ORIGINAL

VARIATION IN MORTALITY INEQUALITIES IN SPANISH REGIONS: A MATTER OF MORTALITY IN PEOPLE WITH LESS EDUCATION

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ABSTRACT

Background. Given the importance of mortality rates in each socioeconomic group, as explanation for the variation in mortality inequalities across populations, the objective of the present study is to evaluate whether regional variation in mortality inequalities in Spain is related to the mortality rates in different socioeconomic groups.

Methods. The study included all persons aged 30-74 years living in Spain in 2001 and followed up for mortality over 7 years. In each of the 17 autonomous communities of Spain mortality rates were estimated for those with low and high education, as well as two measures of mortality inequality according to education: mortality rate difference and mortality rate ratio. Median value of mortality inequalities was calculated for the regions with the highest and lowest mortality rates and for those with intermediate mortality rates. And the Pearson correlation coefficient was used to estimate the relation between mortality rates and the measures of mortality inequality.

Results. The correlation coefficients between mortality rate in low education and mortality rate difference and mortality rate ratio were 0.87 and 0.78 in women and 0.81 and 0.73 in men, respectively. The correlation coefficients between mortality rate in high education and mortality rate difference and mortality rate ratio were -0.07 and -0.24 in women and 0.10 and -0.06 in men, respectively.

Conclusion. Regions with the lowest and highest mortality rates in low education people generally had the lowest and highest inequalities in mortality. The variation in the magnitude of inequalities in mortality from one place to another can be explained by the variation in mortality in low education people. No relation was observed between mortality rate in high education and mortality inequality.

Key words. Health inequalities. Mortality. Educational status. Mortality registries. Socioeconomic factors. Spain

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RESUMEN

Influencia de la mortalidad en personas con bajo nivel educativo en las variación de las desigualdades de mortalidad en las comunidades autónomas

Fundamento. Dada la importancia de las tasas de mortalidad en cada grupo socioeconómico, como explicación de la variación en las desigualdades de mortalidad entre las poblaciones, el objetivo del presente estudio es evaluar si la variación regional en las desigualdades de mortalidad en España está relacionado con las tasas de mortalidad en diferentes grupos socioeconómicos.

Métodos. El estudio incluyó a todas las personas de 30-74 años que vivían en España en 2001 y a las que se realizó un seguimiento para conocer su estado vital más de 7 años. En cada una de las 17 comunidades autónomas se han estimado las tasas de mortalidad en personas con bajo y con alto nivel educativo, así como dos medidas de desigualdad de la mortalidad de acuerdo a la educación: diferencia de tasas de mortalidad y razón de tasas de mortalidad. Se calculó el valor de la mediana de las desigualdades de mortalidad en las comunidades autónomas con las tasas de mortalidad más altas y bajas y en aquellas con las tasas de mortalidad intermedias. Y se estimó el coeficiente de correlación de Pearson para evaluar la relación entre las tasas de mortalidad y las medidas de desigualdad en mortalidad.

Resultados. Los coeficientes de correlación de la tasa de mortalidad en personas con bajo nivel educativo con la diferencia de tasa de mortalidad y con la razón de tasas de mortalidad fueron 0,87 y 0,78 en mujeres y 0,81 y 0,73 en los hombres, respectivamente. Los coeficientes de correlación de la tasa de mortalidad en personas con alto nivel educativo con la diferencia de tasa de mortalidad y con la razón de tasas de mortalidad fueron -0,07 y -0,24 en mujeres y 0,10 y -0,06 en los hombres, respectivamente.

Conclusión. Las comunidades autónomas con las tasas de mortalidad más bajas y más altas en las personas con bajo nivel educativo generalmente tienen las menores y las mayores desigualdades en mortalidad. La variación en la magnitud de las desigualdades en mortalidad de un lugar a otro puede ser explicada por la variación en la tasa de la mortalidad en las personas con bajo nivel educativo.No se observó relación entre la tasa de mortalidad en personas con alto nivel educativo y las desigualdades de la mortalidad.

