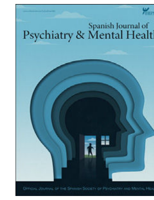
Spanish Journal of Psychiatry and Mental Health 18 (2025) 163–168

Available online at www.sciencedirect.com

Spanish Journal of Psychiatry and Mental Health

journal homepage: http://http://www.elsevier.es/sjpmh



Original

Suicide mortality in Spain (1984–2018): Age-period-cohort analysis

Lucia Cayuela[a], Agustín Sánchez Gayango[b], Paula Antona Sánchez-Trincado[c], Susana Rodríguez-Domínguez[c,*], Antonio Andrés Velasco Quiles[d], Aurelio Cayuela[e]

[a] *Servicio de Medicina Interna, Hospital Universitario Severo Ochoa, Leganés, Madrid, Spain*
[b] *Unidad de Gestión Clínica de Salud Mental, Área de Gestión Sanitaria Sur de Sevilla, Hospital de Valme, Spain*
[c] *Centro de Salud Pino Montano A. Distrito Sevilla, Spain*
[d] *Comunidad Terapéutica, Unidad de Salud Mental, Hospital Universitario Virgen Macarena, Sevilla, Spain*
[e] *Unidad de Gestión Clínica de Salud Pública, Prevención y Promoción de la Salud, Área de Gestión Sanitaria Sur de Sevilla, Hospital de Valme, Spain*

ARTICLE INFO

Article history:
Received 17 March 2020
Accepted 24 May 2020
Available online 13 July 2020

Keywords:
Suicide
Epidemiology
Mortality
Trends
Age-period-cohort analysis

ABSTRACT

Objective: To assess the effects of age, period and cohort suicide mortality trend in Spain (1984–2018).
Methods: Mortality and population data were obtained from the National Institute of Statistics. The analysis of the effect of age, period of death and birth cohort on the evolution of suicide mortality in the period 1984–2018 was performed using a web tool for age-period-cohort analysis provided by the Division of Cancer Epidemiology and Genetics of the National Cancer Institute of the USA.
Results: Rates increase with age (age effect) in both sexes. The period effect shows, in males, an increase over the period 1984–1998 followed by a significant decrease until 2018. In females, rates remain stable over the period 1987–2002, decrease during 2007–2012 ($p < 0.05$) and eventually stabilise. In both males and females, the risk decreases in each successive birth cohort between 1904 and 1939. Subsequently, the risks increase until the birth cohort of the period 1964–1974 after which the risk decreases for males and remains stable for females.
Conclusion: A better understanding of the effects of the birth cohort could open new doors in suicide prevention.

Introduction

Despite the observed decline in age-adjusted mortality rates since 1990, suicide remains a major cause of preventable mortality worldwide (an estimated 817,000 deaths by suicide in 2016, 1.5% of all deaths).[1]

The most recent trends in suicide mortality in Spain show differences according to sex and age at national level[2] (increase of 4.5% per year in the period 2010–2016 in females whereas in males they remain stable) and between the different autonomous communities.[3]

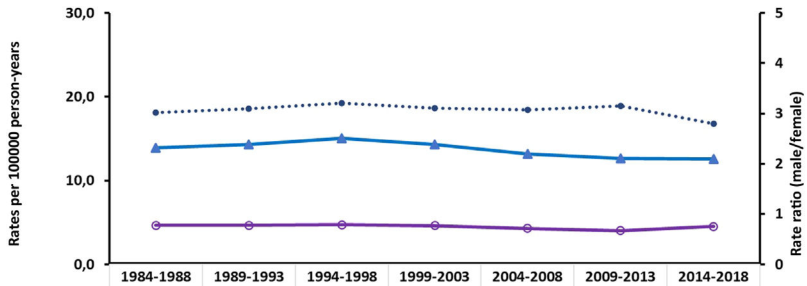
Age-period-cohort analysis has been widely used for decades to assess the nature and character of observed time trends in the prevalence/incidence/mortality of numerous health problems towards improving understanding of the factors involved in these trends. This can be achieved by estimating the effects of these three time-dependent components on rates separately, so that the researcher can consider each component independently of the other two. This type of analysis has already been adopted to assess suicide mortality in many developed countries.[4–6] We found only one study in Spain, published in 1996, which analysed trends in suicide mortality (1959–1991) using an age-period-cohort analysis.[7]

