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Regional Variation and Socio-Economic Determinants of Suicide Mortality in Greece before and during Economic Crisis

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Abstract: Background. Suicide mortality increased in Greece after the 2008 financial crisis. This study aimed to explore the regional variation of suicide mortality before and after the economic crisis, and its correlation with socio-economic and mental health-related variables factors. Methods. This is a quasi-experimental ecological study. Data from the national mortality statistics were analyzed, and standardized death rates and age-specific mortality rates were calculated. The effect of economic crisis was explored by comparing mortality rates before and after crisis onset. Pearson's and Spearman's correlation coefficients and multiple linear regression were used to assess the impact of socioeconomic and mental health-related factors on suicide mortality. Results. Trends of suicide mortality showed a rise during 2011–2014, followed by a decline during 2015–2016. Significant differences were observed between regions, ranging from 27.6% lower to 54% higher than the national average. Unemployment, income, and change of gross domestic product were significantly correlated with regional variation. No association was found with mental disorder mortality rates and psychotropic drug consumption. Conclusions. Socio-economic factors explained only a part of the suicide mortality variation. Mental health-related factors were not significantly correlated with suicide mortality. More research is needed to investigate other possible determinants of suicides.

Keywords: suicide; regional variation; socio-economic factors; economic crisis

1. Introduction

Suicide is one of the most important causes of premature mortality [1], which is preventable with timely, appropriate, and evidence-based interventions [2,3]. Several studies have documented a significant increase in suicide in many European countries during the 2008 financial crisis [4–6]. The impact on suicidality mostly depends on the severity and duration of socio-economic effects and austerity measures applied [7,8]. Suicide rates demonstrate significant variation between countries and areas, which is mostly attributed to demographic, behavioral, and socio-economic differences [8–10] and mental morbidity factors [11–13]. Greece was seriously hit by the economic crisis where the Greek economy shrank by almost 30% between 2008–2014 [14]. The per capita gross domestic product (GDP) and disposable household income (DHI) continued to decline until 2016. The unemployment rate from 12.7% in 2010, reached 27.5% in 2013 and remained above 25% until 2015 [15]. Suicide mortality increased during crisis, especially over the period 2011–2014 [16,17]. Although the relation between

economic crisis and suicide in Greece has been adequately investigated [16–18], there are limited data on the regional patterns of suicide mortality across the country, the determinants of the existing variation, and the impact of financial crisis on these patterns. A systematic review of area-level determinants of suicide in Europe showed an association between suicidal behaviors and local socio-economic disadvantages [8]. However, most of the studies reviewed were not related to the economic crisis short-term effects. In addition, it remains unclear if financial crisis affects suicidality by increasing common mental morbidity, which in turn results in a rise in suicide, or the impact is directly on suicidality, independent of the overall mental morbidity. Better understanding of regional variation provides a background to explore risk factors to strengthen the evidence in studying possible suicide determinants and to plan preventive actions.

The aim of this study was to explore (i) the regional pattern of suicide mortality before and after the economic crisis in Greece, and (ii) the association of the regional suicide variability with possible socio-economic and mental health-related determinants.

2. Materials and Methods

Study design. In this ecological study, we applied a quasi-experimental approach to compare the “exposed” and the “non-exposed” to the 2008 financial crisis period.

2.1. Data Selection

The study was based on datasets obtained from the national mortality statistics including all deaths due to suicide that occurred in Greece from 2001 to 2016 by sex, age group, and region. Data included all deaths under codes X60–X84 of the International Classification of Diseases 10th revision (ICD-10) or codes E950–E959 of ICD-9.

Data on GDP, DHI, and unemployment were obtained from publicly available data of the Hellenic Statistical Authority (ELSTAT) [14,15,19]. Data on mental disorder mortality rates were also obtained from the national mortality statistics provided by ELSTAT [20]. Data on psychotropic drug consumption were provided by the National Health Insurance Organization (EOPY).

2.2. Period Identification

First, we calculated the annual standardized death rates (SDRs) for the years 2001–2016, using as the standard population the population of Greece in 2001. Then, we applied Jointpoint regression analysis of the annual rates to identify possible turn points of suicide trend during the study period. Joint point regression identified 2011 as the time point of a significant change in the slope of suicide SDR. It should be noted that although at the economic level, the onset of crisis was dated in 2008, most of its social consequences on income, employment, etc. started to be felt by the population after 2010 [14,15,19]. Therefore, considering that the statistical identification of the cut-point complies with the socio-economic developments, we used 2011 as a cut-point between the “exposed” and the “non-exposed” to crisis period.

