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ORIGINAL ARTICLE

Rural–urban disparities in the reduction of avoidable mortality and mortality from all other causes of death in Spain, 2003–2019

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Abstract

Aim This study aims to evaluate the trend of avoidable mortality and of mortality from all other causes of death in urban and rural areas in Spain, throughout the first 2 decades of the twenty-first century.

Methods Data deaths and population by age and sex, according to the area of residence, were obtained from the National Institute of Statistics. Avoidable mortality refers to premature deaths (≤ 75 years old) for which there is reasonable scientific consensus that they should not occur in the presence of timely health care. In large urban, small urban, and rural areas, annual age-standardized mortality rates from avoidable causes and from all other causes of death were calculated from 2003 to 2019. The annual percentage change (APC) in the mortality rate in each area was estimated using linear regression models and taking age-standardized mortality rates as dependent variable.

Results Mortality rates decreased between the beginning and the end of the period analysed. Large urban areas and rural areas showed the largest and smallest reduction in mortality rate respectively. The APC in avoidable mortality was −3.5% in men and −3.0% in women in large urban areas, and −2.7% in men and −2.6% in women in rural areas. The APC in the mortality rate from all other causes of death was −2.4% in men and −1.2% in women in large urban areas, and −1.4% in men and −1.0% in women in rural areas.

Conclusion In Spain, avoidable mortality and mortality from other causes of death in rural and urban areas show similar trends, which suggests the presence of a common factor responsible for such findings.

Keywords Mortality · Avoidable mortality · Rural areas · Urban areas · Spain

Introduction

Various characteristics of the residence area show relationship with mortality. The degree of urbanization is one of these characteristics. In rich countries, the difference between mortality of populations residing in rural and urban areas has varied over time (Rioja et al. 2001; Ostry 2010). Until the end of the nineteenth and the beginning of the twentieth centuries, mortality in rural areas was lower than in urban areas. However, since then this difference has been narrowing due to a lower magnitude decrease in mortality in rural areas than in urban areas (Cosby et al. 2008; Pong et al. 2009; Cossman et al. 2010; James 2014).

Several factors have been proposed as possible explanation for this different trend in the population mortality according to residence area. One of these factors is a lower accessibility of the inhabitants of rural areas to the health system (Gamble et al. 2011; Johnston et al. 2019; Manemann

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et al. 2021; Carriere et al. 2018; Murchie et al. 2021). As a consequence, residents in those areas would have benefited to a lesser extent from specialized medical treatments and timely surgical interventions than residents in urban areas. Some findings suggest that this phenomenon could have happened both in the US, where there is no universal health coverage, and in other countries where such coverage does exist.

Some research in countries with universal health coverage has tested this hypothesis by studying avoidable mortality, that is, premature deaths that should not occur in the presence of timely health care (Nolte and McKee 2004, 2011). This is the case of a study carried out in Canada, where a higher avoidable mortality was observed in rural areas than in other areas during the period 2011–2015 (Subedi et al. 2019). The authors concluded that less accessibility to health services could have been responsible for the finding. There was also a study conducted in Korea, in which a smaller reduction in avoidable mortality was observed between 1995 and 2019 in rural areas than in urban areas (Choi et al. 2022). The authors attributed this finding to a lower availability of health resources in rural areas. Something similar could have happened in Spain, another country with universal health coverage, since number of physicians per inhabitant is higher in more densely populated areas (Instituto Nacional de Estadística 2022a).

The authors of the two previous studies in Canada and Korea did not analyse mortality from all other causes of death. The temporal and geographic pattern in avoidable mortality could be similar to the temporal and geographic pattern in mortality from all other causes of death. In such a case, the different accessibility to health services, as an explanation of the observed findings found, would be inadequate. The present study, carried out in Spain, aims to identify a possible lower accessibility to the health system in rural areas than in urban areas, by estimating the magnitude and trend of avoidable mortality and of mortality from all other causes of death in both rural and urban areas, throughout the first 2 decades of the 21st century.

Methods

Data source

The population and the number of deaths by age and sex, according to the population size of the municipality of residence, were obtained from the National Institute of Statistics. The population data correspond to January 1 of each year and come from the population register (Municipal Register of Inhabitants), while death data come from the death register according to cause of death. The first year with available information from the population registry is 2003. The last year with available information on deaths by cause of death is 2020. However, in 2020, the COVID-19 pandemic altered the geographic pattern of general mortality and mortality from cause of death. The inclusion of the year 2020 in this study would offer a distorted image of the difference in mortality between rural and urban areas, compared to previous years. For this reason, the period of analysis relates to the years 2003 to 2019.