The age effect represents a change in rates associated with age (physiological changes, accumulation of social experience, changes in social role or status, or a combination of these). This effect is always important, as the occurrence of certain events tends to increase with increasing age. The period and cohort effects together represent changes in rates associated with time. The period effect represents changes in rates due to factors occurring at a point in time and influencing all age groups simultaneously (wars, economic crisis, introduction of new treatments). The cohort effect is associated with factors that affect a generation (habits or long-term exposures) and causes changes in rates of different magnitude in successive age groups and in successive periods.[8]

Taking all of the above into account, our objective was to provide updated information on suicide mortality in Spain, and to analyse

* Corresponding author.
E-mail address: susana.rodriguez.dominguez@gmail.com (S. Rodríguez-Domínguez).

https://doi.org/10.1016/j.rpsm.2020.05.010



	1984-1988	1989-1993	1994-1998	1999-2003	2004-2008	2009-2013	2014-2018
Males	13,9	14,3	15,1	14,3	13,2	12,7	12,6
Females	4,6	4,6	4,7	4,6	4,3	4,0	4,5
H/M	3,0	3,1	3,2	3,1	3,1	3,2	2,8

Five-year period

Fig. 1. Adjusted suicide mortality rates per 100,000 person-years by sex and five-year period. Male/female rate ratios. Spain 1984–2018.

recent changes in mortality trends in the period 1984–2018 using age-period-cohort analysis.

Patients and methods

Mortality data by age and sex were those published by the Spanish National Institute of Statistics (INE) for the years 1984–2018. Deaths by suicide were used (codes E950-E959 and X60-X84, Y87.0 of the 9th and 10th revisions of the International Classification of Diseases (ICD) for the periods 1984–1998 and 1999–2018 respectively). The populations estimated on 1st July by the INE were used to calculate indicators.

For each sex, standardised rates (all ages) were calculated by the direct method, using the European population as the reference and expressed as rates per 100,000 person-years.

For the age-period-cohort analysis, mortality and population data were organised into seven consecutive five-year periods from 1984–1988 to 2014–2018, 15 five-year age groups from 10–14 years to 80–84 years, and 21 birth cohorts identified by their central year of birth from 1904 to 2004. Because suicide in children under 10 years of age was very rare and persons over 85 years of age were only recorded as one group in the INE database, they were not considered in this study.

The age-period-cohort analysis was performed using Poisson models following the estimable functions approach to avoid the problem of non-identifiability (given the linear relationship between age, period, and cohort).[9] If these functions are identified, no additional assumptions are needed to constrain the parameters, because any of the maximum-likelihood models allow the same results to be obtained for them. In this study, we focus on the following estimable functions: linear trend or net drift indicating the annual percentage change in age-adjusted rates, local drifts indicating the annual percentage change in age-specific rates, cross-sectional age curve (expected age-specific rates in the reference period, adjusted for the cohort effect), the period (or cohort) rate ratio would be the relative risk (RR) of the age-adjusted period (or cohort) and the non-linear cohort (or period) effects in a period (or cohort) versus the reference period.

Age-period-cohort analyses were performed using a web-based tool provided by the Division of Cancer Epidemiology and Genetics at the US National Cancer Institute (http://analysistools.nci.nih.gov/apc/),[10] which has been used in studies on suicide.[11] We used the web tool's default reference values (age ranges, period, and average cohort) as reference points for the calculations.

The Wald test was used to determine significance and p-values less than .05 were considered statistically significant.

Results

Fig. 1 shows the age-adjusted suicide mortality rates (all ages) by sex and five-year period and the male/female rate ratio.

Fig. 2 shows the specific rates by age group and sex in the first and last five years of the study.

Fig. 3 shows for each age group the annual percentage change (local drifts) by sex for the whole study period. For males the estimated annual percentage change (net drift) for the included age groups (10–84 years) was −.5% ($p<.05$) and for females −.3% ($p<.05$).

