

Original

Chronic liver disease and cirrhosis mortality and social deprivation: a spatial analysis in small areas of Madrid region

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Abstract

Objectives: To study census-tract distribution of chronic liver disease and cirrhosis mortality in the Madrid Region and its association with socio-economic deprivation.

Methods: Cross-sectional, ecological (3906 census-tract) study, using mortality data for 1996-2003 and a deprivation index drawn up on the basis of 2001 census data. Standardised mortality ratios were calculated taking Spanish rates for 2001 as reference. Smoothed census-tract relative risks were computed using the Besag-York-Mollie model. Relative risks (RRs) of dying and their 95% credibility intervals (95% CIs) were calculated according to quartiles of the deprivation index (with the fourth quartile -Q- of the indicator being the most unfavourable situation). Maps were plotted depicting the distribution of the posterior probability of RR > 1.

Results: Census tracts with a high risk of mortality were detected, mostly located in the centre and on the eastern, south-eastern and south-western fringes of the city of Madrid. Mortality increased with deprivation. RRs of mortality according to quartiles of the deprivation index were: Q2 = 1.5 (CI: 1.3-1.6), Q3 = 1.9 (CI: 1.7-2.2) and Q4 = 2.5 (CI: 2.2-2.8) for men; and Q2 = 1.3 (CI: 1.1-1.5), Q3 = 1.5 (CI: 1.3-1.7) and Q4 = 1.6 (CI: 1.3-1.8) for women.

Conclusions: This small-area study enabled census tracts with excess mortality eligible for a special public health intervention to be identified, and their association with socio-economic deprivation to be confirmed.

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Key words: Liver cirrhosis. Mortality. Social deprivation. Inequalities. Small-area studies.

MORTALIDAD POR CIRROSIS Y OTRAS HEPATOPATÍAS CRÓNICAS Y PRIVACIÓN SOCIAL: UN ANÁLISIS ESPACIAL POR ÁREAS PEQUEÑAS DE LA COMUNIDAD DE MADRID

Resumen

Objetivos: Estudiar la distribución por secciones censales de la mortalidad por cirrosis y hepatopatías crónicas de la Comunidad de Madrid y su asociación con la privación socioeconómica.

Métodos: Estudio transversal y ecológico (3.906 secciones censales) utilizando los datos del registro de mortalidad de 1996-2003 y un índice de privación construido a partir de los datos del Censo de 2001. Se calcularon razones de mortalidad estandarizadas tomando como referencia las tasas de España del 2001. Los riesgos relativos suavizados de las secciones censales se calcularon siguiendo el modelo Besag-York-Molife. Se han estimado los riesgos relativos (RR) de morir, y su intervalo de credibilidad al 95% (ICI), según los cuartiles del índice de privación (siendo el cuarto cuartil -Q4- del indicador la situación más desfavorable). Se realizaron mapas representando la distribución de la probabilidad posterior de RR > 1.

Resultados: Se han detectado secciones censales con alto riesgo de mortalidad localizadas en su mayoría en el centro y la periferia este, sureste y suroeste de la ciudad de Madrid. La mortalidad se incrementa con la privación social: El RR de mortalidad según cuartiles del índice de privación fue: Q2 = 1,5 (CI: 1,3-1,6); Q3 = 1,9 (CI: 1,7-2,2); Q4 = 2,5 (CI: 2,2-2,8), para los hombres; y Q2 = 1,3 (CI: 1,1-1,5); Q3 = 1,5 (CI: 1,3-1,7); Q4 = 1,6 (CI: 1,3-1,8), para las mujeres.

Conclusiones: El estudio de áreas pequeñas ha permitido identificar secciones censales con sobremortalidad subsidiarias de una intervención especial de salud pública, así como confirmar su asociación con la privación socioeconómica.

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Palabras clave: Cirrosis y hepatopatías crónicas. Mortalidad. Privación social. Desigualdades sociales en salud. Comunidad de Madrid. Análisis por áreas pequeñas.

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Background/objectives

In terms of inequalities in mortality among social classes, mortality due to gastrointestinal diseases (including hepatic cirrhosis) is more relevant in southern than in northern European countries. In Spain, mortality data for the period 1980-1982 indicated that 15.2% of the overall difference in mortality between manual and non-manual workers (males aged 45 to 59 years) was due to gastrointestinal diseases.¹ Some authors have attempted to attribute these differences to higher excessive alcohol consumption in southern European countries.² At the same time, there has been a downward trend in hepatic cirrhosis mortality in southern and western European countries since the end of the 1970s, in tandem with a progressive reduction in alcohol consumption that started as far back as the early 1970s.³

The use of spatial epidemiology has, not only enabled small areas with high mortality to be identified, but has also made it possible for the possible determinants of such mortality, including socio-economic status, to be explored. In Europe, few small-area studies have addressed mortality due to causes that include cirrhosis,⁴ though there have been some interesting precedents in Spain.^{5,6,7} The recent availability of geocoded mortality registry entries, and the advances made in Geographic Identification Systems and Bayesian statistical techniques have enabled new ecological mortality studies to be undertaken in Spain (the *MEDEA* project) targeting smaller areas (such as census tracts), of which this study, centred on the Madrid Region (*Comunidad de Madrid*), is an example.