Variables

The concept of rurality varies between researchers or even between planners and people who have to make decisions. Various criteria have been proposed: population size, population density, distance to an urban area, spatial contiguity, economic activity, proportion of residents who commute to work in an urban centre. However, the availability of routine information of these characteristics is scarce, in addition to the conceptual ambiguity of some criteria and the different meaning of others from one country to another. Therefore, most authors use the population size criterion. It is a definition that can be easily operationalized and, in addition, allows the comparison of research results carried out in different countries. Many investigations consider that rural populations have less than 10,000 inhabitants (Martinez et al. 2004; Gartner et al. 2008). For this reason, in this study, the size of the municipality of residence has been grouped into three categories: fewer than 10,000 inhabitants (rural areas), between 10,000 and 100,000 inhabitants (small urban areas) and more than 100,000 inhabitants (large urban areas). Provincial capitals with fewer than 100,000 inhabitants have also been included in this last category.

The underlying cause of death was coded by the National Institute of Statistics according to the International Classification of Diseases 10th revision. Deaths from avoidable causes and deaths from all other causes of death, as negative control of avoidable causes, have been analysed. The Nolte and McKee list of avoidable causes has been used (Nolte and McKee 2004, 2011). It is the list of avoidable causes most used in scientific practice (Box). It provides a set of conditions for which there is reasonable consensus that health care has an important effect. It has been used in previous research carried out in Spain (Nolasco et al. 2018, Herrero-Huertas et al. 2022). Only deaths in people under 75 years of age were included. For this reason, in deaths from all other causes of death, only those that have occurred in subjects under that age have been included.

Box: Causes of death considered amenable to medical care with International Classification of Diseases 10th revision (ICD-10) codes for each cause

Cause of death	ICD-10
Intestinal infections [1]	A00-A09
Tuberculosis	A15-A19, B90
Diphtheria, tetanus, poliomyelitis	A35-A36, A80
Whooping cough[1]	A37
Septicaemia	A40-A41
Measles[1]	B05
Malignant neoplasm of colon and rectum	C18-C21
Malignant neoplasm of skin	C44
Malignant neoplasm of the female breast	C50
Malignant neoplasm of cervix uteri	C53
Malignant neoplasm of the body of the uterus, part unspecified[1]	C54-C55
Malignant neoplasm of testis	C62
Hodgkin's disease	C81
Leukaemia[2]	C91-C95
Diseases of the thyroid	E00-E07
Diabetes[3]	E10-E14
Epilepsy	G40-G41
Chronic rheumatic heart disease	I05-I09
Hypertensive disease	I10-I13, I15
Ischaemic heart disease[4]	I20-I25
Cerebrovascular disease	I60-I64
Influenza and pneumonia	J10-J18
Peptic ulcer	K25-K27
Appendicitis	K35-K38
Abdominal hernia	K40-K46
Cholelithiasis and cholecystitis	K80-K81
Nephritis and nephrosis	N00-N07, N17-N19, N25-N27
Benign prostatic hyperplasia	N40
Misadventures to patients during surgical and medical care	Y60-Y69, Y83-Y84
Maternal death	O00-O99
Congenital cardiovascular anomalies	Q20-Q28
Perinatal deaths	P00-P96

[1] = Only deaths in those 0–14 years old were included; [2] = Only deaths in those under 45 years of age were included; [3] = Only deaths in those under 50 years of age were included; [4] = 50% of the deaths were included

In addition to mortality from avoidable causes as a whole, mortality from the following specific avoidable causes of death has also been analyzed: infectious diseases (intestinal infections, tuberculosis, diphtheria, tetanus, poliomyelitis septicemia, measles and whooping cough), treatable cancers (colorectal, breast in women, cervix, corpus uteri, testicles, Hodgkin's disease and leukemia), diabetes, heart disease, cerebrovascular disease, respiratory disease (pneumonia and influenza), digestive disease (peptic ulcer, appendicitis, abdominal hernia, cholelithiasis and cholecystitis), perinatal conditions, and rest of avoidable causes.

