Suicide among older people in Spain: The role of sex and urbanicity

Running title: Elderly suicide: rural–urban differences

Gabriel Jesús Rodriguez-Rodriguez, MD[1]; Gonzalo Martínez-Alés, MD, PhD[2-5]; Teresa López-Cuadrado, PhD[6]

1. Department of Psychiatry, Complejo Asistencial Universitario de Palencia, Spain.
2. Department of Psychiatry, Icahn School of Medicine at Mount Sinai, New York, NY
3. CAUSALab, Harvard TH Chan School of Public Health Boston, MA, USA.
4. Hospital La Paz Institute for Health Research (IDIPaz), Madrid, Spain
5. Mental Health Network Biomedical Research Center (CIBERSAM), Madrid, Spain
6. Department of Chronic Diseases Epidemiology, National Center for Epidemiology, Carlos III Health Institute, Madrid, Spain.

Corresponding author:

Gonzalo Martínez-Alés

Department of Psychiatry

Icahn School of Medicine at Mount Sinai

1 Gustave L. Levy Pl, New York, NY 10029, USA

E-mail: gonzalo.martinez-alesgarcia@mountsinai.org

Abstract

Objectives

Suicide rates are driven by availability of lethal means, increase with age, and are often higher in rural vs. urban areas. This study examines temporal and geographic variations in suicides among elderly with a focus on rural-urban differences in method-specific suicide rates among people aged 65 and older in Spain, a rapidly aging country.

Methods

Population-based study including all suicides among people over 65 in Spain between 2010 and 2022. We examined overall and method-specific suicide rates and their temporal and geographical variation, stratifying results by sex and urbanicity level. Time trends were estimated via joinpoint regression. Maps were created to analyze the geographical distribution of suicide rates.

Results

While 2010-2022 suicide rates in people aged 65 and older remained largely stable overall, they increased by an annual 2.6% for women living in urban areas. The most common suicide methods were hanging for men living in rural and urban areas (68.5% and 47.3%, respectively) and for women living in rural areas (42.1%); for women living in urban areas jumping was the modal suicide method (46.9%). Method-specific trend analyses revealed recent increases in male suicide by poisoning and hanging in rural areas, decreases in male suicide by hanging and increases in male suicide by jumping in urban areas, and increases in female suicide by poisoning and jumping in urban areas. We identified and mapped remarkable geographic variation in overall and sex-specific suicide rates across Spain's regions.

Conclusions

These results, highlighting recent increases in female suicides in urban areas and in specific method-specific male suicides both in rural and urban areas, and demonstrating geographical variation across regions, should help guide targeted suicide prevention efforts.

Key words: Suicide, rural, urban, elderly, methods

Key points

- We examined geographic and temporal variations in suicide among individuals aged 65 and older in Spain, with a focus on urbanicity level and suicide method.
- Between 2010 and 2022, suicide rates (especially by hanging and poisoning) increased among men aged 65 and older living in rural areas.
- Variations across place and over time in sex- and method-specific suicide rates can guide development of targeted prevention strategies.

Introduction

Approximately 700,000 people die by suicide each year worldwide[1]. Reducing suicide rates by at least one third by 2030 is one of the main objectives of the World Health Organization's most recent Mental Health Action Plan[2]. Research on the distribution of suicide risk over time, across geographic areas, and across sociodemographic groups is a cornerstone of suicide prevention efforts because it can guide appropriate allocation of prevention strategies to target high-risk populations. Suicide rates typically increase with age, and are highest among people over 70 years of age in most locations across the globe[3]. Expanding our understanding of suicide among older people is paramount to reduce suicide rates, especially in the setting of ongoing shifts in the population age distribution and global ageing.[4]

Spain has one of the lowest suicide mortality rates in Europe[5,6]. While population rates of suicide in Spain have remained largely stable in recent years[7], there is evidence that trends in suicide among specific vulnerable groups, such as migrants[8] or economically disadvantaged individuals[9], have undergone variations in the last decade. In addition, suicide rates among older individuals increased dramatically following the initial pandemic outbreak generating substantial concern in Spain,[10] one of the fastest ageing societies in the world.