As in the rest of Spain,^{8,9} recent decades have witnessed a sharp decline in cirrhosis and other chronic liver disease mortality in the Madrid Region, especially among men. Age-adjusted rates fell from 47.2 (per 100,000 population) in 1976 to 15.6 in 2003 among men and from 16.2 to 6.1 among women. Nevertheless, this disease group continues to be an important cause of mortality. In 2003, digestive diseases were the fourth leading cause of death (5.5% of deaths), with cirrhosis and other chronic liver diseases accounting for more than one quarter of such deaths: 70% of cases occurred in males and specific rates increased with age.¹⁰

Accordingly, this study sought to: describe hepatic cirrhosis mortality in small areas of the Madrid Region; identify areas of elevated mortality with respect to a public health intervention; and investigate the association between such mortality and factors of socio-economic deprivation.

Methods

Design and data

The Madrid Region is a politically autonomous territory situated in the centre of Spain, shown by the 2001 census as having a total of 5,423,384 inhabitants distrib-

uted over 179 towns. The Region has an essentially urban nature, with 54.2% of the population living in the city of Madrid (2,938,723 inhabitants) and 40.0% in the surrounding Greater Madrid metropolitan area. This was a cross-sectional ecological study, in which the units of analysis were the 3906 census tracts in the Madrid Region (2001 census). A census tract is a territorial unit, which is established on the basis of operational criteria for the purposes of statistical field work, and is fundamentally defined by population volume criteria and delimited by territorial features, both geographical and urbanistic. Its small size (median population of around 1000) favours the homogeneity of its constituent households.

Individual mortality data for the period 1996-2003 were supplied by the Madrid Regional Statistics Institute (*Instituto de Estadística de la Comunidad de Madrid*). Based on the deceased's domicile, mortality data were subjected to a postal-address geocoding process and then assigned to the pertinent 2001 census tract. Geocoding proved accurate in 95.6%, roughly approximate in 2.7%, and estimated in 1.7% of entries. Deaths in group settings (old age homes, prisons, and psychiatric and geriatric hospitals) were eliminated from the analysis.

The causes of death analysed basically corresponded to the group denominated, "Chronic liver disease and cirrhosis", as per codes 571 and 573.9 of the International Classification of Diseases 9th revision (ICD-9) and, from 1999 onwards, as per codes K70, K73, K74, K760-K762 and K769 of the ICD-10. Census-tract populations, broken down by age group (19 groups) and sex, were drawn from the 2001 census, the year approximately corresponding to the midpoint of the study period. Person-years for the period were estimated by multiplying the above populations by 8.

We used the deprivation index defined in the *MEDEA* Project¹¹ and drawn up on the basis of family-dwelling data in the 2001 population and household census. This index was calculated by principal components analysis, and its components parts were unemployment, temporary workers, manual workers, and low educational level for both the overall population (ages ≥ 16 years), and the adolescent and young adult population (ages 16-29 years). Quartiles of the indicator for the Madrid Region were calculated (with the fourth quartile being the most unfavourable situation).

Analysis

Standardised mortality ratios (SMRs) were calculated as the ratio between observed and expected deaths. Expected cases were computed, taking Spanish hepatic cirrhosis and other liver disease mortality rates for 2001, broken down by age group and sex, as reference.

Smoothed census-tract relative risks (RRs) were calculated using the autoregressive conditional model developed by Besag, York and Mollie.¹² This is a Poisson spatial model with observed cases as the dependent variable, expected cases as offset, and two random

effects terms that take the following into account: a) effects which vary in a structured manner in space (census-tract contiguity); and, b) a component that models the effects which vary among census tracts in an unstructured manner (census-tract heterogeneity).

The model took the following form:

$$O_i \sim Po(E_i \cdot \theta_i)$$

$$\log(\theta_i) = \alpha + \beta_j \cdot x_{ij} + h_i + b_i$$

where: θ_i is the relative risk in area I; O_i is the number of deaths in area I; E_i are the expected cases; α is the intercept; β_j is the coefficient representing the effect ($\log(RR)$) of the explanatory variable J; x_{ij} refers to the value of the explanatory variable J in the area I; h_i is the census-tract heterogeneity term; and b_i is the spatial term. Initially the model included no explanatory variable, and subsequently the deprivation index was included.

The alpha parameter was excluded in the estimation of RRs ($RR_i < -\exp(b_i + h_i)$), so that the risk for each

section was compared to the mean level of risk for the Madrid Region as a whole.