The estimators obtained from the final age-period-cohort model are shown in Fig. 4 and Fig. 5 for males and females, respectively.

The age effect (cross-sectional age curve) is represented on a logarithmic scale because the specific rates increase exponentially in relation to this variable and are interpretable as expected age-specific mortality rates in the reference period adjusted for cohort effects.

Period and cohort effects can be interpreted as age-specific rate ratios (RR) in each period or cohort in relation to the reference period or cohort.

The period effect shows, in males, a slight increase during the period 1986–1996 followed by a significant decrease until the end of the study period. In females, the rates remain stable during the period 1986–2001, decrease slightly during 2001–2012 ($p<.05$) and stabilise at the end.

In both males and females the risk decreased in each successive birth cohort born between 1904 and 1944. Subsequently, the risks increased until the cohorts born around 1969, after which the risk decreased in males, whereas in females it stabilised until 1994 when it began to increase (although without reaching statistical significance).

Discussion

Our study analysed trends in suicide mortality in Spain over the last 35 years using an age-period-cohort analysis by sex. Suicide rates have declined discretely over the last 35 years (−.5% per year in males and −.3% per year in females).

As expected, this study showed that sex and age are major factors in explaining suicide rates in Spain.

The rate ratio between sexes (male/female) differs greatly by country and age. Our results (Fig. 1) show that it ranges between 3.1 and 3.9 (mean 3.5) over the study period. This is consistent with findings in other studies in Western countries[12] where the adjusted rate ratio is 3–4:1, while in Eastern countries it is usually <2:1.[13]

The age effect has been the component most strongly related to changes in suicide mortality rates in other studies, sometimes for both sexes or only for males.[14]

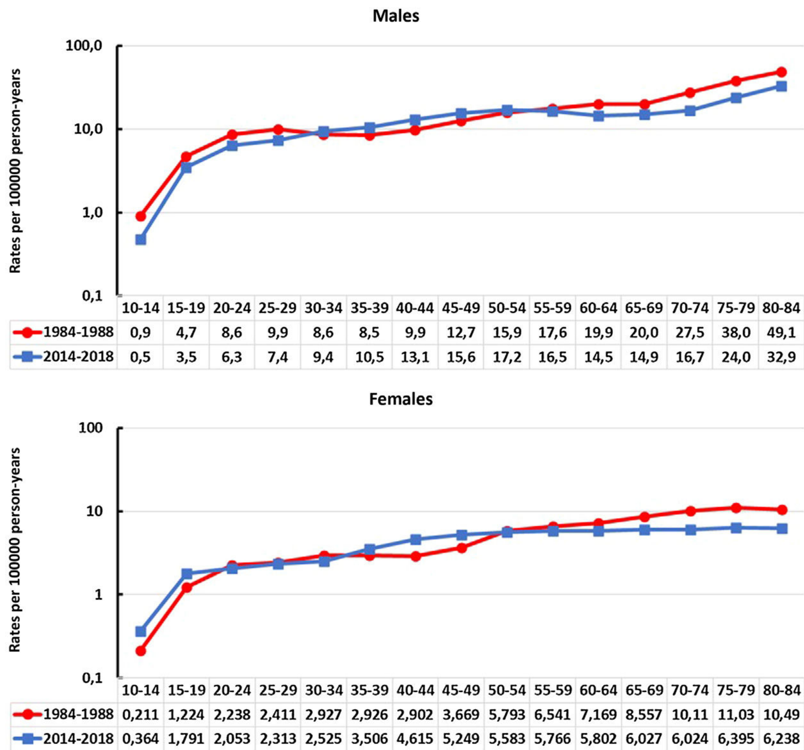


Fig. 2. Specific rates by age group and sex in 1984–1989 and 2014–2018. Suicide mortality in Spain 1984–2018.