Geographic variations in suicide rates may help understand recent trends in suicide among older individuals. Over the recent years, there is accumulating evidence of higher suicide rates in rural areas compared to urban ones[11–14], especially in high-income countries. Plausible explanations to this finding include rural-urban differences in the distribution of economic sectors and opportunities[15], prevalence of social isolation[16], ease of access to mental healthcare services[17–19], and distribution of lethal means, among others. In Spain, a rapidly ageing country, rural areas are characterized by even faster aging and by progressive depopulation – with a 7.1% decrease in the population living in rural areas between 2011-2020, largely due to selective migration of youth to urban areas[20]. Spanish regional studies indicate higher suicide rates in rural areas, particularly among older men[21,22]. However, suicide rates also vary greatly across locations in Spain,[23] and

there are no nation-wide studies examining rural-urban differences in suicide in the Spanish older population.

Examining geographic variations in suicide methods can be critical for targeted public health prevention efforts, given that restriction in access to lethal means is the best established population-level suicide prevention strategy. Acceptability[24,25], availability, and ease of access[12] to lethal means influence method choice and may partially explain urban-rural differences in suicide rates, as well as differences across age groups. Yet there are no population-based studies focused on method-specific suicide rates, trends, and geographical variation in Spain. Description of suicide rates and trends among individuals aged 65 and older in Spain with a focus on urbanicity level and suicide method is a natural first step to causal hypothesis generation that can guide development of specific interventions and is critical for surveillance and resource allocation efforts. The objective of this study is to describe temporal and spatial variations in suicide among individuals 65 or older in Spain according to urbanicity level and suicide method.

Methods

Source of data

A retrospective study including data on all deaths by suicide in persons aged 65 or older in Spain between January 1, 2010 and December 31, 2022. Mortality data were obtained from cause-specific mortality records provided by Spain's National Institute of Statistics[26].

Study variables

We selected the codes indicating suicide as the basic cause of death, according to the International Classification of Diseases 10th edition (ICD-10), (codes X60-X84; Y87.0)[27]. Codes were further classified by suicide method into[28,29]: poisoning (X60-X69), hanging (X70), jumping (X80), and other methods (X71-X79; X81-X84, Y87.0). We also extracted the following sociodemographic variables from the mortality records: age in years, sex (male and female), marital status (single,

married, divorced, and widowed), place of birth (Spain or abroad) and municipality of residence. We created a variable indicating area of residence urbanicity level with two categories: rural (municipalities with a population of <10,000 inhabitants) and urban (municipalities with ≥ 10,000 inhabitants). Age was categorized into groups: 65-69, 70-74, 75-79, 80-84, and >84 years.

Analysis

First, we conducted a descriptive analysis examining the sex-specific distribution of demographic characteristics (age group, place of birth, and marital status) and of suicide method by urbanicity level.

Next, overall and method-specific suicide mortality rates per 100,000 people aged 65 or older were calculated by sex, according to urbanicity level. *Joinpoint* regression models were used to evaluate trends in suicide rates. These models allow the identification of the year in which a trend change occurred (inflection point) using the Monte Carlo permutation test. It quantifies each trend by providing the annual percent change APC, and the trend over the entire study period, using the average annual percent change (AAPC) with their respective confidence intervals[30].

Finally, we represent the geographical distribution of global suicide rates and by sex according to the area of residence using maps.

Statistical analyses were performed with Stata Corp College Station TX version 17. Joinpoint Regression 5.0.2, and the mapSpain package, version 0.8.0, of the R statistical analysis program, version 4.3.2.

Results

Between 2010 and 2022, 15178 deaths by suicide were registered in people aged 65 or older in Spain, for suicide rates of 23.42 per 100,000 men and 5.90 per 100,000 women aged 65 or older, and with 10,492 (69%) suicides corresponding with urban dwellers.