The models were fitted using Bayesian Markov chain Monte Carlo simulation methods. Posterior distributions of RR were obtained using WinBugs 1.1.4,¹³ invoked from R. To this end, three Markov chains were performed, using 300000 iterations, with 10% being discarded as “burn-in” and 1 out of every 90 simulations being retained. The Brooks-Gelman-Rubin Statistic (R-hat) was used to analyse the convergence of the chains, and the effective sample size of the chains (n.eff) to control for autocorrelation. Convergence criteria were: R-hat of under 1.1; and n.eff of over 100.¹⁴

Census tracts with high mortality risk were defined as those having a difference between the number of observed and expected cases equal to or greater than 3, an RR of over 1.25 and a posterior probability of having a relative risk greater than 1 of over 0.9.

To depict smoothed RRs and the distribution of the posterior probability (pp) that $RR > 1$, we used the R

Table I
Chronic liver disease and cirrhosis mortality, according to ICD codes: Madrid Region, 1996-2003

ICD-9 (1996-1998)		ICD-10 (1999-2003)		Total 1996-2003 (ICD-9 + ICD-10)					
ICD-9 Code	Cause of death	ICD-10 Code	Cause of death	Women		Men		Both genders	
				No. deaths	% Total	No. deaths	% Total	No. deaths	% Total
5710-5713	Alcoholic liver disease¹	K700-K704, K709	Alcoholic liver disease	106	5.8	416	12.1	522	9.9
5711	Acute alcoholic hepatitis	K701	Alcoholic hepatitis	18	1.0	34	1.0		
5712	Alcoholic cirrhosis of liver	K703	Alcoholic cirrhosis of liver	45	2.5	211	6.2		
		K704	Alcoholic hepatic failure ²	1	0.1	1	0.0		
5713	Alcoholic liver damage, unspecified	K709	Alcoholic liver disease, unspecified	42	2.3	170	5.0		
5714	Chronic hepatitis	K730-K732; K738-K739	Chronic hepatitis, not elsewhere classified	16	0.9	12	0.4	28	0.5
5715	Cirrhosis of liver without mention of alcohol	K746	Other and unspecified cirrhosis of liver	1081	59.1	2027	59.2	3108	59.2
5716	Biliary cirrhosis	K743-745	Biliary cirrhosis	57	3.1	20	0.6	77	1.5
5716	Biliary cirrhosis	K743	Primary biliary cirrhosis	37	2.0	12	0.4		
		K745	Biliary cirrhosis, unspecified	20	1.1	8	0.2		
5718-5719; 5739	Unspecified chronic liver disease without mention of alcohol + unspecified disorder of liver	K-721; K-760-K762; K769;	Liver disease, unspecified	568	31.1	950	27.7	1518	28.9
5718	Other chronic non-alcoholic liver disease			1	0.1	1	0.0		
5719	Unspecified chronic liver disease without mention of alcohol			330	18.1	330	9.6		
5739	Unspecified disorder of liver	K769	Liver disease, unspecified	353	19.3	619	18.1		
TOTAL				1828	100.0	3425	100.0	5253	100

¹ Includes Alcoholic fatty liver, Acute alcoholic hepatitis, Alcoholic cirrhosis of liver, Alcoholic liver damage, unspecified

² Corresponded to ICD-9 Code 5728 (other sequelae of chronic liver disease). No cases in 1996-1998.

maptools library, along with the Madrid Region census-tract cartography for 2001 obtained from the Regional Statistics Institute.

Results

From 1996 to 2003 there were 5253 deaths due to “cirrhosis and other chronic liver diseases“ in the Madrid Region, 3425 in men (65.2%) and 1828 in women (34.8%). This amounts to an annual mean crude mortality rate of 16.5 deaths per 100,000 men and 8.2 deaths per 100,000 women. Table I shows the distribution of deaths by cause, as defined by ICD code: 59.2% of deaths (in men and women alike) were due to hepatic cirrhosis with no aetiological specification; only in approximately 10% of cases was an association with alcoholism specified. While the proportion of alcoholic hepatopathy among men was double that among women (12.1% vs. 5.8%), the opposite was seen in biliary cirrhosis (0.6% in men vs. 3.1% in women). No significant sex-related differences were

observed for the remaining causes. The proportional distribution of specific causes between the two study periods, corresponding to the two ICD revisions used (ICD-9, 1996-1998; ICD-10, 1999-2003), taking into account the equivalence between the respective codes, displayed no significant differences, except in the case of alcoholic hepatopathies, which rose from 8.2% (184/2248) in 1996-1998 to 11.2% (338/3005) in 1999-2003.

Whereas the risk of dying among men was lower than that for Spain as a whole (with SMRs of 0.87 in the Madrid Region and 0.96 in the city of Madrid), there was excess mortality among women, particularly in the city of Madrid (with SMRs of 1.02 in the Madrid Region and 1.19 in the city of Madrid) (table II). Small-area analysis enabled census tracts with a high risk of mortality to be detected (table III), all of which (except for two in the case of men) were located in the city of Madrid. Although these census tracts were few in number (accounting for less than 1% of the total), attention should nevertheless be drawn to the cluster of tracts with excess risk of mortality in the centre and on the

Table II
Summaries of population, deprivation index and chronic liver disease and cirrhosis mortality in 3906 census tracts of the Madrid Region and in 2358 census tracts of the City of Madrid: 2001 census and mortality, 1996-2003

