 (16.22)      | 55 (13.10)   | 34 (8.79)            | 198 (16.2) |
| More than 35%                          | 43 (15.69)      | 36 (14.81)   | 127 (13.99)          |       |
| Unemployment rate                      |                 |              |                      |       |
| <10%                                   | 100 (16.21)     | 38 (12.67)   | 50 (9.73)            | 188 (13.1) |
| 10%–13%                                | 106 (18.79)     | 62 (13.75)   | 38 (10.76)           | 206 (15.1) |
| >13%                                   | 43 (15.69)      | 94 (14.60)   | 88 (15.55)           | 225 (15.1) |
| Total                                  | 249 (17.11)     | 194 (13.91)  | 176 (12.28)          | 619 (14.5) |

2003 Regional Health Survey of Castile and Leon.

% indicates percentage; n, frequency; PHC-E, primary health care center with emergency services.
of living in a municipality to use of HES. The empty model shows that the variability among municipalities in the use of HES is high (variance 0.484; standard error 0.132), which is statistically significant. Some 12.8% of this variability is due to differences among municipalities (ICC: 12.8%). The distance from the municipality of residence to the hospital explained 4.13% of the variability across municipalities in the use of HES. Compared with the empty model, the individual-level variables (model 1) explained 1.1% of the variability found. After including both the individual and contextual variables in the model (model 4), the percentage of variability explained with respect to the empty model was 31.6%, leaving significant residual variability not explained by the variables included in the model.

**DISCUSSION**

**Principal Findings**

The percentage of people in the present study who had used HES was 14.4%. This percentage decreases with increasing distance from the municipality of residence to the reference hospital.

In relation to context, there is a significant inverse association between distance to the hospital and use of HES ($P=0.001$). This effect is independent of the rest of the variables included in the model.

There is high variability among municipalities in the use of HES (variance 0.484; standard error 0.132). The percentage of variability attributable to differences across municipalities is 12.8%. The final model explained 32% of the variability.

In interpreting the results of the present study, its limitations must be considered. In the first place, the information collected in the survey was self-reported, which could produce an underestimate in the use of HES. In addition, the sampling framework was made up of non-institutionalized persons, which would exclude a certain proportion of older persons who live in residences and who presumably use public HES.

In defining the variables, we assigned the same distance to the hospital for all persons living in the same municipality. Current national legislation on statistical confidentiality does not allow disclosure of the respondent’s mailing address, therefore it is not possible to have individual data on the variable "distance to hospital." Recent study has shown that centroid distances is an acceptable proxy measure.\textsuperscript{24} In addition, we attributed to each person the distance to his or her hospital of reference, without confirming that this was the hospital actually used.

**TABLE 3. Estimates for Fixed Effects Between Individual and Contextual-level Characteristics on Use of Hospital Emergency Services. Multilevel Analysis**