Table 1 summarizes the demographic characteristics and suicide method of all suicide deaths recorded in people aged 65 or older in Spain between 2010 and 2022, stratified by urbanicity level

and sex. While suicide counts were roughly evenly distributed across age groups regardless of levels of urbanicity, there were slightly higher suicide counts among women aged 65-69 living in urban areas and men aged 80 and older living in rural areas. In terms of place of birth, most suicides indicated Spanish origin – although counts of suicides among foreign-born individuals were higher in urban areas. In terms of marital status, most male suicides indicated married status, followed by widowed status, across levels of urbanicity. Most female suicides, on the other hand, indicated widowed status, followed by married status – which was more frequent in rural than urban areas. In rural areas, hanging was the most common method across sex. In contrast, in urban areas, hanging was the predominant method in men, while jumping was the most frequent method among women.

Suicide rates among people aged 65 and older in Spain between 2010 and 2022 were different across urbanicity levels, especially among men, with estimates of 30.3 male suicides and 6.1 female suicides per 100,000 population in rural areas and of 21.0 male suicides and 5.8 female suicides per 100,000 population in urban ones.

Suicide rates among individuals aged 65 and older observed a slight increase between 2010 and 2022, with the overall suicide rate rising from 12.5 in 2010 to 13.6 per 100,000 population in 2022, reflecting an average annual increase of 0.8% (95% CI: 0.3, 1.5).

While suicide rates remained roughly stable for men and women aged 65 living in rural areas (with 2010 and 2022 rates of 29.9 and 29.8 per 100,000 men and of 5.2 and 5.4 per 100,000 women) and for men aged 65 living in urban areas (with 2010 and 2022 rates of 20.4 and 20.7 per 100,000), there was an increase in suicide rates among women aged 65 living in urban areas (with 2010 and 2022 rates of 4.7 and 6.7 per 100,000 – for a 2.6% [95% CI: 0.8, 3.9] average annual increase over the study period). Notably, we found two inflection points in suicide trends among women aged 65 and older living in urban areas: Between 2010 and 2016, there was an average annual increase of 5.2% (95% CI: 3.3, 9.8), followed by an average annual decrease of -6.0% (95% CI: -9.2, -0.9) and an increase of 6.4% (95%: 2.0, 14.3) (**Figure 1, Table S1**).

We also examined trends in method-specific suicide rates (**Figure 2**, **Table S2**), stratified by urbanicity level. Among men aged 65 and older living in rural areas, suicides by poisoning increased from 0.2 in 2010 to 1.9 per 100,000 in 2022, for an average annual increase of 7.9% (95% CI: 1.2, 18.0); and suicides by hanging increased from 15.2 in 2019 to 21.7 per 100,000 in 2022, for an average annual increase of 9.8% (95% CI; 1.8, 22.8). Method-specific suicide trends among women aged 65 and older living in rural areas remained roughly stable during the study period.

Among men aged 65 and older living in urban areas, suicides by poisoning increased from 0.8 in 2010 to 1.5 per 100,000 in 2022, for an average annual increase of 29% (95% CI: 5.5, 55.4) in that period, and remained subsequently stable after 2012; suicides by hanging decreased from 10.9 in 2010 to 9.1 per 100,000 in 2022, for an average annual change of -1.6% (95% CI: -2.4, -0.4); and suicides by jumping first increased by an annual 12.3% (95% CI: 5.3, 31.0) from 2010 to 2013, followed by an annual decrease of -7.4% (95% CI: -12.1, -0.8) from 2013 to 2019, and a subsequent increasing trend of an annual 3.9% (95% CI: 0.9, 13.7) from 2019 to 2022.

Women residing in urban areas experienced increases in the rates of suicide by poisoning (with 2010 and 2022 rates of 0.8 and 1.2 per 100,000 – for a 3.7% [95% CI: 0.4, 7.4] average annual increase over study period) and jumping (with 2010 and 2022 rates of 1.8 and 3.7 per 100,000– for a 2.9% [95% CI: 1.7, 5.2] average annual increase over study period).

