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Suicide in Portugal: Spatial determinants in a context of economic crisis

Paula Santana [a,*], Cláudia Costa [b], Graça Cardoso [c], Adriana Loureiro [b], João Ferrão [d]

[a] Centre of Studies on Geography and Spatial Planning, Department of Geography, University of Coimbra, Portugal
[b] Centre of Studies on Geography and Spatial Planning, University of Coimbra, Portugal
[c] Chronic Diseases Research Center (CEDOC) and Department of Mental Health, NOVA Medical School, New University of Lisbon, Portugal
[d] Institute of Social Sciences, University of Lisbon, Portugal

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ABSTRACT

This study compares the existing statistical association between suicide mortality and the characteristics of places of residence (municipalities), before and during the current economic crisis, in Portugal. We found that (1) the traditional culture-based North/South pattern of suicidal behaviour has faded away, while the socioeconomic urban/rural divide has become more pronounced; (2) suicide is associated with higher levels of rurality and material deprivation; and (3) recent shifts in suicidal trends may result from the current period of crisis. Strategies targeting rural areas combined with public policies that address area deprivation may have important implications for tackling suicide.

1. Introduction

Mental health is an essential and indivisible part of general health and well-being of the individual (Patel et al., 2010). Nonetheless, mental illnesses are currently a leading cause of disability and of higher rates of morbidity and mortality worldwide, with suicide mortality as one of the ten leading causes of death (WHO, 2011).

Typically, males have higher rates of death by suicide than females (Canetto and Sakinofsky, 1998; Kposowa and McElvain, 2006). This gender disparity in Europe is explained by theories related to the male role and men's behaviour (Möller-Leimkühler, 2003). In particular, the culturally-mediated social construction of men's role in society which imputes to them, for instance, the role of economic provider, leads to higher levels of occupational stress and pressure to be successful economically (Kposowa and McElvain, 2006; Qin et al., 2000). Moreover, Reeves et al. (2015, p. 408) found that "rises in male unemployment have contributed to the recent recession-related increases in suicide rates in Europe, although the association varies across European nations".

Social, psychological, cultural and other factors can lead a person to suicidal behaviour (Patel et al., 2010; WHO, 2014). In recent decades empirical evidence has shown that acts of suicide can be influenced by place of residence, independently or beyond individual characteristics. Contextual factors (socio-environmental characteristics of places of residence) have positive or negative impacts on the mental health of individuals (Diez Roux and Mair, 2010; Evans, 2003; Ruth et al., 2014; WHO, 2008), and may influence the incidence of death by suicide (Agerbo et al., 2007; Chang et al., 2011; Derek Cheung et al., 2014; Phillips, 2014).

Several authors have demonstrated that suicide mortality is influenced by contextual factors related to: (1) the socio-economic characteristics, such as poverty (Ferretti and Coluccia, 2009; Murali, 2004), deprivation (Burrows et al., 2011, 2010; Kim et al., 2010; Murali, 2004; Rezaeian et al., 2007; Stark et al., 2007), income and socioeconomic status (Agerbo et al., 2007; Andrés and Halicioglu, 2010; Ceccherini-Nelli and Priebe, 2011; Chang et al., 2011; Derek Cheung et al., 2014; Milner et al., 2012), employment/unemployment (Agerbo et al., 2007; Andrés and Halicioglu, 2010; Barr et al., 2012; Ceccherini-Nelli and Priebe, 2011); and (2) the characteristics of the built environment, such as density (Chang et al., 2011; Stark et al., 2007; Wang et al., 2013), urban/rural typology (Jagodic et al., 2012; Kim et al., 2010; Middleton et al., 2006; Page et al., 2007; Razvodovsky and Stickley, 2009) access to facilities and services (Cheung et al., 2012; Desai et al., 2005) and mobility (Haynie et al., 2006; Potter et al., 2001).

In a context of crisis and austerity these associations tend to

* Correspondence to: Centro de Estudos de Geografia e Ordenamento do Território, Departamento de Geografia, Universidade de Coimbra, Colégio S. Jerónimo, Largo D. Dinis, 3000-043 Coimbra, Portugal.
E-mail address: paulasantana.coimbra@gmail.com (P. Santana).

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worsen (WHO, 2011). Financial and economic crises can foster an unequal distribution of power, status, and resources impacting people's freedom to participate in decisions that affect their lives (Stuckler et al., 2009; Veenhoven and Hagenaars, 1989), contributing to an increase of socio-material vulnerability and inequity. In several countries scientific evidence suggests a link between the increased suicide mortality and the phenomena of economic and financial crisis (Barr et al., 2012; Baumbach and Gulis, 2014; Chang et al., 2013, 2009; Hintikka et al., 1999; Karanikolos et al., 2013; Kentikelenis et al., 2014; Reeves et al., 2012; Stuckler et al., 2011). Most of these studies also identified an association between suicide mortality and unemployment. Nevertheless, the majority of the research concludes that the amplitude and sensitivity to the 'crisis effect' vary across countries (Chang et al., 2013; Fountoulakis et al., 2014; Karanikolos et al., 2013; Laanani et al., 2014).

Since the advent of the financial crisis in 2008, Portugal has requested international support and has been identified as the third European country asking for such assistance. This was not the first time. The presence of the International Monetary Fund (IMF) in Portugal in 1977, 1983 and 2011 brought several austerity policies (Augusto, 2014; Baumbach and Gulis, 2014; Carneiro et al., 2014; Karanikolos et al., 2013; Laanani et al., 2014) and consequent cuts in spending on health care and social support schemes (Barros, 2012; Eurofound, 2013; Sakellarides et al., 2014). Apart from the growth of unemployment and emigration, austerity has contributed to a decrease in patient transportation support and an increase of user charges that directly affect access to services (Eurofound, 2013; Sakellarides et al., 2014).

