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Title: Effect of distance on the use of hospital emergency services: a multilevel analysis

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Abstract: 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 autonomous community 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 0.132). Some 12.8% of the variability is attributable to differences among municipalities. The model explained 32% of the variability.
Conclusion: Distance is a barrier to accessing hospital emergency services. There is large variability among municipalities in the use of emergency services not explained by the model. Variables related with the capacity of primary care facilities to resolve emergencies may reduce part of the observed variability.

Cover Letter

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Dear Sir:

On behalf of all co-authors, I submit the enclosed manuscript *"Effect of Distance on the Use of Hospital Emergency Services: A Multilevel Analysis"* for consideration by Medical Care journal for possible publication.

This study has not been published in this or a substantially similar form (in print or electronically, including on a web site), nor accepted for publication elsewhere, nor is it under consideration by another publication.

All authors have signed this letter as confirmation that they have read and approved the paper, have met the criteria for authorship as stated by the International Committee of Medical Journal Editors. Concretely all the authors have made: 1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

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Effect of Distance on the Use of Hospital Emergency Services: A Multilevel Analysis

ABSTRACT

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variability is attributable to differences among municipalities. The model explained 32% of the variability.

Conclusion: Distance is a barrier to accessing hospital emergency services. There is large variability among municipalities in the use of emergency services not explained by the model. Variables related with the capacity of primary care facilities to resolve emergencies may reduce part of the observed variability.

Key words: emergency service, hospital; health services utilization; multilevel analysis

INTRODUCTION

In recent years many studies have explored the association between context and health. Contextual characteristics such as unemployment level, poverty, or index of crowding, among others, have been associated with health outcomes like birthweight, health status, prevention of infectious diseases or mortality.[1-4]

With regard to the use of health services, there are theoretical and analytical models showing that both individual and contextual variables contribute to health services use.[5] The individual variables in this association have been widely documented in the scientific literature,[6-8] however, the influence of geographical context independently of individual factors has been explored much less extensively.[9-10] People who live in the same municipality have common geographic access to health services. In this regard, approaches using multilevel models have identified distance to health services as a barrier to accessing preventive programs, chronic hospital treatments, and primary physician care.[11,12]

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 two 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.[13] 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.[14] In this regard, the authors suggest that the distance people have to travel to use HES could explain part of the geographic variability found.

In Spain, there are model regions for a multilevel approach that allows a more in-depth study of the effect of distance on the use of HES. Specifically, the autonomous community of Castile and Leon, with a population density of 27.13 inhabitants/km^2, is the largest region in Europe with the greatest population dispersion. About 50% of the population lives in municipalities with a hospital, 37% live 25 to 50 km from a hospital and 21% live more than 50 km from the reference hospital. The rate of use of HES in the region in 2008 was lower than the national mean (442.02 vs. 575.72 HES/1000 population), although the percentage of emergency visits admitted to hospital was higher (14.9 vs. 10.5%).[15,16] This lower rate of use may be related to sociodemographic characteristics of the population,[17] but we do not know if this variability can be explained, in part, by the distance to these health resources.

To date, no study has analyzed the effect of distance on HES use, taking into account both individual 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

The region of Castile and Leon has 2,557,330 inhabitants distributed in 9 provinces and 2,248 municipalities.[18] The region is organized into 11 Health Areas and 248 Basic Health Zones. It has 14 public hospitals, at least one per Health Area, and 220 primary health care centers that attend emergency consultations (PHC-E).[19]

Data sources

The individual data analyzed were taken from the 2003 Regional Health Survey of Castile and Leon, which targets the population aged 16 and over. The complete microdata file was extracted from the 2003 National Health Survey, provided by the Ministry of Health and Consumer Affairs. The sampling framework consisted of all non-institutionalized persons residing in Castile and Leon. A detailed description of the survey methodology can be found on the website of the National Institute of Statistics (http://www.ine.es/metodologia/t15/t1530419.pdf).[20]

