BMJ Open

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028267
Article Type:	Research
Date Submitted by the Author:	29-Nov-2018
Complete List of Authors:	López-Contreras, Natalia Rodríguez- Sanz, Maica; Barcelona Agency of Public Health, ; CIBER Epidemiología y Salud Pública (CIBERESP), Novoa, Ana; Agència Salut Pública de Barcelona, Borrell, Carme Medallo Muñiz, Jordi; Institut de Medicina Legal i Ciències Forenses de Catalunya Gotsens, Merce; Barcelona Agency of Public Health, ; CIBER Epidemiología y Salud Pública (CIBERESP),
Keywords:	Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH, SOCIAL MEDICINE

Title

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Authors

*Natalia López-Contreras [1,2,] Maica Rodríguez-Sanz [1,2,3,4] , Ana M. Novoa [2,3] , Carme Borrell [1,2,3,4], Jordi Medallo [5] , Mercè Gotsens [2,3]

Affiliation

[1] Universitat Pompeu Fabra, Spain
[2] Agència de Salut Pública de Barcelona, Spain
[3] Institut d'Investigació Biomèdica (IIB Sant Pau). Barcelona, Spain
[4] CIBER Epidemiología y Salud Pública (CIBERESP), Spain
[5] Institut de Medicina Legal i Ciències Forenses de Catalunya, Spain

***Corresponding author:**

Natalia López-Contreras
Plaça Lesseps 1 08023 Barcelona, Spain
nlopez@aspb.cat
+34 932027827

Word Count: 2731 words

Keywords

SUICIDE, Health inequalities, SOCIO-ECONOMIC, MORTALITY

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Abstract

Background: Suicide rates are often considered a measure of a country's emotional well-being, especially in times of economic crisis, but few studies have analyzed the socioeconomic inequalities in suicide in that period. This study analyzes the trends of socioeconomic inequalities in mortality by suicide in Barcelona before and after the start of the recent economic crisis.

Methods: We conducted a trend study of three time periods: pre-economic crisis (2006-2008), early crisis (2009-2012) and late crisis (2013-2016). We analyzed the number of suicides among Barcelona residents in relation to individual variables, and contextual variables related to the neighborhood of residence. We calculated age-standardized suicide mortality rates according to the independent variables, and fit Poisson regression models to obtain the relative risks (RR) for each time period.

Results: During 2006-2008, men with a lower level of education were more likely to commit suicide than more well-educated men. This difference disappeared after the onset of the crisis. We found no differences among women. During 2013-2016, suicide risk increased among men living in neighborhoods with higher unemployment levels and among women living neighborhoods with a higher proportion of elderly people living alone.

Conclusions: We observed risks of suicide among men living in neighborhoods of Barcelona with higher unemployment levels, and women living in neighborhoods with a higher proportion of elderly people living alone. In addition, inequalities in suicide mortality according to educational level tended to disappear during the crisis. Thus, it is important to continue monitoring suicide determinants especially in times of economic crisis.

Strengths and limitations

Data were obtained from Barcelona's Judicial Mortality Registry, which is up-to-date and prevents underreporting suicide as a cause of death.

The analysis includes socioeconomic variables, both social and material, which prove to be very useful for suicide surveillance during the economic crisis.

The low number of suicides in Barcelona, especially among women, hindered the detection of significant associations and stratified analyses.

A change in Barcelona's territorial divisions in 2009 made it difficult to obtain contextual data for the time periods studied.

Introduction

Suicide is a major problem for public health. Suicide rates are often considered as measure of a country's emotional well-being(1), especially in times of economic crisis such as that experienced by western countries since 2008.

Suicide, like other health issues, is conditioned by various social determinants. We have summarized these determinants in a conceptual framework (Fig. 1), drawing upon information presented previously by the *Commission on Reducing Social Inequalities in Spain* (Comisión para Reducir las Desigualdades Sociales en Salud en España)(2). These determinants can be classified as either structural or intermediary. In terms of structural determinants, both socioeconomic and political features of a country can influence suicide mortality rates. As macroeconomic and welfare state policies depend on the government in power and also on political traditions, austerity measures and reduced social benefits implemented during an economic crisis tend to increase suicide rates(3). In addition, social cohesion is known to be a protective factor against suicide, with previous studies showing that high social trust (as part of social capital)(4,5) and high electoral participation (voter turnout) are associated with fewer suicides(6,7). Intermediary determinants, which are very important for suicide risk, can be divided into material and social resources. Higher rates of suicide are known to occur in areas with greater levels of unemployment(8) or less social or family support, as measured by the proportion of people living alone(9). Moreover, mental illness is also a risk factor for suicide, and is involved in a high percentage of cases(10). As all these determinants change according to the axes of inequality, they influence suicide in a non-uniform way. For example particular groups are more affected, such as men(11), both young and old adults(8,12), and individuals with a poorer socioeconomic position - whether it be in terms of education, income or occupation(12–16).

While many studies have analyzed trends in suicide mortality during economic crises(17), few have examined concurrent trends in socioeconomic inequalities in suicide mortality during these periods. These latter studies have observed greater suicide mortality among men of manual social class(18) or with a lower level of education(19). However, a more recent study conducted in Spain showed that the trend in educational inequalities in suicide mortality was stable among men before and during the latest economic recession(20). Thus, further studies are required to investigate the impact of the economic crisis on social inequalities in suicide mortality are required.

The objective of our study was to analyze trends in socioeconomic inequalities in suicide mortality in Barcelona before and after the onset of the recent economic crisis, taking into account both individual factors and contextual factors such as the deceased's neighborhood of residence.

Methods

Design and information sources

We performed a trend study of the period 2006-2016, including all Barcelona residents aged >25 years. We gathered information from the Judicial Mortality Registry (maintained by the Catalan Institute of Legal Medicine and Forensic Sciences and Barcelona's Municipal Population Census) and the Drug Addiction Information System maintained by Barcelona Public Health Agency, the city's Municipal Population Census, and the Department of Statistics of Barcelona City Council.

Variables and indicators

The dependent variable in our study was suicide mortality: codes X60-X84 of the International Classification of Diseases (ICD-10).

Individual explanatory variables were: i) level of education ("primary education or lower" or "secondary education or higher") as an indicator of individual socioeconomic position, ii) country of birth ("Spain" or "elsewhere"), iii) neighborhood of residence, and iv) year of death ("pre-economic crisis" [2006-2008], "early crisis" [2009-2012], or "late crisis" [2013-2016]). We used gender as a stratification variable and age as an adjustment variable.

Contextual explanatory variables related to the neighborhood of residence were chosen based on the conceptual framework (Fig. 1): i) level of unemployment (in terms of the average annual percentage of individuals enrolled in the Employment Service of Catalonia) among individuals aged 16-64 years in 2011, ii) the percentage of individuals aged >65 years who lived alone in 2008, iii) the percentage of individuals who participated in general elections in 2011, and iv) the index of high-risk drug use in 2015 (a synthetic index that evaluates drug use by combining five indicators: the incidence of treatment initiation for substance abuse, the incidence of overdose-induced mortality according to place of residence and place of death, the incidence of drug-related hospital emergencies, and the incidence of syringes found in the streets).

Data analysis

All analyses were carried out using STATA 13 program, and were stratified by gender.

First, we directly calculated age-standardized suicide mortality rates (ASMR) according to gender, level of education, and country of birth, for each time period using the study population described above.

Second, we calculated age-standardized suicide mortality rates for the neighborhoods represented in the quartile maps. We calculated the Spearman correlation between suicide mortality rates and the contextual variables.

Finally, due the hierarchical structure of the data, we conducted a multilevel analysis by fitting a Poisson regression model with a random neighborhood effect (random constant) to control for variability between neighborhoods. As we found no significant variability, we decided to fit Poisson regression models including individual and contextual neighborhood variables to estimate relative risks (RR) and 95% confidence intervals (95% CI). Initially, we fit a model containing the individual variables and a term representing the interaction between educational level and time period. In subsequent models, we added a different contextual variable together and a term representing the interaction between this variable and the time period, thereby generating four different models. We evaluated the model fit using the deviance and likelihood ratio between nested models. We then estimated trends in the associations for each variable using the time period as a continuous variable in the model.

Results

Between 2006 and 2016, 1,178 residents of Barcelona aged >25 years committed suicide. For 996 of these individuals, we were able to retrieve information regarding their education levels and neighborhoods of residence. In total, 69.6% (n=722) of the study population were men.

We observed a decrease in the age-standardized suicide mortality rate among men during the study period (Table 1), while that among women remained stable. In all three periods the suicide mortality rate was higher among men than women, and among men born in Spain than among those born elsewhere, although this difference decreased with time. In terms of education level, the rate of suicide between 2006 and 2008 was higher among men with a lower level of education. However, in this group of men the rate decreased in the other time periods, while men with a higher level of education had a higher rate that was stable over time.

Among women, the highest suicide rates were observed during the pre-crisis period (2006-2008) among those born outside of Spain. In this group of women, the rate decreased in the other time periods, while the rate for women born in Spain was higher. Regarding level of education, women with a higher level of education had higher suicide mortality rates in all three periods, and this rate remained stable over time among in this group, and also in women with a lower level of education.

Our analysis of the distribution of suicide mortality in the various neighborhoods of Barcelona (Fig. 2) did not reveal any clear pattern for men or women in any of the time periods.. Table 2 shows the Spearman correlations between suicide mortality rates and the contextual explanatory variables, and shows that suicide mortality in men is positively correlated with the index of high-risk drug use, and negatively correlated with voter turnout. In contrast, suicide mortality among women is positively correlated with voter turnout, and with the proportion of elderly people living alone. Unemployment was not significantly correlated with suicide rate in either men or women, although the correlation in men tended to be opposite to that in women. The distribution in quartiles across the neighborhoods of Barcelona of average annual percentage of unemployed individuals, 2011; the percentage of people aged >65 years who live alone, 2008; the percentage of participation in general elections, 2011; and the index of high-risk drug use, 2015 is in Supplementary Figure 1.

Table 3 summarizes the associations between suicide mortality in men and the individual and contextual characteristics for the three time periods studied. During the pre-crisis period, less well-educated men were more likely to commit suicide than those with a higher level of education (RR=1.46; 95%CI: 1.11-1.91), whereas the level of risk in each group was similar during the early (RR=0.96; 95%CI: 0.72-1.28) and late (RR=1.04; 95%CI: 0.77-1.40) crisis periods. While men living in areas with high unemployment (3rd quartile) had greater risk of suicide during the early crisis (RR=1.56; 95%CI: 1.08-2.25), those living in areas with the highest unemployment had greater risk during the late crisis period (RR=1.57; 95%CI: 1.09-2.25). During the pre-crisis period, men living in neighborhoods in the 4th quartile of voter turnout were less likely to commit suicide (RR=0.55; 95%CI: 0.40-0.90), as were men living in areas in the 3rd quartile during the late crisis period (RR=0.53; 95%CI: 0.37-0.78). Nonetheless, the greatest risk was observed during the early crisis period among men living in 2nd quartile areas (RR=1.61; 95%CI: 1.05-2.46), with significant variation in risk over time. In addition, the index of high-risk drug use was a risk factor during the pre-crisis period among men living in 4th

quartile neighborhoods (RR=1.53; 95%CI: 1.04-2.24), and in the early crisis period among those living in 3rd quartile neighborhoods (RR=1.66: 95%CI: 1.16-2.37).

Table 4 summarizes the associations between suicide mortality in women and the individual and contextual characteristics for the three time periods studied. Regarding level of education, we found no statistically significant differences in suicide risk for any of the periods. In contrast unemployment proved to be protective against suicide during the late crisis among women living in neighborhoods in the 3rd quartile of unemployment (RR=0.48; 95%CI: 0.27-0.84). Finally, women living in neighborhoods with the highest proportions of elderly people living alone were generally more likely to commit suicide during the late crisis period (RR=2.13; 95%CI: 1.15-3.93), although this risk did not vary significantly over time.

Discussion

In this study, we analyzed trends in socioeconomic inequalities in relation to suicide mortality in Barcelona. We found that after the onset of the economic crisis, inequalities in suicide rates according to level of education tended to disappear in men, suicide risk tended to increase among men living in neighborhoods with higher unemployment. Among women, we did not find any inequalities in relation to education level, but observed higher suicide risk in the late crisis period among those living in neighborhoods with a higher proportion of elderly people living alone.

Several studies have reported an association between suicide mortality and lower education levels(12–14), but few have evaluated the effect of economic crises. Studies in the United States(21) and in Asian countries(19) found that inequality according to level of education remained stable or even increased during economic recession. This contrasts with our results, in that we found that suicide mortality decreased among men with a lower level of education and remained stable among men with a higher level of education. This suggests that the economic crisis in Barcelona has had a greater effect on men with a socioeconomic advantage, possibly because labor market restructuring created additional work-related stress and a feeling of job insecurity. In such a scenario, men with greater responsibilities could experience a more negative response, and a decline in mental health(22). This notion is supported by the results of a Norwegian study(23) that found that suicide rates were higher among women with a higher level of education.

There is abundant evidence on the association between unemployment levels and suicide, especially during times of economic crisis(8,24,25). Consistent with this evidence, we found that, during the early (2009-2012) and late (2013-2016) crisis periods, men living in areas with higher unemployment were more likely to commit suicide. In women, we found the opposite, with those living in neighborhoods with high unemployment being less likely to commit suicide.

It is widely accepted that poor mental health is associated with suicide mortality(10). During the economic crisis in Spain, men experienced a general deterioration in mental health(26), especially those from lower socioeconomic classes. We observed general correlation between suicide and the indicator for substance consumption, although note that we did not have access to the relevant individual information to properly support this assertion, so it may be susceptible to ecological fallacy. More specifically, we found that men living in neighborhoods with problematic drug consumption had higher risk of suicide (although the statistical significance of this decreased in the late crisis period).

The material and social factors that influence suicide mortality appear to differ between men and women, which may be because traditional gender roles create more pressure on men in terms of economic income and unemployment. In contrast, job loss among women is culturally more accepted since women typically find psychological compensation in their family role(27). According to studies on masculinity, this could also be associated with the fact that men are less likely to express their feelings and seek support in social networks when they need help regarding their mental health(28). In contrast, increased suicide risk among women is more likely to be due to alterations in social factors than to alterations in material factors. This is confirmed by a study conducted in Denmark(29) and by our study, in that we observe greater suicide risk among women living in neighborhoods where more elderly people live alone.

One of the limitations of our study is low statistical power due to the low number of suicides in Barcelona, especially among women, which made it impossible to detect significant associations and to stratify the analyses by other variables such as age. It was also quite difficult to obtain contextual data for the time periods studied because in 2009 Barcelona underwent a change in its territorial divisions. Nonetheless, we were able to collect indicators for most determinants that are relevant for social inequalities in suicide.