Traditionally, Portugal is one of the countries with the lowest suicide rate in Europe (Gusmão and Quintão, 2013). However, according to Fountoulakis et al. (2014, p. 3), it is the only "country that did not witness a clear reduction in the suicide rate during 2000–2011".

Based on the literature review, there are no studies linking the economic crisis with suicide mortality in Portugal at the local level and regarding how places of residence influence suicidal behaviour. Recently, three studies have investigated the impact of the economic crisis, through the analysis of unemployment rate and suicide mortality in several countries as a whole, including Portugal (Baumbach and Gulis, 2014; Fountoulakis et al., 2014; Karanikolos et al., 2013). All of them found an association between suicide mortality and unemployment, though it was weak or insignificant. Some of them examined other economic indices such as GDP per capita and National Growth rate, however no direct association between them and suicide was found.

The aim of the present study is to verify whether there is a statistical association between the increase in suicide mortality and the characteristics of places of residence at local level (municipalities), before and during the present economic crisis. For this purpose we will: (1) describe the evolution of geographical patterns of suicide mortality in Portugal (mainland) in the last twenty years; (2) analyse whether men and women have the same geographical pattern of suicide mortality; and (3) analyse the statistical association between suicide mortality risk and health determinants (material deprivation and rurality), before (1999–2003) and during (2008–2012) an economic crisis.

2. Materials and methods

2.1. Design and sources of information

This study follows an ecological design. The Portuguese National Statistics Institute was the source of data in respect of mortality, population and socioeconomic conditions.

Fig. 1. Mainland Portugal: NUTS II and metropolitan areas and the North/South divide. The figure shows the administrative borders of mainland Portugal, namely the NUTS II level and the Metropolitan Areas. The Lisbon NUTS II has the same limit than Lisbon Metropolitan Area (MA). Oporto is the capital of Oporto MA and Lisbon is the capital of Lisbon MA. The North/South divide is based on the work of Orlando Ribeiro (1998. *Portugal. O Mediterrâneo e o Atlântico*, Livraria Sá da Costa Editora, 7th edition [1st edition: 1945]).

In order to identify trends from the last twenty years, three five-year periods around census data have been analysed: 1989–1993, 1999–2003 and 2008–2012. The last coincides with the crisis period.

The units of analysis were identified as the municipalities of Portugal mainland (i.e. hence excluding the islands of Madeira and the Azores) (Fig. 1). Municipalities, which correspond to small geographic units, have more internal homogeneity than larger areas and their aggregate socioeconomic characteristics are thus more likely to reflect the nature of the social environment where people live (Chang et al., 2011). Mainland Portugal had 275 municipalities in the first period and 278 in the last two periods (three new municipalities were disaggregated from the previous ones). Due to data confidentiality, mortality has been grouped into 200 aggregated municipalities for the first period and 202 for the last two periods.

2.2. Indicators

The mortality data by suicide and intentional self-harm (ICD-9[1]: E950–E959; ICD-10: X60–X84) have been disaggregated by age groups (10–14; 15–49; 50–69; ≥ 70), gender (total, male, female), and area of residence ($N=200/202$), in order to comply with data

[1] International Classification of Diseases – Version 9.

confidentiality rules.

The study population consisted of residents in Portugal in the 1991, 2001 and 2011 Censuses, aged 10 or more years, stratified by the same gender and age groups as the mortality data.

To evaluate the characteristics of the area of residence (municipality), a material deprivation index (MDI) and rurality index (RI) were constructed for 1991, 2001 and 2011. The MDI is based upon the following indicators: (1) illiteracy rate (% of people older than 10 years that cannot read or write); (2) unemployment rate (% of unemployed among the active population); and (3) substandard housing rate (% of houses without a toilet). The RI aggregates: (1) population density (people per km^2); (2) geographic accessibility to hospitals (time needed to get to the closest hospital, weighted by population distribution); and (3) rural population (% of population living in parishes classified as predominantly rural or medium urban areas). In both cases the selection of indicators was based on a literature review, where indicators, analysed at small area level, showed an association with suicide (Chang et al., 2011; Gotsens et al., 2013; Marí-Dell'Olmo et al., 2015; Santana et al., 2015) or other causes of death (Ahern et al., 2011; Borrell et al., 2014; Domínguez-Berjón et al., 2008; Hoffmann et al., 2014; Ribeiro et al., 2014; Santana et al., 2014). Based on the Carstairs and Morris method, the indicators considered in each index were standardised (using the *z*-score method) so that each indicator has a weighted mean of zero and a variance of one, and exerted the same influence upon the final result (Carstairs and Morris, 1990).

2.3. Data analysis

The mortality indicator used for this analysis is the Standardized Mortality Ratio (SMR). By using this indicator, the effect of variation in age structure is removed. This variable is dependent on population size, so areas with low population tend to present estimates with a high variance. To overcome this, we used the hierarchical Bayesian model proposed by Besag, York and Mollié to obtain smoothed SMR (sSMR) and the probability of excess risk (sSMR higher than the Portugal mainland pattern: 100) (Besag et al., 1991). This model takes into account two types of random effects, spatial and heterogeneous, allowing us to produce smoothed estimates, while minimizing potential bias and presenting a valid spatial pattern (Graham, 2008; Hoffmann et al., 2014). This model has already been successfully used in previous studies on suicide (Chang et al., 2011; Marí-Dell'Olmo et al., 2015; Middleton et al., 2006; Pirkola et al., 2009; Santana et al., 2015; Gotsens et al., 2013).

The sSMR was estimated for each sex and period of analysis by applying indirect standardization, taking as reference the population distribution in 1991, 2001 and 2011 and the mortality rates by gender and age group. The statistical association with contextual-level variables was obtained through the application of an ecological regression model that introduces those indexes as explanatory variables.