Palabras clave. Mortalidad. Nivel de educación. Desigualdades en salud. España.Registros de mortalidad.

INTRODUCCIÓN

One of the most important findings of international comparative studies on inequalities in mortality is the variation in the magnitude of one place to another[1-3]. Among the suggested theories to explain this variation is the theory of 'mathematical artefact'[4-5]. According this theory, increasing relative inequalities in health outcomes are inevitable when the over-all level of the outcome falls[6-8]. In general, the rarer the health problem, the greater is the relative inequality and the smaller in the absolute inequality in the occurrence of this problem[9-10].

It has been observed an association between the average frequency of health problems in a population and the level of the relative risk for socioeconomic status: relative risks for mortality and morbidity tend to be higher when average mortality and morbidity are lower[11]. And one study found that countries with the lowest mortality rates in children under 5 years had the highest relative inequalities and the lowest absolute inequalities in mortality[12]. Likewise, declines in total mortality among adults in various European populations between the 1980s and 1990s were accompanied by increasing relative inequalities in mortality[13].

Nevertheless, Mackenbach has pointed out that larger health inequalities are not a mathematical necessity when population health improves[5]. Furthermore, absolute inequalities in mortality have also increased in several countries despite the decrease mortality in the population[13-15], and the pattern of between-country variation in absolute inequalities in mortality is largely similar to that of relative inequalities in mortality[3], so that it is difficult to see how the 'mathematical artifact' could explain the variation in the magnitude of mortality inequalities. Perhaps the theory of ´mathematical artefact´ has to be reformulated on the basis of new evidence about inequalities in mortality. For example, a study comparing several European populations has shown much higher lifespan variation across countries among lower than among higher educated groups[16]. This finding suggests that, before trying to compare mortality inequalities across different populations, it is necessary to compare mortality rates by socioeconomic group.

Given that possible importance of mortality rates in each socioeconomic group, as explanation for the variation in mortality inequalities across populations, the objective of the present study is to estimate the magnitude of mortality inequalities in the 17 regions of Spain and to evaluate whether regional variations in mortality inequalities are related to the mortality rates in different socioeconomic groups.

MATERIAL AND METHODS

The source for the data was the cohort of the entire Spanish population at the time of the 2001 census and followed up for mortality over 7 years and 2 months. The data were compiled by the National Institute of Statistics and based on individual census records linked to the national population register and the national mortality register using personal identifiers. Deaths refer to persons who died between 1 November 2001 –the date of the census – and 31 December 2008 – the end of the follow-up period. The National Institute of Statistics provided the investigators with the final data file after eliminating information referring to personal characteristics to guarantee protection of confidentiality. The 2001 population census was made up of 40,844,371 persons, but 1.7% of these were excluded from the follow-up cohort due to lack of information in either the population register or the death register. The contribution to the risk of death of 395,675 persons was censored during follow-up because they moved out of Spain and no information could be obtained on their vital status (alive or deceased) after they left the country.

This study included subjects whose age range is similar to that used in several international comparative studies – persons who were between 30 and 74 years of age on the date of the census. In total, we included 157 million person-years and 1,052,532 deaths. Besides age, other variables collected in the census and used in this study were sex, region of residence and educational level. Educational level refers to the highest academic degree completed by the subject. All analyses were made separately for men and women.

Age-adjusted mortality rates were first estimated for those with low and high education, using the European standard population. The low- education group comprised persons up to low secondary level, and the high-education group included those with upper secondary level or higher education. We then calculated a measure of absolute inequalities -the mortality rate difference- and a measure of relative inequalities -the mortality rate ratio- between the low- and high-education groups and their 95% confidence intervals by stratified analysis[17].

The regions were ordered by their mortality rate in low and high education, and the median value of mortality inequalities was calculated for the five regions with the highest and lowest mortality rates and for the remaining seven regions with intermediate mortality rates. We also calculated the relation of mortality rates with mortality rate difference and with mortality rate ratio, using Pearson´s correlation coefficient.