Figures S1, S2, and S3 ilustrate the geographic distribution of suicide mortality rates among men and women aged 65 or older from 2018 to 2022. Overall, we found the highest suicide rates in the Northwest (with urban rates of 21.5 and rural rates of 28.4 suicides per 100,000) and Southern regions of Spain (with urban rates of 21.4 and rural rates of 27.8 suicides per 100,000) and the lowest suicide rates in the Central region (with urban rates of 6.6 and rural rates of 8.1 suicides per 100,000). Sex-specific geographical differences in suicide rates largely followed the overall distribution.

Discussion

This is the first study in Spain to examine suicide in people 65 or older in Spain with a focus on suicide methods and urbanicity level. We found relevant differences across age groups and urbanicity levels for both overall and method-specific suicide rates. The highest suicide rates affected men aged >80 living in rural areas, the most common suicide methods were hanging for men and jumping for women, and violent suicides (i.e., suicide by hanging or jumping) increased with age among older men. Notably, while suicide rates remained roughly stable for men, regardless of area of residence and for women living in rural areas – except for a 2013-2022 decrease suicide–, we detected a 2010-2016 increase in suicide rates among women aged 65 or older living in urban areas – largely driven by increases in suicide by jumping. Our findings are at odds with global trends indicating overall decreases in suicides among older individuals[31] – largely driven by decreases in suicide by pesticide poisoning in China and, to a less extent, India, the two most populated countries[6], and should help guide public health prevention efforts and provide hints to potential causes underlying recent trends in suicide among people aged 65 or older in Spain.

Suicide rates in rural areas

Between 2010 and 2022, suicide rates among rural dwellers aged 65 or older in Spain remained stable, with approximately 30 and 5.2 deaths per 100,000 men and women, respectively. This finding adds to the existing literature highlighting the role of local and contextual factors in shaping suicide trends in rural areas across the globe: for instance, while there have been marked recent decreases in rural suicide among older people in China[32], largely attributed to decreases in access to pesticides, sustained increases in suicides among women aged 65 and older were registered in the United States between 2005 and 2017[33], a phenomenon that was attributed to a generalized progressive erosion of the welfare system in the United States affecting especially rural dwellers[34].

In line with reports from other countries[28,35], in Spain hanging was the predominant suicide method across sex for rural dwellers aged 65 and older – with recent increases affecting only men. Again, a comparison with other well-studied countries serves to emphasize the role of context-specific factors and especially access to lethal means in modal suicide method: while in rural areas of China poisoning (mainly by pesticides) continues to be the most common suicide method among the elderly, followed by hanging[36], firearm suicides are most common among men over 65 years of age residing in isolated and/or rural areas in Australia[37] and the United States[38]. While a clear explanation to these cross-national differences in suicide trends in the older population remains elusive, an examination of the factors most salient to trends in other countries can help contextualize our findings. During the study period, trends in use of the more hazardous pesticides[39] and trends in national economy, expressed as annual GDP growth[40], and in socioeconomic inequality, expressed as annual Gini index[41], all remained roughly stable among the Spanish population. Moreover, laws regulating firearm ownership in Spain were last modified in 1992[42]. In addition, research has indicated that prevalence of physical multimorbidity, which is associated with suicidal behaviors in a dose-response manner[43], remained stable among Spanish individuals aged 60 and older between 2006-2017[44]. Last, retirement pensions for older Spanish citizens have increased sustainedly – e.g., by 29% since 2018, likely contributing to reduce risk of socioeconomic vulnerability in this age group[45].