We evaluate two models where the indexes have been introduced without any adjustment and two other models where adjustments have been made: (A) statistical association with RI; (B) statistical association with MDI; (C) statistical association with MDI, adjusted by rurality level; and (D) statistical association with RI, adjusted by material deprivation level. All models have been analysed by categorizing the variables into quintiles, in order to evaluate the relative risk. Moreover, Models C and D were adjusted by introducing both indexes as dummies. Relative risk (RR) estimates were obtained based on their posterior means, along with the corresponding 95% credible intervals (95%CI) for all models. A RR will be considered significantly higher or lower than 1 if its 95% CI does not include 1.

In the models used, an intrinsic conditional autoregressive prior distribution was assigned to the spatial effect, while the heterogeneous effect was represented using independent normal distributions. A half-normal distribution was assigned to the standard deviations and a vague prior distribution was assigned to the explanatory variables. These models were developed using the INLA library (version 3.0.1) and the R statistical package (version R.2.15.2) (Rue et al., 2009).

3. Results

Suicide mortality presented a marked oscillation over time (Table 1). The most recent period, where the "crisis-effect" is evident, shows the highest mortality by suicide and the highest crude rate. Between the first and the second period the suicide rate decreased (−5.4%), while between the second and the third period it witnessed a large increase (22.6%). However, we identified gender differences. Compared to women, men showed a suicide rate three times higher and a greater increase between periods.

Suicide mortality had a marked geographical distribution (Fig. 2); it was lower in the North and higher in the South of Portugal. However, this pattern has changed in the last twenty years. The class with the lowest sSMR had almost no incidence in the last period, with the exception of some municipalities from Oporto Metropolitan Area (MA). The class with the highest sSMR had a major incidence in the last period than in the first, mainly in the Alentejo region.

Fig. 3 shows the probability that the sSMR for suicide of each area is higher than the pattern for mainland Portugal (100). Comparison between the three time periods shows that the marked North/South divide, although still relevant, is fading away. This trend is due to an increase of risk in the Centro region and in the inland of the Norte region, mainly in rural municipalities close to the border with Spain, and a decrease in some urban municipalities from the Lisbon MA and the Algarve region.

The pattern shown for total mortality differs when analysed by gender (Fig. 4). The increase in the number of municipalities with

Table 1
Suicide descriptive analysis. Population quartiles (P25, P50 and P75) and deaths due to suicide by municipality in 1989–1993, 1999–2003 and 2008–2012.

	1989–1993				1999–2003				2008–2012			
	Population	Deaths by suicide			Population	Deaths by suicide			Population	Deaths by suicide		
	Total	Total	*M*	*W*	Total	Total	*M*	*W*	Total	Total	*M*	*W*
P25	665,423	434	314	120	647,405	442	347	95	588,807	535	428	107
P50	1,052,154	549	414	135	1,069,840	572	443	129	1,035,043	730	580	150
P75	1,831,582	920	652	268	1,982,092	925	705	220	2,013,958	1174	895	279
Total	9,375,926	3982	2921	1061	9,869,343	3963	3034	929	10,047,621	4948	3824	1124
Crude rate (per 100.000)		42.5				40.2				49.3		

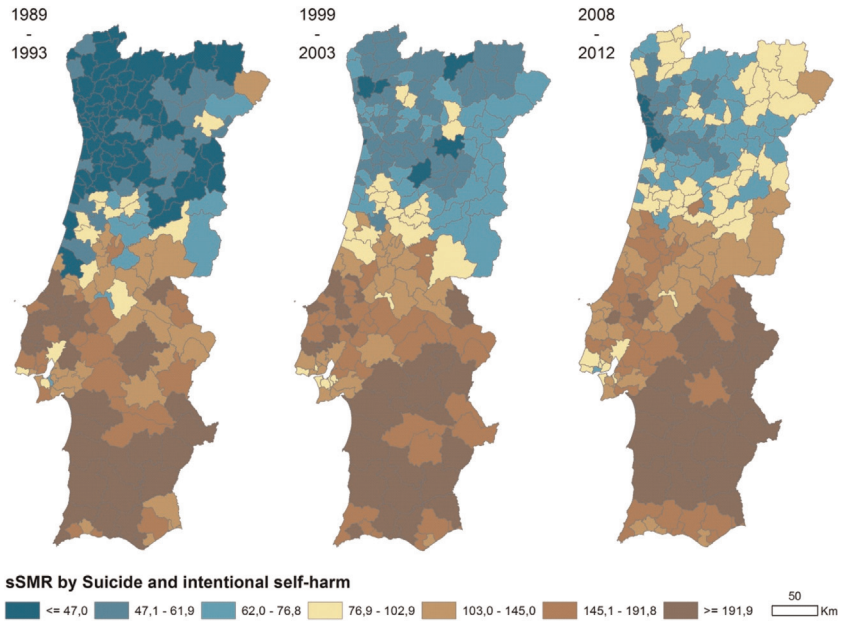

Fig. 2. Portugal: sSMR by suicide and intentional self-harm by municipality in the last 20 years. The figure shows the geographical distribution of sSMR, using septiles from the three periods: the dark blue areas have the lowest sSMR from the three periods and the dark brown areas have the highest ones. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
Source: Based on Health Statistics, produced by the National Statistics Institute (INE).

very high risk of mortality by suicide is more evident for men than for women. Furthermore, in the first period women show a higher and significant risk in some Lisbon MA municipalities and in the inland, border area of the Centro and Alentejo regions. Men showed a higher and more significant risk in the central area of the Alentejo region. In the last period, the higher increase of suicide mortality occurs in the interior of the Centro region, in some municipalities from the periphery of the Lisbon MA and in the northern area of the Alentejo region, and is mainly masculine.