The main strength of our study is that we use data from Barcelona's Judicial Mortality Registry, which not only is more up-to-date than the Mortality Registry, but also avoids underreporting suicide as a cause of death(30). Furthermore, this registry allows us to analyze social inequalities because it includes socioeconomic variables (education level, country of birth, and neighborhood of residence), and thus proves very useful for suicide surveillance during the economic crisis. Similarly, while most previous studies only analyzed variables related to material deprivation in suicide mortality, we evaluated both social and material contextual indicators.

In conclusion, we have shown that education level inequalities in suicide mortality among men tended to disappear during the crisis, although men living in neighborhoods with higher unemployment levels were still more likely to commit suicide. In contrast, we found no association between suicide and education level in women, but women living in neighborhoods with a higher number of elderly people living alone were more likely to commit suicide. Future studies should analyze the socioeconomic inequalities of suicide and further explore the causes of gender differences in suicide. Since suicide is the endpoint of a process that can be treated previously at the population level, it is also important to continue monitoring its social determinants, especially during periods of economic crisis. This could be accomplished by establishing alliances with health centers that deal with cases of attempted suicide. In this way, we could gain further insight into the phenomenon, and develop better strategies to improve the living conditions of people and preventing unnecessary deaths.

References

1. Okada K, Samreth S. A study on the socio-economic determinants of suicide: Evidence from 13 European OECD countries. J Socio Econ [Internet]. Elsevier Inc.; 2013;45:78–85. Available from: http://dx.doi.org/10.1016/j.socec.2013.04.009
2. Borrell C, Malmusi D, Artazcoz L, Diez E, Rodríguez-Sanz IP y M, Campos P, et al. Propuesta de politicas e intervenciones para reducir las desigualdades sociales en salud en España. Gac Sanit. 2012;26(2):182–9.
3. Kentikelenis A, Karanikolos M, Reeves A, McKee M, Stuckler D. Greece's health crisis: From austerity to denialism. Lancet [Internet]. Elsevier Ltd; 2014;383(9918):748–53. Available from: http://dx.doi.org/10.1016/S0140-6736(13)62291-6
4. Kelly BD, Davoren M, Mhaoláin ÁN, Breen EG, Casey P. Social capital and suicide in 11 European countries: An ecological analysis. Soc Psychiatry Psychiatr Epidemiol. 2009;44(11):971–7.
5. Smith NDL, Kawachi I. State-level social capital and suicide mortality in the 50 U.S. states. Soc Sci Med [Internet]. Elsevier Ltd; 2014;120:269–77. Available from: http://dx.doi.org/10.1016/j.socscimed.2014.09.007
6. Whitley E, Gunnell D, Dorling D, Smith GD. Ecological study of social fragmentation, poverty, and suicide. BMJ [Internet]. 1999;319:1034–7. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=28254&tool=pmcentrez&rendertype=abstract
7. De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: A systematic review. J Epidemiol Community Health. 2005;59(8):619–27.
8. Milner A, McClure R, De Leo D. Socio-economic determinants of suicide: An ecological analysis of 35 countries. Soc Psychiatry Psychiatr Epidemiol. 2012;47(1):19–27.
9. Middleton N, Whitley E, Frankel S, Dorling D, Sterne J, Gunnell D. Suicide risk in small areas in England and Wales, 1991-1993. Soc Psychiatry Psychiatr Epidemiol. 2004;39(1):45–52.
10. Turecki G, Brent DA. Suicide and suicidal behaviour. Lancet [Internet]. Elsevier Ltd; 2016;387(10024):1227–39. Available from: http://dx.doi.org/10.1016/S0140-6736(15)00234-2
11. World Health Organization. Preventing suicide. A global imperative. CMAJ. 2014;143(7):609–10.

12. Kim MH, Jung-Choi K, Jun HJ, Kawachi I. Socioeconomic inequalities in suicidal ideation, parasuicides, and completed suicides in South Korea. Soc Sci Med [Internet]. Elsevier Ltd; 2010;70(8):1254–61. Available from: http://dx.doi.org/10.1016/j.socscimed.2010.01.004
13. Lorant V, Kunst AE, Huisman M, Costa G, Mackenbach J. Socio-economic inequalities in suicide: A European comparative study. Br J Psychiatry. 2005;187(JULY):49–54.
14. Li Z, Page A, Martin G, Taylor R. Attributable risk of psychiatric and socio-economic factors for suicide from individual-level, population-based studies: A systematic review. Soc Sci Med [Internet]. Elsevier Ltd; 2011;72(4):608–16. Available from: http://dx.doi.org/10.1016/j.socscimed.2010.11.008
15. Burrows S, Auger N, Gamache P, St-laurent D, Hamel D. Influence of social and material individual and area deprivation on suicide mortality among 2 . 7 million Canadians : A prospective study. BMC Public Health. 2011;11:577.
16. Milner A, Spittal MJ, Pirkis J, Lamontagne AD. Suicide by occupation : systematic review and meta-analysis. Br J Psychiatry. 2013;203:409–16.
17. Parmar D, Stavropoulou C, Ioannidis JPA. Health outcomes during the 2008 financial crisis in Europe: systematic literature review. bmj BMJ BMJ [Internet]. 2016;354354:4588–4588. Available from: http://dx.doi.org/10.1136/bmj.
18. Valkonen T. Changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland. Eur J Public Health [Internet]. 2000;10(4):274–80. Available from: http://eurpub.oxfordjournals.org/content/10/4/274
19. Lee WY, Khang YH, Noh M, Ryu JI, Son M, Hong YP. Trends in educational differentials in suicide mortality between 1993 - 2006 in Korea. Yonsei Med J. 2009;50(4):482–92.
20. Borrell C, Marí-Dell'Olmo M, Gotsens M, Calvo M, Rodríguez-Sanz M, Bartoll X, et al. Socioeconomic inequalities in suicide mortality before and after the economic recession in Spain. BMC Public Health. BMC Public Health; 2017;17(1):1–8.
21. Harper S, Charters TJ, Strumpf EC, Galea S, Nandi A. Economic downturns and suicide mortality in the USA, 1980-2010: Observational study. Int J Epidemiol. 2015;44(3):956–66.
22. Chan CH, Caine ED, You S, Fu KW, Chang S Sen, Yip PSF. Suicide rates among working-age adults in South Korea before and after the 2008 economic crisis. J Epidemiol Community Health [Internet]. 2014;68(3):246–52. Available from:

http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=prem&NEWS=N&AN=24248999

23. Strand BH, Grøholt E-K, Steingrímsdóttir OA, Blakely T, Graff-Iversen S, Naess Ø. Educational inequalities in mortality over four decades in Norway: prospective study of middle aged men and women followed for cause specific mortality, 1960-2000. BMJ [Internet]. 2010;340(May):c654. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2827714&tool=pmcentrez&rendertype=abstract
24. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, LeWinn K, et al. The Health Effects of Economic Decline. Annu Rev Public Health. 2011;32(47):1–17.
25. Baumbach A, Gulis G. Impact of financial crisis on selected health outcomes in Europe. Eur J Public Health. 2014;24(3):399–403.
26. Bartoll X, Palencia L, Malmusi D, Suhrcke M, Borrell C. The evolution of mental health in Spain during the economic crisis. Eur J Public Health. 2014;24(3):415–8.
27. Artazcoz L, Benach J, Borrell C, Cortes I. Unemployment and mental health: understanding the interactions among gender, family roles, and social class. Am J Public Health. 2004;94(1):82–8.
28. Möller-Leimkühler AM. The gender gap in suicide and premature death or: Why are men so vulnerable? Eur Arch Psychiatry Clin Neurosci. 2003;253(1):1–8.
29. Agerbo E, Sterne JAC, Gunnell DJ. Combining individual and ecological data to determine compositional and contextual socio-economic risk factors for suicide. Soc Sci Med. 2007;64(2):451–61.
30. Gotsens M, Olmo MM, Rodríguez-sanz M, Martos D, Espelt A, Pérez G, et al. Validación de la causa básica de defunción en las muertes que requieren intervención medicolegal. Rev Esp Salud Publica. 2011;85(2):163–74.

Footnotes

Contributors
MRS and MG made substantial contributions to conception and design of this study. NLC, MRS and MG performed data analysis. All authors contributed to the interpretation of data. NLC were involved in drafting the manuscript, and the rest of the authors revised it critically for important intellectual content. All authors gave final approval of the version to be published.

Funding
This research was partially supported by the CIBER Epidemiología y Salud Pública.

Competing of interest
None.

Patient consent
Not required.

Data Sharing
No additional data available

Acknowledgements
To María Dolores Martos Hinojosa for her invaluable collaboration codifying all the judicial deaths of the Registry of Judicial Mortality of Barcelona.
To the people of the Institut de Medicina Legal i Ciències Forenses de Catalunya and Civil Registry of Barcelona who have made this study possible.

Figure 1

Conceptual framework of the determinants of inequalities in suicide. This figure has been adapted from the conceptual framework of the determinants of health inequalities developed by the Commission on Reducing Social Inequalities in Spain (Comisión para Reducir las Desigualdades Sociales en Salud en España).

Figure 2

Distribution in quartiles of age-standardized mortality rates in men during the periods (a) 2006-2008 (b) 2009-2012 (c) 2013-2016, and in women during the periods (d) 2006-2008 (e) 2009-2012 (f) 2013-2016.

Table 1

Age-standardized suicide mortality rates (ASMR)* stratified by gender, country of birth, and level of education. Barcelona, 2006-2016.

		2006 - 2008			2009 - 2012			2013 - 2016		
		n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)
Men										
Total		221	1,762,191	13.87 (12.04-15.90)	225	2,379,238	9.89 (8.62-11.29)	242	2,350,383	10.59 (9.28-12.02)
Country of birth	Spain	199	1,402,158	14.73 (12.71-16.98)	201	1,815,824	11.01 (9.53-12.66)	204	1,771,794	11.26 (9.75-12.94)
	Elsewhere	22	360,033	6.14 (3.00-13.65)	24	563,414	7.26 (3.07-14.62)	38	578,589	8.71 (4.39-15.53)
Level of education	Primary or lower	96	533,198	16.69 (13.34-20.63)	69	659,573	8.95 (6.84-11.52)	63	500,705	9.34 (6.89-12.43)
	Secondary or higher	125	1,228,993	11.71 (9.51-14.28)	156	1,719,665	9.43 (7.9-11.19)	179	1,849,678	10.09 (8.55-11.84)
Women										
Total		86	2,026,864	4.20 (3.36-5.19)	100	2,733,362	3.61 (2.94-4.4)	122	2,720,035	4.22 (3.49-5.04)
Country of birth	Spain	73	1,683,270	4.16 (3.24-5.25)	97	2,171,574	4.41 (3.55-5.41)	113	2,102,161	4.78 (3.90-5.80)
	Elsewhere	13	343,594	6.57 (2.7-13.14)	3	561,788	0.46 (0.09-2.52)	9	617,874	2.04 (0.64-4.88)
Level of education	Primary or lower	32	753,070	3.74 (2.24-5.87)	33	908,527	2.99 (1.79-4.70)	42	733,161	3.85 (2.14-6.40)
	Secondary or higher	54	1,273,794	4.47 (3.28-5.98)	67	1,824,835	3.76 (2.87-4.85)	80	1,986,874	4.27 (3.34-5.39)

*Rate per 100,000 inhabitants

Table 2

Spearman correlations between suicide mortality and the contextual variables during the three time periods. Barcelona, 2006-2016.

	ASMR 2006-2008	ASMR 2009-2012	ASMR 2013-2016
Men			
% unemployment, 2011	0.01	0.11	0.22
% elderly people living alone, 2008	0.10	0.02	0.12
% voter turnout, 2011	-0.20	0.02	- 0,28*
Index of high-risk drug use, 2015	0.13	0.02	0,25*
Women			
% unemployment, 2011	-0.12	-0.12	-0.19
% elderly people living alone, 2008	0,26*	0.16	0,39*
% voter turnout, 2011	0.19	0.02	0,23*
Index of high-risk drug use, 2015	-0.17	-0.04	-0.14

* Significant correlation, p<0.05

ASMR = Age-standardized suicide mortality rates

Table 3
Association between suicide mortality among **men** and individual and contextual factors for each time period, Barcelona, 2006-2016.

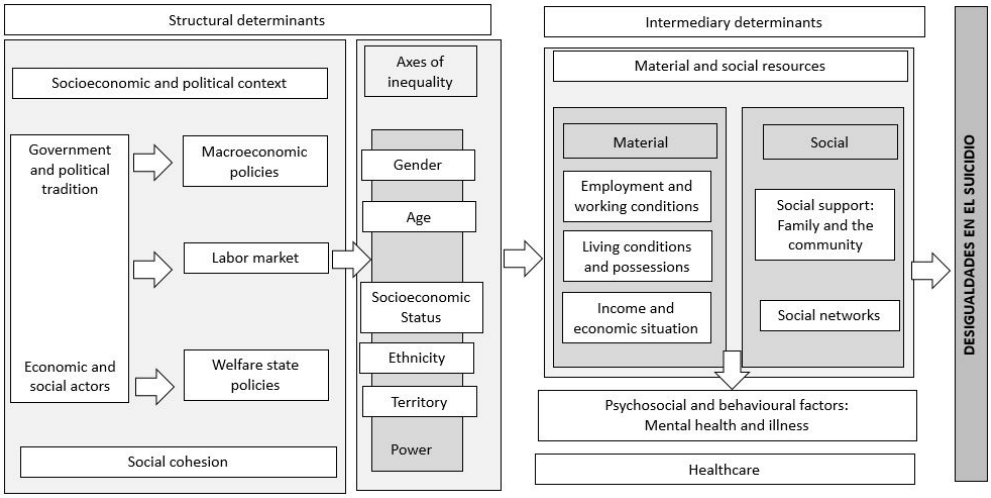
		Model 1			**Model 2**			**Model 3**			**Model 4**			**Model 5**			**p interaction**
		RR			RR			RR			RR			RR			
Men		P 1	P 2	P 3	P 1	P 2	P 3	P 1	P 2	P3	P1	P 2	P 3	P 1	P 2	P 3	
Level of education	Primary or lower	1.46*	0.96	1.04	1.46*	0.89	0.97	1.46*	0.95	1.05	1.33*	0.99	0.97	1.36*	0.92	0.98	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.081
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.97	1.41	1.16										0.212
	Q3				0.86	1.56*	1.03										
	Q4 (most)				1.04	1.36	1.57*										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.10	0.94	0.95							0.749
	Q3							0.92	0.85	0.94							
	Q4 (most)							1.30	0.88	1.22							
% Voter turnout	Q1 (least)										1.00	1.00	1.00				
	Q2										0.72	1.61	0.95				0.013
	Q3										0.60	1.13	0.53*				
	Q4 (most)										0.55*	1.19	0.78				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.08	1.08	1.03	0.192
	Q3													1.03	1.66*	1.29	
	Q4 (most)													1.53*	1.02	1.37	
Deviance		3,412.89			3,398.70			3,404.99			3,385.90			3,394.63			
p value					0.116			0.5448			0.0014			0.0323			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.