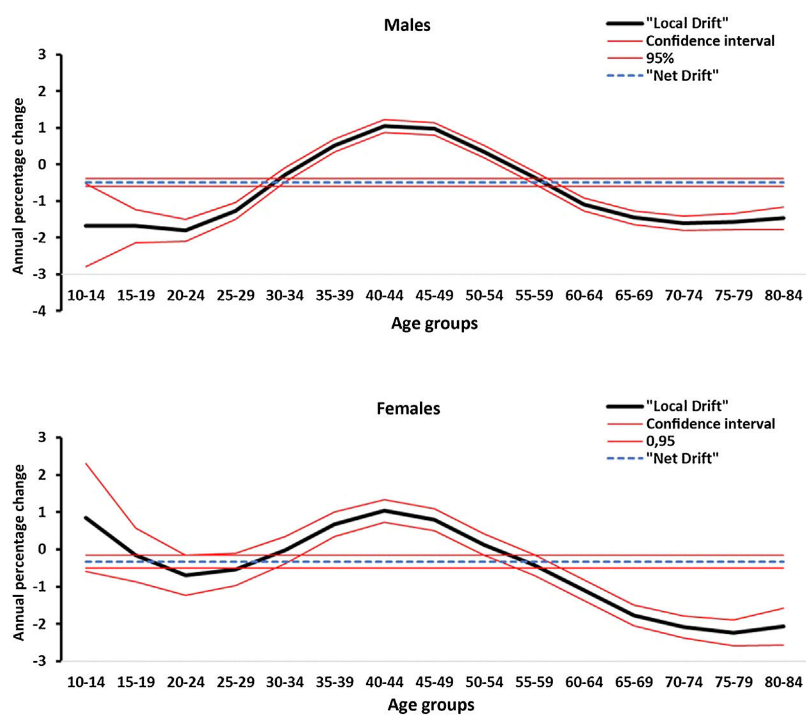


Fig. 3. Annual percentage change (local drifts) and 95% confidence interval by age group and sex for the entire study period. Percentage change in all age groups (net drift) and 95% confidence interval.

In our findings we observed that in both sexes the rates increase according to age (Figs. 2, 4 and 5) throughout the study period. This may be due to physiological changes, life experiences, changes in social role or status, or a combination of these.[15] The reason suicide risk peaks in old age is probably because retirement, death of a family member (especially spouse) and/or friends, physical limitations to mobility and serious illness can result in greater isolation in later life.[16] This has considerable implications because, due to ageing of the population, the baby boomer cohort, and longer life expectancy, an increase in the number of suicides could be expected if appropriate preventive measures are not taken.

Suicide patterns by age (that is, variations in suicide rates across the life cycle from childhood to old age) differ between countries

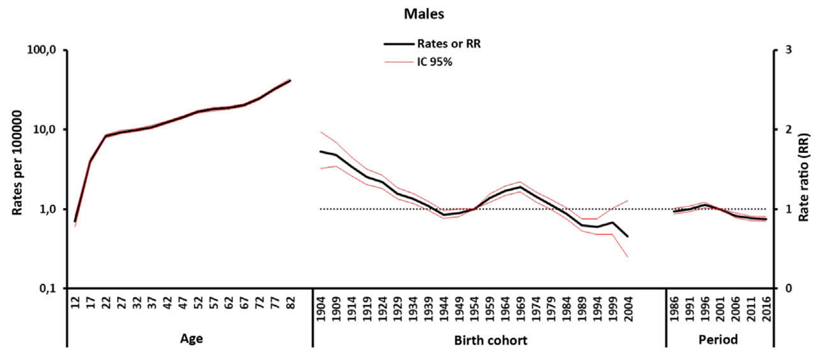


Fig. 4. Estimated age-period-cohort effects. Suicide mortality in males, Spain 1984–2018.