RESULTS

Table 1 presents the number of person-years of follow-up, the number of deaths and the age-standardised mortality by region.

Table 2 show the mortality rate differences and the mortality rate ratios by region ranked according to the age-standardized mortality rate in low education group. The five regions with the lowest and highest mortality rates had, respectively, the lowest and highest median value for mortality rate difference and mortality rate ratios.

Table 1
Person-years, number of deaths and age-standardised mortality rate per 100,000 person-years in each Spanish region. Men and women aged 30 to 74 years at start of follow-up. Spain, 2001-2008

Region	Women			Men		
	Person-years of Follow-up	Deaths	Mortality rate	Person-years of Follow-up	Deaths	Mortality rate
Andalusia	13,863,109	69,345	454.7	13,103,739	127,369	1003.4
Aragon	2,415,043	11,196	368.3	2,366,192	21,719	826.3
Asturias	2,274,825	11,002	383.7	2,081,207	22,529	980.2
Balearic Islands	1,616,381	6,767	402.2	1,584,469	13,140	898.1
Basque Country	4,379,206	18,127	361.7	4,156,111	38,771	906.6
Canary Islands	3,205,650	14,282	455.9	3,130,150	26,419	968.5
Cantabria	3,411,238	15,635	354.9	1,051,454	9,621	887.7
Castille & Leon	4,909,814	21,892	348.1	4,842,471	43,915	801.5
Castille-Mancha	3,411,238	15,635	367.4	3,379,450	29,009	788.7
Catalonia	12,708,676	55,398	380.5	12,041,791	106,089	871.2
Extremadura	1,974,316	10,244	412.4	1,939,662	20,002	954.9
Galicia	5,565,862	26,420	379.5	5,103,688	51,479	907.6
Madrid	10,872,954	40,452	352.0	9,749,964	74,436	810.2
Murcia	2,199,845	10,097	417.3	2,114,634	18,357	903.0
Navarra	1,095,341	4,166	333.7	1,093,702	8,646	779.8
Rioja	545,269	2,137	329.9	547,148	4,666	803.0
Valencia	8,257,892	38,964	416.2	7,845,031	72,227	916.9

Table 2
Rate difference and rate ratio in Spanish Regions ranked according to the age standardized mortality rate in low education group in women and men. Sapin. 2001-2008