Statistical analysis

Analyses have been performed separately in men and women. In each of the three areas of residence, mortality rate was calculated for each year, from 2003 to 2019, for the causes of death mentioned. Specifically, the age-standardized mortality rate per 100,000 inhabitants was calculated, using the 2013 European Standard Population. Subsequently, in each area of residence, the magnitude of the trend in mortality rates was estimated using linear regression models. The dependent variable was the natural logarithm of the mortality rate, and the independent variable was time. Time was defined as a continuous variable from 2003 to 2019. The magnitude of the trend is presented as the average annual percentage change in the mortality rate. If β_1 is the coefficient of the regression models over time, the annual percentage change is 100 x [exp (β_1) −1].

Results

The population and deaths in the years of study, in the three areas of residence, are shown in Table 1 and in Supplementary Table 1. In men, residents in rural areas represented 23% in 2003 and 21 % in 2019, while in women those figures were

Table 1 Population and deaths from avoidable causes and from all other causes of death in those under 75 years, according to area of residence. Spain, 2003 and 2019

Sex and residence area	Population		Avoidable causes of death		All other causes of death	
	2003	2019	2003	2019	2003	2019
Men						
Large urban areas	8,370,200	8,796,674	10,128	6923	29,383	23,905
Small urban areas	6,939,195	8,100,072	7564	6347	22,528	21,873
Rural areas	4,498,596	4,379,147	5731	3855	16,312	13,532
Women						
Large urban areas	8,672,609	9,217,539	7038	5207	12,003	11,798
Small urban areas	6,781,432	8,005,920	5169	4348	8664	9478
Rural areas	4,194,734	4,044,298	3677	2381	6,212	5,050

21% and 19% respectively. Deaths in rural areas represented 24% in 2003 and 23 % in 2019, while in women those figures were 23% and 20% respectively.

Figures 1 and 2 show, respectively, the age-standardized mortality rate from avoidable causes and from all other causes of death in each year of study, according to the area of residence. Mortality rates decreased between the beginning and the end of the analysed period. In men and women, residents in rural areas showed the lowest mortality rate from avoidable causes and from all other causes of death in 2003. The difference in mortality rate in rural areas, with respect to mortality rate in urban areas, was reduced throughout the analysed period. Even in 2019, the mortality rate from all other causes in men and the mortality rate from avoidable causes in women showed a higher magnitude in rural areas than in large urban areas.

Table 2 shows the avoidable mortality rate and the mortality rate from all other causes of death in 2003 and 2019, as well as the average annual percentage change in the rates throughout the period analysed, by area of residence. The reduction was greater in avoidable mortality than in mortality from all other causes of death. Large urban areas and rural areas showed the largest and smallest reduction in mortality rate, respectively. The average annual percentage change in avoidable mortality was −3.5% in men and −3.0% in women in large urban areas, and −2.7% in men and −2.6% in women in rural areas. The average annual percentage change in the mortality rate from all other causes of death was −2.4% in men and −1.2% in women in large urban areas, and −1.4% in men and −1.0% in women in rural areas.

Table 3 shows the mortality rate from the main avoidable causes of death in 2003 and 2019, as well as the average annual percentage change in the rate throughout the period analysed, by area of residence. Mortality from infectious diseases, diabetes, heart disease, and cerebrovascular disease showed the greatest reduction, whose average annual percentage change was greater than 4% in several areas. Mortality from respiratory diseases and mortality from digestive diseases showed the least reduction, whose average annual percentage change did not reach 1% in several areas. In general, large urban areas and rural areas showed the largest and smallest reduction in mortality rate respectively. However, some exceptions were observed. In men, small urban areas showed the greatest reduction in the mortality rate from diabetes and perinatal conditions. In women, rural areas showed the greatest reduction in the mortality rate from infectious diseases, diabetes, and heart disease.

Discussion

Main findings

In Spain, throughout the first 2 decades of the twenty-first century, there was a decrease in avoidable mortality and in mortality from all other causes of death, both in rural and urban areas. A greater reduction was observed in avoidable mortality than in mortality from all other causes of death. Large urban areas and rural areas showed the largest and smallest reduction in avoidable mortality and in mortality from all other causes of death. As consequence, the mortality advantage found in rural areas at the beginning of the study period was reduced or disappeared at the end of it. In general, the reduction in mortality from the main avoidable causes of death according to area of residence showed a similar pattern, except in women in mortality from infectious diseases, diabetes, and heart disease.

Possible explanations

As in our study, other investigations carried out in different rich countries have also shown a greater reduction in avoidable mortality than in mortality from all other causes of death (Karanikolos et al. 2018; Nolasco et al. 2018; Mackenbach et al. 2017). These findings have been attributed to advances in treatment for certain diseases, which means that health services are more effective in reducing premature deaths in patients suffering from these diseases. The efficacy of health promotion and disease prevention measures may also have contributed to these findings.