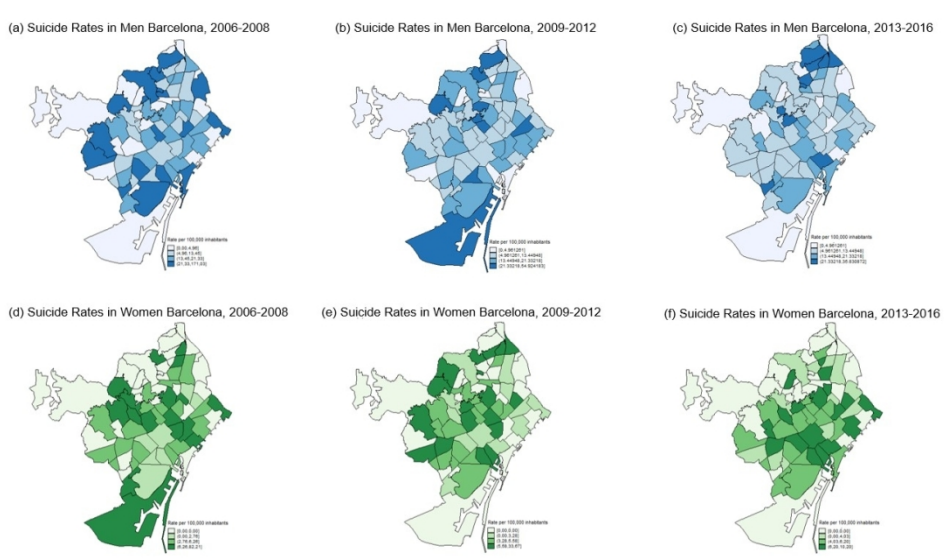
Table 4
Association between suicide mortality among **women** and individual and contextual factors for each time period. Barcelona, 2006-2016.

		Model 1			Model 2			Model 3			Model 4			Model 5			p interaction
		RR			RR			RR			RR			RR			
Women		P 1	P 2	P 3	P 1	P 2	P 3	P1	P 2	P 3	P 1	P 2	P3	P 1	P 2	P 3	
Level of education	Primary or lower	0.71	0.70	0.98	0.78	0.73	1.07	0.71	0.71	1.02	0.74	0.69	1.03	0.70	0.68	0.99	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.407
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.85	1.01	0.81										
	Q3				0.74	0.67	0.48*										0.809
	Q4 (most)				0.66	1.06	0.88										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.61	1.02	1.36							
	Q3							1.46	1.19	1.85							0.374
	Q4 (most)							1.14	1.04	2.13*							
% Voter turnout	Q1 (least)										1.00	1.00	1.00				
	Q2										1.20	0.74	1.05				
	Q3										1.20	0.82	1.17				0.927
	Q4 (most)										1.34	0.80	1.32				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.09	0.82	1.00	
	Q3													1.14	0.75	0.82	0.791
	Q4 (most)													1.09	1.35	0.93	
Deviance		1,899.06			1,886.99			1,887.73			1,896.30			1,894.52			
p value					0.210			0.254			0.973			0.873			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.



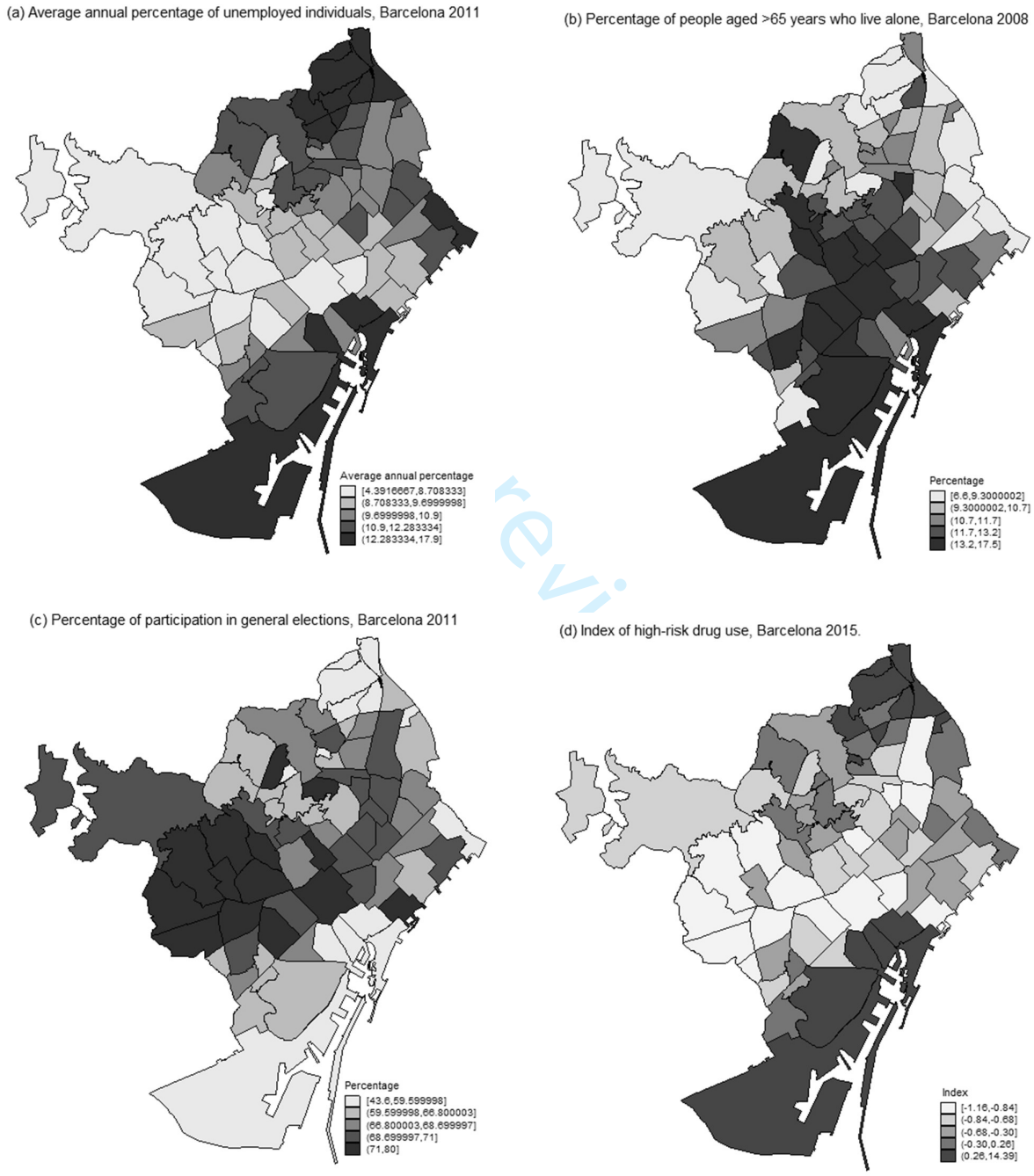
262x132mm (96 x 96 DPI)



361x203mm (96 x 96 DPI)

Supplementary Figure 1

Distribution in quartiles across the neighborhoods of Barcelona of: (a) average annual percentage of unemployed individuals, 2011; (b) the percentage of people aged >65 years who live alone, 2008; (c) the percentage of participation in general elections, 2011; and (d) the index of high-risk drug use, 2015.



BMJ Open

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028267.R1
Article Type:	Research
Date Submitted by the Author:	17-Jun-2019
Complete List of Authors:	López-Contreras, Natalia Rodríguez- Sanz, Maica; Barcelona Agency of Public Health, ; CIBER Epidemiología y Salud Pública (CIBERESP), Novoa, Ana; Agència Salut Pública de Barcelona, Borrell, Carme Medallo Muñiz, Jordi; Institut de Medicina Legal i Ciències Forenses de Catalunya Gotsens, Merce; Barcelona Agency of Public Health, ; CIBER Epidemiología y Salud Pública (CIBERESP),
Primary Subject Heading:	Public health
Secondary Subject Heading:	Mental health, Epidemiology
Keywords:	Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH, SOCIAL MEDICINE

Title

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Authors

*Natalia López-Contreras,[1,2,] Maica Rodríguez-Sanz,[1,2,3,4] Ana M. Novoa,[2,3] Carme Borrell,[1,2,3,4] Jordi Medallo,[5] Mercè Gotsens [2,3]

Affiliations

[1] Universitat Pompeu Fabra, Spain
[2] Agència de Salut Pública de Barcelona, Spain
[3] Institut d'Investigació Biomèdica (IIB Sant Pau). Barcelona, Spain
[4] CIBER Epidemiología y Salud Pública (CIBERESP), Spain
[5] Institut de Medicina Legal i Ciències Forenses de Catalunya, Spain

***Correspondence to**

Natalia López-Contreras
Plaça Lesseps 1 08023 Barcelona, Spain
nlopez@aspb.cat
+34 932027827

Word Count: 2731 words

Keywords

SUICIDE, HEALTH INEQUALITIES, SOCIOECONOMIC, MORTALITY

Trends in socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016)

Abstract

Background: Suicide rates are often considered a measure of a country's emotional well-being, especially in times of economic crisis, but few studies have analysed socioeconomic inequalities in suicide during these periods. This study aimed to analyse trends in socioeconomic inequalities in suicide mortality in Barcelona before and after the start of the economic crisis that started at the end of 2008, including both individual factors and contextual factors of the deceased's neighbourhood of residence.

Methods: We conducted a trend study of three time periods: pre-economic crisis (2006-2008), early crisis (2009-2012) and late crisis (2013-2016). We analysed the number of suicides among Barcelona residents in relation to individual variables and contextual variables related to the neighbourhood of residence. We calculated age-standardised suicide mortality rates according to independent variables and fitted Poisson regression models to obtain the relative risks (RR) for each time period.

Results: From 2006 to 2008, men with a lower educational level were more likely to commit suicide than better educated men. This difference disappeared after the onset of the crisis. We found no differences among women. From 2013 to 2016, suicide risk increased among men living in neighbourhoods with higher unemployment levels and among women living neighbourhoods with a higher proportion of elderly people living alone.

Conclusions: We observed risks for suicide among men living in neighbourhoods of Barcelona with higher unemployment levels, and women living in neighbourhoods with a higher proportion of elderly people living alone. Inequalities in suicide mortality according to educational level tended to disappear during the crisis among men. Thus, it is important to continue to monitor suicide determinants especially in times of economic crisis.

Strengths and limitations of this study

- Data were obtained from the Judicial Mortality Registry of Barcelona, which is up-to-date and prevents underreporting of suicide as a cause of death.
- The analysis includes socioeconomic variables, both social and material, which proved to be very useful for suicide surveillance during the economic crisis.
- The low number of suicides in Barcelona, especially among women, hindered detection of significant associations and stratified analyses.
- A change in Barcelona's territorial divisions in 2009 hampered collection of contextual data for the time periods studied.

INTRODUCTION

Suicide is a major problem for public health. Suicide rates are often considered as a measure of a country's emotional well-being,(1) especially in times of economic crisis such as that experienced by western countries since 2008.

Like other health issues, suicide is influenced by various social determinants. We have summarised these determinants in a conceptual framework (figure 1), drawing on information previously presented by the *Commission on Reducing Social Inequalities in Spain* (Comisión para Reducir las Desigualdades Sociales en Salud en España).(2) These determinants can be classified as either structural or intermediary. In terms of structural determinants, both the socioeconomic and political features of a country can influence suicide mortality rates. Because macroeconomic and welfare state policies depend on the government in power, as well as on political traditions, austerity measures and reduced social benefits implemented during an economic crisis tend to increase suicide rates.(3) In addition, social cohesion is known to be a protective factor against suicide, with previous studies showing that high social trust (as part of social capital)(4,5) and high electoral participation (voter turnout) are associated with fewer suicides.(6,7) Intermediary determinants, which are very important for suicide risk, can be divided into material and social resources. Higher suicide rates are known to occur in areas with greater unemployment(8) or less social or family support, as measured by the proportion of people living alone.(9) Moreover, mental illness is also a risk factor for suicide and is involved in a high percentage of cases.(10) Because all these determinants change according to axes of inequality, they influence suicide in a non-uniform manner. For example, particular groups are more affected, such as men,(11) both young and old adults(8,12), and individuals with a poorer socioeconomic position - whether it be in terms of education, income or occupation.(12–16)

While many studies have analysed trends in suicide mortality during economic crises,(17) few have examined concurrent trends in socioeconomic inequalities in suicide mortality during these periods. These latter studies have observed greater suicide mortality among men from a manual social class(18) or with a lower level of education.(19) However, a more recent study conducted in Spain showed that the trend in educational inequalities in suicide mortality was stable among men before and during the latest economic recession.(20) Thus, further studies are required to investigate the impact of the economic crisis on social inequalities in suicide mortality, using updated

data after the economic crisis by gender and taking into account many aspects presented in our conceptual framework.

The objective of our study was to analyse trends in socioeconomic inequalities in suicide mortality in Barcelona before and after the onset of the recent economic crisis, including both individual and contextual factors of the deceased's neighbourhood of residence.

METHODS

Design and information sources

We performed a trend study of the period 2006 to 2016, including all Barcelona residents aged >25 years. We gathered information from the Judicial Mortality Registry (maintained by the Catalan Institute of Legal Medicine and Forensic Sciences and the Municipal Population Census of Barcelona) and the Drug Addiction Information System maintained by Barcelona Public Health Agency, the city's Municipal Population Census, and the Department of Statistics of Barcelona City Council.

Variables and indicators

The dependent variable was suicide mortality: codes X60-X84 of the International Classification of Diseases (ICD-10).

Individual explanatory variables were: i) educational level ("primary education or lower" or "secondary education or higher") as an indicator of individual socioeconomic position, ii) country of birth ("Spain" or "elsewhere"), iii) neighbourhood of residence, and iv) year of death ("pre-economic crisis" [2006-2008], "early crisis" [2009-2012], or "late crisis" [2013-2016]). We used gender as a stratification variable and age as an adjustment variable.

Contextual explanatory variables related to the neighbourhood of residence were chosen based on the conceptual framework (figure 1): i) level of unemployment (in terms of the average annual percentage of individuals enrolled in the Employment Service of Catalonia) among individuals aged 16 to 64 years in 2011, ii) the percentage of individuals aged >65 years who lived alone in 2008, iii) the percentage of individuals who participated in general elections in 2011, and iv) the index of high-risk drug use in 2015 (a synthetic index that evaluates drug use by combining five indicators: the incidence of treatment initiation for substance abuse, the incidence of overdose-induced mortality according to place of residence and place of death, the incidence of drug-related hospital emergencies, and the incidence of syringes found in the streets).

Patient and public involvement

This study analysed the Judicial Mortality Registry database. Therefore, we did not inform participants of the research question, outcome measures, or results. No participants were involved in the study, including it design, recruitment or conduct. There was no patient adviser for the contributors' statement.

Data analysis

All analyses were carried out using the STATA 13 programme, and were stratified by gender.