Women				Men			
Region	Mortality rate[1]	Rate difference IC 95%[2]	Rate ratio IC 95%	Region	Mortality rate[1]	Rate difference IC 95%[2]	Rate ratio IC 95%
La Rioja	337	11 (-38—60)	1.03 (0.89—1.20)	Castille-La Mancha	812	98 (67—129)	1.14 (1.09—1.19)
Navarra	346	55 (25—85)	1.19 (1.08—1.31)	La Rioja	831	55 (-10—121)	1.07 (0.99—1.16)
Castille & León	361	51 (36—66)	1.16 (1.11—1.22)	Basque Country	831	220 (199—240)	1.28 (1.25—1.32)
Madrid	365	46 (37—54)	1.14 (1.11—1.17)	Navarra	837	179 (138—220)	1.27 (1.20—1.35)
Cantabria	367	25 (-8—59)	1.07 (0.97—1.18)	Castilla & León	849	167 (147—187)	1.25 (1.21—1.28)
Median value		**46 (37—54)**		**Median value**		**167 (147—187)**	**1.25 (1,21—1.28)**
Castille- La Mancha	376	102 (79—126)	1.37 (1.26—1.49)	Aragon	872	136 (106—165)	1.18 (1.14—1.23)
Basque Country	378	51 (35—68)	1.16 (1.10—1.22)	Madrid	898	218 (205—230)	1.32 (1.30—1.34)
Aragon	380	56 (33—78)	1.17 (1.09—1.26)	Catalonia	939	230 (218—243)	1.32 (1.30—1.35)
Galicia	390	67 (51—83)	1.21 (1.15—1.27)	Murcia	954	231 (196—265)	1.32 (1.26—1.38)
Catalonia	396	76 (67—85)	1.24 (1.20—1.27)	Balearic Islands	960	257 (222—292)	1.37 (1.30—1.43)
Asturias	398	65 (42—87)	1.19 (1.12—1.28)	Galicia	964	229 (208—250)	1.31 (1.28—1.35)
Balearic Islands	417	100 (73—127)	1.31 (1.21—1.43)	Valencia	967	217 (200—234)	1.36 (1.33—1.38)
Median value		**67 (51—83)**	**1.21 (1.15—1.27)**	**Median value**		**229 (208—250)**	**1.32 (1.30—1.35)**
Extremadura	423	126 (51—83)	1.43 (1.29—1.58)	Cantabria	968	268 (226—310)	1.38 (1.31—1.46)
Murcia	428	91(61—120)	1.27 (1.16—1.38)	Extremadura	992	210 (168—251)	1.27 (1.20—1.34)
Com. Valenciana	431	108(95—120)	1.33 (1.28—1.38)	Canary Islands	1,034	283 (255—311)	1.38 (1.33—1.43)
Andalucía	467	119(108—130)	1.34 (1.30—1.39)	Asturias	1,059	271 (240—301)	1.34 (1.30—1.39)
Canarias	473	133(112—155)	1.39 (1.31—1.48)	Andalusia	1,063	279 (265—293)	1.36 (1.33—1.38)
Median value		**119 (108—130)**	**1.34 (1.30—1.39)**	**Median value**		**271 (240—301)**	**1.36 (1.33—1.38)**

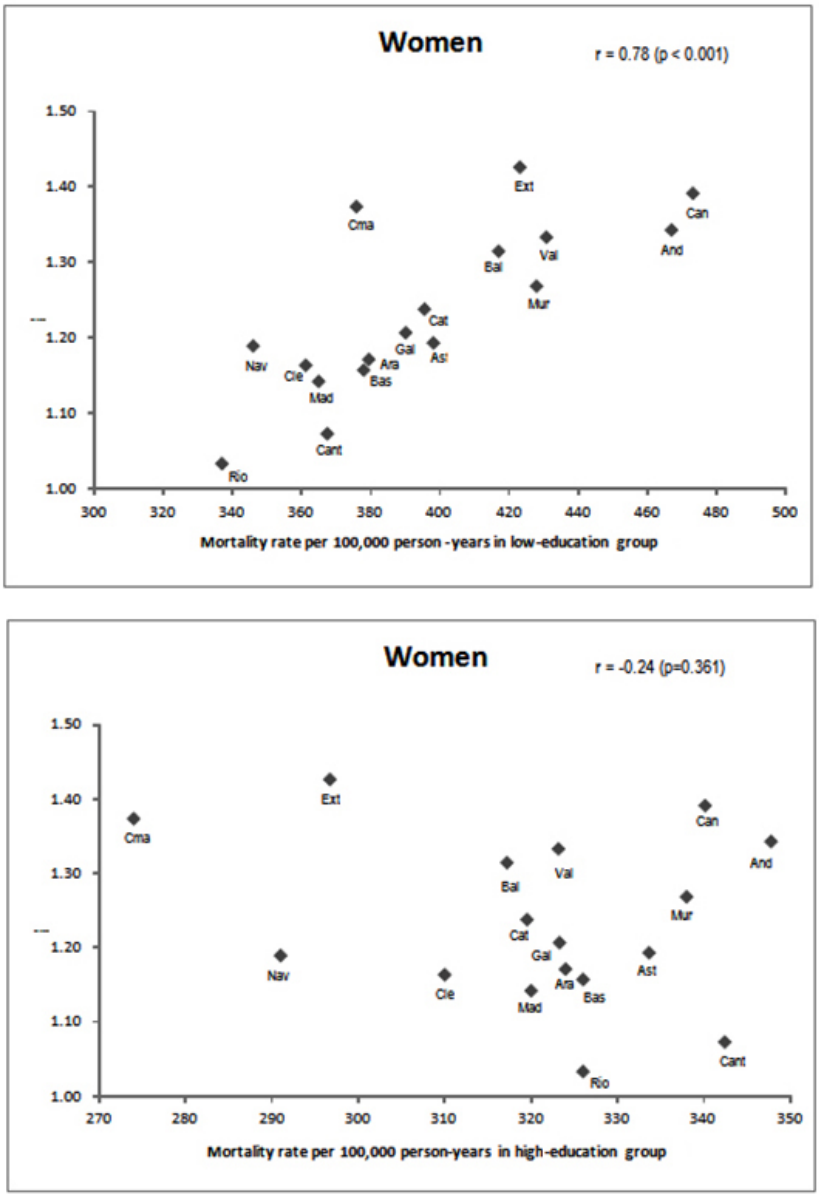
[1]Mortality rate by 100.000 persons-years. [2]Mortality rate in low-educational group minus mortality rate in high-educational group expressed as deaths per 100.000 person-year at risk.