The municipal-level variables on unemployment and percentage of households without a vehicle were obtained from the 2001 Population and Housing Census.[21]

The health resources of each municipality included in the survey were obtained from the web server of the Ministry of Health of Castile and Leon.[19] Road distances measured in travel time from the municipality of residence to the municipality where the reference hospital is located were obtained from the web server of the Territorial Information System of the regional government of Castile and Leon.[22]

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 variables

The sociodemographic variables used were sex and age. The indicator of socioeconomic level was mean household income per month grouped into four categories: up to 900€, 900-1800€ 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 two categories: no chronic disease vs. 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. A value of 0 minutes was given to municipalities that had a hospital. The cut-off points were: tertile 1: municipality with a hospital; tertile 2: municipality with no hospital and nearest reference hospital is up to 34 minutes away; tertile 3: nearest reference hospital is over 34 minutes away.

The unemployment rate was collected as a continuous variable and subsequently categorized into tertiles with the following cut-off points: less than or equal to 10%, 11-13%, and over 13%.

The percentage of households without a vehicle was dichotomized using receiver operating characteristic (ROC) curves. The cut-off point obtained was 30%.

Statistical analysis

We first made a descriptive study – an analysis of frequencies. To quantify the independent effect of distance to the hospital on the use of HES we then performed a two-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 and contextual variables. Odds ratios (OR) and their 95% confidence intervals (CI) were obtained from the beta 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 due to their epidemiological importance.

Bivariate collinearity between the independent variables was analyzed by calculating Spearman's rho 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 = $(V_m)/(V_m+V_i)$ X 100, where: V_m = variance between municipalities and V_i = individual variance. Since the dependent variable is dichotomous, the ICC was calculated using the method of Snijders and Bosker, where $V_i = \pi^2/3$.[23]

At the second level, the proportion of variance explained (PVE) by the different models was calculated as follows: PVE = $(V_0-V_1)/(V_0)$ X 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.

Weighted coefficients for the community of Castile and Leon were used in all the analyses. The Stata software package, version 11.00, was used to perform the analyses.[24] The parameters were estimated by maximum likelihood with adaptive quadrature using the gllamm program.[25,26]

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, while 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 21.9% for people living in a municipality with a hospital (tertile 1), and 38.6% 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 (16.5% *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 ($p<0.001$). People who live in municipalities that do not have a hospital are only about half as likely to use

HES: OR=0.57 (95% CI: 0.37, 0.85) for those who live up to 34 minutes away from a hospital, and OR=0.48 (95% CU: 0.32, 0.72) for those who live more than 34 minutes away.

Table 4 provides summary results from the “random effects” multilevel models that examined the relative contribution of individual and contextual characteristics of living in a municipality to use of HES. The empty model shows that the variability among municipalities in the use of HES is 48% (variance 0.484; standard error 0.132), which is statistically significant. Some 12.8% of this variability is due to differences among municipalities (ICC: 12.82). The distance from the municipality of residence to the hospital explained 3.4% of the variability found across municipalities with regard to use of HES.

Table 5 shows the contribution of including individual and contextual variables to the reduction of variability among municipalities in relation to the use of HES. Compared with the empty model (model 1), the individual variables (model 2) explained 1.1% of the variability found. After including both the individual and contextual variables in the model (model 5), the percentage of variability explained with respect to the empty model was 32.0%, 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.

Age was the only individual variable independently associated with lower use of HES (p=0.027). Having been diagnosed with a chronic disease increases use of HES (p<0.001). With regard 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, although significant residual variability remained that was not explained by the variables included in the model.

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 community of Castile and Leon had one of the lowest rates of HES use in Spain.[14,15] Several authors have shown that the percentage of HES use decreases with increasing distance to the hospital.[9,13,27] Furthermore, inappropriate use of HES is lower in the older population.[28-30] Thus, the lower percentage of HES use found in the present study could reflect characteristics of a region with a large elderly population and a high percentage of the population living in areas that are far from the reference hospital. This result, together with the fact that Castile and Leon is a region with a rate of emergency hospital admissions higher than the national mean (14.9% vs. 10.5%) could indicate that HES is used more appropriately in this region than in the country overall.