First, we directly calculated age-standardised suicide mortality rates (ASMR) according to gender, educational level, and country of birth, for each time period using the study population described above. And we conducted Poisson regression models adjusted for age using the variable period in continuous to estimate trends across time.

Second, we calculated age-standardised suicide mortality rates for the neighbourhoods represented in the quartile maps. We calculated the Spearman correlation between suicide mortality rates and the contextual variables.

Finally, due to the hierarchical structure of the data, we conducted a multilevel analysis by fitting a Poisson regression model with a random neighbourhood effect (random constant) to control for variability between neighbourhoods. As we found no significant variability, we decided to fit Poisson regression models including individual and contextual neighbourhood variables to estimate relative risks (RR) of suicide mortality and 95% confidence intervals (95% CI). Initially, we fitted a model (Model 1) containing the individual variables and a term representing the interaction between educational level and time period. In subsequent models, we added a different contextual variable and a term representing the interaction between this variable and the time period, thereby generating four different models (Model 2: % Unemployment; Model 3 % Elderly living alone; Model 4: % Voter turnout; Model 5: Drug use index). We evaluated the model fit by using the deviance and likelihood ratio between nested models (p value). We then estimated the interaction of contextual explanatory variables and time periods for each variable using the time period as a categorical variable in the model (presenting the p value of the interaction).

RESULTS

Between 2006 and 2016, 1,178 residents of Barcelona aged >25 years committed suicide. In 996 of these individuals, we were able to retrieve information regarding their educational levels and neighbourhoods of residence through the Judicial Mortality Registry. These individuals formed the final study sample and constituted the target population for the statistical analyses. In total, 69.1% (n=688) of the study population were men.

The age-standardised suicide mortality rate decreased among men (p value= 0.022) during the study period (table 1), while rates among women remained stable. In all three periods, the suicide mortality rate was higher among men than women. Suicide mortality rate was higher among men born in Spain compare to those born elsewhere. This difference decreased with time because rates among men born outside of Spain increased during the last period of the study (p value= 0.019). By educational level, the rate of suicide between 2006 and 2008 was higher among men with a lower level of education. However, in this group of men, the rate decreased in the other time periods (p value=: 0.002), while men with a higher educational level had stable rate over time.

Among women, suicide rates were highest during the pre-crisis period (2006-2008) among those born outside Spain, but the number of suicides was very low in this group. In this group of women, the rate decreased in the other time periods (p value = 0.025), while the rate was higher for women born in Spain. By educational level, women with a higher level of education had higher suicide mortality rates in all three periods, and this rate remained stable over time among in this group, as well as in women with a lower level of education.

Analysis of the distribution of suicide mortality in the various neighbourhoods of Barcelona (figure 2) revealed no clear patterns for men or women in any of the time periods. Table 2 shows the Spearman correlations between suicide mortality rates and the contextual explanatory variables, and shows that suicide mortality in men was positively correlated with the index of high-risk drug use, and negatively correlated with voter turnout. In contrast, suicide mortality among women was positively correlated with voter turnout, and with the proportion of elderly people living alone. Unemployment was not significantly correlated with the suicide rate in either men or women, although the correlation in men tended to be opposite to that in women. Supplementary figure 1 shows the distribution in quartiles across the neighbourhoods of Barcelona of average annual percentage of unemployed individuals for 2011, the percentage of people aged >65 years living alone in 2008, the percentage of participation in the general election in 2011, and the index of high-risk drug use in 2015.

Table 3 summarises the associations between suicide mortality in men and the individual and contextual characteristics for the three time periods studied. During the pre-crisis period, less well-educated men were more likely to commit suicide than those with a higher level of education (RR=1.46; 95%CI: 1.11-1.91), whereas the level of risk in each group was similar during the early (RR=0.96; 95%CI: 0.72-1.28) and late (RR=1.04; 95%CI: 0.77-1.40) crisis periods. While men living in areas with high unemployment (3rd quartile) had greater risk of suicide during the early crisis (RR=1.56; 95%CI: 1.08-2.25), those living in areas with the highest unemployment had greater risk during the late crisis period (RR=1.57; 95%CI: 1.09-2.25). During the pre-crisis period, men living in neighbourhoods in the 4th quartile of voter turnout were less likely to commit suicide (RR=0.55; 95%CI: 0.40-0.90), as were men living in areas in the 3rd quartile during the late crisis period (RR=0.53; 95%CI: 0.37-0.78). Nonetheless, the highest risk was observed during the early crisis period among men living in 2nd quartile areas (RR=1.61; 95%CI: 1.05-2.46), with significant variation in risk over time. In addition, the index of high-risk drug use was a risk factor during the pre-crisis period among men living in 4th quartile neighbourhoods (RR=1.53; 95%CI: 1.04-2.24), and in the early crisis period among those living in 3rd quartile neighbourhoods (RR=1.66: 95%CI: 1.16-2.37).

Table 4 summarises the associations between suicide mortality in women and the individual and contextual characteristics for the three time periods studied. Educational level showed no statistically significant differences in suicide risk for any of the periods. In contrast, unemployment proved to be protective against suicide during the late crisis among women living in neighbourhoods in the 3rd quartile of unemployment (RR=0.48; 95%CI: 0.27-0.84). Finally, women living in neighbourhoods with the highest proportions of elderly people living alone were generally more likely to commit suicide during the late crisis period (RR=2.13; 95%CI: 1.15-3.93), although this risk did not vary significantly over time.

DISCUSSION

In this study, we analysed trends in socioeconomic inequalities in suicide mortality in Barcelona. We found that after the onset of the economic crisis, inequalities in suicide rates by educational level of education tended to disappear in men, while suicide risk tended to increase among men living in neighbourhoods with higher unemployment. Among women, we found no inequalities by educational level, but observed higher suicide risk in the late crisis period among those living in neighbourhoods with a higher proportion of elderly people living alone.

Several studies have reported an association between suicide mortality and lower educational levels,(12–14) but few have evaluated the late effect of economic crises. Studies in the United States(21) and Asian countries(19) found that inequality by educational level remained stable or even increased during economic recession. This contrasts with our results, in that we found that suicide mortality decreased among men with a lower educational level and remained stable among men with a higher level of education. This suggests that the economic crisis in Barcelona has had a greater effect on men with a socioeconomic advantage, possibly because labour market restructuring created additional work-related stress and a feeling of job insecurity. In such a scenario, men with greater responsibilities could experience a more negative response, and a decline in mental health.(22) This notion is supported by the results of a Norwegian study(23) reporting that suicide rates were higher among women with a higher level of education.

There is abundant evidence on the association between unemployment levels and suicide, especially during times of economic crisis.(8,24,25) Consistent with this evidence, we found that during the early (2009-2012) and late (2013-2016) crisis periods men living in areas with higher unemployment were more likely to commit suicide. In women, we found the opposite, with those living in neighbourhoods with high unemployment being less likely to commit suicide.

It is widely accepted that poor mental health is associated with suicide mortality.(10) During the economic crisis in Spain, men experienced a general deterioration in mental health,(26) especially those from lower socioeconomic classes. We observed a general correlation between suicide and the indicator for substance consumption, although we did not have access to the relevant individual information to properly support this assertion, so it may be susceptible to ecological fallacy. More specifically, we found that men living in neighbourhoods with problematic drug consumption had a higher risk of suicide (although the statistical significance of this factor decreased in the late crisis period).

The material and social factors that influence suicide mortality appear to differ between men and women, which may be because traditional gender roles create more pressure on men in terms of income and unemployment. In contrast, job loss among women is culturally more accepted since women typically find psychological compensation in their family role.(27) According to studies on masculinity, this could also be associated with the fact that men are less likely to express their feelings and seek

support in social networks when they need help concerning their mental health.(28) In contrast, the increased risk of suicide among women may be likely due to alterations in social factors than to alterations in material factors. This is similar to a study conducted in Denmark(29) and in our study, in that we observed a higher suicide risk among women living in neighborhoods with more elderly people living alone.

One of the limitations of our study is its low statistical power due to the small number of suicides in Barcelona, especially among women, which made it impossible to detect significant associations and to stratify the analyses by other variables such as age. It was also fairly difficult to obtain contextual data for the time periods studied because Barcelona underwent a change in its territorial divisions in 2009. Nonetheless, we were able to collect indicators for most determinants that are relevant for social inequalities in suicide.

The main strength of our study is that this study offers a conceptual framework that presents the social determinants most commonly related to suicide. It also offers an analysis by gender, which is relevant taking into account the difference in the risk factors for each gender. On the other hand, we used data from the Judicial Mortality Registry of Barcelona, which is not only more up-to-date than the Mortality Registry, but also avoids underreporting suicide as a cause of death.(30). Furthermore, this registry allowed us to analyse social inequalities because it includes socioeconomic variables (educational level, country of birth, and neighbourhood of residence), and was thus very useful for suicide surveillance during the economic crisis. Likewise, the records to obtain the contextual variables have a tradition of being of good quality and provide information at a small area level, which is not always available for this type of study. Similarly, while most previous studies only analysed variables related to material deprivation in suicide mortality, we evaluated both social and material contextual indicators.

Another strength is that this study provides a conceptual framework that concisely presents the social determinants most commonly related to suicide. It also provides an analysis by gender, which is relevant when considering the differences in the risk factors for each gender.

In conclusion, we have shown that inequalities in suicide mortality by educational level among men tended to disappear during the crisis, although men living in neighbourhoods with higher unemployment may be more likely to commit suicide. In contrast, we found no association between suicide and educational level in women, but

suicide might be more likely in women living in neighbourhoods with a higher number of elderly people living alone. Future studies should analyse the socioeconomic inequalities of suicide and further explore the causes of gender differences in this phenomenon. Since suicide is the endpoint of a process that can be treated previously at the population level, it is also important to continue monitoring its social determinants, especially during periods of economic crisis. This could be accomplished by establishing alliances with health centres that deal with cases of attempted suicide. In this way, we could gain further insight into the phenomenon, and develop better strategies to improve the living conditions of people and prevent unnecessary deaths.

References

1. Okada K, Samreth S. A study on the socio-economic determinants of suicide: Evidence from 13 European OECD countries. J Socio Econ. 2013;45:78–85.
2. Borrell C, Malmusi D, Artazcoz L, Diez E, Rodríguez-Sanz IP y M, Campos P, et al. Propuesta de politicas e intervenciones para reducir las desigualdades sociales en salud en España. Gac Sanit. 2012;26(2):182–9.
3. Kentikelenis A, Karanikolos M, Reeves A, McKee M, Stuckler D. Greece's health crisis: From austerity to denialism. Lancet. 2014;383(9918):748–53.
4. Kelly BD, Davoren M, Mhaoláin ÁN, Breen EG, Casey P. Social capital and suicide in 11 European countries: An ecological analysis. Soc Psychiatry Psychiatr Epidemiol. 2009;44(11):971–7.
5. Smith NDL, Kawachi I. State-level social capital and suicide mortality in the 50 U.S. states. Soc Sci Med. 2014;120:269–77.
6. Whitley E, Gunnell D, Dorling D, Smith GD. Ecological study of social fragmentation, poverty, and suicide. BMJ. 1999;319:1034–7.
7. De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: A systematic review. J Epidemiol Community Health. 2005;59(8):619–27.
8. Milner A, McClure R, De Leo D. Socio-economic determinants of suicide: An ecological analysis of 35 countries. Soc Psychiatry Psychiatr Epidemiol. 2012;47(1):19–27.
9. Middleton N, Whitley E, Frankel S, Dorling D, Sterne J, Gunnell D. Suicide risk in small areas in England and Wales, 1991-1993. Soc Psychiatry Psychiatr Epidemiol. 2004;39(1):45–52.
10. Turecki G, Brent DA. Suicide and suicidal behaviour. Lancet. 2016;387(10024):1227–39.
11. World Health Organization. Preventing suicide. A global imperative. CMAJ. 2014;143(7):609–10.
12. Kim MH, Jung-Choi K, Jun HJ, Kawachi I. Socioeconomic inequalities in suicidal ideation, parasuicides, and completed suicides in South Korea. Soc Sci Med. 2010;70(8):1254–61.
13. Lorant V, Kunst AE, Huisman M, Costa G, Mackenbach J. Socio-economic inequalities in suicide: A European comparative study. Br J Psychiatry. 2005;187(JULY):49–54.
14. Li Z, Page A, Martin G, Taylor R. Attributable risk of psychiatric and socio-economic factors for suicide from individual-level, population-based studies: A systematic review. Soc Sci Med. 2011;72(4):608–16.

15. Burrows S, Auger N, Gamache P, St-laurent D, Hamel D. Influence of social and material individual and area deprivation on suicide mortality among 2 . 7 million Canadians : A prospective study. BMC Public Health. 2011;11:577.
16. Milner A, Spittal MJ, Pirkis J, Lamontagne AD. Suicide by occupation : systematic review and meta-analysis. Br J Psychiatry. 2013;203:409–16.
17. Parmar D, Stavropoulou C, Ioannidis JPA. Health outcomes during the 2008 financial crisis in Europe: systematic literature review. bmj BMJ BMJ. 2016;354354:4588–4588.
18. Valkonen T. Changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland. Eur J Public Health. 2000;10(4):274–80.
19. Lee WY, Khang YH, Noh M, Ryu JI, Son M, Hong YP. Trends in educational differentials in suicide mortality between 1993 - 2006 in Korea. Yonsei Med J. 2009;50(4):482–92.
20. Borrell C, Marí-Dell'Olmo M, Gotsens M, Calvo M, Rodríguez-Sanz M, Bartoll X, et al. Socioeconomic inequalities in suicide mortality before and after the economic recession in Spain. BMC Public Health. 2017;17(1):1–8.
21. Harper S, Charters TJ, Strumpf EC, Galea S, Nandi A. Economic downturns and suicide mortality in the USA, 1980-2010: Observational study. Int J Epidemiol. 2015;44(3):956–66.
22. Chan CH, Caine ED, You S, Fu KW, Chang S Sen, Yip PSF. Suicide rates among working-age adults in South Korea before and after the 2008 economic crisis. J Epidemiol Community Health. 2014;68(3):246–52.
23. Strand BH, Grøholt E-K, Steingrímsdóttir OA, Blakely T, Graff-Iversen S, Naess Ø. Educational inequalities in mortality over four decades in Norway: prospective study of middle aged men and women followed for cause specific mortality, 1960-2000. BMJ. 2010;340(May):c654.
24. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, LeWinn K, et al. The Health Effects of Economic Decline. Annu Rev Public Health. 2011;32(47):1–17.
25. Baumbach A, Gulis G. Impact of financial crisis on selected health outcomes in Europe. Eur J Public Health. 2014;24(3):399–403.
26. Bartoll X, Palencia L, Malmusi D, Suhrcke M, Borrell C. The evolution of mental health in Spain during the economic crisis. Eur J Public Health. 2014;24(3):415–8.
27. Artazcoz L, Benach J, Borrell C, Cortes I. Unemployment and mental health: understanding the interactions among gender, family roles, and social class. Am

J Public Health. 2004;94(1):82–8.