Table 3
Rate difference and rate ratio in Spanish Regions ranked according to the age standardized mortality rate in high education group in women and men. Sapin, 2001-2008

Women				Men			
Region	Mortality rate[1]	Rate difference IC 95%[2]	Rate ratio IC 95%	Region	Mortality rate[1]	Rate difference IC 95%[2]	Rate ratio IC 95%
Castille-La Mancha	274	102 (79—126)	1.37 (1.26—1.49)	Navarra	658	179 (138—220)	1.27 (1.20—1.35)
Navarra	291	55 (25—85)	1.19 (1.08—1.31)	Madrid	681	218 (205—230)	1.32 (1.30—1.34)
Extremadura	297	126 (96—157)	1.43 (1.29—1.58)	Castilla & León	682	167 (147—187)	1.25 (1.21—1.28)
Castilla & León	310	51 (36—66)	1.16 (1.11—1.22)	Cantabria	700	268 (226—310)	1.38 (1.31—1.46)
Balearic Islands	317	100 (3—127)	1.31 (1.21—1.43)	Balearic Islands	702	257 (222—292)	1.37 (1.30—1.43)
Median value		**100 (73—127)**	**1.31 (1.21—1.43)**	**Median value**		**218 (205—230)**	**1.32 (1.30—1.34)**
Cataluña	320	76 (67—85)	1.24 (1.20—1.27)	Cataluña	709	230 (218—243)	1.32 (1.30—1.35)
Madrid	320	46 (37—54)	1.14 (1.11—1.17)	Castille-La Mancha	714	98 (67—129)	1.14 (1.09—1.19)
Valencia	323	108 (95—120)	1.33 (1.28—1.38)	Murcia	723	231 (196—265)	1.32 (1.26—1.38)
Galicia	323	67 (51—83)	1.21 (1.15—1.27)	Galicia	735	229 (208—250)	1.31 (1.28—1.35)
Aragon	324	56 (33—78)	1.17 (1.09—1.26)	Aragón	736	136 (106—165)	1.18 (1.14—1.23)
La Rioja	326	11 (-38—60)	1.03 (0.89—1.20)	Valencia	750	217 (200—234)	1.36 (1.33—1.38)
Basque Country	326	51 (35—68)	1.16 (1.10—1.22)	Canary Islands	751	283 (255—311)	1.38 (1.33—1.43)
Median value		**56 (33—78)**	**1.17 (1.09—1.26)**	**Median value**		**229 (208—250)**	**1.32 (1.26—1.38)**
Asturias	334	65 (42—87)	1.19 (1.12—1.28)	Basque Country	772	220 (199—240)	1.28 (1.25—1.32)
Murcia	338	91 (61—120)	1.27 (1.16—1.38)	La Rioja	776	55 (-10—121)	1.07 (0.99—1.16)
Canarias	340	133 (112—155)	1.39 (1.31—1.48)	Extremadura	782	210 (168—251)	1.27 (1.20—1.34)
Cantabria	342	25 (-8—59)	1.07 (0.97—1.18)	Asturias	784	279 (265—293)	1.36 (1.33—1.38)
Andalusia	348	119 (108—130)	1.34 (1.30—1.39)	Andalusia	789	271 (240—301)	1.34 (1.30—1.39)
Median value		**91 (61—120)**	**1.27 (1.16—1.38)**	**Median value**		**220 (199—240)**	**1.28 (1.25—1.32)**