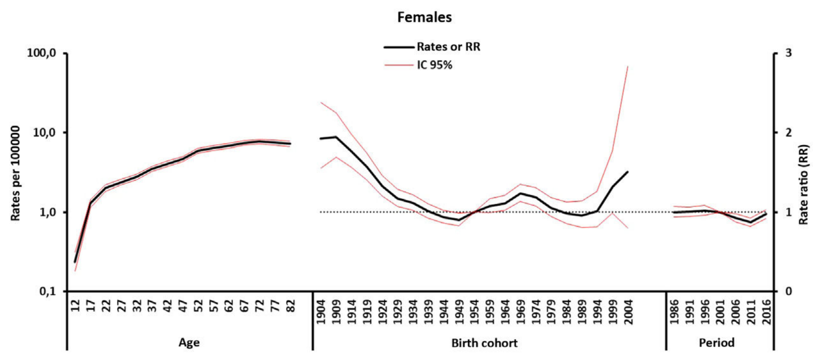


Fig. 5. Estimated age-period-cohort effects. Suicide mortality in females, Spain 1984–2018.

and, within countries, by population groups characterised by gender, race/ethnicity, and social class and differ over time.[17]

Our results show relevant changes in the age profile of suicide rates over time (Fig. 2). In both sexes, a significant downward trend has been observed in older age groups (≥60 years), although higher in females than in males (Fig. 3). A similar trend has been observed in Australia, Belgium, Canada, France, Italy, the Netherlands, the United Kingdom, and the United States, where death rates from suicide in old age are lower in 2005 than in 1985, and it has been suggested that the decline in suicide rates in old age can be partly attributed to improved socio-economic conditions for older people and the recognition and treatment of physical and mental disorders.[18] Because the number and proportion of older people in the population will increase substantially in coming decades, more research is needed to better understand the causes of the downward trend observed.

In Spain, males aged 35–54 years show upward trends with a peak of around 1% per year in the 40–49 age groups and in females a significant increase is observed in the 35–49 age groups (Fig. 3). Something similar was observed in the US white population[15] and was attributed to the fact that the baby boomer birth cohort may have a unique suicide risk that they carry with them throughout life.[19]

A major concern, from a public health perspective, is that certain birth cohorts may be more predisposed to suicide as they age. Such a cohort effect could arise due to exposure to factors during development or early adulthood. Adversity in childhood, including physical and sexual abuse, inadequate care due to parental death or separation, or traumatic experiences (such as war) increase the risk of suicidal behaviour and mental disorders throughout the life cycle.[16] Typical social variables that drive birth cohort effects are opportunities for education, career attainment, the possibility of living with a partner or, more generally, the relative size of a cohort with respect to other cohorts, thus determining cohort-specific life chances.[20]

In Spain (Figs. 4 and 5), for both sexes, in successive birth cohorts from the beginning of the 20th century until 1939–1949 there was gradually a lower suicide risk throughout their lives. After the end of the Civil War the risk increases until it peaks in the late 1960s (middle-aged people during the economic crisis of 2008),[21] thereafter the risk decreases for males and stabilises for females until 1994, when it starts to increase (although without reaching statistical significance).

Our data show that both effects (period and cohort) have influenced suicide mortality rates in Spain in both sexes and the pre- and post-Civil War cohort effect is consistent with that observed in a study published in 1996 (limited to birth cohorts prior to 1979).[7] In other Western countries, a higher risk of suicide was also observed in successive cohorts born in the post-war periods.[22] This reinforces the idea that post-war cohorts are a group at increased risk of suicide and should therefore be a target population for future preventive activities.

Some studies have attributed the cohort effect to increased alcohol and illicit drug abuse, because it is known that addictive behaviour is usually determined at an early age and differs from birth cohort to birth cohort.[23]

From a strategic perspective, the sex-specific differences in younger cohorts (decreased risk in males and stabilisation in females) are not only an important challenge but also a promising opportunity to improve understanding of the underlying mechanisms. Different mechanisms may be at work for birth cohort effects in males and females and any hypotheses must be adjusted for this possibility.[20] An increase in risk (although not reaching statistical significance) will require further follow-up of these cohorts to establish the permanence of the described cohort effect in the coming years. Previous studies have shown that cohort effects underpin the increasing suicide mortality observed among younger age groups.[24] In Scotland, the risk of suicide increased for those born between 1960 and 1980, especially for those living in more deprived areas, resulting in an increase in age-standardised rates for suicide among young adults during the 1990s.[25]

A complex web of factors underlies suicide mortality, including risk factors and protective factors at the individual, family, and community levels.[26] Possible causes of the observed decline (mainly in males) include improvements in medical care, in terms of accessibility to diagnosis and treatment of mental disorders, improved educational attainment, and increased awareness of suicide in the population[27] in cohorts born in the late 1960s. Increased education may also improve problem-solving skills, conflict resolution, and dispute management skills, which are protective factors.