The characteristics of place of residence improved in the last 20 years. However, the highest quintiles of MDI and RI continue to be found in the interior of the country (Figs. 5 and 6).

Table 2 shows the statistical association between mortality by suicide and the contextual variables: MDI and RI. A positive association between suicide mortality and RI was found for the three periods of time: the higher the rurality level, the higher the RR of dying from suicide (Model A). This association decreases between the first and the second periods and then increases in the last period. The population living in municipalities with the highest level of rurality has a higher risk (1.73; 95%CI: 1.41–2.09) than those living in municipalities with the lowest level of rurality. The suicide risk was higher for women than for men in the first and second periods, but in the last one we did not find a statistical association between the lowest and the highest quintile of RI for

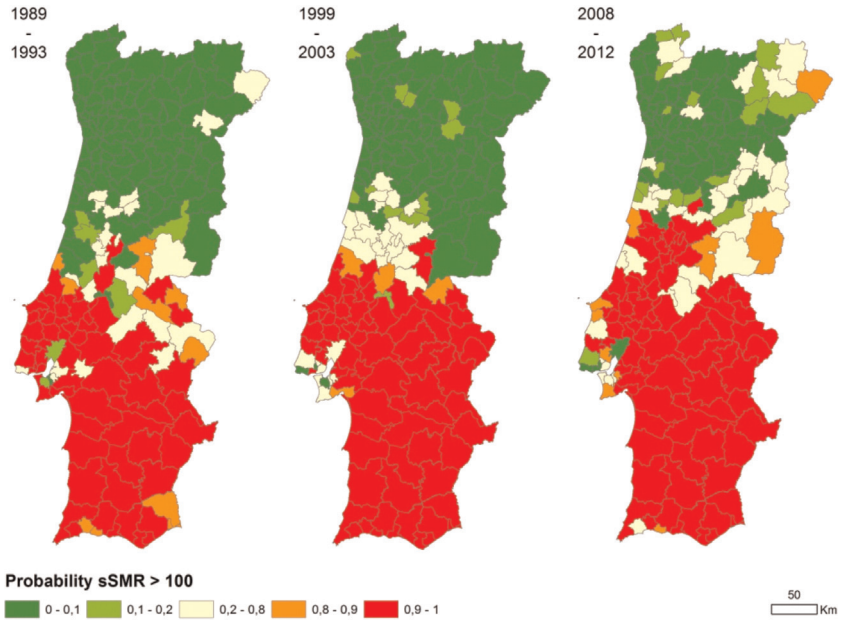

Fig. 3. Portugal: risk of mortality by suicide (probability that the sSMR is higher than 100) by municipality in the last 20 years. The figure shows the probability of excess risk, using five fixed categories: [0–0.1] (lowest probability sSMR > 100),]0.1–0.2],]0.2–0.8],]0.8–0.9] and]0.9–1.0] (highest probability sSMR > 100).
Source: Based on Health Statistics, produced by the National Statistics Institute (INE).

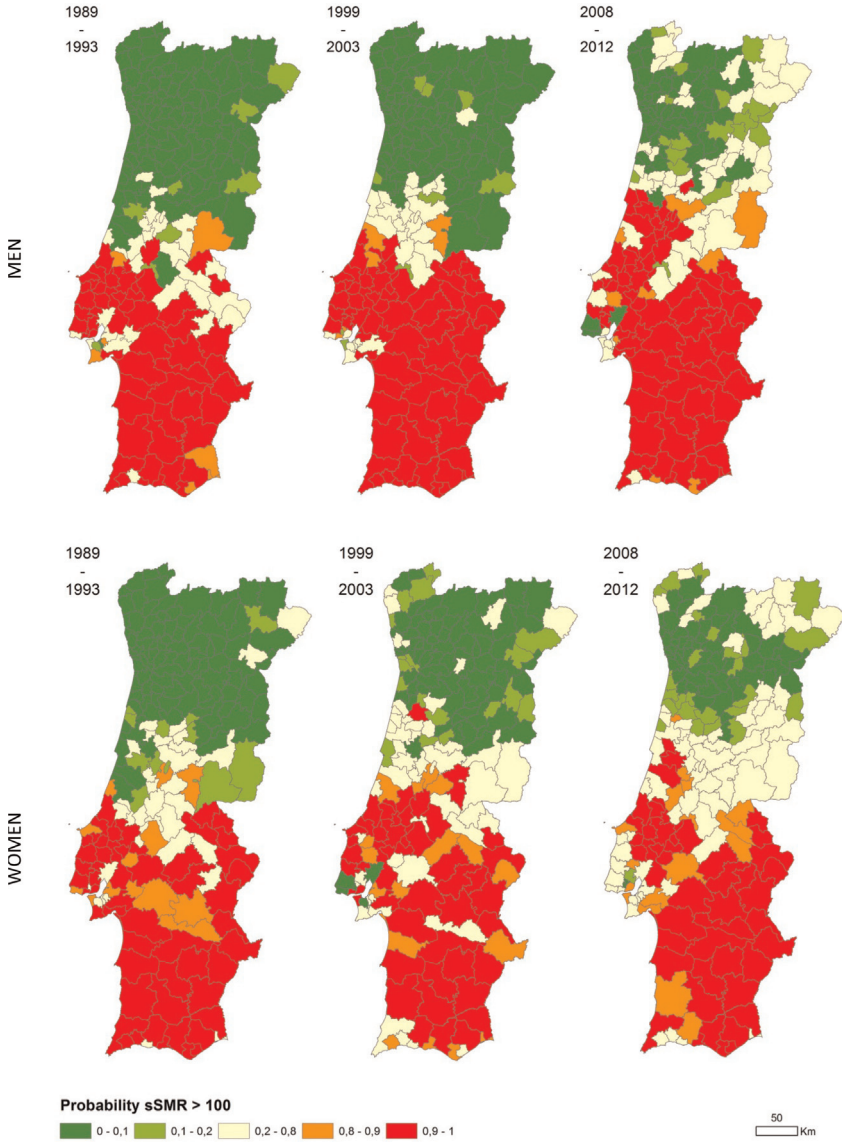

Fig. 4. Portugal: risk of mortality by suicide (probability that the sSMR is higher than 100) by gender and municipality in the last 20 years. The figure shows the probability of excess risk by sex, using five fixed categories: [0–0.1] (lowest probability sSMR > 100),]0.1–0.2],]0.2–0.8],]0.8–0.9] and]0.9–1.0] (highest probability sSMR > 100). *Source*: Based on Health Statistics, produced by the National Statistics Institute (INE).

women.