|                                      | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) | Model 4 OR (95% CI) | Model 5 OR (95% CI) |
|--------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| **Individual variables**             |                     |                     |                     |                     |                     |
| Sex                                  |                     |                     |                     |                     |                     |
| Women                                | Reference            | Reference            | Reference            | Reference            | Reference            |
| Men                                  | 0.95 (0.80; 1.14)    | 1.02 (0.85; 1.23)    | 1.02 (0.85; 1.23)    | 1.02 (0.84; 1.22)    | 1.01 (0.84; 1.22)    |
| Age                                  |                     |                     |                     |                     |                     |
| 15–34 y                              | Reference            | Reference            | Reference            | Reference            | Reference            |
| 35–54 y                              | 0.82 (0.63; 1.07)    | 0.74 (0.59; 0.95)    | 0.76 (0.58; 0.98)    | 0.76 (0.58; 0.98)    | 0.75 (0.58; 0.98)    |
| 55 y or over                         | 1.18 (0.90; 1.53)    | 0.97 (0.67; 1.41)    | 0.88 (0.64; 1.20)    | 0.86 (0.63; 1.18)    | 0.86 (0.63; 1.18)    |
| Presence of chronic disease          |                     |                     |                     |                     |                     |
| No                                   | Reference            | Reference            | Reference            | Reference            | Reference            |
| Yes                                  | 1.80 (1.44; 2.25)    | 1.80 (1.40; 2.31)    | 1.84 (1.42; 2.38)    | 1.84 (1.42; 2.38)    | 1.83 (1.41; 2.38)    |
| Income/month                         |                     |                     |                     |                     |                     |
| Up to 900€                           | Reference            | Reference            | Reference            | Reference            | Reference            |
| 900–1800€                            | 0.92 (0.74; 1.14)    | 1.05 (0.81; 1.37)    | 1.00 (0.78; 1.29)    | 1.02 (0.79; 1.32)    | 1.03 (0.80; 1.33)    |
| Over 1800€                           | 0.77 (0.52; 1.15)    | 0.96 (0.60; 1.54)    | 0.88 (0.58; 1.36)    | 0.91 (0.59; 1.39)    | 0.92 (0.59; 1.42)    |
| Municipality-level variables         |                     |                     |                     |                     |                     |
| Distance to the hospital             |                     |                     |                     |                     |                     |
| t1 (up to 7 min away)                | Reference            | Reference            | Reference            | Reference            | Reference            |
| t2 (8–34 min away)                   | 0.78 (0.55; 1.11)    | 0.74 (0.51; 1.08)    | 0.60 (0.40; 0.90)    | 0.60 (0.40; 0.91)    |                     |
| t3 (more than 34 min away)           | 0.58 (0.41; 0.82)    | 0.55 (0.38; 0.81)    | 0.46 (0.31; 0.69)    | 0.49 (0.32; 0.75)    |                     |
| PHC-E center in municipality         |                     |                     |                     |                     |                     |
| No                                   | Reference            | Reference            | Reference            | Reference            | Reference            |
| Yes                                  | 0.69 (0.51; 0.94)    | 0.64 (0.47; 0.89)    | 0.63 (0.45; 0.86)    |                     |                     |
| % of households without a vehicle    |                     |                     |                     |                     |                     |
| Up to 31%                            | Reference            | Reference            | Reference            | Reference            | Reference            |
| 31%–35%                             | 0.62 (0.41; 0.92)    | 0.77 (0.51; 1.15)    | 0.91 (0.62; 1.34)    |                     |                     |
| More than 35%                        | 0.85 (0.59; 1.23)    | 1.30 (0.88; 1.94)    | 1.35 (0.92; 1.99)    | 1.59 (1.10; 2.31)    |                     |
| Unemployment rate                    |                     |                     |                     |                     |                     |
| <10%                                 | Reference            | Reference            | Reference            | Reference            | Reference            |
| 10%–13%                              | 1.30 (0.88; 1.94)    | 1.35 (0.92; 1.99)    | 1.59 (1.10; 2.31)    |                     |                     |

Model 1, univariate; Model 2, individual variables; Model 3, Model 2+distance to hospital; Model 4, Model 3+availability of PCE; Model 5, individual+contextual variables. % indicates percentage; 95% CI, 95% confidence interval; OR, odds ratio; PHC-E, primary health care center with emergency services; t, tertile.
TABLE 4. Random Effects Multilevel Models

| Model                          | Municipality-Level Variance (Standard Error) | Municipality-Level Variance Explained (%) |
|-------------------------------|---------------------------------------------|-------------------------------------------|
| Empty model                   |                                             |                                           |
| Intraclass correlation        | 12.80% (0.132)                              | Reference                                 |
| Univariate models:            |                                             |                                           |
| Age (35 y and over vs. under 35 y) | 0.484 (0.132) | 0.01                                      |
| Sex (men vs. women)           | 0.483 (0.132) | 0.18                                      |
| Monthly income (reference category: less than 900€) | 0.483 (0.133) | 0.20                                      |
| Chronic disease (yes vs. no)  | 0.480 (0.133) | 0.80                                      |
| PHC-E center in municipality (yes vs. no) | 0.441 (0.121) | 8.84                                      |
| Distance to hospital (reference category: tertile 1) | 0.464 (0.128) | 4.13                                      |
| Municipal unemployment rate (reference category: tertile 1) | 0.458 (0.129) | 5.20                                      |
| Percentage of households without a vehicle (reference category: tertile 1) | 0.459 (0.122) | 5.20                                      |
| Multivariate models:          |                                             |                                           |
| Model 1: level 1: sex,        | 0.478 (0.135) | 1.1                                       |
| socioeconomic variables and age |                                           |                                           |
| Model 2: level 1 + context (socioeconomic + travel) | 0.427 (0.119) | 11.7                                      |
| Model 3: model 2 + PHC-E center | 0.386 (0.106) | 20.3                                      |
| Model 4: model 3 + hospital distance | 0.331 (0.108) | 31.6                                      |