Deaths from treatable cancers and cardiovascular diseases account for about 85% and 80% of avoidable deaths in men and women respectively. Advances in treatment for these conditions explain this important reduction in avoidable mortality. To this must be added the contribution of measures to reduce health risk behaviours, in the case of cardiovascular diseases, and the contribution of early disease detection programs, in the case of cancers. In Spain, the percentage of smokers in 2003 was 34% in men and 22% in women, while in 2019 it was 23% and 16% respectively. Likewise, the percentage of sedentary people between 2003 and 2019 was reduced from 41% to 32% in men and from 52% to 40% in women (Ministerio de Sanidad 2022a). On the other hand, in the first 2 decades of the twenty-first century, an increase in the coverage of early cancer detection programs was observed, reaching 80% of the target population in 2019 for breast and cervical cancers and 32% for colon cancer (Ministerio de Sanidad 2022a).

Other causes of death, such as infectious diseases, contribute little to the overall number of deaths from avoidable causes. However, mortality from infectious diseases was the one that showed the greatest reduction throughout the period analysed. Most probably, the effectiveness of the vaccines is behind this finding. Throughout the period analysed, coverage of diphtheria, tetanus, polio, measles, and whooping cough vaccine was greater than 95% (Ministerio de Sanidad 2022b).

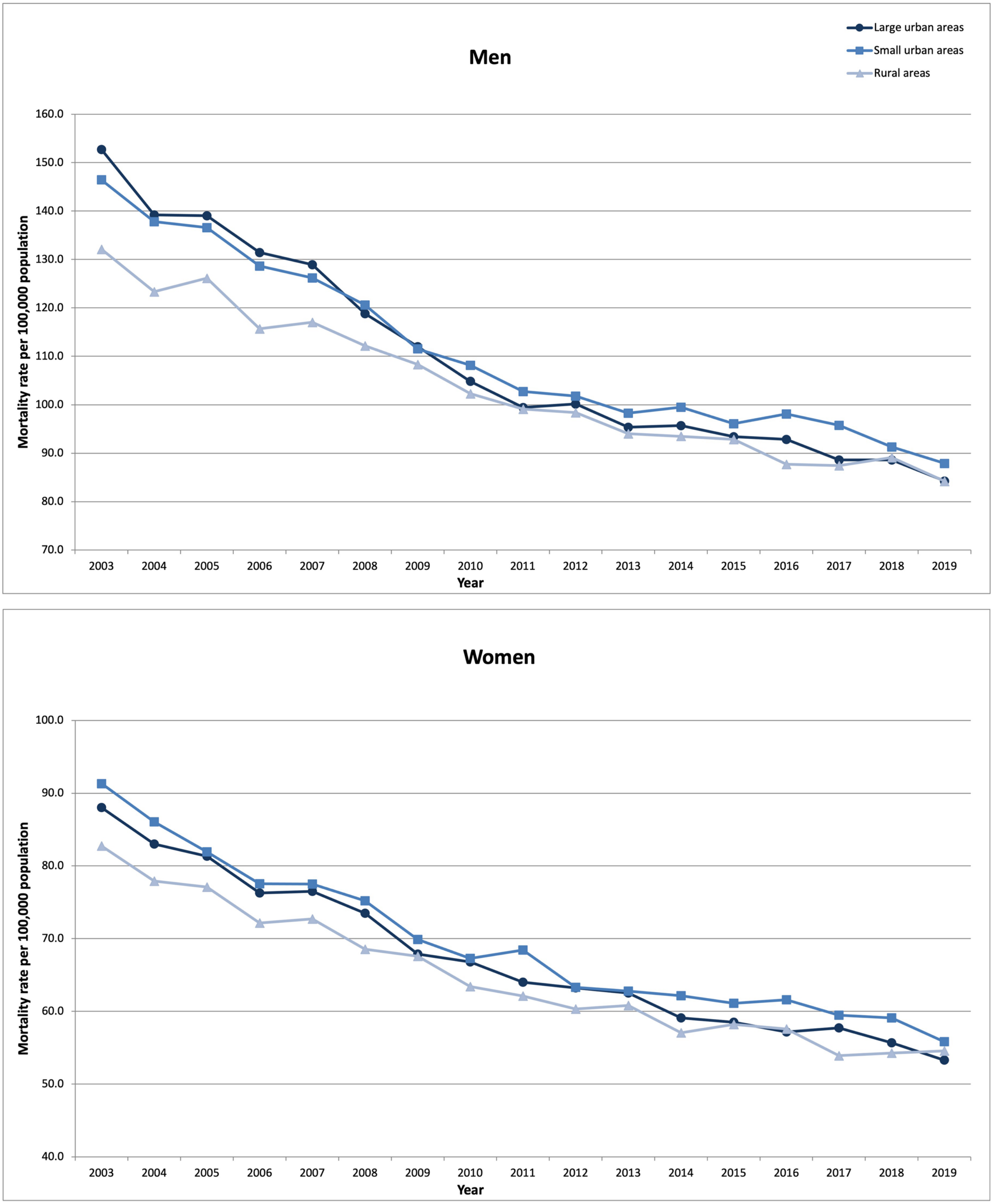

Fig. 1 Age-adjusted mortality rate from avoidable causes of death in people under 75 years of age per 100,000 inhabitants, according to area of residence in men and women

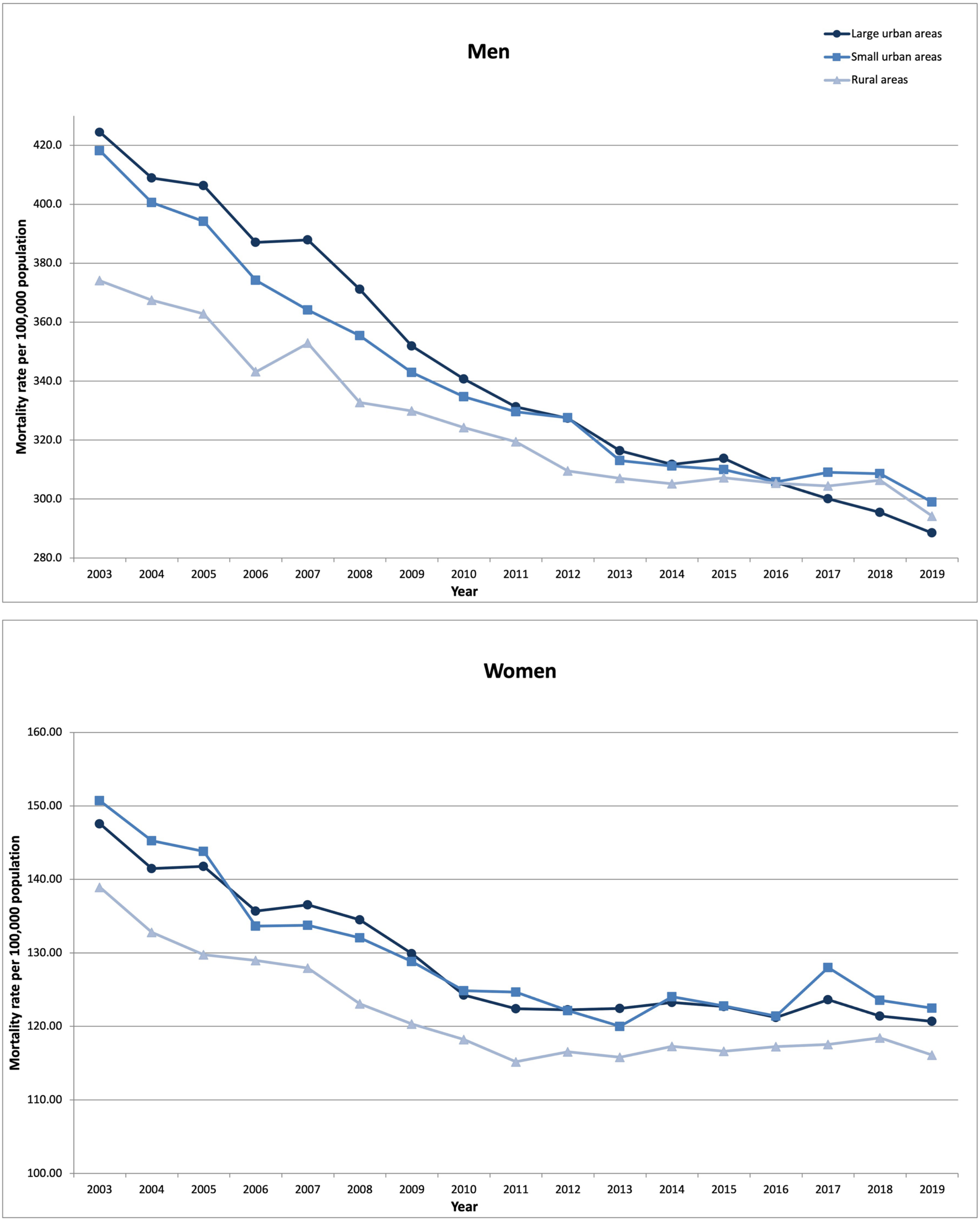

Fig. 2 Age-adjusted mortality rate from all other causes of death in people under 75 years of age per 100,000 inhabitants, according to area of residence in men and women