There is a positive statistical association between suicide mortality and MDI (model B). However, this association was only found in the first and last periods, and mostly for the total population (both genders) and for men. We found a significant statistical association for women only in the first period of time, when the risk was higher for women than for men. In the last period the population living in municipalities included in the quintile with higher deprivation had a 46% (95%CI: 1.19–1.80) higher risk than those living in municipalities with lower deprivation. For men the risk factor was 57% (95%CI: 1.23–2.01).

The statistical association changes when we adjust both models (Model C and D). The association between material deprivation and suicide mortality ceases to be significant (Model C) after the RI effect is removed, especially for the last period. The statistical association between RI and suicide mortality after removing the effect of MDI (Model D) remains significant, showing slight differences compared to Model A. Generally, the RR is smaller for Model D than for Model A.

4. Discussion

This research found that: (1) the North/South suicide pattern (found in mainland Portugal) is fading away and the urban/rural divide is becoming more pronounced; (2) female and male suicide evolved differently in time and space; (3) higher levels of rurality and material deprivation are statistically associated with increased suicide mortality for men but not necessarily for women; and (4) recent shifts in suicidal trends may result from the current period of crisis.

First, we detected a North/South and urban/rural geographical pattern, with southern and rural municipalities showing the highest suicide rates. Yet the North/South pattern is fading away through time, with suicide mortality becoming more prevalent towards the North. On the contrary, the urban/rural pattern is becoming more pronounced, a trend that is mainly visible when we compare the last period with the first one. In the last twenty years the suicide mortality risk in Portugal increased in more rural municipalities and decreased in more urbanized areas, especially in the metropolitan areas. Several factors may account for these

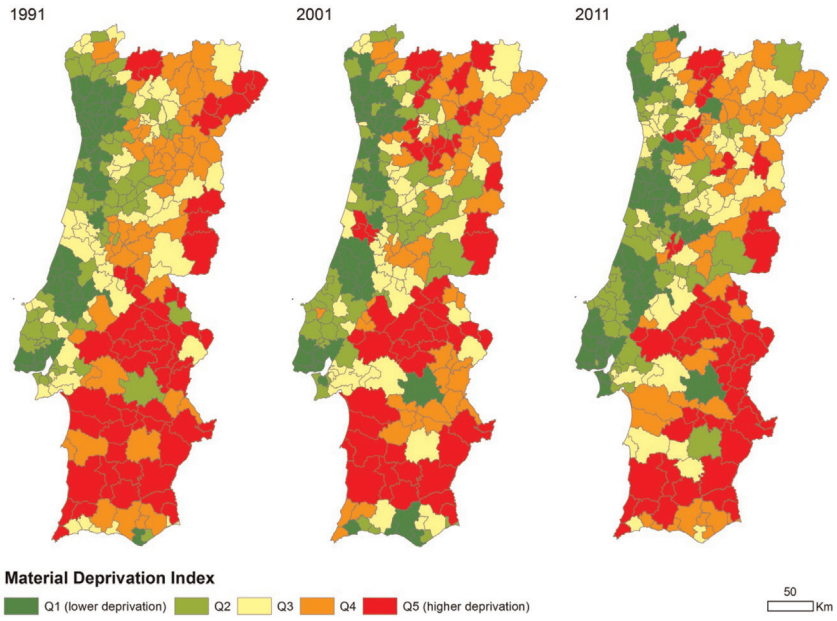

Fig. 5. Portugal: Material Deprivation Index (MDI) by municipality in the last 20 years. The figure shows the geographic distribution of material deprivation by quintiles. The Q1, in green, represents the areas with lower material deprivation. The Q5, in red, represents the areas with higher material deprivation. In 1991 the MDI ranges from −4.3 to 7.4. In 2011, MDI ranges from −0.9 to 8.3. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
Source: Based on Censuses Data, produced by the National Statistics Institute (INE).