28. Möller-Leimkühler AM. The gender gap in suicide and premature death or: Why are men so vulnerable? Eur Arch Psychiatry Clin Neurosci. 2003;253(1):1–8.

29. Agerbo E, Sterne JAC, Gunnell DJ. Combining individual and ecological data to determine compositional and contextual socio-economic risk factors for suicide. Soc Sci Med. 2007;64(2):451–61.

30. Gotsens M, Olmo MM, Rodríguez-sanz M, Martos D, Espelt A, Pérez G, et al. Validación de la causa básica de defunción en las muertes que requieren intervención medicolegal. Rev Esp Salud Publica. 2011;85(2):163–74.

Footnotes

Contributors
MRS and MG made substantial contributions to the conception and design of this study. NLC, MRS and MG performed data analysis. NLC, MRS, MG, CB and AN contributed to the interpretation of data. NLC was involved in drafting the manuscript, and MRS, MG, CB, AN and JM revised it critically for important intellectual content. All authors gave final approval of the version to be published.

Funding
This research was partially supported by the CIBER Epidemiología y Salud Pública.

Competing interests
None.

Patient consent
Not required.

Data Sharing
No additional data available

Acknowledgements
To María Dolores Martos Hinojosa for her invaluable collaboration codifying all the judicial deaths of the Registry of Judicial Mortality of Barcelona.
To the people of the Institut de Medicina Legal i Ciències Forenses de Catalunya and Civil Registry of Barcelona who have made this study possible.

Figure 1

Conceptual framework of the determinants of inequalities in suicide. This figure was adapted from the conceptual framework of the determinants of health inequalities developed by the Commission on Reducing Social Inequalities in Spain (*Comisión para Reducir las Desigualdades Sociales en Salud en España*). (2)

Figure 2

Distribution in quartiles of age-standardised mortality rates in men during the periods (a) 2006-2008 (b) 2009-2012 (c) 2013-2016, and in women during the periods (d) 2006-2008 (e) 2009-2012 (f) 2013-2016.

Table 1

Age-standardised suicide mortality rates (ASMR)* stratified by gender, country of birth, and educational level, Barcelona, 2006-2016

		2006 - 2008			2009 - 2012			2013 - 2016			
		n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)	P value
Men											
Total		221	1,762,191	13.87 (12.04-15.90)	225	2,379,238	9.89 (8.62-11.29)	242	2,350,383	10.59 (9.28-12.02)	0.022
Country of birth	Spain	199	1,402,158	14.73 (12.71-16.98)	201	1,815,824	11.01 (9.53-12.66)	204	1,771,794	11.26 (9.75-12.94)	0.721
	Elsewhere	22	360,033	6.14 (3.00-13.65)	24	563,414	7.26 (3.07-14.62)	38	578,589	8.71 (4.39-15.53)	0.019
Level of education	Primary or lower	96	533,198	16.69 (13.34-20.63)	69	659,573	8.95 (6.84-11.52)	63	500,705	9.34 (6.89-12.43)	0.002
	Secondary or higher	125	1,228,993	11.71 (9.51-14.28)	156	1,719,665	9.43 (7.9-11.19)	179	1,849,678	10.09 (8.55-11.84)	0.577
Women											
Total		86	2,026,864	4.20 (3.36-5.19)	100	2,733,362	3.61 (2.94-4.40)	122	2,720,035	4.22 (3.49-5.04)	0.665
Country of birth	Spain	73	1,683,270	4.16 (3.24-5.25)	97	2,171,574	4.41 (3.55-5.41)	113	2,102,161	4.78 (3.90-5.80)	0.168
	Elsewhere	13	343,594	6.57 (2.7-13.14)	3	561,788	0.46 (0.09-2.52)	9	617,874	2.04 (0.64-4.88)	0.025
Level of education	Primary or lower	32	753,070	3.74 (2.24-5.87)	33	908,527	2.99 (1.79-4.70)	42	733,161	3.85 (2.14-6.40)	0.333
	Secondary or higher	54	1,273,794	4.47 (3.28-5.98)	67	1,824,835	3.76 (2.87-4.85)	80	1,986,874	4.27 (3.34-5.39)	0.661

*Rate per 100,000 inhabitants

P value= to compare age-standardised suicide mortality rates trends

Table 2

Spearman correlations between suicide mortality and the contextual variables during the three time periods. Barcelona, 2006-2016

	ASMR 2006-2008	ASMR 2009-2012	ASMR 2013-2016
Men			
% unemployment, 2011	0.01	0.11	0.22
% elderly people living alone, 2008	0.10	0.02	0.12
% voter turnout, 2011	−0.20	0.02	−0.28*
Index of high-risk drug use, 2015	0.13	0.02	0.25*
Women			
% unemployment, 2011	−0.12	−0.12	−0.19
% elderly people living alone, 2008	0.26*	0.16	0.39*
% voter turnout, 2011	0.19	0.02	0.23*
Index of high-risk drug use, 2015	−0.17	−0.04	−0.14

* Significant correlation, p<0.05

ASMR = Age-standardised suicide mortality rates

Table 3
Association between suicide mortality among **men** and individual and contextual factors for each time period, Barcelona, 2006-2016

		Model 1			Model 2			Model 3			Model 4			Model 5			p interaction
		RR			RR			RR			RR			RR			
Men		P 1	P 2	P 3	P 1	P 2	P 3	P 1	P 2	P3	P1	P 2	P 3	P 1	P 2	P 3	
Level of education	Primary or lower	1.46*	0.96	1.04	1.46*	0.89	0.97	1.46*	0.95	1.05	1.33*	0.99	0.97	1.36*	0.92	0.98	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.081
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.97	1.41	1.16										0.212
	Q3				0.86	1.56*	1.03										
	Q4 (most)				1.04	1.36	1.57*										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.10	0.94	0.95							0.749
	Q3							0.92	0.85	0.94							
	Q4 (most)							1.30	0.88	1.22							
% Voter turnout	Q1 (least)										1.00	1.00	1.00				
	Q2										0.72	1.61	0.95				0.013
	Q3										0.60	1.13	0.53*				
	Q4 (most)										0.55*	1.19	0.78				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.08	1.08	1.03	0.192
	Q3													1.03	1.66*	1.29	
	Q4 (most)													1.53*	1.02	1.37	
Deviance		3,412.89			3,398.70			3,404.99			3,385.90			3,394.63			
p value					0.116			0.5448			0.0014			0.0323			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.
p value= likelihood ratio test to compare models with and without contextual explanatory variables
p interaction= likelihood ratio test to compare models with and without the interaction of contextual explanatory variables and time period variable
All models were adjusted by Age and Country of birth. Model 1: Level of education, Model 2: Level Education and % Unemployment, Model 3: Level Education and % Elderly living alone, Model 4: Level Education and % Voter turnout, Model 5: Level Education and Drug use index

Table 4

Association between suicide mortality among **women** and individual and contextual factors for each time period. Barcelona, 2006-2016

		Model 1			**Model 2**			**Model 3**			**Model 4**			**Model 5**			**p interaction**
		RR			RR			RR			RR			RR			
Women		P 1	P 2	P 3	P 1	P 2	P 3	P1	P 2	P 3	P 1	P 2	P3	P 1	P 2	P 3	
Level of education	Primary or lower	0.71	0.70	0.98	0.78	0.73	1.07	0.71	0.71	1.02	0.74	0.69	1.03	0.70	0.68	0.99	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.407
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.85	1.01	0.81										
	Q3				0.74	0.67	0.48*										0.809
	Q4 (most)				0.66	1.06	0.88										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.61	1.02	1.36							
	Q3							1.46	1.19	1.85							0.374
	Q4 (most)							1.14	1.04	2.13*							
% Voter turnout	Q1 (least)										1.00	1.00	1.00				
	Q2										1.20	0.74	1.05				
	Q3										1.20	0.82	1.17				0.927
	Q4 (most)										1.34	0.80	1.32				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.09	0.82	1.00	
	Q3													1.14	0.75	0.82	0.791
	Q4 (most)													1.09	1.35	0.93	
Deviance		1,899.06			1,886.99			1,887.73			1,896.30			1,894.52			
p value					0.210			0.254			0.973			0.873			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.
p value= likelihood ratio test to compare models with and without contextual explanatory variables
p interaction= likelihood ratio test to compare models with and without the interaction of contextual explanatory variables and time period variable
All models were adjusted by Age and Country of birth. Model 1: Level of education, Model 2: Level Education and % Unemployment, Model 3: Level Education and % Elderly living alone, Model 4: Level Education and % Voter turnout, Model 5: Level Education and Drug use index

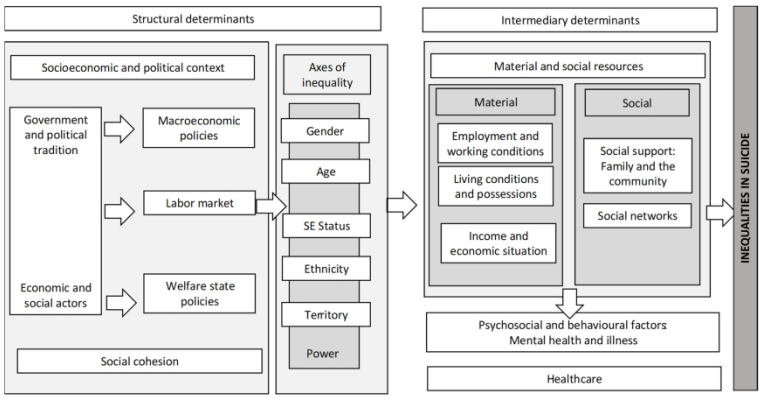


Figure 1: Conceptual framework of the determinants of inequalities in suicide. This figure was adapted from the conceptual framework of the determinants of health inequalities developed by the Commission on Reducing Social Inequalities in Spain (Comisión para Reducir las Desigualdades Sociales en Salud en España). (2)

338x190mm (300 x 300 DPI)

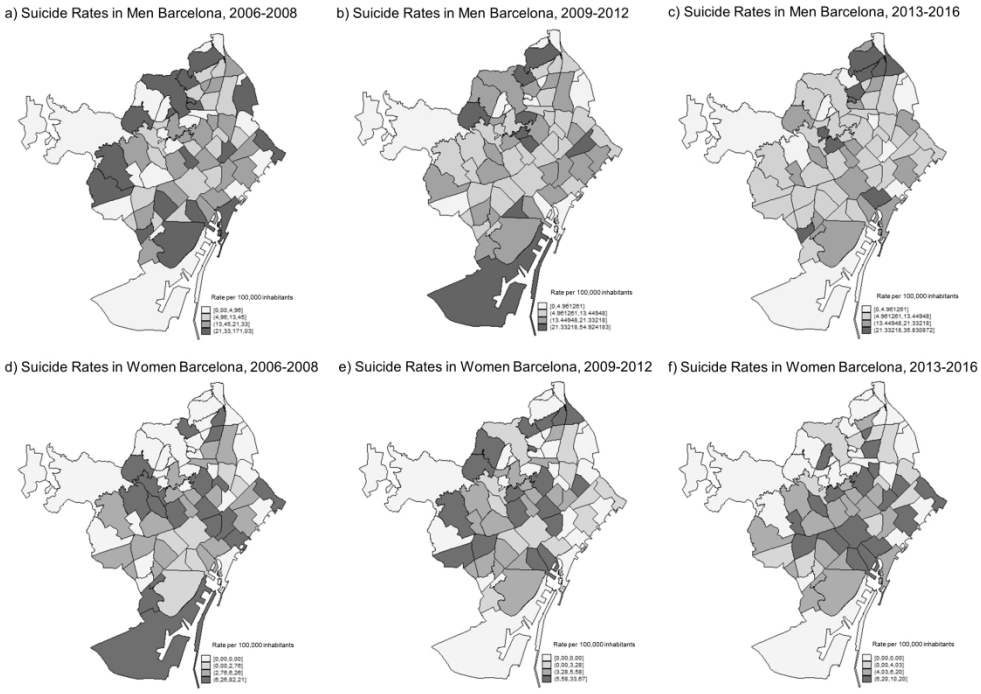
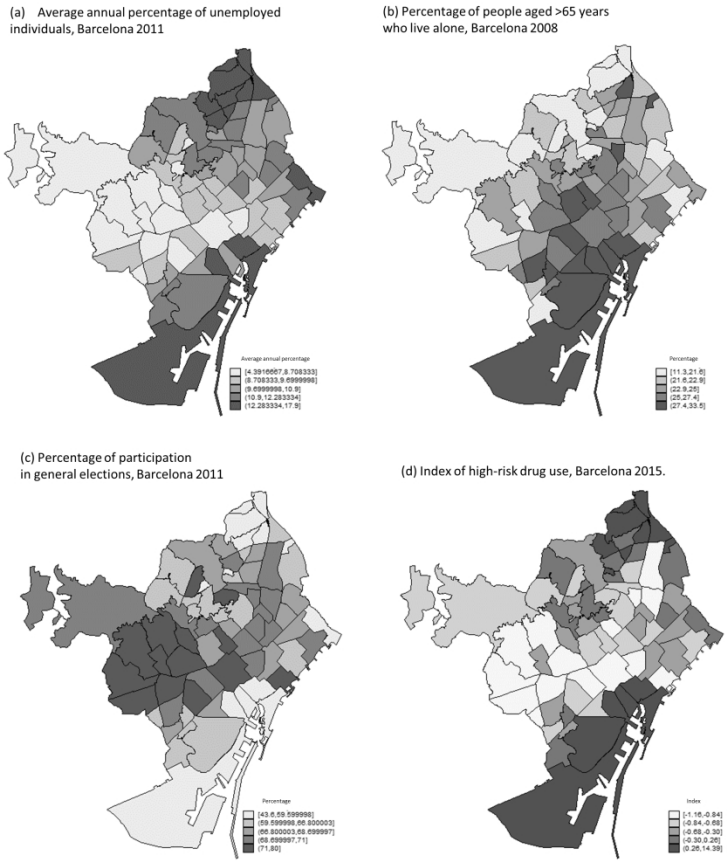


Figure 2: Distribution in quartiles of age-standardised mortality rates in men during the periods (a) 2006-2008 (b) 2009-2012 (c) 2013-2016, and in women during the periods (d) 2006-2008 (e) 2009-2012 (f) 2013-2016.

275x190mm (300 x 300 DPI)

Supplementary Figure 1

Distribution in quartiles across the neighborhoods of Barcelona of: (a) average annual percentage of unemployed individuals, 2011; (b) the percentage of people aged >65 years who live alone, 2008; (c) the percentage of participation in general elections, 2011; and (d) the index of high-risk drug use, 2015.