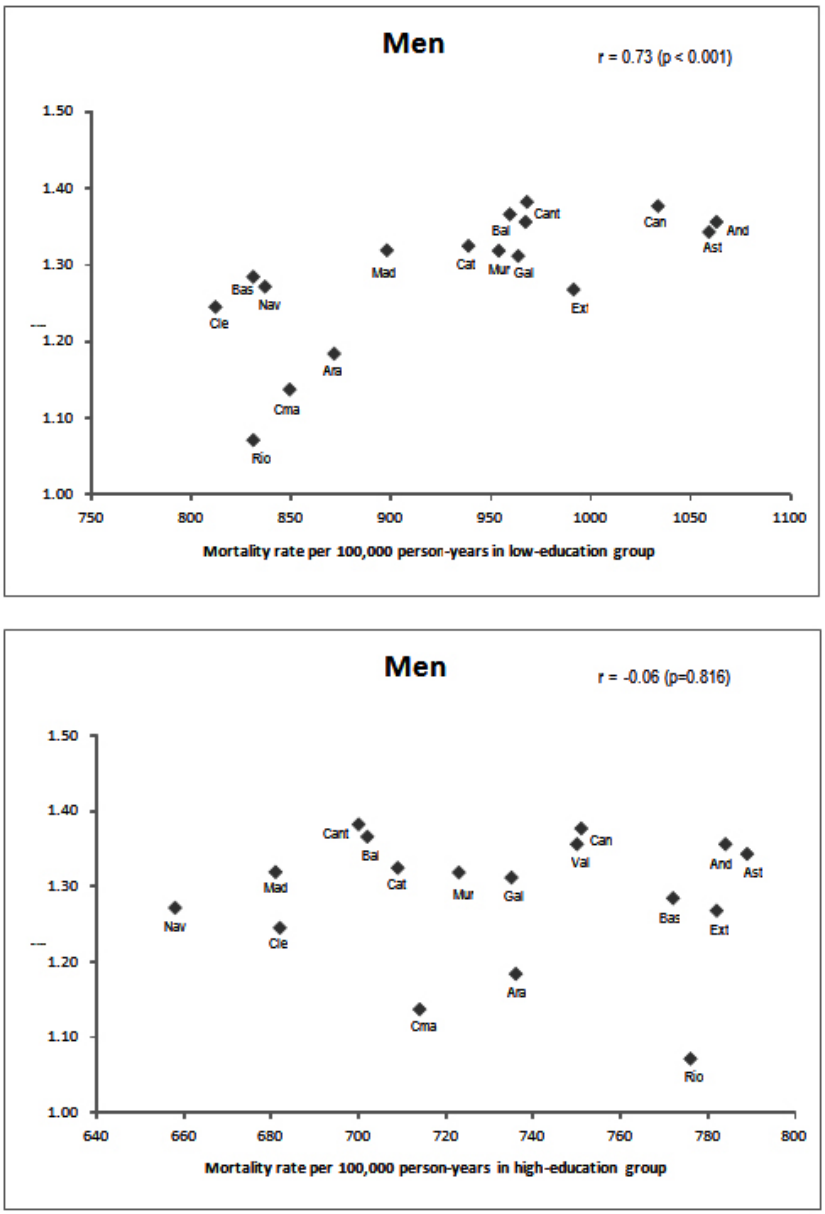
[1]Mortality rate by 100,000 persons-years. [2]Mortality rate in low-educational group minus mortality rate in high-educational group expressed as deaths per 100,000 person-year at risk.