Table 2 Age-adjusted mortality rates per 100,000 population in people under 75 years old in 2003 and 2019, and annual percentage change (APC) in rates of mortality from avoidable causes of death and from all other causes of death, according to area of residence, from 2003 to 2019

Cause of death and area of residence	Men				Women			
	Mortality rate		Trend		Mortality rate		Trend	
	2003	2019	APC[1]	*P* value	2003	2019	APC[1]	*P* value
Avoidable mortality								
Large urban areas	152.7	84.3	−3.5	< 0.001	88.0	53.3	−3.0	< 0.001
Small urban areas	146.5	87.9	−3.0	< 0.001	91.3	55.8	−2.8	< 0.001
Rural areas	132.1	84.2	−2.7	< 0.001	82.7	54.6	−2.6	< 0.001
All other causes of death								
Large urban areas	424.4	288.5	−2.4	< 0.001	147.6	120.7	−1.2	< 0.001
Small urban areas	418.2	298.9	−2.0	< 0.001	150.7	122.5	−1.1	< 0.001
Rural areas	374.1	294.2	−1.4	< 0.001	138.9	116.1	−1.0	< 0.001

[1] The following linear regression model has been estimated for each mortality rate (Y):

$\log(Y) = \beta0 + \beta1 \text{ time} + e$

The trend of the log (Y) in the period 2003–2019 is β1. The APC in the dependent variable (Y) is 100 x [exp (β1) − 1].

In contrast, mortality from pneumonia and influenza showed little reduction, and therefore the decrease in mortality from respiratory diseases was of little magnitude. Variation in the number of deaths from pneumonia and influenza, as a consequence of influenza epidemics over time, may explain this finding. Digestive diseases were another cause of death whose mortality experienced little reduction. Most of the avoidable digestive diseases require surgical treatment — appendicitis, abdominal hernia, and cholelithiasis and cholecystistis — and mortality from these health problems is probably related to suffering from concurrent chronic diseases.

Lower accessibility to health services in rural areas could explain the lower reduction in avoidable mortality in these areas. The authors of some previous studies carried out in Spain suggested this possibility. For example, two investigations, using hospitalization data in 2006 and primary health care data in 2010, showed a lower frequency of avoidable hospitalization and lower frequency of morbidity in the population of rural areas than in the population of urban areas (Borda-Olivas et al. 2013; Foguet-Boreu et al. 2014; Sarria-Santamera et al. 2015). The authors pointed out that this lower frequency of health problems recorded in hospitals and primary care centres could be due to less accessibility to health services in rural areas. However, in another investigation in which a lower frequency of use of emergency services was found in the population of rural areas, with data from 2006 and 2011, the authors concluded that this finding could imply an overuse of these emergency services in urban areas and not an underuse of those services in rural areas (Sarria-Santamera et al. 2015).

According to the second interpretation, the findings on avoidable hospitalization and morbidity in primary care, together with the lower avoidable mortality and the lower mortality from all other causes of death observed in rural areas in those years, suggest a lower burden of disease in rural areas than in urban areas rather than lower accessibility to services in rural areas. In fact, in different health surveys, only 1% of the Spanish population reported inaccessibility to health services due to transportation difficulties or long distances (Instituto Nacional de Estadística 2022b). In any case, the fact that the population in rural areas shows the lowest reduction in the mortality rate, both from avoidable causes and from all other causes of death, does not support a lower geographical accessibility to health services in rural areas. Likewise, the findings in women about mortality rate from infectious diseases, diabetes, and heart disease, whose greatest reduction was observed in rural areas, do not support this explanation either.