Our estimates show, after an initial period in which the risk remains stable, a period of declining risk in both sexes. In males the decline starts in 1996 and lasts until the end of the study period and in females it starts in 2004 but only lasts until 2011 when the risk stabilises (Figs. 2 and 3).

Economic conditions could be a factor influencing suicide rates in certain years in all age groups (period effect).[28] Austerity measures were introduced in Spain at the end of 2011, involving drastic cuts in the public sector (including health, education, and social services).[29] It could be thought that some of these measures, such as reductions in payments under the Dependency Law, would have affected females more given their predominant role as caregivers[30] and this would be reflected in the different trend in suicide risk by gender observed.

The unemployment rate and its relationship with economic indicators has been related to high suicide mortality in Spain as a whole and in some autonomous communities some years after the beginning of the 2008 financial crisis.[31] However, the hypothetical relationship between the economic recession and the increase in suicides in Spain is a matter of debate and, therefore, specific analytical studies are needed to shed light on the role of recent socio-economic changes in suicide mortality trends and to help establish preventive strategies.[32]

In other countries the effect of the 2008 crisis showed different effects. In some countries rates increased (Greece, the Netherlands, and the United Kingdom), while in others the pre-crisis downward trends came to a halt (Germany and Italy).[33]

In Spain, the decrease in suicide rates could be explained, at least in part, by the more extensive use of antidepressant medication and general improvements in mental health services, which have been deinstitutionalised and decentralised.[34]

Historical or social events that occur over a given time period and affect all age groups create period effects, but in so far as such events have a differential impact according to the life course stage at which they are experienced, they may produce cohort effects. Certainly, the impact of some social changes on individuals depends in part on their age and social circumstances at the time. For example, economic shocks, a period effect, are likely to have a disproportionate impact on those in middle age who are breadwinners, creating a cohort effect like the one we observed.

While some studies have found the cohort effect to be of little importance for changes in suicide mortality compared to the period effect, others have found the cohort effect to be more important than the period effect and some, like us, have found both effects to influence changes in suicide mortality.[7,14]

Strengths and limitations of the study

The long study period (1984–2018) is a strength of the study, and therefore the ability to provide a systematic analysis of long-term trends in suicide mortality in Spain.

The study is based on official data that may be affected by problems of underreporting and misclassification.[35] However, despite a possible underestimation of cases, Spain has demonstrated good reliability of suicide mortality statistics.[36] In addition, since 1982, some regional health administrations have assumed responsibility for verifying and confirming death certificates with unspecified causes of death,[37] and it has been observed that the trend obtained using only deaths classified as suicidal and the trend obtained using deaths classified as suicidal plus deaths of undetermined intent are very similar.[38] Over the study period, there was a transition from the 9th to the 10th revision of the International Classification of Diseases. Fortunately, existing research suggests that these changes did not have a substantial impact on the analysis of temporal trends in suicide in our context.[39]

The cohort effects of the young and the very old should be interpreted with caution because number of observations in both groups are few and their standard errors are larger than in other groups; therefore, we have focused on the general patterns of cohort effects in the middle-aged range.

Given the ecological design (based on aggregated data) of our study, the level of inference of its estimates is also aggregated, otherwise there would be a potential ecological fallacy.[40]

Despite their limitations, age-period cohort analyses are useful strategies to describe trends more accurately.

Conclusions

Although progress has been made in Spain in reducing suicide mortality in recent decades, suicide remains a major preventable public health problem. Its importance and the complexity of its aetiology justify epidemiological surveillance to better assess the associated risk factors and improve prevention.

Age-period-cohort analysis shows that, in the same birth cohort, the risk of death by suicide increases exponentially with age for both sexes. Period and cohort relative risks show a similar pattern for both sexes (albeit with nuances) over the entire period.

A better understanding of birth cohort effects could open new doors to suicide prevention.

Funding

No funding was received for this work.

Conflict of interests

The authors have no conflict of interests to declare.

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