190x275mm (300 x 300 DPI)

BMJ Open

Socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016): a time trend study

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-028267.R2
Article Type:	Research
Date Submitted by the Author:	17-Jul-2019
Complete List of Authors:	López-Contreras, Natalia; Pompeu Fabra University, Department of Experimental and Health Sciences; Agencia de Salut Publica de Barcelona Rodríguez- Sanz, Maica; Agencia de Salut Publica de Barcelona; Centro de Investigacion Biomedica en Red de Epidemiologia y Salud Publica Novoa, Ana; Agencia de Salut Publica de Barcelona; Institut d'Investigació Biomèdica (IIB) de Sant Pau Borrell, Carme; Agencia de Salut Publica de Barcelona; Centro de Investigacion Biomedica en Red de Epidemiologia y Salud Publica Medallo Muñiz, Jordi; Institut de Medicina Legal i Ciències Forenses de Catalunya Gotsens, Merce; Agencia de Salut Publica de Barcelona; Centro de Investigacion Biomedica en Red de Epidemiologia y Salud Publica
Primary Subject Heading:	Public health
Secondary Subject Heading:	Mental health, Epidemiology
Keywords:	Suicide & self-harm < PSYCHIATRY, PUBLIC HEALTH, SOCIAL MEDICINE

Title

Socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016): a time trend study

Authors

*Natalia López-Contreras,[1,2,] Maica Rodríguez-Sanz,[1,2,3,4] Ana M. Novoa,[2,4] Carme Borrell,[1,2,3,4] Jordi Medallo,[5] Mercè Gotsens [2,3,4]

Affiliations

[1] Pompeu Fabra University, Department of Experimental and Health Sciences Barcelona, Catalunya, ES
[2] Agencia de Salut Publica de Barcelona. Barcelona, Catalunya, ES
[3] Centro de Investigacion Biomedica en Red de Epidemiologia y Salud Publica Madrid, ES
[4] Institut d'Investigació Biomèdica (IIB Sant Pau). Barcelona, Spain
[5] Institut de Medicina Legal i Ciències Forenses de Catalunya, Spain

***Correspondence to**

Natalia López-Contreras
Plaça Lesseps 1 08023 Barcelona, Spain
ext_nlopez@aspb.cat
+34 932027827

Word Count: 2988 words

Keywords

SUICIDE, HEALTH INEQUALITIES, SOCIOECONOMIC, MORTALITY

Socioeconomic inequalities in suicide mortality in Barcelona during the economic crisis (2006-2016): a time trend study

Abstract

Objectives: This study aimed to analyse trends in socioeconomic inequalities in suicide mortality in Barcelona before and after the start of the economic crisis that started at the end of 2008, including both individual factors and contextual factors of the deceased's neighbourhood of residence.

Design: Trend study of three time periods: pre-economic crisis (2006-2008), early crisis (2009-2012) and late crisis (2013-2016).

Setting: Total Barcelona residents between 2006 – 2016 (>25 years of age) and death data derived from the Judicial Mortality Registry of Barcelona.

Participants: 996 deaths by suicide between 2006 and 2016 were analysed.

Primary and secondary outcome measures: Age-standardised suicide mortality rates and the associations (relative and absolute risk) between suicide mortality and individual and contextual characteristics for the three time periods.

Results: From 2006 to 2008, men with a lower educational level were more likely to commit suicide than better educated men (RR=1.46; 95%CI: 1.11-1.91). This difference disappeared after the onset of the crisis. We found no differences among women. From 2013 to 2016, suicide risk increased among men living in neighbourhoods with higher unemployment levels (RR=1.57; 95%CI: 1.09-2.25) and among women living neighbourhoods with a higher proportion of elderly people living alone (RR=2.13; 95%CI: 1.15-3.93).

Conclusions: We observed risks for suicide among men living in neighbourhoods of Barcelona with higher unemployment levels, and women living in neighbourhoods with a higher proportion of elderly people living alone. Inequalities in suicide mortality according to educational level tended to disappear during the crisis among men. Thus, it is important to continue to monitor suicide determinants especially in times of economic crisis.

Strengths and limitations of this study

- Data were obtained from the Judicial Mortality Registry of Barcelona, which is up-to-date and prevents underreporting of suicide as a cause of death.
- The analysis includes socioeconomic variables, both social and material, which proved to be very useful for suicide surveillance during the economic crisis.
- The low number of suicides in Barcelona, especially among women, hindered detection of significant associations and stratified analyses.
- A change in Barcelona's territorial divisions in 2009 hampered collection of contextual data for the time periods studied.

INTRODUCTION

Suicide is a major problem for public health. Suicide rates are often considered as a measure of a country's emotional well-being,(1) especially in times of economic crisis such as that experienced by western countries since 2008.

Like other health issues, suicide is influenced by various social determinants. We have summarised these determinants in a conceptual framework (figure 1), drawing on information previously presented by the *Commission on Reducing Social Inequalities in Spain* (Comisión para Reducir las Desigualdades Sociales en Salud en España).(2) These determinants can be classified as either structural or intermediary. In terms of structural determinants, both the socioeconomic and political features of a country can influence suicide mortality rates. Because macroeconomic and welfare state policies depend on the government in power, as well as on political traditions, austerity measures and reduced social benefits implemented during an economic crisis tend to increase suicide rates.(3) In addition, social cohesion is known to be a protective factor against suicide, with previous studies showing that high social trust (as part of social capital)(4,5) and high electoral participation (voter turnout) are associated with fewer suicides.(6,7) Intermediary determinants, which are very important for suicide risk, can be divided into material and social resources. Higher suicide rates are known to occur in areas with greater unemployment(8) or less social or family support, as measured by the proportion of people living alone.(9) Moreover, mental illness is also a risk factor for suicide and is involved in a high percentage of cases.(10) Because all these determinants change according to axes of inequality, they influence suicide in a non-uniform manner. For example, particular groups are more affected, such as men,(11) both young and old adults(8,12), and individuals with a poorer socioeconomic position - whether it be in terms of education, income or occupation.(12–16)

While many studies have analysed trends in suicide mortality during economic crises,(17) few have examined concurrent trends in socioeconomic inequalities in suicide mortality during these periods. These latter studies have observed greater suicide mortality among men from a manual social class(18) or with a lower level of education.(19) However, a more recent study conducted in Spain showed that the trend in educational inequalities in suicide mortality was stable among men before and during the latest economic recession.(20) Thus, further studies are required to investigate the impact of the economic crisis on social inequalities in suicide mortality, using updated

data after the economic crisis by gender and taking into account many aspects presented in our conceptual framework.

The objective of our study was to analyse trends in socioeconomic inequalities in suicide mortality in Barcelona before and after the onset of the recent economic crisis, including both individual and contextual factors of the deceased's neighbourhood of residence.

METHODS

Design and information sources

We performed a trend study of the period 2006 to 2016, including all Barcelona residents aged >25 years. We gathered information from the Judicial Mortality Registry (maintained by the Catalan Institute of Legal Medicine and Forensic Sciences and the Municipal Population Census of Barcelona) and the Drug Addiction Information System maintained by Barcelona Public Health Agency, the city's Municipal Population Census, and the Department of Statistics of Barcelona City Council.

Variables and indicators

The dependent variable was suicide mortality: codes X60-X84 of the International Classification of Diseases (ICD-10).

Individual explanatory variables were: i) educational level ("primary education or lower" or "secondary education or higher") as an indicator of individual socioeconomic position, ii) country of birth ("Spain" or "elsewhere"), iii) neighbourhood of residence, and iv) year of death ("pre-economic crisis" [2006-2008], "early crisis" [2009-2012], or "late crisis" [2013-2016]). We used gender as a stratification variable and age as an adjustment variable. For all independent variables, the proportion of missing data was <11%. An analysis of missing data was carried out. We observed a random distribution of the independent variables among people older than 25 years, with the education level and the address assigned, and those who did not have this information.

Contextual explanatory variables related to the neighbourhood of residence were chosen based on the conceptual framework (figure 1): i) level of unemployment (in terms of the average annual percentage of individuals enrolled in the Employment Service of Catalonia) among individuals aged 16 to 64 years in 2011, ii) the percentage of individuals aged >65 years who lived alone in 2008, iii) the percentage of individuals who participated in general elections in 2011, and iv) the index of high-risk drug use in 2015

(a synthetic index that evaluates drug use by combining five indicators: the incidence of treatment initiation for substance abuse, the incidence of overdose-induced mortality according to place of residence and place of death, the incidence of drug-related hospital emergencies, and the incidence of syringes found in the streets). All the contextual explanatory variables related to the neighbourhood of residence were categorized in quartiles.

Patient and public involvement

This study analysed the Judicial Mortality Registry database. Therefore, we did not inform participants of the research question, outcome measures, or results. No participants were involved in the study, including it design, recruitment or conduct. There was no patient adviser for the contributors' statement.

Data analysis

All analyses were carried out using the STATA 13 programme, and were stratified by gender.

First, we directly calculated age-standardised suicide mortality rates (ASMR) according to gender, educational level, and country of birth, for each time period using the study population described above. And we conducted Poisson regression models adjusted for age using the variable period in continuous to estimate trends across time.

Second, we calculated age-standardised suicide mortality rates for the neighbourhoods represented in the quartile maps. We calculated the Spearman correlation between suicide mortality rates and the contextual variables.

Finally, due to the hierarchical structure of the data, we conducted a multilevel analysis by fitting a Poisson regression model with a random neighbourhood effect (random constant) to control for variability between neighbourhoods. As we found no significant variability, we decided to fit Poisson regression models including individual and contextual neighbourhood variables to estimate relative risks (RR) and absolute risk (AR) of suicide mortality and 95% confidence intervals (95% CI). Initially, we fitted a model (Model 1) containing the individual variables and a term representing the interaction between educational level and time period. In subsequent models, we added a different contextual variable and a term representing the interaction between this variable and the time period, thereby generating four different models (Model 2: % Unemployment; Model 3 % Elderly living alone; Model 4: % Voter turnout; Model 5: Drug use index). We evaluated the model fit by using the deviance and likelihood ratio between nested models (p value). We then estimated the interaction of contextual

explanatory variables and time periods for each variable using the time period as a categorical variable in the model (presenting the p value of the interaction).

RESULTS

Between 2006 and 2016, 1,178 residents of Barcelona aged >25 years committed suicide. In 996 of these individuals, we were able to retrieve information regarding their educational levels and neighbourhoods of residence through the Judicial Mortality Registry. These individuals formed the final study sample and constituted the target population for the statistical analyses. In total, 69.1% (n=688) of the study population were men.

The age-standardised suicide mortality rate decreased among men (p value= 0.022) during the study period (table 1), while rates among women remained stable. In all three periods, the suicide mortality rate was higher among men than women. Suicide mortality rate was higher among men born in Spain compare to those born elsewhere. This difference decreased with time because rates among men born outside of Spain increased during the last period of the study (p value= 0.019). By educational level, the rate of suicide between 2006 and 2008 was higher among men with a lower level of education. However, in this group of men, the rate decreased in the other time periods (p value= 0.002), while men with a higher educational level had stable rate over time.

Among women, suicide rates were highest during the pre-crisis period (2006-2008) among those born outside Spain, but the number of suicides was very low in this group. In this group of women, the rate decreased in the other time periods (p value = 0.025), while the rate was higher for women born in Spain. By educational level, women with a higher level of education had higher suicide mortality rates in all three periods, and this rate remained stable over time among in this group, as well as in women with a lower level of education.

Analysis of the distribution of suicide mortality in the various neighbourhoods of Barcelona (figure 2) revealed no clear patterns for men or women in any of the time periods. Table 2 shows the Spearman correlations between suicide mortality rates and the contextual explanatory variables, and shows that suicide mortality in men was positively correlated with the index of high-risk drug use, and negatively correlated with voter turnout. In contrast, suicide mortality among women was positively correlated with voter turnout, and with the proportion of elderly people living alone. Unemployment was not significantly correlated with the suicide rate in either men or women, although the correlation in men tended to be opposite to that in women. Supplementary figure 1 shows

the distribution in quartiles across the neighbourhoods of Barcelona of average annual percentage of unemployed individuals for 2011, the percentage of people aged >65 years living alone in 2008, the percentage of participation in the general election in 2011, and the index of high-risk drug use in 2015.

Table 3 summarises the associations between suicide mortality in men and the individual and contextual characteristics for the three time periods studied. During the pre-crisis period, less well-educated men were more likely to commit suicide than those with a higher level of education (RR=1.46; 95%CI: 1.11-1.91), whereas the level of risk in each group was similar during the early (RR=0.96; 95%CI: 0.72-1.28) and late (RR=1.04; 95%CI: 0.77-1.40) crisis periods. While men living in areas with high unemployment (3rd quartile) had greater risk of suicide during the early crisis (RR=1.56; 95%CI: 1.08-2.25), those living in areas with the highest unemployment had greater risk during the late crisis period (RR=1.57; 95%CI: 1.09-2.25). During the pre-crisis period, men living in neighbourhoods in the 1st quartile of voter turned out to be more likely to commit suicide (RR=1.68; 95%CI: 0.40-0.90). Nonetheless, men living in neighbourhoods in the 3rd quartile areas were less likely to commit suicide during the late crisis period (RR=0.69; 95%CI: 0.49-0.98), with significant variation in the relative risk over time. In addition, the index of high-risk drug use was a risk factor during the pre-crisis period among men living in 4th quartile neighbourhoods (RR=1.53; 95%CI: 1.04-2.24), and in the early crisis period among those living in 3rd quartile neighbourhoods (RR=1.66: 95%CI: 1.16-2.37).

Table 4 summarises the associations between suicide mortality in women and the individual and contextual characteristics for the three time periods studied. Educational level showed no statistically significant differences in suicide risk for any of the periods. In contrast, unemployment proved to be protective against suicide during the late crisis among women living in neighbourhoods in the 3rd quartile of unemployment (RR=0.48; 95%CI: 0.27-0.84). Finally, women living in neighbourhoods with the highest proportions of elderly people living alone were generally more likely to commit suicide during the late crisis period (RR=2.13; 95%CI: 1.15-3.93), although this risk did not vary significantly over time.

In general, the results obtained from absolute risks have the same pattern as those observed for the relative risks in both men and women. In men, the absolute risk decreases in those with lower levels of education, and increases in men living in neighbourhoods with higher unemployment. In women, the absolute risk increases in women who live in neighbourhoods with more elderly people living alone (Supplementary Table 1).

DISCUSSION

In this study, we analysed trends in socioeconomic inequalities in suicide mortality in Barcelona. We found that after the onset of the economic crisis, inequalities in suicide rates by educational level of education tended to disappear in men, while suicide risk tended to increase among men living in neighbourhoods with higher unemployment. Among women, we found no inequalities by educational level, but observed higher suicide risk in the late crisis period among those living in neighbourhoods with a higher proportion of elderly people living alone.

Several studies have reported an association between suicide mortality and lower educational levels,(12–14) but few have evaluated the late effect of economic crises. Studies in the United States(21) and Asian countries(19) found that inequality by educational level remained stable or even increased during economic recession. This contrasts with our results, in that we found that suicide mortality decreased among men with a lower educational level and remained stable among men with a higher level of education. This suggests that the economic crisis in Barcelona has had a greater effect on men with a socioeconomic advantage, possibly because labour market restructuring created additional work-related stress and a feeling of job insecurity. In such a scenario, men with greater responsibilities could experience a more negative response, and a decline in mental health.(22) This notion is supported by the results of a Norwegian study(23) reporting that suicide rates were higher among women with a higher level of education.