It could be argued that the avoidable mortality itself included a large spectrum of diseases; and for many diseases, patients can seek treatment in an urban hospital, so this may not be affected by the rural access. However, the gateway to the public health care system in Spain is the general practitioner. Likewise, the estimates of the national health surveys, by interviews carried out in 2003 and the last one in 2017, reveal an absence of differences in the frequency of medical consultation in rural and urban areas in Spain (Ministerio de Sanidad 2023). Probably, this absence of difference in medical consultation between urban and rural areas reflects public health coverage. During the study period, the percentage of the population with public health coverage was practically universal: 99% in large urban areas and over 99.5% in rural areas (Ministerio de Sanidad 2023).

In these surveys, the response of the people interviewed about accessibility to health services does not reflect participation in population screening programs. Numerous studies carried out in rich countries have found a lower frequency of use of population screening services in rural

Table 3 Age-adjusted mortality rates per 100,000 population in people under 75 years old in 2003 and 2019, and annual percentage change (APC) in rates of mortality from amenable causes of death, according to area of residence, from 2003 to 2019

Cause of death and area of residence	Men				Women			
	Mortality rate		Trend		Mortality rate		Trend	
	2003	2019	APC[1]	*P* value	2003	2019	APC[1]	*P* value
Infectious disease								
Large urban areas	4.8	1.8	−5.1	< 0.001	2.5	1.0	−4.4	< 0.001
Small urban areas	5.1	2.4	−3.8	< 0.001	2.9	1.2	−4.1	< 0.001
Rural areas	4.2	2.1	−4.8	< 0.001	2.4	0.9	−5.1	< 0.001
Tratable cancer								
Large urban areas	27.3	20.2	−1.6	< 0.001	39.8	30.0	−1.7	< 0.001
Small urban areas	23.6	20.9	−0.7	0.006	38.8	29.9	−1.3	< 0.001
Rural areas	22.3	20.6	0.0	0.985	35.5	29.5	−1.1	< 0.001
Diabetes								
Large urban areas	0.4	0.2	−4.9	< 0.001	0.1	0.1	−3.6	0.011
Small urban areas	0.5	0.2	−6.1	< 0.001	0.2	0.0	−5.9	0.076
Rural areas	0.5	0.3	−4.2	0.003	0.2	0.0	−7.0	0.007
Heart disease								
Large urban areas	67.1	32.6	−4.3	< 0.001	16.5	7.1	−4.7	< 0.001
Small urban areas	67.7	34.9	−3.9	< 0.001	19.3	8.3	−5.0	< 0.001
Rural areas	59.8	33.2	−3.5	< 0.001	16.9	7.7	−5.1	< 0.001
Cerebrovascular disease								
Large urban areas	29.1	14.3	−4.6	< 0.001	14.5	7.0	−4.6	< 0.001
Small urban areas	28.9	14.8	−4.3	< 0.001	16.7	8.2	−4.3	< 0.001
Rural areas	27.3	14.1	−4.4	< 0.001	14.7	8.4	−4.1	< 0.001
Respiratory disease								
Large urban areas	7.7	5.3	−2.3	0.001	2.9	2.2	−1.8	0.002
Small urban areas	6.5	5.5	−0.7	0.284	2.6	2.5	0.2	0.797
Rural areas	6.1	4.8	−1.0	0.234	2.2	2.1	−0.1	0.916
Digestive disease								
Large urban areas	3.4	2.6	−0.6	0.347	1.4	1.2	−1.6	0.002
Small urban areas	2.6	2.6	−0.4	0.390	1.8	1.5	−1.2	0.071
Rural areas	3.1	2.8	−0.4	0.390	1.7	1.3	−0.4	0.585
Perinatal conditions								
Large urban areas	3.0	1.9	−3.2	< 0.001	2.8	1.6	−4.4	< 0.001
Small urban areas	3.0	1.5	−4.0	< 0.001	2.1	1.2	−3.2	< 0.001
Rural areas	2.0	1.4	−3.8	< 0.001	1.7	1.4	−2.4	0.009
Other								
Large urban areas	9.9	5.3	−3.8	< 0.001	7.6	3.2	−4.7	< 0.001
Small urban areas	8.5	5.1	−2.9	< 0.001	6.9	3.0	−4.6	< 0.001
Rural areas	6.8	5.0	−2.1	< 0.001	7.6	3.2	−4.6	< 0.001

[1] The following linear regression model has been estimated for each mortality rate (Y):

$\log(Y) = \beta 0 + \beta 1\ \text{time} + e$

The trend of the log (Y) in the period 2003–2019 is β1. The APC in the dependent variable (Y) is 100 x [exp (β1) −1].

areas (Horner-Johnson et al. 2015; Leung et al. 2014). These findings could help explain the higher mortality from treatable cancer in rural areas observed in some countries. Likewise, studies carried out in Spain in the first decade of the twenty-first century also found a lower frequency of population screening in rural areas (Puig-Tintoré et al. 2008; Ricardo-Rodrigues et al. 2015). This could explain the lower observed reduction in mortality from treatable cancers in rural areas than in urban areas, given deaths from colon cancer, breast cancer, and cervical cancer account for three-quarters of deaths from treatable cancers (Instituto Nacional de Estadística 2022c). In any case, geographical differences in participation in population screening programs may be only part of the explanation, since rural areas also show the lowest reduction in mortality from all other causes of death.