2.3. Study Variables

We calculated the cumulative 6-year SDR of the exposed (2011–2016) and of an equal non-exposed to crisis period (2005–2010), and we tested the significance of their differences. In addition, we calculated comparative mortality figures (CMFs) by region and their 95% confidence interval. The CMF expresses the relationship of each regional SDR with that of the standard population. Sex-and-age-specific suicide rates by region were also computed.

Investigating factors affecting suicide mortality, the correlation between suicide SDR and two sets of possible determinants was explored. The first set included five socioeconomic variables: (i) per capita GDP, which is a monetary measure of the value of all the final goods and services produced in a specific time period; (ii) average change (%) in per capita GDP; (iii) per capita disposable household income (DHI), which measures the net income of households including social benefits, interests and

dividends received, after payment of taxes and social contributions; (iv) unemployment rate as a percent of the economically active population that is unemployed; and (v) long-term unemployment rate (over 12 months). The second set included a number of mental health-related variables associated with suicide: (i) standardized death rate (SDR) of all mental disorders; (ii) SDR of organic and non-organic psychoses; (iii) SDR of alcohol dependence syndrome; (iv) average per capita consumption of all types of psychotropic drugs, as an indirect measure of the overall prevalence of mental disorders; (v) average per capita consumption of antipsychotic drugs, as a measure of psychosis prevalence; and (vi) average per capita consumption of antidepressants, as a measure of depression prevalence. Drug consumption was measured in units of prescribed packaging per 100 people. All dependent and independent variables were calculated at a regional level, achieving a total of 208 observations per variable excluding drug consumption, where the reduced availability of data limited the number of observations to 52.

2.4. Statistical Analysis

The regional variation of SDRs was explored using (a) the coefficient of variance (CV), which is the standard deviation of the regional SDRs as a percentage of the mean value and (b) the max/min rate ratio of SDRs. The “Change of SDR” between the two periods, expressed as a percentage, was also calculated as $(SDR_{n+1} - SDR_n) \times 100 / SDR_n$.

Jointpoint regression analysis was applied to identify the cut-point between the “exposed” and “non-exposed” to crisis period. The differences between the SDRs of the exposed and non-exposed period were tested with the Mantel-Haenszel χ^2 test. After testing for normality of data distribution with a Kolmogorov–Smirnov test, correlation analyses were performed using Pearson’s and Spearman’s correlation coefficients.

Further exploring the effect of the associated variables, a multiple linear regression model with variable selection was applied. Multiple linear regression analysis was included in the model of three of the five correlated variables: (i) change in per capita GDP, (ii) average per capita DHI, and (iii) unemployment rate. Statistical analyses were carried out with Jointpoint Regression Program and SPSS.

2.5. Ethical Aspects

The study did not address ethical issues as no human subjects were used and no environmental rights were violated.

3. Results

During 2005–2016, 5305 deaths due to suicide occurred in Greece, from which 57.2% occurred in 2011–2016. The cumulative 6-year SDR increased from 19.8 to 26.8 deaths per 100,000 standard population (35.1%). The difference in SDR between the two periods is statistically significant ($p < 0.001$). The annual suicide SDR showed an upward trend after 2011, which took its highest value in 2014 (Figure 1), followed by a decline during 2015 and 2016.