There is abundant evidence on the association between unemployment levels and suicide, especially during times of economic crisis.(8,24,25) Consistent with this evidence, we found that during the early (2009-2012) and late (2013-2016) crisis periods men living in areas with higher unemployment were more likely to commit suicide. In women, we found the opposite, with those living in neighbourhoods with high unemployment being less likely to commit suicide.

It is widely accepted that poor mental health is associated with suicide mortality.(10) During the economic crisis in Spain, men experienced a general deterioration in mental health,(26) especially those from lower socioeconomic classes. We observed a general correlation between suicide and the indicator for substance consumption, although we did not have access to the relevant individual information to properly support this assertion, so it may be susceptible to ecological fallacy. More specifically, we found that men living in neighbourhoods with problematic drug

consumption had a higher risk of suicide (although the statistical significance of this factor decreased in the late crisis period).

The material and social factors that influence suicide mortality appear to differ between men and women, which may be because traditional gender roles create more pressure on men in terms of income and unemployment. In contrast, job loss among women is culturally more accepted since women typically find psychological compensation in their family role.(27) According to studies on masculinity, this could also be associated with the fact that men are less likely to express their feelings and seek support in social networks when they need help concerning their mental health.(28) In contrast, the increased risk of suicide among women may be likely due to alterations in social factors than to alterations in material factors. This is similar to a study conducted in Denmark(29) and in our study, in that we observed a higher suicide risk among women living in neighborhoods with more elderly people living alone.

One of the limitations of our study is its low statistical power due to the small number of suicides in Barcelona, especially among women, which made it impossible to detect significant associations and to stratify the analyses by other variables such as age. It was also fairly difficult to obtain contextual data for the time periods studied because Barcelona underwent a change in its territorial divisions in 2009. Nonetheless, we were able to collect indicators for most determinants that are relevant for social inequalities in suicide.

The main strength of our study is that this study offers a conceptual framework that presents the social determinants most commonly related to suicide. It also offers an analysis by gender, which is relevant taking into account the difference in the risk factors for each gender. On the other hand, we used data from the Judicial Mortality Registry of Barcelona, which is not only more up-to-date than the Mortality Registry, but also avoids underreporting suicide as a cause of death.(30). Furthermore, this registry allowed us to analyse social inequalities because it includes socioeconomic variables (educational level, country of birth, and neighbourhood of residence), and was thus very useful for suicide surveillance during the economic crisis. Likewise, the records to obtain the contextual variables have a tradition of being of good quality and provide information at a small area level, which is not always available for this type of study. Similarly, while most previous studies only analysed variables related to material deprivation in suicide mortality, we evaluated both social and material contextual indicators.

Another strength is that this study provides a conceptual framework that concisely presents the social determinants most commonly related to suicide. It also provides an analysis by gender, which is relevant when considering the differences in the risk factors for each gender.

In conclusion, we have shown that inequalities in suicide mortality by educational level among men tended to disappear during the crisis, although men living in neighbourhoods with higher unemployment may be more likely to commit suicide. In contrast, we found no association between suicide and educational level in women, but suicide might be more likely in women living in neighbourhoods with a higher number of elderly people living alone. Future studies should analyse the socioeconomic inequalities of suicide and further explore the causes of gender differences in this phenomenon. Since suicide is the endpoint of a process that can be treated previously at the population level, it is also important to continue monitoring its social determinants, especially during periods of economic crisis. This could be accomplished by establishing alliances with health centres that deal with cases of attempted suicide. In this way, we could gain further insight into the phenomenon, and develop better strategies to improve the living conditions of people and prevent unnecessary deaths.

References

1. Okada K, Samreth S. A study on the socio-economic determinants of suicide: Evidence from 13 European OECD countries. J Socio Econ. 2013;45:78–85.
2. Borrell C, Malmusi D, Artazcoz L, Diez E, Rodríguez-Sanz IP y M, Campos P, et al. Propuesta de politicas e intervenciones para reducir las desigualdades sociales en salud en España. Gac Sanit. 2012;26(2):182–9.
3. Kentikelenis A, Karanikolos M, Reeves A, McKee M, Stuckler D. Greece's health crisis: From austerity to denialism. Lancet. 2014;383(9918):748–53.
4. Kelly BD, Davoren M, Mhaoláin ÁN, Breen EG, Casey P. Social capital and suicide in 11 European countries: An ecological analysis. Soc Psychiatry Psychiatr Epidemiol. 2009;44(11):971–7.
5. Smith NDL, Kawachi I. State-level social capital and suicide mortality in the 50 U.S. states. Soc Sci Med. 2014;120:269–77.
6. Whitley E, Gunnell D, Dorling D, Smith GD. Ecological study of social fragmentation, poverty, and suicide. BMJ. 1999;319:1034–7.
7. De Silva MJ, McKenzie K, Harpham T, Huttly SRA. Social capital and mental illness: A systematic review. J Epidemiol Community Health. 2005;59(8):619–27.
8. Milner A, McClure R, De Leo D. Socio-economic determinants of suicide: An ecological analysis of 35 countries. Soc Psychiatry Psychiatr Epidemiol. 2012;47(1):19–27.
9. Middleton N, Whitley E, Frankel S, Dorling D, Sterne J, Gunnell D. Suicide risk in small areas in England and Wales, 1991-1993. Soc Psychiatry Psychiatr Epidemiol. 2004;39(1):45–52.
10. Turecki G, Brent DA. Suicide and suicidal behaviour. Lancet. 2016;387(10024):1227–39.
11. World Health Organization. Preventing suicide. A global imperative. CMAJ. 2014;143(7):609–10.
12. Kim MH, Jung-Choi K, Jun HJ, Kawachi I. Socioeconomic inequalities in suicidal ideation, parasuicides, and completed suicides in South Korea. Soc Sci Med. 2010;70(8):1254–61.
13. Lorant V, Kunst AE, Huisman M, Costa G, Mackenbach J. Socio-economic inequalities in suicide: A European comparative study. Br J Psychiatry. 2005;187(JULY):49–54.
14. Li Z, Page A, Martin G, Taylor R. Attributable risk of psychiatric and socio-economic factors for suicide from individual-level, population-based studies: A systematic review. Soc Sci Med. 2011;72(4):608–16.

15. Burrows S, Auger N, Gamache P, St-laurent D, Hamel D. Influence of social and material individual and area deprivation on suicide mortality among 2 . 7 million Canadians : A prospective study. BMC Public Health. 2011;11:577.
16. Milner A, Spittal MJ, Pirkis J, Lamontagne AD. Suicide by occupation : systematic review and meta-analysis. Br J Psychiatry. 2013;203:409–16.
17. Parmar D, Stavropoulou C, Ioannidis JPA. Health outcomes during the 2008 financial crisis in Europe: systematic literature review. bmj BMJ BMJ. 2016;354354:4588–4588.
18. Valkonen T. Changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland. Eur J Public Health. 2000;10(4):274–80.
19. Lee WY, Khang YH, Noh M, Ryu JI, Son M, Hong YP. Trends in educational differentials in suicide mortality between 1993 - 2006 in Korea. Yonsei Med J. 2009;50(4):482–92.
20. Borrell C, Marí-Dell'Olmo M, Gotsens M, Calvo M, Rodríguez-Sanz M, Bartoll X, et al. Socioeconomic inequalities in suicide mortality before and after the economic recession in Spain. BMC Public Health. 2017;17(1):1–8.
21. Harper S, Charters TJ, Strumpf EC, Galea S, Nandi A. Economic downturns and suicide mortality in the USA, 1980-2010: Observational study. Int J Epidemiol. 2015;44(3):956–66.
22. Chan CH, Caine ED, You S, Fu KW, Chang S Sen, Yip PSF. Suicide rates among working-age adults in South Korea before and after the 2008 economic crisis. J Epidemiol Community Health. 2014;68(3):246–52.
23. Strand BH, Grøholt E-K, Steingrímsdóttir OA, Blakely T, Graff-Iversen S, Naess Ø. Educational inequalities in mortality over four decades in Norway: prospective study of middle aged men and women followed for cause specific mortality, 1960-2000. BMJ. 2010;340(May):c654.
24. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, LeWinn K, et al. The Health Effects of Economic Decline. Annu Rev Public Health. 2011;32(47):1–17.
25. Baumbach A, Gulis G. Impact of financial crisis on selected health outcomes in Europe. Eur J Public Health. 2014;24(3):399–403.
26. Bartoll X, Palencia L, Malmusi D, Suhrcke M, Borrell C. The evolution of mental health in Spain during the economic crisis. Eur J Public Health. 2014;24(3):415–8.
27. Artazcoz L, Benach J, Borrell C, Cortes I. Unemployment and mental health: understanding the interactions among gender, family roles, and social class. Am

J Public Health. 2004;94(1):82–8.

28. Möller-Leimkühler AM. The gender gap in suicide and premature death or: Why are men so vulnerable? Eur Arch Psychiatry Clin Neurosci. 2003;253(1):1–8.

29. Agerbo E, Sterne JAC, Gunnell DJ. Combining individual and ecological data to determine compositional and contextual socio-economic risk factors for suicide. Soc Sci Med. 2007;64(2):451–61.

30. Gotsens M, Olmo MM, Rodríguez-sanz M, Martos D, Espelt A, Pérez G, et al. Validación de la causa básica de defunción en las muertes que requieren intervención medicolegal. Rev Esp Salud Publica. 2011;85(2):163–74.

Footnotes

Contributors

MRS and MG made substantial contributions to the conception and design of this study. NLC, MRS and MG performed data analysis. NLC, MRS, MG, CB and AN contributed to the interpretation of data. NLC was involved in drafting the manuscript, and MRS, MG, CB, AN and JM revised it critically for important intellectual content. All authors gave final approval of the version to be published.

Funding

This research was partially supported by the CIBER Epidemiología y Salud Pública.

Competing interests

None.

Patient consent

Not required.

Data Sharing

No additional data available

Acknowledgements

To María Dolores Martos Hinojosa for her invaluable collaboration codifying all the judicial deaths of the Registry of Judicial Mortality of Barcelona.
To the people of the Institut de Medicina Legal i Ciències Forenses de Catalunya and Civil Registry of Barcelona who have made this study possible.

Figure 1

Conceptual framework of the determinants of inequalities in suicide. This figure was adapted from the conceptual framework of the determinants of health inequalities developed by the Commission on Reducing Social Inequalities in Spain (*Comisión para Reducir las Desigualdades Sociales en Salud en España*). (2)

Figure 2

Distribution in quartiles of age-standardised mortality rates in men during the periods (a) 2006-2008 (b) 2009-2012 (c) 2013-2016, and in women during the periods (d) 2006-2008 (e) 2009-2012 (f) 2013-2016.

Table 1

Age-standardised suicide mortality rates (ASMR)* stratified by gender, country of birth, and educational level. Barcelona, 2006-2016

		2006 - 2008			2009 - 2012			2013 - 2016			
		n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)	n	Population	ASMR (95%CI)	P value
Men											
Total		221	1,762,191	13.87 (12.04-15.90)	225	2,379,238	9.89 (8.62-11.29)	242	2,350,383	10.59 (9.28-12.02)	0.022
Country of birth	Spain	199	1,402,158	14.73 (12.71-16.98)	201	1,815,824	11.01 (9.53-12.66)	204	1,771,794	11.26 (9.75-12.94)	0.721
	Elsewhere	22	360,033	6.14 (3.00-13.65)	24	563,414	7.26 (3.07-14.62)	38	578,589	8.71 (4.39-15.53)	0.019
Level of education	Primary or lower	96	533,198	16.69 (13.34-20.63)	69	659,573	8.95 (6.84-11.52)	63	500,705	9.34 (6.89-12.43)	0.002
	Secondary or higher	125	1,228,993	11.71 (9.51-14.28)	156	1,719,665	9.43 (7.9-11.19)	179	1,849,678	10.09 (8.55-11.84)	0.577
Women											
Total		86	2,026,864	4.20 (3.36-5.19)	100	2,733,362	3.61 (2.94-4.40)	122	2,720,035	4.22 (3.49-5.04)	0.665
Country of birth	Spain	73	1,683,270	4.16 (3.24-5.25)	97	2,171,574	4.41 (3.55-5.41)	113	2,102,161	4.78 (3.90-5.80)	0.168
	Elsewhere	13	343,594	6.57 (2.7-13.14)	3	561,788	0.46 (0.09-2.52)	9	617,874	2.04 (0.64-4.88)	0.025
Level of education	Primary or lower	32	753,070	3.74 (2.24-5.87)	33	908,527	2.99 (1.79-4.70)	42	733,161	3.85 (2.14-6.40)	0.333
	Secondary or higher	54	1,273,794	4.47 (3.28-5.98)	67	1,824,835	3.76 (2.87-4.85)	80	1,986,874	4.27 (3.34-5.39)	0.661

*Rate per 100,000 inhabitants

P value= to compare age-standardised suicide mortality rates trends

Table 2

Spearman correlations between suicide mortality and the contextual variables during the three time periods. Barcelona, 2006-2016

	ASMR 2006-2008	ASMR 2009-2012	ASMR 2013-2016
Men			
% unemployment, 2011	0.01	0.11	0.22
% elderly people living alone, 2008	0.10	0.02	0.12
% voter turnout, 2011	−0.20	0.02	−0.28*
Index of high-risk drug use, 2015	0.13	0.02	0.25*
Women			
% unemployment, 2011	−0.12	−0.12	−0.19
% elderly people living alone, 2008	0.26*	0.16	0.39*
% voter turnout, 2011	0.19	0.02	0.23*
Index of high-risk drug use, 2015	−0.17	−0.04	−0.14

* Significant correlation, p<0.05

ASMR = Age-standardised suicide mortality rates

Table 3
Association between suicide mortality among **men** and individual and contextual factors for each time period, Barcelona, 2006-2016

		Model 1			Model 2			Model 3			Model 4			Model 5			p interaction
		RR			RR			RR			RR			RR			
Men		P 1	P 2	P 3	P 1	P 2	P 3	P 1	P 2	P3	P1	P 2	P 3	P 1	P 2	P 3	
Level of education	Primary or lower	1.46*	0.96	1.04	1.46*	0.89	0.97	1.46*	0.95	1.05	1.33*	0.99	0.97	1.36*	0.92	0.98	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.081
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.97	1.41	1.16										0.212
	Q3				0.86	1.56*	1.03										
	Q4 (most)				1.04	1.36	1.57*										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.10	0.94	0.95							0.749
	Q3							0.92	0.85	0.94							
	Q4 (most)							1.30	0.88	1.22							
% Voter turnout	Q1 (least)										1.68*	0.84	1.29				
	Q2										1.20	1.36	1.22				0.014
	Q3										1.30	0.96	0.69*				
	Q4 (most)										1.00	1.00	1.00				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.08	1.08	1.03	0.192
	Q3													1.03	1.66*	1.29	
	Q4 (most)													1.53*	1.02	1.37	
Deviance		3,412.89			3,398.70			3,404.99			3,385.90			3,394.63			
p value					0.116			0.5448			0.0014			0.0323			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.
p value= likelihood ratio test to compare models with and without contextual explanatory variables
p interaction= likelihood ratio test to compare models with and without the interaction of contextual explanatory variables and time period variable
All models were adjusted by Age and Country of birth. Model 1: Level of education, Model 2: Level Education and % Unemployment, Model 3: Level Education and % Elderly living alone, Model 4: Level Education and % Voter turnout, Model 5: Level Education and Drug use index