Madrid Region								
	Total	Mean	Standard deviation	Median	Min	Max	P5-P95	No. (%) with 0 counts
Total population	5423384	1388.5	538.9	1288.5	27	4798	728.0-2429.3	-
Male population	2609746	668.1	276.6	608.5	16	2353	333.0-1210.0	-
Female population	2813638	720.3	266.2	675	11	2445	385.0-1229.0	-
Deprivation index	-	0	1	0.05	-2.09	4.08	-1.62-1.60	-
Chronic liver disease and cirrhosis mortality								
Men								
Observed	3425	0.9	1.0	1.0	0	7	0-3	1768 (45.3)
Expected	3985.5	1.0	0.3	1.0	0	2.4	0.6-1.6	0(0)
SMR	0.86	0.87	1.03	0.00	0.00	9.09	0.00-2.89	1768 (45.3)
Women								
Observed	1828	0.47	0.7	0	0	5	0-2	2531 (64.8)
Expected	1703.1	0.43	0.2	0.4	0	1.1	0.2-0.7	0(0)
SMR	1.07	1.02	1.66	0.00	0.00	14.24	0.00-4.37	2531 (64.8)
Madrid City alone								
Population	2938723	1246.3	415.3	1170.0	526	3322	725.0-1995.5	-
Male population	1372933	582.2	207.4	543.0	208	1675	330.0-973.2	-
Female population	1565790	664.03	212.196	631.00	280	1647	388.0-1063.1	-
Deprivation index	-	-0.1	1	-0.2	-2.09	4.08	-1.61-1.66	-
Chronic liver disease and cirrhosis mortality								
Men								
Observed	2318	1.0	1.1	1.00	0	7	0-3.0	958 (40.6)
Expected	2420.8	1.0	0.3	1.0	0.2	2.1	0.6-1.5	0(0)
SMR	0.96	0.97	1.09	0.84	0.00	0.91	0.00-3.08	958 (40.6)
Women								
Observed	1411	0.6	0.8	0	0	5	0-2	1346 (57.1)
Expected	1168.6	0.5	0.2	0.5	0	1.1	0.3-1.1	0(0)
SMR	1.20	1.19	1.67	0.00	0.00	14.24	0.00-4.49	1346 (57.1)

Table III

Census tracts with highest risk of chronic liver disease and cirrhosis mortality (with a difference between the number of observed and expected cases equal to or greater than 3, an RR of over 1.25, and a posterior probability of over 0.9): Madrid Region, 1996-2003

	<i>N census tracts</i>	<i>% census tracts in Madrid Region</i>	<i>Median</i>	<i>Median</i>	<i>Median</i>	<i>Median</i>	<i>Median</i>	<i>Population in selected census tracts (by gender)</i>
			<i>RR</i>	<i>SMR</i>	<i>Obs</i>	<i>Esp</i>	<i>Deprivation index</i>	
<i>Men</i>								
Highest risk	27*	0.69	1.9	4.3	5	0.97	0.79	16,716
<i>Women</i>								
Highest risk	11**	0.28	1.6	7.2	4	0.55	0.22	7,098

*25 in Madrid city; **All in Madrid city.

eastern, south-eastern and south-western fringes of the city (fig. 1).

The map depicting the distribution of the composite material-deprivation indicator is shown in figure 2 and the summaries of deprivation index components

in table IV. Within the city of Madrid, the most depressed areas were concentrated on the eastern, south-eastern and south-western fringes; outside the city limits, these were concentrated in census tracts lying to the south and east of the metropolitan ring