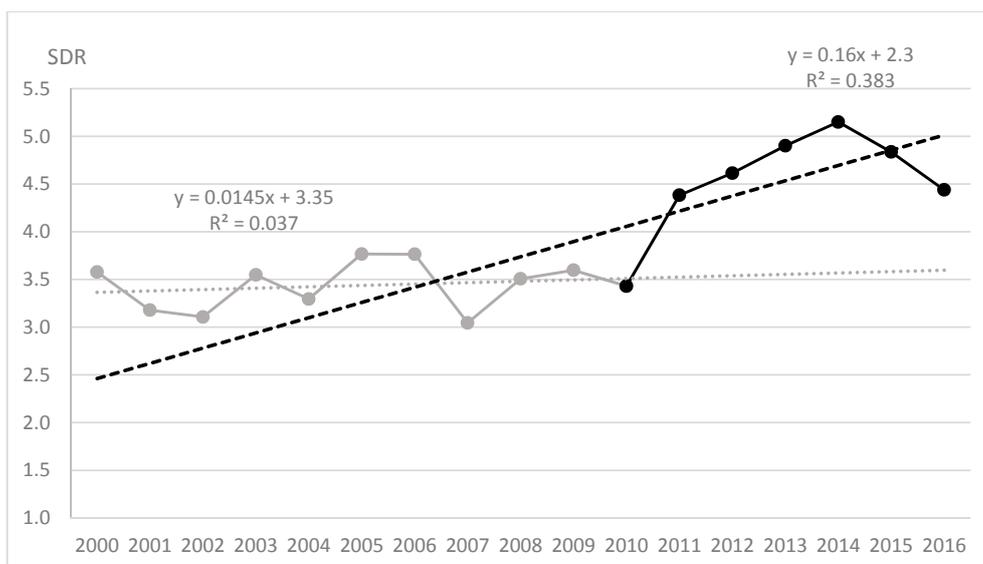


Figure 1. Suicide SDR (Standardized Death Rate), 2000–2016.

3.1. Regional Variation

Exploring the regional suicide rates, significant variation was observed in both periods (Table 1). In the pre-crisis period, the regional SDRs ranged from 15.8 to 30.5/100,000, with significantly higher rates in the Ionian Islands ($p < 0.01$), Crete ($p < 0.001$), Peloponnese ($p < 0.001$), and West Greece ($p < 0.05$). The max/min SDR ratio was calculated at 1.92 and the coefficient of variance was 19.9%. In the exposed to crisis period, the regional SDRs ranged from 19.4 to 37.6/100,000. The rate remained significantly higher than the national average only in Crete ($p < 0.001$). The max/min rate ratio of SMRs was found to be 1.93 and the CV was 16.5%. Focusing on the change of rates between the two periods, significant increase was observed in most regions, with a higher rise in Attica (58.6%), South Aegean Islands (37.9%), and Central Macedonia (33.4%). Sex-and-age-specific suicide rates (Table 2) revealed significantly higher rates in males 45–64 years old in Crete and East Macedonia-Thrace, and over 65 years in Crete, Epirus, Peloponnese, and East Macedonia-Thrace. In females, higher rates were observed in the age group of 45–64 in Epirus, and over 65 years in age in Epirus and the Ionian Islands.

Table 1. Suicide standardized death rate (SDR) and comparative mortality figure (CMF) by region, 2005–2010, 2011–2016.

Regions	SDR 2005–2010	SDR 2011–2016	Change of SDR *	CMF 2011–2016	95% CI _{CMF}	
					Min	Max
East Macedonia/Thrace	24.3	29.6	22.2% ¹	148.8	128.9	171.7
Central Macedonia	15.8 ¹	21.1 ¹	33.4% ¹	106.1	96.2	117.0
West Macedonia	18.6	24.0	29.0% ²	120.5	95.3	152.4
Epirus	23.7	28.6	20.8% ¹	143.5	118.6	173.7
Thessaly	20.6	26.7	29.6% ¹	134.2	116.8	154.2
Central Greece	20.9	24.6 ³	17.4% ²	123.3	104.8	145.1
Ionian Islands	30.5 ²	31.9	4.7%	160.1	125.8	203.9
West Greece	24.2 ³	30.7	26.7% ¹	153.9	134.6	176.0
Peloponnese	27.5 ¹	28.9	5.2%	144.9	125.0	168.0
Attica	16.8 ¹	26.6	58.6% ¹	133.6	125.7	142.1
North Aegean Islands	19.9	19.4 ¹	−2.2%	97.6	71.2	133.7
South Aegean Islands	20.0	27.6	37.9% ¹	138.6	112.2	171.3
Crete	29.9 ¹	37.6 ¹	25.8% ¹	188.6	165.8	214.5
Greece	19.8	26.8	35.1% ¹	134.4	129.6	139.3

Significance of difference from national average: ¹ $p < 0.001$, ² $p < 0.01$, ³ $p < 0.05$. * Change of SDR = $(SDR_{n+1} - SDR_n) \times 100 / SDR_n$. The p -values refer to the significance of the difference between the two periods.

Table 2. Sex-and-age-specific suicide rates by region, 2011–2016 *.