Relative contribution of individual and contextual characteristic of living in a municipality in regard to use of hospital emergency services.

PHC-E indicates primary health care center with emergency services.

However, any error resulting from people having used the closest hospital rather than the reference hospital would bias the measure of association toward the null value. The small number of persons living in municipalities close to the hospital (tertile 1) that do not have a PHC-E makes it impossible to evaluate possible interaction between presence of a PHC-E in the municipality and distance to the hospital, in the use of HES. However, when we used other cut-off points that allow such an evaluation—such as 10 minutes/11 to 30 minutes/over 30 minutes—the interaction terms were not significant ($P = 0.4961$).

Owing to multicollinearity with the variable “distance to hospital,” the contextual variables “index of dependence,” defined as the percentage of the population under age 16 plus the population age 65 and over with respect to the population age 16 to 64 years (0.78), and “percentage of persons aged 65 or over in the municipality” (0.74) could not be included in the model.

We had no individual-level information on variables such as the availability of private transportation in the respondent’s home. Nor did we have information on any variables relating to propensity to access HES, therefore we could not rule out possible endogeneity in the model pertaining to hospital location and geographic propensity to access HES.

Possible Explanations

The percentage of use of HES (14.4%) in the present study is lower than the national mean (17.7%), according to data from the 2003 National Health Survey of Spain. This lower regional use of HES has been seen in other studies with an ecological design, in which the region of Castile and Leon had one of the lowest rates of HES use in Spain. Several authors have shown that the percentage of HES use decreases with increasing distance to the hospital. Furthermore, inappropriate use of HES is lower in the older population. Thus, the lower percentage of HES use found in the present study could reflect characteristics of a region with a large percentage of older persons (mean age in the region is 43 yr vs. 39 yr at the national level) and a large percentage of the population living in areas far from the reference hospital.

With respect to fixed effects, the inclusion of individual-level variables in the multivariate analysis shows that HES is lower in persons over age 34 and is higher in those with worse health status (Table 3: level 1 model). However, after including distance to the hospital and the rest of the contextual variables in the model, the association of age and chronic diseases with HES use remains practically constant across all the models. The effect of age and chronic diseases on HES use is independent of the distance people must travel to reach the hospital, despite the fact that Castile and Leon is a region in which municipalities far from the hospital have a large proportion of older residents with a lower socioeconomic level and less availability of private transportation.

The most innovative contribution of this study is the finding of an independent effect of distance to the hospital on HES use. The use of HES decreases with increasing distance from the municipality to the hospital. This effect is independent of individual characteristics and of the existence of a PHC-E center in the municipality of residence. Ecological studies conducted by Lee et al show that distance to the hospital is a determinant of HES use after adjusting for sociodemographic factors. This lower probability of using HES with increasing distance to the hospital may indicate that distance is a barrier to accessing HES; that people who live far from the hospital are more likely to resolve their urgent health problems in PHC-E centers; or that there is variability among health professionals in the decision to refer a patient depending on the distance to the reference hospital.