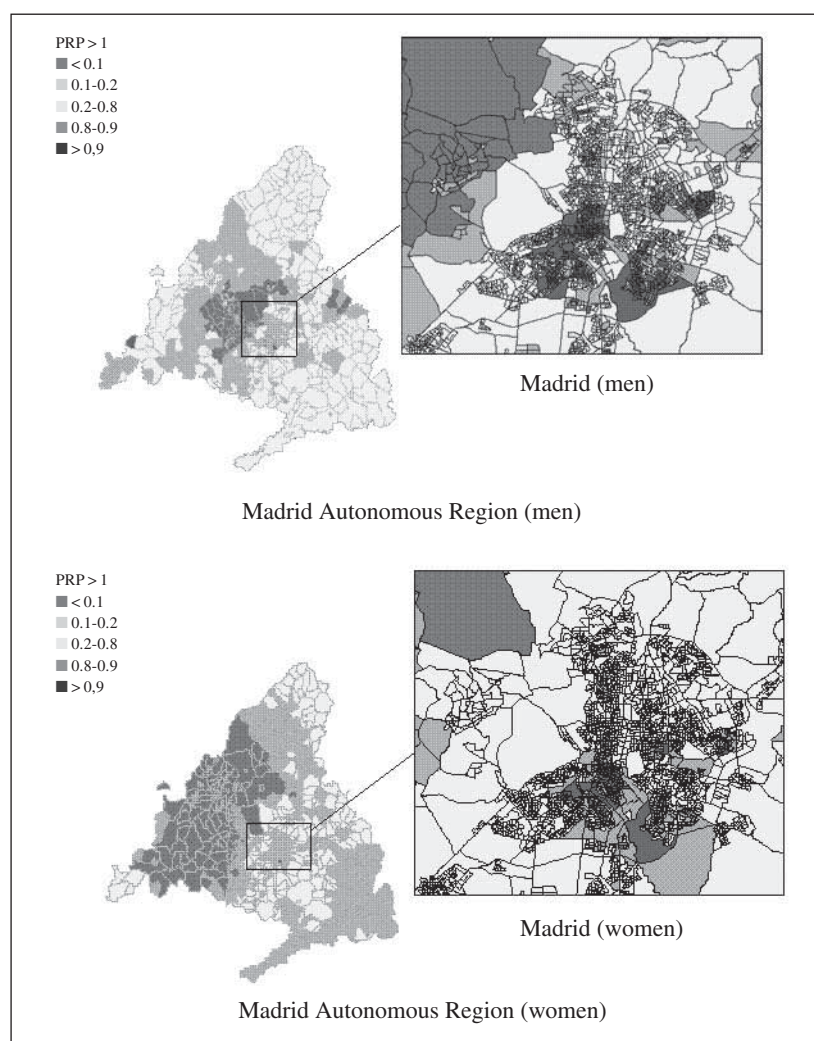


Fig. 1.—Cirrhosis and other chronic liver disease mortality (PRP > 1) by census tract in MEN and WOMEN: Madrid Autonomous Region, 1996-2003.

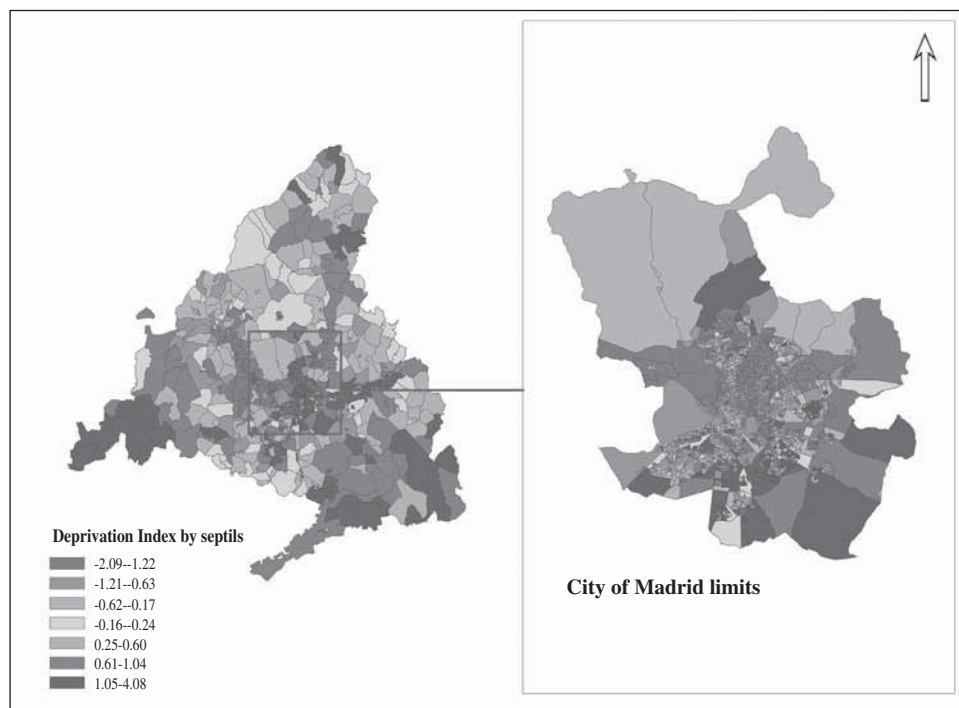


Fig. 2.—Indicator of material deprivation by census tract: Madrid Autonomous Region and Madrid City, 2001.

and in rural towns situated at the three vertices of the triangle formed by the region's boundaries. The most prosperous areas lay in the northern half of the city of Madrid and in outlying towns in the north and north-east of the region. On analysing the association between census-tract mortality and socio-economic status, measured according to the deprivation index, mortality risk was observed to increase with the level of deprivation (measured in quartiles of the index), especially in men. The RRs of mortality (and their credibility intervals, CI) by quartile (taking Q1, least deprivation, as the reference category) were: Q2 = 1.5 (1.3-1.6), Q3 = 1.9 (1.7-2.2) and Q4 = 2.5 (2.2-2.8) for men; and Q2 = 1.3 (1.1-1.5), Q3 = 1.5 (1.3-1.7) and Q4 = 1.6 (1.3-1.8) for women.