Regions	Males			Females		
	15–44	45–64	65+	15–44	45–64	65+
East Macedonia/Thrace	5.9	17.7 ²	17.0 ²	2.3	3.2	2.0
Central Macedonia	4.9 ²	11.5 ²	8.9 ²	1.7	2.7	1.8
West Macedonia	8.2	13.7	11.2	0.3	1.4	1.5
Epirus	6.4	13.8	20.0 ¹	1.1	4.7 ²	4.6 ¹
Thessaly	6.8	15.3	12.7	2.6	2.0	2.2
Central Greece	5.9	15.8	11.4	0.9	3.4	2.2
Ionian Islands	8.1	14.8	15.0	3.4	2.4	3.4 ²
West Greece	7.8	15.5	17.8	1.8	3.2	2.0
Peloponnese	7.6	15.1	19.2 ¹	1.8	2.3	1.9
Attica	7.3	12.6	12.9	2.0	2.3	2.2
North Aegean Islands	5.5	11.2 ²	10.2	1.8	2.1	0.7 ²
South Aegean Islands	7.8	9.2 ¹	17.6	3.1	2.2	1.3
Crete	7.9	23.6 ¹	22.5 ¹	1.5	2.0	3.3 ²
Greece	6.8	14.0	13.9	1.9	2.5	2.2

Significance of difference from the respective national average ¹ $p < 0.01$, ² $p < 0.05$. * The age group of 0–14 years was not included in the table, since only four deaths of this age were recorded during the entire 2011–2016 period.

3.2. Determinants of Regional Variation

Exploring the association between the regional SDRs and the aforementioned socio-economic variables, significant correlation was found with all five of them. Positive association was found with unemployment and long-term unemployment rate, and negative association with per capita GDP, average change (%) in GDP, and per capita DHI (Table 3). The strongest association was found with unemployment rate (Spearman's $\rho = 0.268$, $p < 0.001$), followed by “change in per capita GDP” (Spearman's $\rho = -0.266$, $p < 0.001$) and “average per capita DHI” (Spearman's $\rho = -0.228$, $p < 0.001$). The annual values of all socio-economic variables are presented in Table S1 of Supplementary Materials. The correlation of the regional suicide SDR with the same variables was also explored separately by region. Unemployment was found to be the most constant determinant, displaying significant correlation with suicide rate in eight regions, followed by long-term unemployment correlated in five regions. Change in per capita GDP was significantly correlated with suicide rates in four regions, while average per capita DHI in three regions. In the larger region of Attica, all socio-economic variables were correlated with suicide rate. Exploring the association of suicide with the set of variables including mental disorder mortality rates and psychotropic drug consumption, no association was found with any of them.

Multiple linear regression analysis showed a positive correlation with unemployment, with a partial correlation of 15.2%, a negative association with “change in per capita GDP” with a partial correlation of 14%, and a negative correlation with average per capita DHI with a partial correlation of 17.1%. The beta coefficient of unemployment was calculated at 0.078, corresponding to 0.78 suicides per 1 million population for every 1% change of unemployment rate. The beta coefficient of average per capita DHI was calculated at -0.121 , corresponding to 1.2 suicides per 1 million population, for every 1000 euros reduction in average DHI. The beta coefficient of the “change in per capita GDP” was calculated at -0.034 , which corresponded to 0.34 suicides per 1 million population for every 1% change in GDP.

Table 3. Correlation between variables and regional suicide SDR 2001–2016.

I. Socio-Economic Variables	Average 2001–2010	Average 2011–2016	Pearson’s R	Spearman’s ρ	Significance (P)
Average per capita GDP ^{1,*}	18,557.7	16,931.7		−0.177	0.011
Annual change (%) of per capita GDP ^{1,*}	4.3%	−3.5%		−0.266	0.000
Average per capita DHI ^{2,*}	12,074.1	10,394.6		−0.228	0.001
Unemployment rate	9.9%	24.1%		0.268	0.000
Long-term unemployment rate	4.8%	16.0%		0.255	0.000
II. Mental health-related variables					
SDR ³ due to all mental disorders *	1.22	4.62		0.124	0.074
SDR ³ due to organic and non-organic psychoses *	0.93	4.30		0.095	0.172
SDR ³ due to alcohol dependence syndrome *	0.24	0.24		0.024	0.731
Average per capita psychotropic drug consumption **		10.55	−0.054		0.743
Average per capita antipsychotic drug consumption **		0.33	0.171		0.299
Average per capita antidepressant drug consumption **		0.63	0.038		0.817

Data on drug consumption include 2013–2016. ¹ GDP: gross domestic product; ² DHI: disposable household income; ³ SDR: standardized death rate, deaths per 100,000 standard population. * Kolmogorov–Smirnov $p < 0.05$; ** Kolmogorov–Smirnov $p > 0.2$.