In line with a study by Garrido et al, we found that the percentage of people referred to HES by a health professional was higher among patients who lived far from the hospital than those who lived nearer (41% vs. 18%); that is, patients who live far from the hospital are less apt to seek HES on their own initiative. Thus, it is possible that these patients are more likely to resolve their urgent health problems in PHC-E centers. Although this hypothesis cannot be confirmed based on our data, it is important to note that the variable “PHC-E center” acts as a confounding factor in the association between distance to the hospital and use of...
emergency services. Inclusion of this variable in the model accentuates the effect of distance on HES use. The findings of studies on the role of extra-hospital emergency services in the use of HES are controversial.31–33 A recent study in Spain shows that increasing access to emergency care in PHC-E centers does not decrease the use of HES.34 It may be that the highly dispersed population in the region explains our results, a dispersion that is not reflected in national-level studies.

On the other hand, there may be variability in medical practice according to distance to the reference hospital. Some authors have pointed out that the rural physician needs to have different skills from the city physician, sometimes having to deal with emergency situations that would be referred to the hospital if it was more accessible.30,35 Thus, the criteria for patient referral may vary with distance, and this could explain part of the variability found in our study.

With respect to random effects, the absence of multilevel studies on HES use makes it impossible to compare our data with those of other authors. It is important to point out that the variable that contributes most to reducing the PVE is existence of a PHC-E center in the municipality. After including the individual-level and contextual variables in the model, the percentage of variability explained was 31.6%, although there was significant residual variability not explained by the variables included in the model.

Despite these limitations, it can be concluded from our study that increased distance from the municipality of residence to the hospital reduces the use of HES in the region of Castile and Leon. However, there is a high degree of variability across municipalities in the use of HES that is not explained by the variables analyzed in this study. It may be that variables related to the use of PHC-E centers and to variability in medical practice could partly reduce the residual variability found in this study.