Discussion

In the Madrid Region, cirrhosis mortality does not register a uniform distribution by small area: instead, there is a mortality gradient in accordance with the level of socio-economic deprivation. As described in other studies,^{5,7} this relationship is clearer in men than in women. Hepatic cirrhosis and other chronic liver disease mortality is closely associated with social inequalities in health, particularly in men. Excess mortality has been previously associated with unemployment, manual occupations, low educational level, low income, and membership of the socially most disadvantaged ethnic groups.^{15,16,17} A number of ecological small-area studies in the city of Barcelona have encountered significant associations between hepatic cirrhosis and other liver

disease mortality, and socio-economic indicators, such as unemployment⁵, or extreme poverty and/or social unrest (in the case of men).⁶ In a nationwide study, which used "town" as the unit of analysis, a strong association between cirrhosis mortality and two deprivation indices was reported in men.⁷

Socio-economic factors may exert their effect on cirrhosis mortality, not only via mechanisms such as excessive alcohol consumption^{18,19} and hepatotropic virus infection,^{20,21} but also through differences in access to health services (including hepatitis B vaccination, treatment of alcoholism, cirrhosis and its complications, as well as criteria used for liver transplants),²² which may delay disease onset or increase the probability of survival. With regard to other causes of cirrhosis, a substantial number of which (half of all non-alcoholic cirrhoses according to some sources)²³ are assumed to be the result of autoimmune processes, e.g., chronic active hepatitis and primary biliary cirrhosis, consideration must be given to the possible influence of weak social ties²⁴ and psycho-social distress and stressors²⁵ on immune function.

A recent study on inequalities in alcohol-related mortality according to educational level in 16 European populations,²⁶ including that of the Madrid Region, concluded that the socio-economic inequalities in alcohol-related mortality (including mortality due to cirrhosis and other chronic liver diseases) in these populations were great and, in general, greater than those in overall mortality. The differences were more pronounced in males. In the Madrid Region, the Relative Index of Inequality (RII) between the two extremes of the educational hierarchy was higher and

Table IV
Summaries of deprivation index components (*) in Madrid Region census tracts (n = 3.906). 2001 Census

	Minim	Maxim	Range	P5	Median	P95	Mean	SD
<i>Unemployment (%)</i>								
Total	0.00	33.21	33.21	7.93	12.17	18.40	12.53	3.6
Men	0.00	34.35	34.35	5.07	9.62	16.51	10.10	3.61
Women	0.00	40.00	40.00	9.34	15.44	24.45	15.92	4.64
<i>Manual workers (%)</i>								
Total	8.95	93.85	84.90	16.60	49.84	75.20	47.90	18.48
Men	6.87	95.85	88.98	15.42	54.84	80.42	51.58	20.60
Women	8.72	100.00	91.28	17.16	42.92	66.67	42.21	15.44
<i>Temporary workers (%)</i>								
Total	2.13	52.90	50.77	12.10	22.63	33.40	22.51	6.57
Men	0.00	53.57	53.57	9.09	19.15	30.43	19.40	6.59
Women	0.00	66.67	66.67	14.49	27.11	40.32	27.07	8.01
<i>Low educational level in ages ≥ 16 years (%)</i>								
Total	3.07	87.85	84.78	8.09	30.76	52.21	30.42	13.58
Men	1.01	87.95	86.95	5.22	26.91	48.61	26.71	13.57
Women	3.61	87.75	84.13	10.40	34.19	55.81	33.66	13.95
<i>Low educational level in ages 16-29 years (%)</i>								
Total	0.00	89.15	89.15	2.61	9.80	23.68	10.93	6.99
Men	0.00	87.88	87.88	2.50	11.20	27.71	12.49	8.08
Women	0.00	90.48	90.48	1.91	8.18	20.82	9.32	6.50
Deprivation index	-2.09	4.08	6.17	-1.62	0.05	1.60	0	1

* For more information about deprivation index estimation process see: Domínguez-Berjón MF, Borrell C, Cano-Serral G, Esnaola S, Nolasco A, Pasarín MI, Ramis R, Saurina C, Escolar-Pujolar A. Construcción de un índice de privación a partir de datos censales en grandes ciudades. (Proyecto MEDEA). *Gac Sanit* 2008; 22: 179-87. (available in: http://scielo.isciii.es/scielo.php?pid=S0213-91112008000300002&script=sci_arttext)

clearer among males (RII: 2.36; 95% CI: 1.87-2.98) than females (RII: 1.54; 95% CI: 0.99-2.40).

In our study, the gender-related difference in the social gradient of mortality (which, it should be recalled here, is more intense and obvious in men) might perhaps be explained by the different presence of the above-mentioned, eminently socially-determined risk factors (alcoholism, hepatotrop virus infection, etc.) in the two sexes and their respective social strata. Thus, our study data indicate a higher proportion of alcoholic hepatopathies among men than among women. Various population health surveys confirm greater excessive alcohol consumption among men than among women, though this difference is shrinking.²⁷ There is also confirmation of a social gradient of the opposite sign in consumption in the two sexes, albeit with variable results according to the indicator of social stratification used (social class or educational level). Hence, according to a telephone survey of a sample of the adolescent and young adult population (ages 18 to 64 years) in the Madrid Region from 1999 to 2001,²⁸ the proportion of risk drinkers (alcohol consumption higher or equal to 50cc/day in men and higher or equal to 30 cc/day in women) was almost three times more frequent among men than among women, i.e., 6.5% versus 2.2%. In men, moreover, the