Suicide rates in urban areas

While suicide rates among urban male residents remained stable during the years 2010 and 2022 at around 20 deaths per 100,000 men aged 65 and older; females recorded an increase from 4.7 in 2010 to 6.7 per 100,000 in 2022, with especially pronounced increases between 2010-2016 and after 2019. This is in keeping with findings from the United States, where there was a 51% increase in suicides among women (of all ages) living in urban areas between 2000 and 2015[13]. Regarding the method, we found marked differences by sex in urban suicides, with hanging and jumping being the most common methods for men and women, respectively. While this finding is in keeping with prior research highlighting the role of urbanicity and built structures in

incidence of suicide by jumping[46], it has long been observed that female suicide is most often characterized by less violent suicide methods (e.g., poisoning) than male suicide. For instance, in Australia, a similar study found poisoning to be the most common suicide method for women over 65 years of age living in urban areas[25]. Our finding is striking and suggest the possibility that deaths due to non-violent suicide methods may be differentially subject to misclassification as accidental and hence underestimated in our setting[47].

We found recent increases in suicides by jumping (a modal method only in urban settings) and especially poisoning (across urbanicity levels) in both sexes. Notably, for men aged 65 and older living in urban areas, suicides by poisoning increased by 29.4% between 2010 and 2012 – largely at odds with studies conducted in other countries in the recent decades[24,28,48]. This finding may be linked to recent increases in prescription of medication and polypharmacy among Spanish individuals aged 65 and older[49], given that most older individuals who undertake voluntary overdoses use prescribed drugs[50]. Further, depression, a major risk factor for suicide, is independently associated with polypharmacy in this population[51]. In contrast, suicide by hanging showed a moderately decreasing trend throughout the study period, with the exception of men living in rural areas, along the lines of a recent analysis conducted in Serbia where male suicides by hanging decreased between 1991 and 2020[52].

Additional factors potentially underlying rural-urban differences in suicides in older population in Spain

In this study, higher suicide rates were observed in rural areas compared to urban areas for both men and women aged 65 and older, consistent with findings from national and international studies[11,14,22,32]. Social isolation, often intensified by widowhood, singleness, or loss of support networks, has been identified as a key factor contributing to rural-urban suicide disparities: In Spain, older individuals living in rural areas report higher prevalence of perceived loneliness that urban counterparts [53,54]and, as mentioned, rural areas are characterized by depopulation.

An additional potential explanation to rural-urban differences in suicide among individuals aged 65 and older may be limitations in timely access to healthcare, especially given that older people typically have higher prevalence of limitations in mobility, may contribute to higher fatality rates in poisoning attempts in rural vs urban areas. Stigma surrounding mental health disorders[17], a major risk factor for suicide, and low health literacy can also contribute to urban-rural differences, acting as barriers in access to mental health resources in rural areas[55]. Of note, we found no evidence of temporal changes in these factors during the study period in Spain, and specific suicide prevention programs have been implemented at the regional level across Spain since 2010[56] – both in rural[57] and urban[58,59] areas.

Geographically, higher suicide rates were consistently noted in rural and urban areas of northwestern and southern Spain, with slight variations by sex, a pattern previously described by Álvaro-Meca et al. in regions like Galicia and Andalusia (1981–2008)[60]. Further research efforts should focus on investigating factors underlying such geographical variations.

We should note several limitations to our study. The primary limitation arises from the use of death registries, which provide only partial data on certain sociodemographic factors. Additionally, the lack of information on individuals' medical histories, including somatic and mental health conditions, socioeconomic status, educational attainment, social support, and healthcare accessibility, limits a more comprehensive understanding of the suicide phenomenon. While the rural (defined as areas with fewer than 10,000 inhabitants) and urban (more than 10,000 inhabitants) classifications adhere to the criteria established by the National Institute of Statistics, this definition may not fully capture the complexities of the geographic areas under study. As such, it may lack the sensitivity needed to reflect the nuanced differences between these two regions. Last, lack of availability of population denominator data disaggregated by marital status for each level of urbanicity and for each sex for the study period prevented us from providing suicide rates marital status in addition to suicide counts, which would have further improved interpretation of results.