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REFERENCES

1. Kim D, Diez Roux AV, Kiefe CI, et al. Do neighborhood socioeconomic deprivation and low social cohesion predict coronary calcification?: the CARDIA study. Am J Epidemiol. 2010;172:288–298.
2. Pang PT, Leung CC, Lee SS. Neighbourhood risk factors for tuberculosis in Hong Kong. Int J Tuberc Lung Dis. 2010;14:585–592.
3. Gray SC, Gelfand AE, Miranda ML. Hierarchical spatial modeling of uncertainty in air pollution and birth weight study. Stat Med. 2011. doi: 10.1002/sim.4234. [Epub ahead of print].
4. Daley E, Ailio A, Anstey EH, et al. Examining barriers to cervical cancer screening and treatment in Florida through a socio-ecological lens. J Community Health. 2011;36:121–131.
5. Andersen RM. National Health Surveys and the Behavioral Model of Health Services Use. Med Care. 2008;46:647–653.
6. Tountas Y, Oikononomou N, Pallikarona G, et al. Sociodemographic and socioeconomic determinants of health services utilization in Greece: the Hellas Health I study. Health Serv Manag Res. 2011;24:8–18.
7. Sanz B, Regidor E, Galindo S, et al. Pattern of health services use by immigrants from different regions of the world residing in Spain. Int J Public Health. 2011. [Epub ahead of print].
8. Regidor E, Martínez D, Calle ME, et al. Socioeconomic patterns in the use of public and private health services and equity in health care. BMC Health Serv Res. 2008;8:183.
9. Lee JE, Sung JH, Ward WB, et al. Utilization of the emergency room: impact of geographic distance. Geospatial Health. 2007;2:243–253.
10. Turnbull J, Martin D, Lattimer V, et al. Does distance matter? Geographical variation in GP out-of-hours service use: an observational study. Br J Gen Pract. 2008;58:471–477.
11. Dejardin O, Bouvier AM, Faivre J, et al. Access to care, socioeconomic deprivation and colon cancer survival. Aliment Pharmacol Ther. 2008;27:940–949.
12. Hiscock R, Pearce J, Blakely T, et al. Is neighborhood access to health care provision associated with individual-level utilization and satisfaction? Health Serv Res. 2008;43:2183–2200.
13. Garcia Benavides F, Cayuela Domínguez A, Belda Bañez J, et al. Relationship between the distance to hospital emergency services and their utilization. Rev Sanit Hig Publica (Mad). 1990;64:643–650.
14. Peiró S, Librero J, Ríado M, et al. Variability in Spanish National Health System hospital emergency services utilization. Gac Sanit. 2010;24:6–12.
15. Instituto Nacional de Estadística. Padrón Municipal de Habitantes 2009. Available at: http://www.ine.es/inmemenu/index.html/#6. (Accessed February, 2011).
16. Junta de Castilla y León. Consejería de Sanidad. Guía de Ordenación Sanitaria 2007. Available at: http://www.salud.jcy1.es/sanidad/cm/institucion/kContent?p极品=1233532149v42. FIdContent = 31247&kcal cale=es&ExtTextOnly=false. Accessed February, 2011.
17. Instituto Nacional de Estadística. Encuesta Nacional de Salud 2003. Metodología detallada. Available at: http://www.ine.es/metodologia/ t15/t1530419.pdf. Accessed February, 2011.
18. Instituto Nacional de Estadística. Censo de Población y Vivienda 2001. Available at: http://www.ine.es/jaxi/menu.do?type=pcaxis&param =%2 Fid%2F2Fe242&file=inebas&L=0. Accessed February, 2011.
19. Junta de Castilla y León. Consejería de Fomento. Sistema de Información Territorial de la Junta de Castilla y León. Guía web de carreteras. Available at: http://www.sitcy1.jcy1.es/guiacarreteras/viewer.htm. Accessed February, 2011.
20. Snijders TAB, Bosker RJ. Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modelling. Thousand Oaks, CA: Sage Publications; 1999:13–37.
21. Stata Statistical Software [computer program]. Version Release 11. StataCorp: College Station, TX; StataCorp LP, 2009.
22. Rabe-Hesketh S, Skrondal A Pickles A 2004. ). GLLAMM Manual. Paper 160.
23. Rabe-Hesketh S, Skrondal A. Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modelling. Thousand Oaks, CA: Sage Publications; 1999:13–37.
24. Bliss RL, Katz JN, Losina E, et al. Estimating proximity to care: Are straight line and zip code centroid distances acceptable proxy measures? Med Care. 2012. (In press).
25. Ministerio de Sanidad y Política Social. Estadística de Establecimientos Sanitarios con Régimen de Internado (Indicadores Hospitalarios) Año 2008. Available at: http://www.msc.es/estadEstudios/estadisticas/docs/ESCR12008.pdf. Accessed February, 2011.
26. Badwick A, Fu R, Warden C, et al. Distances to emergency department in children. Acad Emerg Med. 2009;16:411–417.
27. Carret ML, Fassa AC, Domingues MR. Inappropriate use of emergency services: a systematic review of prevalence and associated factors. Cad Saúde Pública. 2009;25:7–28.
28. Oterino D, Peiró S, Calvo R, et al. Utilización inadecuada de un servicio de urgencias hospitalario. Una evaluación con criterios explicitos. Gac Sanit. 1999;13:361–370.
29. Torner Vilagrasa E, Guargu Rojas A, Torras Boatella MG, et al. Análisis de la demanda en los servicios de urgencias de Barcelona. Aten Primaria. 2003;32:423–429.
30. Garrido Cruz I, Montilla Sanz MA, Espejo Rosillo I, et al. Comparison of the place of origin of the referral of patients to hospital emergency service. *Aten Primaria*. 1997;20:361–366.

31. Hilditch JR. Changes in hospital emergency department use associated with increased family physician availability. *J Fam Pract*. 1980;11:91–96.

32. Bolívar I, Balanzó X, Armada A, et al. El impacto de la reforma de la atención primaria en la utilización de servicios de urgencias hospitalarios. *Med Clin*.107: Barc; 1996:289–295.

33. Franco SM, Mitchell CK, Buzon RM. Primary care physician access and gatekeeping: a key to reducing emergency department use. *Clin Pediatr*. 1997;36:63–68.

34. Oterino de la Fuente D, Baños Pino JF, Blanco VF, et al. Does better access to primary care reduce utilization of hospital accident and emergency departments? A time-series analysis. *Eur J Public Health*. 2007;17:186–192.

35. Navas Alonso M. La ruralidad como seña de identidad de Atención Primaria. *Centro de Salud*. 2002;387–388.