likelihood of being a risk drinker rises as educational level declines, with no clear gradient between social classes in evidence. Among women however, there is a lower likelihood of risk consumption, both in the lower educational level categories and in the most disadvantaged social classes (classes IV and V). In addition, the 2005 City of Madrid Health Survey²⁹ reports a higher prevalence of risk consumers among males in the lower (5% in class V, 4% in class IV) versus the better-off classes (3% in classes I, II, III). This social gradient in risk consumption of alcohol is not seen in women. In this same survey, the district with the highest prevalence in both sexes was the "Centro" district, with 8% of risk consumers, something that coincides with the elevated risk of mortality observed by us in several census tracts of this same district. Furthermore, cases of hepatitis B and C reported from 2000 to 2003 display a predominance of men (70%-74% in hepatitis B and 57%-65% in hepatitis C).³⁰ Serovigilance surveys of the regional population indicate a lower prevalence of hepatitis C infection across the sexes as the educational level rises.³¹

The Madrid Region has a system of universal access to health services, so that risk factors associated with health care should not be determinants of mortality. At all events, for the purpose of future studies, data on risk

factors (risk consumption of alcohol, hepatitis C and B incidence, etc.) or health service use should be collected at a more disaggregated level (below that of "district"), so as to facilitate analysis of their relationship with mortality.

The principal biases of this study are those specific to all ecological studies, though in this case, due to our having worked with small areas and to the type of methodology used, ecological bias was minimised. In addition, mention should be made of the fact that socio-economic and demographic factors were obtained from the 2001 census, and mortality data corresponded to the period 1996-2003. Accordingly, any attempt to associate the socio-economic characteristics of the areas studied with their local chronic liver-disease mortality is coherent only if it can be assumed that differences between the areas in terms of these social characteristics remained stable in recent years. Based on our local knowledge of the territory studied, this hypothesis can be safely assumed. In our region, the great social and economic changes linked to a rapid, intensive immigration began in 2000. Yet even since then, the principal contingents of immigrants from low-income countries have settled in the most socially depressed geographical areas, with the result that the differential geographical pattern has not undergone excessive variation.

Conclusions

In the light of the above, we can conclude that there is a cirrhosis mortality gradient in accordance with the level of socio-economic deprivation in the Madrid Region. This relationship is clearer in men than in women. The cluster of tracts with excess risk of mortality was located in the centre and on the eastern, south-eastern and south-western fringes of the city. Small-area analysis has enabled us, both to identify census tracts (27 in men, 11 in women) with excess mortality eligible for a special public health intervention, and to postulate a causal hypothesis to be tested in future studies.

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References

1. Kunst AE, Groenhouf F, Mackenbach JP, Health EW. Occupational class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studies. EU Working Group on Socioeconomic Inequalities in Health. *BMJ* 1998; 316 (7145): 1636-42.
2. Mackenbach JP. Socio-economic inequalities in health in developed countries: the facts and the options. In Detels R, McEwen J, Beaglehole R and Tanaka H (editors): Oxford Textbook of Public Health Vol. 3 1773-1790. Oxford University Press. Fourth Edition. 2002.
3. Corrao G, Ferrari P, Zambon A, Torchio P, Aricò S, Decarli A. Trends of liver cirrhosis mortality in Europe, 1970-1989: age-period-cohort analysis and changing alcohol consumption. *Int J Epidemiol* 1997; 26 (1):100-9.
4. Lorant V. Mortality socio-economic inequalities for small-areas in Belgium: assessing concentration. *Rev Epidemiol Sante Publique*. 2000; 48 (3): 239-47.
5. Pasarín M, Borrell C, Plasència A. Two patterns of social inequalities in mortality in Barcelona, Spain. *Gac Sanit* 1999; 13 (6): 431-40.
6. Pasarín MI, Borrell C, Brugal MT, Díaz-Quijano E. Weighing social and economic determinants related to inequalities in mortality. *J Urban Health* 2004; 81 (3): 349-62.
7. Benach J, Yasui Y, Borrell C, Sáez M, Pasarín MI. Material deprivation and leading causes of death by gender: evidence from a nationwide small area study *J Epidemiol Community Health* 2001; 55: 239-45.
8. Llácer A, Fernández-Cuenca R, Martínez de Aragón MV. Mortalidad en España en 1998. Evolución en la década 1989-1998 (II). Mortalidad general, principales causas de muerte por sexo y edad. *Boletín Epidemiológico semanal* 2001; 9 (24): 249-60.
9. Ribes J, Cléries R, Borràs J, Galceran J, Bosch FX Time trends in incidence and mortality for chronic liver disease and liver cancer in the interval 1980-1997 in Catalonia, Spain. *Eur J Gastroenterol Hepatol* 2004; 16 (9): 865-72.
10. Mortalidad por enfermedades no transmisibles en la Comunidad de Madrid, año 2003. Boletín Epidemiológico de la Comunidad de Madrid, abril, 2006, Vol. 12, pp. 52-54.
11. Domínguez-Berjón MF, Borrell C, Cano-Serral G, Esnaola S, Nolasco A, Pasarín MI, Ramis R, Saurina C, Escolar-Pujolar A. Construcción de un índice de privación a partir de datos censales en grandes ciudades. (Proyecto MEDEA). *Gac Sanit* 2008; 22: 179-87.
12. Besag J, York J, Mollie A. Bayesian Image-Restoration, with Applications in Spatial Statistics. *Annals of the Institute of Statistical Mathematics* 1991; 43: 1-20.
13. Spiegelhalter D, Thomas A, Best N: WinBUGS user manual. Version 1.4.1. Cambridge, MRC; 2003.
14. Smith BJ: Bayesian Output Analysis Program (BOA), Version 1.1.5 for R. 2006 [http://www.public-health.uiowa.edu/boa].
15. Singh GK, Hoyert DL. Social epidemiology of chronic liver disease and cirrhosis mortality in the United States, 1935-1997: trends and differentials by ethnicity, socioeconomic status, and alcohol consumption. *Hum Biol* 2000; 72 (5): 801-20.
16. Balarajan R, Raleigh VS. Patterns of mortality among Bangladeshis in England and Wales. *Ethn Health* 1997; 2 (1-2): 5-12.
17. Haworth EA, Soni Raleigh V, Balarajan R. Cirrhosis and primary liver cancer amongst first generation migrants in England and Wales. *Ethn Health* 1999; 4 (1-2): 93-9.
18. Hemström O. Alcohol-related deaths contribute to socioeconomic differentials in mortality in Sweden. *Eur J Public Health* 2002; 12 (4): 254-62.
19. Makela P, Keskimaki I, Koskinen S. What underlies the high alcohol related mortality of the disadvantaged: high morbidity or poor survival? *J Epidemiol Community Health* 2003; 57 (12): 981-6.