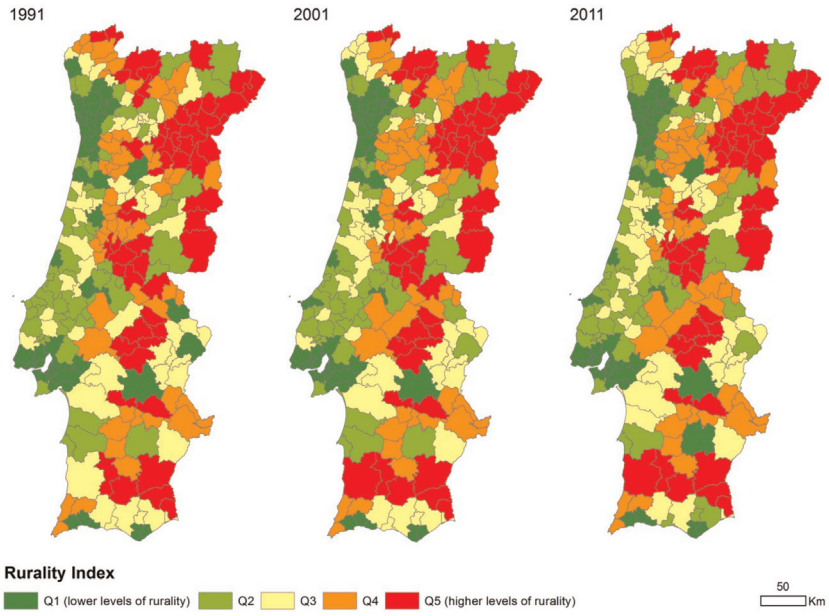

Fig. 6. Portugal: Rurality Index (RI) by municipality in the last 20 years. The figure shows the geographic distribution of the Rurality Index, by quintiles. The Q1, in green, represents the areas with lower levels of rurality. The Q5, in red, represents the areas with higher levels of rurality. In 1991 the RI ranges from −10.7 to 5.4. In 2011, RI ranges from −10.3 to 5.3. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)
Source: Based on Censuses Data, produced by National Statistics Institute (INE) and GeoHealthS project.

changes. The traditional North/South divide has strong cultural roots, with clear expression in terms of social values, attitudes and behaviour (e.g. religious beliefs and practices, family and community relationships, political behaviour, etc.), with the Northern region being more conservative and catholic overall. This cultural environment may encourage the underreporting of suicides (Gusmão and Quintão, 2013). The North/South smoothening reveals the secularization/ modernization of Portuguese society (Garelli, 2013), and partially explains the existence of a more balanced regional pattern nowadays. The urban/rural divide, which is increasing, may be related to social and economic factors rather than cultural ones. In addition to the decrease in religious involvement, the main factors contributing to suicide increase in rural areas are social isolation, stigma towards mental disorders (especially in men), easy access to highly toxic pesticides, and economic hardship (Hirsch, 2006; Judd et al., 2006; Stark et al., 2007). Nowadays, municipalities from Oporto MA are the only ones showing the lowest sSMR by suicide while Lisbon MA concentrate the municipalities whose suicide risk levels decreased in the last twenty years. As several authors argue, urban areas have important pockets of deprived and poor areas, but they also promote neighbourhood interaction, access to services, walkable urban green spaces, and social support networks (Santana et al., 2009). Moreover, urban areas were more resilient to the economic

Table 2
Suicide mortality rate ratios (RR) between the 1st quintile and the others of contextual variables in Portugal in the last 20 years.

		A. Rurality Index (when compared with the quintile with lower rurality)			B. Material Deprivation Index (when compared with the quintile with lower deprivation)			C. Material Deprivation Index without the effect of the Rurality Index			D. Rurality Index without the effect of material deprivation		
		1989-1993	1999-2003	2008-2012	1989-1993	1999-2003	2008-2012	1989-1993	1999-2003	2008-2012	1989-1993	1999-2003	2008-2012
Total													
Q2	RR	1.44*	1.2	1.34*	1.47*	1.03	1.22*	1.41*	1.02	1.21*	1.44*	1.2	1.32*
	CI	1.11–1.83	0.99–1.44	1.13–1.56	1.11–1.89	0.85–1.24	1.04–1.43	1.06–1.83	0.85–1.23	1.03–1.40	1.11–1.85	0.99–1.44	1.12–1.55
Q3	RR	1.76*	1.48*	1.52*	1.52*	1.11	1.23*	1.44*	1.07	1.16	1.78*	1.49*	1.48*
	CI	1.36–2.24	1.22–1.77	1.28–1.78	1.14–2.03	0.91–1.35	1.03–1.46	1.04–1.95	0.89–1.30	0.97–1.38	1.35–2.29	1.22–1.79	1.25–1.74
Q4	RR	1.92*	1.4*	1.59*	1.63*	1.21	1.28*	1.49*	1.1	1.14	1.95*	1.42*	1.52
	CI	1.47–2.47	1.14–1.71	1.33–1.89	1.19–2.22	0.97–1.50	1.05–1.57	1.02–2.09	0.88–1.39	0.91–1.39	1.45–2.55	1.14–1.75	1.26–1.82
Q5	RR	1.87*	1.52*	1.73*	1.99*	1.23	1.46*	1.73*	1.08	1.21	1.91*	1.55*	1.63*
	CI	1.38–2.48	1.21–1.89	1.41–2.09	1.41–2.78	0.98–1.54	1.19–1.80	1.09–2.59	0.84–1.38	0.95–1.51	1.36–2.59	1.20–1.95	1.32–2.00
Men													
Q2	RR	1.46*	1.18	1.3*	1.48*	1.09	1.27*	1.43*	1.08	1.25*	1.47*	1.19	1.29*
	CI	1.12–1.86	0.97–1.43	1.05–1.58	1.12–1.92	0.89–1.32	1.04–1.53	1.07–1.86	0.89–1.30	1.03–1.50	1.12–1.89	0.97–1.44	1.04–1.57
Q3	RR	1.76*	1.47*	1.54*	1.49*	1.19	1.25*	1.42*	1.15	1.17	1.78*	1.48*	1.51*
	CI	1.35–2.25	1.21–1.77	1.25–1.88	1.11–1.99	0.97–1.45	1.01–1.54	1.02–1.92	0.95–1.41	0.94–1.45	1.35–2.30	1.23–1.79	1.22–1.85
Q4	RR	1.89*	1.34*	1.57*	1.50*	1.21	1.28	1.39	1.11	1.11	1.92*	1.37*	1.51*
	CI	1.43–2.44	1.08–1.64	1.26–1.94	1.09–2.06	0.97–1.52	1.00–1.63	0.95–1.96	0.88–1.48	0.85–1.43	1.42–2.54	1.10–1.70	1.19–1.88
Q5	RR	1.72*	1.5*	1.87*	1.87*	1.30*	1.57*	1.64*	1.15	1.27	1.75*	1.54*	1.78*
	CI	1.25–2.29	1.17–1.87	1.45–2.36	1.33–2.63	1.03–1.64	1.23–2.01	1.04–2.48	0.89–1.48	0.95–1.65	1.24–2.41	1.20–1.96	1.36–2.29
Women													
Q2	RR	1.49*	1.31	1.48*	1.43	0.95	1.06	1.38	0.94	1.05	1.51*	1.3	1.45*
	CI	1.04–2.06	0.94–1.77	1.12–1.93	0.97–2.03	0.68–1.28	0.80–1.37	0.92–1.98	0.67–1.26	0.80–1.36	1.04–2.11	0.93–1.77	1.09–1.88
Q3	RR	1.76*	1.58*	1.44*	1.55*	0.97	1.14	1.48	0.93	1.11	1.81*	1.57*	1.38*
	CI	1.24–2.42	1.14–2.12	1.07–1.87	1.03–2.28	0.70–1.32	0.86–1.51	0.94–2.22	0.67–1.28	0.81–1.47	1.24–2.54	1.15–2.12	1.02–1.80
Q4	RR	1.94*	1.57*	1.62*	1.76*	1.25	1.24	1.63	1.14	1.17	2.01*	1.55*	1.48*
	CI	1.32–2.73	1.09–2.18	1.18–2.16	1.14–2.66	0.87–1.78	0.90–1.71	0.97–2.58	0.77–1.64	0.81–1.63	1.32–2.92	1.07–2.22	1.04–2.02
Q5	RR	2.22*	1.57*	1.4	2.13*	1.10	1.17	1.89	0.95	1.05	2.33*	1.55*	1.25
	CI	1.46–3.24	1.04–2.27	0.97–1.93	1.34–3.32	0.75–1.58	0.83–1.63	0.99–3.28	0.62–1.42	0.68–1.52	1.45–3.54	1.02–2.32	0.84–1.78