With regard to fixed effects, inclusion of individual-level variables in the multivariate model 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 concentration of older residents, as well as persons with a low 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 use of HES. People who live in municipalities without a hospital make less use of HES. This effect is independent of individual characteristics and of the existence of a PHC-E center in the municipality of residence. Studies conducted by Lee et al. show that, at ecological level, distance to the hospital is a determinant of HES use after adjusting for sociodemographic factors.[9] This lower probability of using HES with increasing distance to the hospital may indicate that distance is a barrier to accessing HES, and that people who live far from the hospital are more likely to resolve their urgent health problems in PHC-E centers. It may also suggest 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,[31] 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, since we do not know what routes patients follow when they request emergency are, 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 HES. Inclusion of this variable in the model accentuates the effect of distance, suggesting that presence of a PHC-E center is a possible modulating factor in the use of HES.

In this regard, the findings of studies on the role of extra-hospital emergency services in the use of HES are controversial.[32-34] A recent study in Spain shows that increasing access to emergency care in PHC-E centers does not decrease the use of HES.[35] 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 must 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.[31,36] Thus, the criteria for patient referral may vary with distance, and this could explain part of the variability found in our study.

With regard 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, again suggesting the possible modulating role of PHC-E centers in the use of HES.

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 attributed to each person the distance to their hospital of reference, without confirming that this was the hospital actually used. 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. With regard to limiting the dependent variable to the use of public hospitals, it was not possible to know what private hospital was used, therefore no information is available on distance in such cases. However, only 0.9% of respondents in our sample had used a private hospital for the most recent emergency episode.

A high correlation was found during the analysis between sociodemographic contextual, socioeconomic, and health status variables. This obliged us to reduce the number of variables that could be included in the multivariate model.

Despite these limitations, it can be concluded from our study that distance from the municipality of residence to the hospital is a barrier in accessing HES. This barrier may be producing inequalities in access to health resources, but in turn may promote increased use of PHC-E centers and more appropriate use of HES. 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 their capacity to resolve health problems 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. Cerdá M, Diez-Roux AV, Tchetgen ET, et al. The relationship between neighbourhood poverty and alcohol use: estimation by marginal structural models. *Epidemiology.* 2010;21:482-489.
3. Muhajarine N, Vu LT. Neighborhood contexts and low birthweight: social disconnection heightens single parents risks in Saskatoon. *Can J Public Health*. 2009;100:130-134.
4. Pang PT, Leung CC, Lee SS. Neighbourhood risk factors for tuberculosis in Hong Kong. *Int J Tuberc Lung Dis*. 2010;14:585-592.
5. Andersen RM. National Health Surveys and the Behavioral Model of Health Services Use. *Med Care*. 2008; 46:647-653.

6. Tountas Y, Oikonomou N, Pallikarona G, et al. Sociodemographic and socioeconomic determinants of health services utilization in Greece: the Hellas Health I study. *Health Serv Manage 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 Feb 10. [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. Jae Eun Lee, Jung Hye Sung, William B. Ward, 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 Dominguez A, et al. Relationship between the distance to hospital emergency services and their utilization. *Rev Sanid Hig Publica (Madr)*. 1990;64:643-650.