Table 4
Association between suicide mortality among **women** and individual and contextual factors for each time period. Barcelona, 2006-2016

		Model 1			Model 2			Model 3			Model 4			Model 5			p interaction
		RR			RR			RR			RR			RR			
Women		P 1	P 2	P 3	P 1	P 2	P 3	P1	P 2	P 3	P 1	P 2	P3	P 1	P 2	P 3	
Level of education	Primary or lower	0.71	0.70	0.98	0.78	0.73	1.07	0.71	0.71	1.02	0.74	0.69	1.03	0.70	0.68	0.99	
	Secondary or higher	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.407
% Unemployment	Q1 (least)				1.00	1.00	1.00										
	Q2				0.85	1.01	0.81										
	Q3				0.74	0.67	0.48*										0.809
	Q4 (most)				0.66	1.06	0.88										
% Elderly living alone	Q1 (least)							1.00	1.00	1.00							
	Q2							1.61	1.02	1.36							
	Q3							1.46	1.19	1.85							0.374
	Q4 (most)							1.14	1.04	2.13*							
% Voter turnout	Q1 (least)										0.75	1.26	0.76				
	Q2										0.90	0.93	0.80				
	Q3										0.89	1.03	0.80				0.973
	Q4 (most)										1.00	1.00	1.00				
Drug use index	Q1 (least)													1.00	1.00	1.00	
	Q2													1.09	0.82	1.00	
	Q3													1.14	0.75	0.82	0.791
	Q4 (most)													1.09	1.35	0.93	
Deviance		1,899.06			1,886.99			1,887.73			1,896.30			1,894.52			
p value					0.210			0.254			0.973			0.873			

RR = relative risk; * p<0.05; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
RR for each variable in each time period was obtained from the combined effect of the variable coefficients and the interaction between the variable and the period.
p value= likelihood ratio test to compare models with and without contextual explanatory variables
p interaction= likelihood ratio test to compare models with and without the interaction of contextual explanatory variables and time period variable
All models were adjusted by Age and Country of birth. Model 1: Level of education, Model 2: Level Education and % Unemployment, Model 3: Level Education and % Elderly living alone, Model 4: Level Education and % Voter turnout, Model 5: Level Education and Drug use index

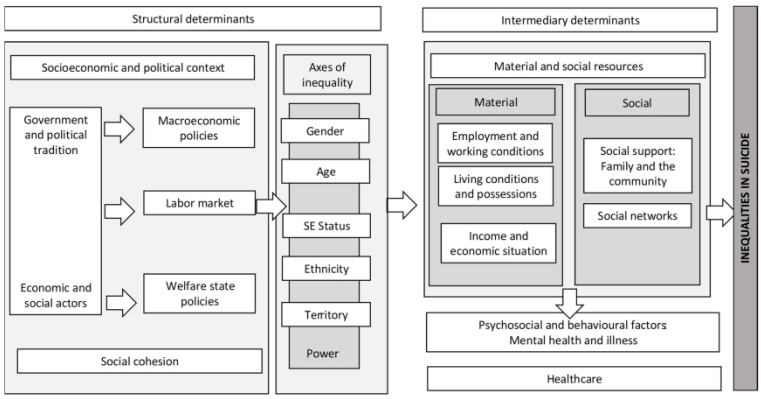


Figure 1: Conceptual framework of the determinants of inequalities in suicide. This figure was adapted from the conceptual framework of the determinants of health inequalities developed by the Commission on Reducing Social Inequalities in Spain (Comisión para Reducir las Desiguald ades Sociales en Salud en España). (2)

338x190mm (300 x 300 DPI)

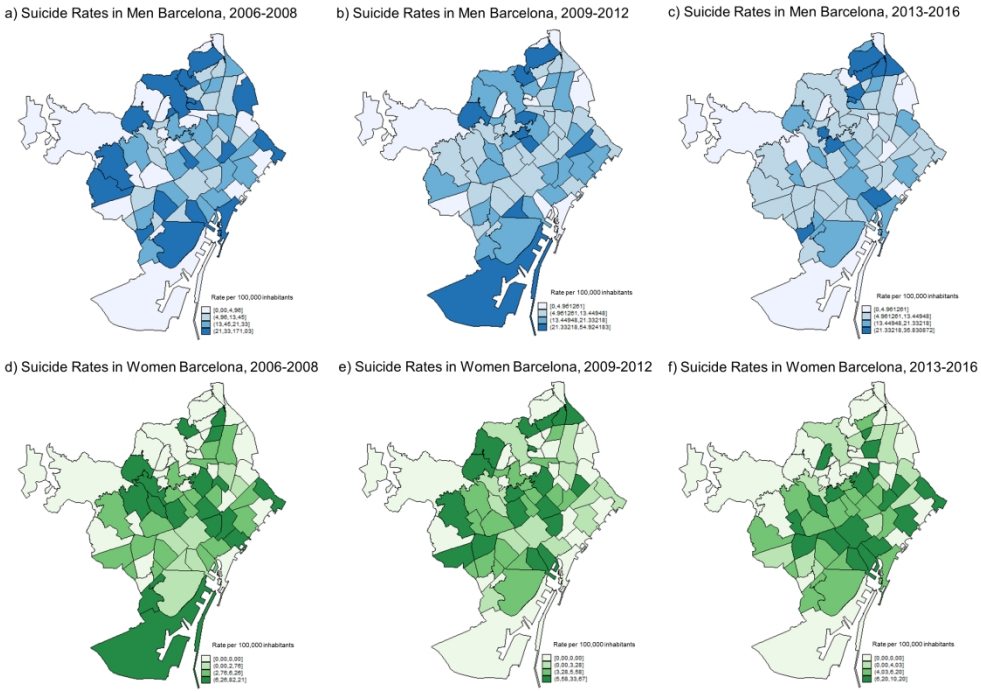
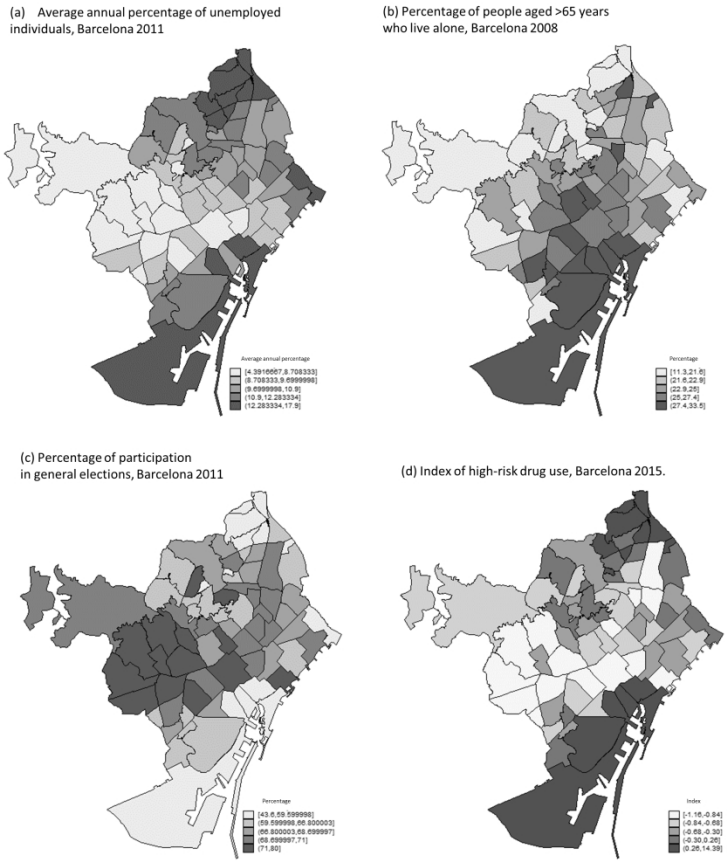


Figure 2: Distribution in quartiles of age-standardised mortality rates in men during the periods (a) 2006-2008 (b) 2009-2012 (c) 2013-2016, and in women during the periods (d) 2006-2008 (e) 2009-2012 (f) 2013-2016.

275x190mm (300 x 300 DPI)

Supplementary Figure 1

Distribution in quartiles across the neighborhoods of Barcelona of: (a) average annual percentage of unemployed individuals, 2011; (b) the percentage of people aged >65 years who live alone, 2008; (c) the percentage of participation in general elections, 2011; and (d) the index of high-risk drug use, 2015.



190x275mm (300 x 300 DPI)

Supplementary Table 1

Absolute risk between suicide mortality and individual and contextual factors for each time period. Barcelona, 2006-2016

		Men			Women		
		AR (95%CI)			AR (95%CI)		
		P 1	P 2	P 3	P 1	P 2	P 3
Level of education	Primary or lower	2.42 (0.14, 4.70)	-0.15 (-1.83, 1.52)	0.16 (-1.70, 2.03)	-0.49 (-1.46, 0.49)	-0.36 (-1.24, 0.53)	-0.18 (-0.78, 0.41)
	Secondary or higher	–	–	–	–	–	–
% Unemployment	Q1 (least)	–	–	–	–	–	–
	Q2	-0.11 (-2.12, 1.90)	1.84 (-0.19, 3.87)	0.79 (-1.11, 2.70)	-0.37 (-1.68, 0.94)	-0.01 (-1.12, 1.11)	-0.31 (-1.06, 0.44)
	Q3	-0.64 (-2.68, 1.40)	2.52 (0.21, 4.83)	0.17 (-1.75, 2.09)	-0.65 (-2.05, 0.75)	-0.80 (-1.94, 0.35)	-0.90 (-1.83, 0.03)
	Q4 (most)	0.16 (-2.11, 2.43)	1.29 (-0.914, 3.50)	2.48 (-0.04, 4.99)	-0.94 (-2.45, 0.57)	-0.06 (-1.37, 1.24)	-0.22 (-1.09, 0.65)
% Elderly living alone	Q1 (least)	–	–	–	–	–	–
	Q2	0.45 (-1.80, 2.70)	-0.44 (-2.89, 2.00)	-0.30 (-2.50, 1.90)	1.06 (-0.57, 2.69)	0.04 (-1.22, 1.31)	0.32 (-0.38, 1.03)
	Q3	-0.58 (-2.79, 1.63)	-1.09 (-3.55, 1.38)	-0.48 (-2.72, 1.76)	0.77 (-0.76, 2.29)	0.37 (-0.96, 1.70)	0.71 (-0.17, 1.60)
	Q4 (most)	1.06 (-1.15, 3.27)	-1.12 (-3.48, 1.24)	0.79 (-1.42, 3.00)	0.15 (-1.14, 1.45)	0.03 (-1.19, 1.24)	0.92 (-0.03 ,1.87)
% Voter turnout	Q1 (least)	2.74 (0.160, 5.32)	-1.30 (-3.50, 0.89)	1.03 (-1.44, 3.51)	-0.72 (-2.25, 0.80)	0.26 (-1.11, 1.64)	-0.44 (-1.34, 0.46)
	Q2	0.99 (-1.11, 3.08)	1.90 (-0.58, 4.37)	1.20 (-1.13, 3.53)	-0.24 (-1.68, 1.20)	-0.21 (-1.38, 0.96)	-0.32 (-1.13, 0.49)
	Q3	1.35 (-0.58, 3.27)	-0.32 (-2.25, 1.61)	-1.93 (-3.85, -0.01)	-0.27 (-1.53, 1.00)	0.00 (-1.05, 1.05)	-0.19 (-0.91, 0.53)
	Q4 (most)	–	–	–	–	–	–
Drug use index	Q1 (least)	–	–	–	–	–	–
	Q2	0.41 (-1.38, 2.20)	0.38 (-1.42, 2.18)	0 .12 (-1.62, 1.86)	0.19 (-0.96, 1.34)	-0.43 (-1.45, 0.59)	0.01 (-0.64, 0.67)
	Q3	0.31 (-1.82, 2.44)	3.33 (0.54, 6.11)	1.49 (-0.84, 3.82)	0.34 (-1.13, 1.82)	-0.61 (-1.81, 0.60)	-0.25 (-1.03, 0.52)
	Q4 (most)	2.35 (-0.24, 4.95)	-0.32 (-2.49, 1.84)	1.34 (-1.07, 3.75)	0.07 (-1.43, 1.58)	0.50 (-1.01, 2.01)	-0.14 (-1.00, 0.72)

AR = absolute risk; P 1= pre-crisis period (2006-2008); P 2= early crisis period (2009-2012); P 3= late crisis period (2013-2016)
AR in relation with the highest level of every variable

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P:2 / L: 1.2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P: 2 / L: 5-29
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P: 4 / L: 3-5 P: 5 / L: 1,2
Objectives	3	State specific objectives, including any prespecified hypotheses	P: 5 / L: 3-6
Methods			
Study design	4	Present key elements of study design early in the paper	P: 5 / L: 10
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P: 5 / L: 10,11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	P: 5 /L: 10-15
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P: 5 / L: 17-34
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P: 5 / L: 17-34
Bias	9	Describe any efforts to address potential sources of bias	P: 5 / L: 10-15 P: 6 / L: 15-36 P: 7 / L: 1-2
Study size	10	Explain how the study size was arrived at	P: 7 / L: 6-11
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P: 5 / L: 19-34 P: 6 / L: 1-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P: 6 / L: 15-36 P: 7 / L: 1-2
		(*b*) Describe any methods used to examine subgroups and interactions	P: 6 / L: 24-36 P: 7 / L: 1-2
		(*c*) Explain how missing data were addressed	P: 5 / L: 24-27
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	P: 6 / L: 15-36 P: 7 / L: 1-2
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P: 7 / L: 6-11
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P: 7 / L: 6-11 P: 17

		(b) Indicate number of participants with missing data for each variable of interest	P: 5 / L: 24-27
Outcome data	15*	Report numbers of outcome events or summary measures	P: 7 / L: 6-11 P: 17
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	P: 7 / L: 6-36 P: 8 / L: 1-36
		(*b*) Report category boundaries when continuous variables were categorized	P: 8 / L: 5-36
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	P: 8 / L. 31-36
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	N/A
Discussion			
Key results	18	Summarise key results with reference to study objectives	P:9 / L: 2-8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P: 10 / L: 16-22
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P: 9 / L: 9-36 P: 10 / L: 1-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	N/A
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.