Note: the numbers with * inform that there is a statistical association.

crisis than rural areas, given the vulnerability of the social structure and the economic specialization of these areas (Ferrão, 2013).

Secondly, there are substantial and increasing gender differences in suicide rates: female suicide in the 1989-1993 period represented three out of ten suicides and in 2008–2012 only two out of ten suicides. This differential reflects societal changes that have occurred in Portugal, including the rise in female labour force participation, the increasing prevalence of women in institutions of higher education, and changes in family formation patterns, as it happens in other countries (Phillips, 2014). Indeed, this has had geographical implications. Most of the municipalities that in 1989–1993 showed a risk of higher female suicide mortality rates presented a higher risk for men in the last period. This is the case of several municipalities from the southern area of the Lisbon MA, the Centro region and northern area of the Alentejo. Most of the municipalities that had a higher risk for men than for women twenty years ago kept the same pattern. Currently, women do not show a distinct pattern when compared with men. The construction, real estate, unskilled industries and services have been highly affected by the economic crisis (Ferrão, 2013) and they employ mostly men.

Thirdly, we found that suicide mortality is statistically associated with both contextual variables: rurality and material deprivation.

In the first case, we have observed that the higher the rurality, the higher the risk of suicide mortality, particularly for men. Although this association is declining, people living in municipalities with higher levels of RI in the last period (2008–2012) still have 73% higher risk of dying from suicide. This was also found in other studies associating the characteristics of rurality with suicide mortality (Chang et al., 2011; Hempstead, 2006; Jagodic et al., 2012; Kim et al., 2010; Razvodovsky and Stickley, 2009; Wang et al., 2013). Higher levels of rurality promote social isolation and lack of social support which may deter individuals from suicide (Locker, 2008). On the other hand, studies comparing characteristics of urban concentration with hospitalization due to mental disorders found that higher population density was associated with higher rates of hospitalization (Loureiro et al., 2015). This may be related to better access to healthcare facilities, which tend to be located in places with higher population concentration. As stated by several authors, attempted suicide is a more "urban" phenomenon compared to successful suicide, while suicidal behaviour is more likely to result in fatalities in areas with higher levels of rurality (Hempstead, 2006; Woo et al., 2012).

We also found that suicide mortality was statistically associated with material deprivation: the higher the deprivation, the higher the risk of suicide mortality. This association was found for the first and the third periods covered by our study. Comparing both periods we also confirmed that this association is declining. Nevertheless, in the last period, people living in municipalities with higher deprivation have almost a 50% higher risk of suicide mortality than those living in municipalities with lower deprivation. Places with higher deprivation have higher social vulnerability, worse life perspectives and a higher incidence of social problems, with negative consequences in terms of quality of life and well-being, and amplification of mental health disorders and territorial inequities (Patel et al., 2010). Similar findings were observed in other countries (Burrows et al., 2011; Kim et al., 2010; Rezaeian et al., 2007; Stark et al., 2007).

The association between suicide mortality and RI and MDI is

different for men and women. Men show a statistical association with both indexes for all quintiles. Women merely show a statistical association with RI and only for some quintiles. These gender inequalities (not related with suicide mortality though) have also been described in other studies (Marí-Dell'Olmo et al., 2015; Middleton et al., 2006), which state that women may not be as influenced by the context as men (Li et al., 2011; Santana et al., 2015).

Finally, although suicide mortality is statistically associated with both material deprivation and rurality, this association is higher for the second contextual variable. Besides, if we take adjustments into account, the association with material deprivation is irrelevant while the association with RI remains significant. RI had a higher punitive effect, since the amplitude is greater: over time municipalities with high levels of rurality have lost population, mainly young and active people, while those with low levels of RI have gained population. During the last twenty years, material deprivation ceased to be a relevant factor in terms of explaining suicide mortality, because contextual conditions have been improved overall. Several programmes focused on education and housing conditions, implemented by the Portuguese government at national and local level, were successful in increasing the levels of education of the population and in improving residential dwelling conditions.