Figure 1
Pearson correlation coefficients of mortality rate in low education and high education groups with mortality rate ratio in women



The Regions are Andalusia (And), Aragon (Ara), Asturias (Ast), Balearic Islands (Bal), Basque Country (BC), Canary Islands(Can), Cantabria (Cant), Castilla & León (Cle), Castille-La Mancha (Cma), Catalonia (Cat), Extremadura (Ext), Galicia (Gal), Madrid (Mad), Murcia (Mur), Navarra (Nav), La Rioja (Rio) y Valencia (Val).

Figure 2
Pearson correlation coefficients of mortality rate in low education and high education groups with mortality rate ratio in men



The Regions are Andalusia (And), Aragon (Ara), Asturias (Ast), Balearic Islands (Bal), Basque Country (BC), Canary Islands(Can), Cantabria (Cant), Castilla & León (Cle), Castille-La Mancha (Cma), Catalonia (Cat), Extremadura (Ext), Galicia (Gal), Madrid (Mad), Murcia (Mur), Navarra (Nav), La Rioja (Rio) y Valencia (Val).

In the case of women, in the regions with lowest mortality, the mortality rate difference varied between 11 and 55 per 100,000 person-years, and the mortality rate ratio between 1.03 and 1.19. In the regions with highest mortality, the mortality rate difference varied between 91 and 133 per 100,000 person-years, and the mortality rate ratio between 1.27 and 1.43.

In the case of men, in the regions with the lowest mortality, the mortality rate difference varied between 98 and 218 per 100,000 person-years, and the mortality rate ratio between 1.07 and 1.32. In the regions with the highest mortality, the mortality rate difference varied between 210 and 283 per 100,000 person-years, and the mortality rate ratio between 1.27 and 1.38.

Table 3 show the mortality rate differences and the mortality rate ratios by region ranked according to the age-standardized mortality rate in high education group. It was no observed a clear pattern in the median values for mortality rate difference and mortality rate ratios according the magnitude of mortality rate. The five regions with the lowest mortality rate in women, and the seven regions with the intermediate mortality rates in men, had the highest median value for mortality rate difference. The seven regions with the intermediate mortality rate in women, and the five regions with the highest mortality rates in men, had the lowest median value for mortality rate ratio.

In the case of women, in the regions with lowest mortality, the mortality rate difference varied between 51 and 126 per 100,000 person-years, and the mortality rate ratio between 1.16 and 1.43. In the regions with highest mortality, the mortality rate difference varied between 25 and 133 per 100,000 person-years, and the mortality rate ratio between 1.07 and 1.39.

In the case of men, in the regions with the lowest mortality, the mortality rate difference varied between 167 and 268 per 100,000 person-years, and the mortality rate ratio between 1.25 and 1.38. In the regions with the highest mortality, the mortality rate difference varied between 55 and 279 per 100,000 person-years, and the mortality rate ratio between 1.07 and 1.36.

The correlation coefficients of mortality rate in low education group with mortality rate difference was 0.87 ($p<0.001$) in women and 0.81 ($p< 0.001$) in men, whereas the coefficients of mortality rate in high education group with mortality rate difference was -0.07 ($p=775$) in women and 0.10 ($p=0.708$) in men. And similar findings were observed with the mortality rate ratios, as it is shown in figures 1 and 2: significance correlation coefficient of mortality rate ratio with mortality rate in low education group, but not with mortality rate in high education group.

DISCUSSION

Our findings show that the magnitude of mortality inequalities by education in the regions of Spain is related with the mortality rate in persons with low education. In general, the higher the mortality rate, the higher relative and absolute inequalities in mortality.