14. Peiró S, Librero J, Ridao M, et al. Variability in Spanish National Health System hospital emergency services utilization. *Gac Sanit.* 2010;24:6-12.
15. 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/ESCRI2008.pdf Accessed February, 2011
16. Junta de Castilla y León. Consejería de Sanidad. Establecimientos Sanitarios con Régimen de Internado. Castilla y León. Año 2008. Available at: http://www.salud.jcyl.es/sanidad/cm/institucion/tkContent?idContent=751726&locale=es_ES&textOnly=false Accessed February, 2011.
17. Marín N, Caba A, Ortiz B, et al. Socioeconomic determinants and utilization of emergency hospital services. *Med Clin (Barc).* 1997;108:726-729.
18. Instituto Nacional de Estadística. Padrón Municipal de Habitantes 2009. Available at:: http://www.ine.es/inebmenu/indice.htm#6 Accessed February, 2011.
19. Junta de Castilla y León. Consejería de Sanidad. Guía de Ordenación Sanitaria 2007. Available at:: http://www.salud.jcyl.es/sanidad/cm/institucion/tkContent?pgseed=1233532149842&idContent=312478&locale=es_ES&textOnly=false Accessed February, 2011.
20. Instituto Nacional de Estadística. Encuesta Nacional de Salud 2003. Metodología detallada. Available at:: http://www.ine.es/metodologia/t15/t1530419.pdf Accessed February, 2011

21. Instituto Nacional de Estadística. Censo de Población y Vivienda 2001. Available at:: http://www.ine.es/jaxi/menu.do?type=pcaxis&path=%2Ft20%2Fe242&file=inebase&L=0 Accessed February, 2011
22. 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.sitcyl.jcyl.es/guiacarreteras/viewer.htm Accessed February, 2011
23. Snijders TAB, Bosker RJ. Multilevel analysis: an introduction to basic and advanced multilevel modelling. Thousand Oaks, CA: Sage Publications, 1999: 13-37.
24. Stata Statistical Software [computer program]. Version Release 11. StataCorp. College Station, TX: StataCorp LP; 2009.
25. Rabe-Hesketh S, Skrondal A Pickles, A. (2004). GLLAMM Manual. U.C. Berkeley Division of Biostatistics Working Paper Series. Working Paper 160.
26. Rabe-Hesketh S, Skrondal A, Gjessing HK. Biometrical Modeling of Twin and Family Data Using Standard Mixed Model Software. *Biometrics.* 2007; 64: 280–288.
27. Ludwick A, Fu R, Warden C, et al. Distances to emergency department and to primary care provider's office affect emergency department use in children. *Acad Emerg Med*. 2009;16:411-417.
28. Carret ML, Fassa AC, Domingues MR. Inappropriate use of emergency services: a systematic review of prevalence and associated factors. *Cad Saude Publica*. 2009;25:7-28.

29. Oterino D, Peiró S, Calvo R, et al. Utilización inadecuada de un servicio de urgencias hospitalario. Una evaluación con criterios explícitos. *Gac Sanit.* 1999;13:361-70.
30. Torné Vilagrasa E, Guarga Rojas A, Torras Boatella MG, et al. Análisis de la demanda en los servicios de urgencias de Barcelona. Aten Primaria 2003;32(7):423-429.
31. 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.
32. Hilditch JR. Changes in hospital emergency department use associated with increased family physician availability. J Fam Prac. 1980;11:91–96.
33. 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 (Barc) 1996;107: 289–95.
34. 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.
35. 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.
36. Navas Alonso, M. La ruralidad como seña de identidad de Atención Primaria. Centro de Salud. 2002: 387-388.

Effect of Distance on the Use of Hospital Emergency Services: A Multilevel Analysis

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Table

Table 1: Description of the sample. 2003 Regional Health Survey of Castile and Leon