In conclusion, between 2010-2022 suicide rates among Spanish people aged 65 and older remained largely stable overall, with increases mainly affecting female urban dwellers. Most common suicide methods were hanging for men across levels of urbanicity and for women living in rural areas, and jumping for women living in urban areas. We found recent recent increases in male suicide by poisoning and hanging in rural areas, decreases in male suicide by hanging and increases in male suicide by jumping in urban areas, and increases in female suicide by poisoning and jumping in urban areas. We identified and mapped remarkable geographic variation in overall and sex-specific suicide rates across Spain's regions.

These findings should provide guidance for the advancement of structurally-appropriate suicide prevention strategies for individuals aged 65 and older in Spain. Of note, Spain has had a Clinical Practice Guideline for the Prevention and Treatment of Suicidal Behavior since 2012 (updated in 2020)[61]. Additionally, the National Health System's Mental Health Strategy for 2022-2026 includes interventions targeting vulnerable groups, particularly the elderly, with a focus on those experiencing involuntary loneliness. At the regional level, several autonomous communities have developed their own suicide prevention plans.[62] However, despite significant efforts in creating these guidelines, few effective interventions have been implemented to reduce suicide rates among individuals aged 65 and older. To date, there are no documented quality evaluations of these interventions.

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Table 1. General characteristics of suicide in people >64 years according to residential area (2010-2022)

	Urban				Rural			
	Total	**Men**	**Women**	**P-value**	**Total**	**Men**	**Women**	**P-value**
Total	10,492	7,601 (72.4)	2,891		4,686	3,773	913	
Age group				<0.001				<0.001
65-69y	2,222 (21.2)	1,521 (20.0)	701 (24.2)		808 (17.2)	626 (16.6)	182 (19.9)	
70-84y	2,077 (19.8)	1,444 (19.0)	633 (21.9)		864 (18.4)	663 (17.6)	201 (22.0)	
75-79y	2,075 (19.8)	1,529 (20.1)	546 (18.9)		958 (20.4)	767 (20.3)	191 (20.9)	
80-84y	1,987 (18.9)	1,497 (19.7)	490 (17.0)		1,020 (21.8)	845 (22.4)	175 (19.2)	
>84y	2,131 (20.3)	1,610 (21.2)	521 (18.0)		1,036 (22.1)	872 (23.1)	164 (18.0)	
Place of birth				0.034				0.001
Abroad	540 (5.1)	361 (4.7)	179 (6.2)		132 (2.8)	103 (2.7)	29 (3.2)	
Spain	9,946 (94.9)	7,234 (95.3)	2,712 (93.8)		4,552 (97.2)	3,668 (97.3)	884 (96.8)	
Marital status				<0.001				<0.001
Single	1,184 (11.3)	881 (11.6)	303 (10.5)		677 (14.5)	596 (15.8)	81 (8.9)	
Married	5,210 (49.8)	4,176 (55.1)	1,034 (35.8)		2,427 (51.9)	2,025 (53.8)	402 (44.1)	
Widowed	3,270 (31.2)	1,931 (25.5)	1,339 (46.4)		1,380 (29.5)	977 (26.0)	403 (44.2)	
Divorced	807 (7.7)	597 (7.9)	210 (7.3)		193 (4.1)	167 (4.4)	26 (2.9)	
Suicide method				<0.001				<0.001
Poisoning	1,018 (9.7)	500 (6.6)	518 (17.9)		274 (5.9)	150 (4.0)	124 (13.6)	
Hanging	4,203 (40.1)	3,592 (47.3)	611 (21.1)		2,968 (63.3)	2,584 (68.5)	384 (42.1)	
Jumping	3,559 (33.9)	2,203 (29.0)	1,356 (46.9)		574 (12.2)	391 (10.4)	183 (20.0)	
Other methods	1,712 (16.3)	1,306 (17.2)	406 (14.0)		870 (18.6)	648 (17.2)	222 (24.3)	

Title of figure

Figure 1. Temporal trends in suicide rates among individuals aged 65 and older by sex and area of residence

Figure 2. Temporal trends in suicide rates among individuals aged 65 and older by sex, methods and area of residence