Similar results can be obtained if we analyze the findings of comparative studies of inequalities in mortality in several European populations[18]. For example, if we estimate the correlation coefficients between mortality rates and inequalities in mortality in a study that compared 16 populations, in women the coefficients between the mortality rate in low education group and absolute and relative inequalities are 0.89 and 0.79, respectively, while the coefficients between the mortality rate in high education group and absolute and relative inequalities are 0.53 and 0.35, respectively. And similar results can be obtained in men.

The greatest variation from one place to another in the mortality rate in people with low education level, with respect the variation in the mortality rate in people with high education level, is responsible for these findings. In the present study, the coefficient of variation in the mortality rate in people with low educational level is 9.9% in women and 8.4% in men, while the coefficient of variation in the mortality rate in people with high level of education is 6.0% in women and 5.5% in men. Likewise, an another study comparing mortality by educational level in 10 European countries also found more variation across countries in lifespan in groups with less as opposed to those with more education[16]. And, as in the present study, countries where people with low education had lower mortality showed lower socioeconomic inequality in lifespan.

Some authors have noted that comparison of the magnitude of mortality inequalities across countries, especially by mortality rate ratios, does not permit us to obtain reasonably valid conclusions about the possible impact of welfare policies[6,19-20]. According these authors, the Nordic countries, with a long tradition in such policies, have lower absolute inequalities in mortality but higher relative inequalities in mortality, as compared with other European populations. So, for them what is most important is the cross-national variation in mortality rates in low socioeconomic groups, and not the magnitude of mortality inequalities per se, since the level of mortality in less-privileged groups is likely to be related to how well the welfare policy is able to buffer and compensate for inequalities generated in the market. However, estimates of mortality rates in comparative international do not support this explanation. Except for Sweden, the mortality rate in low socioeconomic groups was higher in Finland, Denmark and Norway than in other European populations[21]. The regional variation in mortality inequalities found in our study also fails to support this theory, since the study subjects were exposed throughout their lives to the same social policies established by the central government. Although implementation of some social policies was gradually transferred to the regions during the last decades of the 20th century, it is unlikely that the regional variation found in our results could be attributed to regional variation in the management of health or education services since that time.

Although the findings do not support welfare policies to explain variation the magnitude of inequalities in mortality, the similarity of the pattern of inequalities in mortality, when comparing the Spanish regions and when comparing different European populations, suggests that some regional and country-specific circumstances are responsible for the low or high mortality in people with low education. Today these unusual circumstances are unknown. Meanwhile, mortality in higher educated would be less dependent on regional and country-specific circumstances. Probably people with more education are better able to access a wide variety of material and non-material resources that allow them to optimise their health and, to some degree, extend their lives to reach the uppermost age limits.

In the interpretation of our findings is necessary to consider that the data used in this study come from a large national prospective study including all persons living in Spain in 2001. This has allowed for the first time comparing mortality inequalities in seventeen populations using the same source of data. Use of education has made it possible to compare our results with the results of international studies in European populations, as this is the indicator of socioeconomic position indicator most used. The education as an indicator of socioeconomic position has several advanta-

ges. For example, unlike occupational class, education allows classification of individuals who do not work. Furthermore, level of education is acquired early in life, which makes it unlikely that low socioeconomic position is the result of poor health.

Several authors have commented on the difficulty of interpreting temporal and geographic variations in mortality inequalities[8-10] due to a mathematical artefact: the lower the underlying rate, the larger the relative inequality and the smaller the absolute inequality in mortality. However, our findings show that if we take into account the mortality rate in the low socioeconomic group, the pattern of relative and absolute inequalities in mortality shows the same relation with that mortality rate.

In summary, our findings show that the variation in the magnitude of inequalities in mortality, from one place to another, can be explained by the greatest variation in mortality in subjects with low socioeconomic position, with respect the variation in mortality rate in subjects with high socioeconomic position, and suggest the need to reformulate the theory of ´mathematical artefact´ as explanation of that variation in the inequalities in mortality.

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