	Distance from municipality to hospital							
	Hospital in municipality		Up to 34 minutes away		More than 34 minutes away		Total	
Individual variables	n	%	n	%	n	%	n	%
Sex								
- Women	761	52.9	724	51.3	676	47.2	2161	50.5
- Men	678	47.1	686	48.7	756	52.8	2120	49.5
Age								
- 15-34 years	496	34.5	415	29.4	357	24.9	1268	29.6
- 35-54 years	493	34.3	471	33.4	432	30.2	1396	32.6
- 55 years or over	451	31.3	523	37.1	643	44.9	1617	37.8
Presence of chronic disease								
- No	738	51.3	683	48.4	690	48.2	2111	49.3
- Yes	701	48.7	727	51.6	743	51.9	2171	50.7
Income/month								
- Up to 900€	244	17.0	373	26.5	504	35.2	1121	26.2
- 900-1800 €	450	31.3	480	34.0	430	30.0	1360	31.8
- Over 1800 €	276	19.2	156	11.1	103	7.2	535	12.5
- NA	470	32.7	401	28.4	395	27.6	1266	29.6
Municipality-level variables								
PHC-E center in municipality								
- No	0	0.0	518	36.7	723	50.5	1241	29.0
- Yes	1440	100.0	892	63.3	709	49.5	3041	71.0
% of households without a vehicle								
- >= 30%	1049	72.9	711	50.4	1296	90.5	3056	71.4
- <30%	391	27.2	699	49.6	137	9.6	1227	28.7
Unemployment rate								
-< 10%	617	42.9	300	21.3	514	35.9	1431	33.4
- 10-13%	446	31.0	569	40.4	353	24.7	1368	32.0
- > 13%	376	26.1	541	38.4	565	39.5	1482	34.6
TOTAL	1439	100.0	1410	100.0	1432	100.0	4281	100.0

n: frequency %: percentage;PHC-E: primary health care center with emergency services

Table 2: Percentage of use of hospital emergency services in the last 12 months. 2003 Regional Health Survey of Castile and Leon

	Distance from municipality to hospital							
	Hospital in municipality		Up to 34 minutes away		More than 34 minutes away		Total	
Individual variables	n	%	n	%	n	%	n	%
Sex								
- Women	125	16.4	106	14.7	88	13.0	319	14.8
- Men	112	16.5	99	14.4	88	11.6	299	14.1
Age								
- 15-34 years	81	16.36	62	14.90	44	12.32	187	14.75
- 35-54 years	78	15.82	50	10.62	43	9.95	171	12.25
- 55 years or over	78	17.29	94	17.97	89	13.82	261	16.13
Presence of chronic disease								
- No	89	12.1	73	10.7	70	10.1	232	11.0
- Yes	148	21.1	132	18.2	106	14.3	386	17.8
Income/month								
- Up to 900€	46	18.9	54	14.5	66	13.1	166	14.8
- 900-1800 €	79	17.6	67	13.9	46	10.7	192	14.1
- Over 1800 €	45	16.3	20	12.9	6	5.9	71	13.3
- NA	67	14.3	65	16.2	57	14.4	189	14.9
Municipal-level variables								
PHC-E center in municipality								
- No	237	16.5	112	12.6	72	10.1	421	13.8
- Yes	----	----	94	18.1	104	14.4	198	16.0
% of households without a vehicle								
- >= 30%	153	14.6	106	14.9	162	12.5	420	13.7
- <30%	85	21.7	100	14.3	14	10.3	198	16.2
Unemployment rate								
-< 10%	100	16.2	38	12.7	50	9.7	188	13.1
- 10-13%	89	20.0	79	13.9	38	10.8	206	15.1
- > 13%	48	12.7	89	16.5	88	15.5	225	15.1
TOTAL	237	16.5	206	14.6	176	12.3	619	14.5

n: frequency %: percentage;PHC-E: primary health care center with emergency services

Tabla 3: Estimates for fixed effects between individual and contextual-level characteristics on use of hospital emergency services. Multilevel analysis