20. Niederau C, Bemba G, Kautz A. Socioeconomic characteristics, quality of life, and state of knowledge of patients with hepatitis C viral infection in Germany—socioeconomic aspects in hepatitis C. *Z Gastroenterol* 2006; 44 (4): 305-17.
21. Niederau C, Fischer C, Kautz A. Socio-economical aspects, quality of life and state of knowledge in hepatitis B patients. Socio-economical aspects in hepatitis B. *Z Gastroenterol* 2007; 45 (5): 355-68.
22. Ratcliffe J, Buxton M, Young T, Longworth L. Determining priority for liver transplantation: a comparison of cost per QALY and discrete choice experiment-generated public preferences. *Appl Health Econ Health Policy* 2005; 4 (4): 249-55.
23. Logan, RFA, Farthing, MJG and Langman, MJS. Gastrointestinal disease: public health aspects. In Detels R, McEwen J, Beaglehole R and Tanaka H (editors): *Oxford Textbook of Public Health Vol. 3* 1773-1790. Oxford University Press. Fourth Edition. 2002.
24. Berkman LF, Glass T. Social integration, social networks, social support, and health. In Berkman L and Kawachi I, (editors): *Social Epidemiology*. Oxford University Press. 2000. pp. 137 to 189.
25. Kubzansky LD, Kawachi I. Affective states and health. In: Berkman L and Kawachi I, (editors): *Social Epidemiology*. Oxford University Press. 2000. pp. 213 to 241.
26. Oyen H van, Demarest S, Borrell C, Deboosere P, Leinsalu M, Roskam AJ et al. Inequalities in alcohol-related mortality by educational level in 16 European populations. Chapter 6. In: *Tackling Health Inequalities in Europe: an Integrated Approach*. Eurothine Final Report. Rotterdam: Department of Public Health, University Medical Centre Rotterdam, 2007.
27. Galán Iñaki, Rodríguez-Artalejo Fernando, Tobías Aurelio, Gandarillas Ana, Zorrilla Belén. Vigilancia de los risk factors de las enfermedades no transmisibles mediante encuesta telefónica: resultados de la Comunidad de Madrid en el período 1995-2003. *Gac Sanit* 2005; 19 (3): 193-205. Available at: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S0213-91112005000300004&lng=es&nrm=iso.
28. Consumo de alcohol y efectos sobre la salud en la población adulta y juvenil de la Comunidad de Madrid, 2003. Boletín Epidemiológico de la Comunidad de Madrid. No. 6. Volumen 9. Junio 2003.
29. Estudio de salud de la ciudad de Madrid. Madrid Salud. Ayuntamiento de Madrid. 2007.
30. Morbilidad por Enfermedades de Declaración Obligatoria, Comunidad de Madrid, año 2003. Boletín Epidemiológico de la Comunidad de Madrid no. 10. Volumen 10. Octubre 2004.
31. Ramírez R, Castañeda R, Barranco D et al. II Encuesta de serovigilancia de la Comunidad de Madrid. Serie de Documentos Técnicos de Salud Pública no. 29. Consejería de Sanidad y Servicios Sociales. Madrid 1995.