On the other hand, the similar trends in avoidable mortality and in mortality from all other causes of death suggest the existence of some other factor related to both area of residence and health. One such factor could be health risk behaviours. However, this explanation is implausible, given that the prevalence of smoking and the prevalence of physical inactivity showed the greatest reduction in rural areas throughout the period considered (Moreno-Lostao et al. 2019).

It could also be argued that the results are due to deaths in older people, since most deaths occur between 50 and 74 years of age. However, the findings by age groups showed a similar pattern. In men, the average annual percentage change in avoidable mortality in people under 15 years of age, in those aged 15 to 49 years, and in those aged 50 to 74 years were, respectively, −6.9%, −5.0%, and −3.4% in large urban areas, and −6.6%, −4.2% and −2.4% in rural areas. In women, the average annual percentage change in avoidable mortality in these three age groups was, respectively, −6.3%, −3.3%, and −3.0% in large urban areas and −-5.1% , −2.7%, and −2.7% in rural areas.

A sociodemographic characteristic strongly associated with mortality is educational level. People with university education show the lowest premature mortality from most leading causes of death (Reques et al. 2014). However, this characteristic cannot be responsible for the findings of the present study, since the percentage of the population with university education, throughout the first 2 decades of the twenty-first century, multiplied by 2 in urban areas and by 3 in rural areas (Instituto Nacional de Estadística 2023)

There is evidence that places where the number of inhabitants is reduced show high mortality rate, while those where the population is growing show low mortality rates (Davey Smith et al. 1998; Molarius and Janson 2000; Davey Smith et al. 2001; Regidor et al. 2002). This could be a consequence of the healthy immigrant bias. That is, people who move to areas with population growth could be healthier than people who stay. In the present study, we have classified the areas of residence into urban and rural and we have found that, between 2003 and 2019, the population increased by 10% in urban areas, but decreased by 3% in rural areas. Therefore, we cannot rule out the possibility that this variation in population size may have contributed to the different trend in avoidable mortality and in mortality from all other causes of death.

In many rich countries, mortality in rural areas is higher than in urban areas. However, in the present study, mortality in rural areas is lower than mortality in large urban areas. Similar findings have been observed at various locations in the UK (O'Reilly et al. 2007; Gartner et al. 2008) and in other countries (Fukuda et al. 2004). Probably the greater reduction in lifestyle-related health risk factors and other exposures in urban areas than in rural areas started earlier in some countries than in others.

Strengths and limitations

One of the strengths of this study is the availability of information on deaths and population in rural and urban areas in Spain in the first 2 decades of the twenty-first century. Another strength is the analysis of a negative control of the outcome variable. It has been observed that the trend in avoidable mortality is similar to the trend in mortality from all other causes of death. One of the limitations is the lack of information on the socioeconomic characteristics of the areas and the inhabitants who reside in them. The socioeconomic profile of the areas and individuals may have varied over time. Likewise, the existence of a numerator–denominator classification bias is possible, given that annual deaths have been analysed but the population corresponds to January 1 of each year. In any case, its influence on the results must have been minimal, since it is unlikely that this bias would have changed from one year to another.

Conclusion

In summary, in the populations of rural and urban areas, a similar trend has been observed in avoidable mortality and in mortality from all other causes of death, which suggests a common factor responsible for both trends. Future research should test whether the increase in population in urban areas is responsible for this finding, as consequence of the migration of healthy individuals to those areas. Likewise, health interventions, in order to reduce the burden of disease, should establish priorities by taking into account that the advantages in mortality of rural areas have been disappearing.

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Data availability The datasets analyzed in this work can be requested from the National Institute of Statistics of Spain.

Declarations

Consent to participate No human participants.

Consent for publications No human participants.

Ethical approval The study databases did not include individual identifiers, so approval by the Ethics Committee was not required.

Conflicts of interest The authors declare they have no conflict of interest.

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