	MODEL 1	MODEL 2	MODEL 3	MODEL 4	MODEL 5
Individual variables	**OR 95% CI**	**OR 95% CI**	**OR 95% CI**	**OR 95% CI**	**OR 95% CI**
Sex					
- Women	Reference	Reference	Reference	Reference	Reference
- Men	0.95 (0.80 ; 1.14)	1.02 (0.85 ; 1.23)	1.03 (0.85 ; 1.24)	1.02 (0.85 ; 1.23)	1.02 (0.85 ; 1.23)
Age					
- 15-34 Years	Reference	Reference	Reference	Reference	Reference
- 35-54 years	0.82 (0.63 ; 1.07)	0.74 (0.59 ; 0.95)	0.75 (0.59 ; 0.96)	0.75 (0.59 ; 0.95)	0.75 (0.59 ; 0.95)
- 55 years or over	1.18 (0.90 ; 1.53)	0.97 (0.67 ; 1.41)	0.99 (0.68 ; 1.44)	0.98 (0.67 ; 1.42)	0.98 (0.67 ; 1.43)
Presence of chronic disease					
- No	Reference	Reference	Reference	Reference	Reference
- Yes	1.80 (1.44 ; 2.25)	1.80 (1.40 ; 2.31)	1.79 (1.39 ; 2.30)	1.79 (1.39 ; 2.30)	1.79 (1.39 ; 2.30)
Income/month					
- Up to 900€	Reference	Reference	Reference	Reference	Reference
- 900-1800 €	0.92 (0.74 ; 1.14)	1.05 (0.81 ; 1.37)	1.04 (0.80 ; 1.35)	1.06 (0.81 ; 1.38)	1.06 (0.81 ; 1.38)
- Over 1800 €	0.77 (0.52 ; 1.15)	0.96 (0.60 ; 1.54)	0.94 (0.59 ; 1.49)	0.96 (0.60 ; 1.53)	0.95 (0.59 ; 1.53)
Municipality-level variables					
Distance to the hospital					
- t1 (hospital in municipality)	Reference		Reference	Reference	Reference
- t2 (up to 34 min away)	0.81 (0.55 ; 1.19)		0.77 (0.52 ; 1.16)	0.60 (0.39 ; 0.92)	0.57 (0.37 ; 0.85)
- t3 (more than 34 min away)	0.60 (0.40 ; 0.88)		0.56 (0.37 0.85)	0.45 (0.29 ; 0.69)	0.48 (0.32 ; 0.72)
PHC-E center in municipality					
- No	Reference			Reference	Reference
- Yes	0.69 (0.51 ; 0.94)			0.64 (0.46 ; 0.89)	0.59 (0.42 ; 0.82)
% of households without a vehicle					
- >= 30%	Reference				Reference
- <30%	1.30 (0.92 ; 1.82)				1.30 (0.94 ; 1.80)
Unemployment rate					
-< 10%	Reference				Reference
- 10-13%	1.30 (0.88 ; 1.94)				1.43 (0.98 ; 2.07)
- > 13%	1.51 (1.03 ; 2.21)				1.62 (1.12 ; 2.36)

%: percentage; PHC-E: primary health care center with emergency services ; t: tertile; OR: odds ratio; 95% CI: 95% confidence interval

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

Tabla 4: Random effects multilevel models. Relative contribution of individual and contextual characteristic of living in a municipality en la utilización de los servicios de urgencias hospitalarias

	Municipality-level variance (standard error)	Municipality-level variance explained (%)
Empty model		
Intraclass correlation	12.80%	
	0.484 (0.132)	Reference
Univariate models:		
Age (35 years and over vs. under 35 years)	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/s 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)	0.467 (0.127)	3.40
Municipal unemployment rate (reference category: tertile 1)	0.458 (0.129)	5.20
Percentage of households without a vehicle (<30% vs. > 30%)	0.473 (0.129)	2.17

PHC-E: primary health care center with emergency services

Table 5: Random-effects multilevel models. Contribution of individual and contextual variables to reducing the variability among municipalities in regard to use of hospital emergency services

		Municipality-level variance (standard error)	Explained municipality-level variance (%)
Model 1:	Intercept only	0.484 (0.132)	Reference
Model 2:	level 1: sex, socioeconomic variables and age	0.478 (0.135)	1.1
Model 3:	Level 1 + context (socioeconomic + travel)	0.430 (0.126)	11.1
Model 4:	model 3 + PHC-E center	0.382 (0.110)	21.0
Model 5:	model 4 + hospital distance	0.329 (0.108)	32.0

PHC-E: primary health care center with emergency services