Nevertheless, we identified an association between economic crisis and suicide through material deprivation. A relevant statistical association between suicide distribution and this contextual variable, which translates the education, housing and employment conditions in each small-area (compared to the national average), was found for the first and the last study periods, which are closer to two IMF interventions in Portugal, and not for the middle period. The middle period (1999–2003) is associated with an economic boom. The recent evolution reflects the current economic crisis, responsible of a shift on the previous tendency of decreasing deprivation (Ferrão, 2013). With the implementation of austerity measures and the consequent cuts in spending on health care and social support (Ayuso-Mateos et al., 2013; Barros, 2012; Sakellarides et al., 2014), vulnerable population groups living in municipalities with higher deprivation were more affected by negative consequences. Accordingly, it includes difficulties in acquiring prescription drugs such as antidepressants or in accessing mental health services (Sakellarides et al., 2014). Portuguese municipalities are unequally vulnerable to the economic crisis. Those with a weak social and economic structure are more exposed and have greater difficulties in adjusting to the effects of the economic crisis (Ferrão, 2013). Political decisions, through social, education and housing policies and labour market programmes, can protect these places from absolute deprivation by maintaining widespread access to health care (Marmot and Bell, 2009) and mitigating the impact on health outcomes (Baumbach and Gulis, 2014) (e.g., the increase in the number of suicides, as referred by Stuckler et al. (2009)). As other studies suggest, prevention strategies that focus on socio-economic targets have the potential to have similar population-levelling effects as strategies that target more proximal psychiatric risk factors in the prevention and control of suicide (Li et al., 2011; Marmot and et al., 2012; Melhuish et al., 2008).

4.1. Strengths and limitations

This is the first study aiming at understanding how places of residence (municipalities) may influence suicidal behaviour, considering the current economic crisis and suicide mortality in Portugal. Although the results may be considered robust in analytical terms, there are limitations that may introduce some bias.

In relation to data constraints, four aspects stand out. First, Portugal still presents inaccurate statistics for causes of death, with about a 9.6% rate of ill-defined deaths, according to the Portuguese National Statistics Office. According to this, the phenomenon of suicide mortality may be under-represented, in spite of the improvement in suicide registry. However, the geographic pattern of ill-defined deaths is different from the one for suicide mortality, so it does not impact the identified spatial pattern (Gusmão and Quintão, 2013). Secondly, due to the need to keep confidentiality at statistical level, the access to suicide mortality data was only possible with aggregated data in four age groups. Moreover, the suicide mortality data from 76 municipalities (27%) have been aggregated. As a consequence, the situation of municipalities with low levels of suicide has been subsumed in the analysis. This aggregation may obscure the kind of statistical association between variables. However, as Richardson et al. (2004) mention, the small area level is considered the best one to avoid the ecological bias component (the Modifiable Areal Unit Problem) created by heterogeneity and to detect geographical patterns in mortality, which would not be evident with larger geographical areas. Thirdly, the data used to measure the area-level characteristics have been collected from the National Census, thus corresponding to one year per decade, while mortality data corresponds to five-year periods. This constraint is particularly concerning in the case of the unemployment analysis taking into account that this rate doubled between 2008 and 2012. Finally, the literature has shown the relevance of social fragmentation indexes to explain spatial disparities of mental health needs. However, it was not possible to build a social deprivation index for Portugal at municipal level because the INE (the national authority for statistics) did not produce enough indicators related with social behaviour for the three periods under consideration.

In terms of methodology, there are three main constraints. First, the standardization of mortality data took into account a structure of four age groups, which does not entirely remove the effect of age. Secondly, the existence of statistical associations between the characteristics of places of residence (municipalities) and suicide patterns may be carefully interpreted in terms of causality (Jokela, 2014). Thirdly, the method used to build the two composite indexes may be considered simplistic since it is based on three indicators in both cases. Nevertheless, this method is frequently mentioned in the literature of ecological spatio-temporal studies, especially at small area level, relating deprivation with health outcomes.

Finally, it is quite likely that the shift that occurred between the second and the third period is a consequence of the current economic crisis. At the same time, there seems to be strong empirical evidence on the spatially uneven impact of the current economic crisis in terms of suicidal behaviour. Nonetheless, we need further in-depth research to confirm both statements, namely to identify the dynamics of causality between suicide mortality and its social determinants. In any case, it is "probably too early to arrive at conclusions concerning the impact of the current economic crisis on health, mental health and the suicide rate in particular. It seems necessary to wait until data up to at least 2020 are gathered in order to have a complete picture." (Fountoulakis et al., 2014, p. 8).

5. Recommendations

Suicide mortality is overrepresented in rural, less populated and more deprived areas, mainly with respect to men. These characteristics of the place of residence have a relevant effect on suicidal behaviour at local level. These findings are significant in justifying resource allocation for tackling suicide clustering in those particular areas. Several researchers state the need to detect and monitor geographical suicide clusters because it allows key service providers to intervene and prevent further death or harm

in areas of high risk (Coldefy, 2014; Derek Cheung et al., 2014; Exeter and Boyle, 2007; Gould et al., 1994; Qi et al., 2010).

Strategies targeting rural areas with high suicide rates may show a positive impact in reducing the rural–urban disparity in suicide. Moreover, social and spatial planning policies that address area deprivation and promote people concentration may have important implications for tackling higher suicide rates in the most disadvantaged areas of Portugal.

Nowadays, one of the targets of the Portuguese National Health Plan 2012–2016 is to reduce suicides in people with less than 65 years by at least 12%. However, this goal will only be achieved if demographic, social and contextual diversity, e.g. a place-based approach, is taken into account when designing public policies that impact the population's mental health. This means that more attention must be given to the characteristics of the built environment and social contexts at intra-municipal level, making use of different quantitative and qualitative methods.

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