4. Discussion

Greece has one of the lowest suicide rates among European countries, without increasing trends until 2010 [21]. Financial crisis resulted in a dramatic and unprecedented deterioration of the socio-economic conditions in the country. In such a socio-economic context, the suicide SDR recorded an increase by 50.1% from 2010 until 2014, and thereafter, a reduction by 13.8% until 2016. A systematic review of the association between unemployment and suicide found that unemployment might increase the risk of suicide by 250% within the first five years [22]. The same review found that even after 12–15 years, the suicide rate remained elevated by about 20%. Other studies have shown that suicide rates tend to return to previous levels after an economic crisis [23].

The study findings showed a significant variation in suicide rates among regions, with a gap of 93% between the highest and lowest SDR values. In most countries, the gap in regional differences does not exceed 50–65% [24–27]. The magnitude of the differences observed in Greece and the fact that they already existed before the crisis, raises questions about the factors resulting in that variation, which are discussed below. It is the first time that these large differences in the regional suicide rates in Greece have been reported. Exploring the literature, several epidemiological factors have been identified that may explain variation in suicidality. Cultural, religious, genetic, socio-economic factors as well as mental morbidity have been identified as main determinants [8–11,28]. Considering that religious factors have small variation in Greece, we should explore whether differences are driven by cultural, socio-economic, genetic, or mental factors. However, specific correlation analyses focusing on the pre-crisis period did not find any association of suicide rates with any single socio-economic or mental disorder mortality variable, except unemployment ($p < 0.05$). In addition, the only regression model that showed a statistically significant effect was the one including as independent variables the “change in per capita GTP”, “per capita DHI”, and “unemployment”. No other model was able to provide explanatory results during the pre-crisis period. These findings turn our attention to cultural along with geophysical factors such as insularity, which has been associated with elevated rates of suicidality [29]. The investigation of these factors was out of the scope of our study. The mental health-related factors are discussed below. Focusing on the financial crisis effects, we found only one study providing findings about the crisis impact on regional variation in suicide from Spain, which found a maximum gap between regions of about 55–65% [27]. Another study exploring the crisis effects on the variation between seven Spanish cities reported elevated suicide rates associated with crisis in three cities, and no effect in four cities [30]. There is evidence from previous research [31] that social and economic transition may not be uniform, with some regions affected much more than others. In our study, the coefficient of variance and the max/min SDR ratio were calculated at similar levels in the exposed and non-exposed period, indicating that crisis did not further widen overall regional inequalities. Similar findings were reported by Ruiz-Perez et al. in Spain [27]. Borrell et al., who explored suicide variability among European cities and metropolitan areas during crisis, also found that area inequalities in suicide mortality did not change significantly after the onset of the crisis in Europe [32]. The differences observed among the various studies may be due to differences in their scope, methods, and limitations, or they may express real differences in the effects that economic crisis may have in the various countries.

4.1. Socio-Economic Determinants

We found significant correlation of suicide mortality with unemployment rate, reduction in GDP, and low disposable income. In the region of Attica where a higher rise in suicide rate was observed, unemployment recorded a higher increase among all Greek regions, and was found to be the main determinant of the elevated rate. In the same region, the suicide rate was also associated with change in per capita GDP and average DHI. In the second larger region, Central Macedonia, the increase by 33.4% was found to be significantly associated only with unemployment rate. It is known from many studies that these parameters are among the strongest social determinants of suicide [4,6] and the results of the present study were consistent with them. A systematic review of the association between

unemployment and suicide found that unemployment might increase the risk of suicide by 250% within the first five years, the effects remaining even after that period, but at a lower level [22]. However, that correlation with the socio-economic variables cannot explain all regional differences observed in our study. The regression model we applied could only explain 17.2% of the overall regional variation. This finding means that other not-investigated factors determine suicide patterns, underlining a need for further research. As stated above, these factors may include cultural, geophysical, genetic, or mental determinants.

A remarkable methodological finding of our study was that the variables “change (%) in per capita GDP” and “average disposable household income” were found to be more predictive than the “per capita GDP” itself. This is likely to be because the change in income is more strongly perceived by the population than the GDP itself. The per capita GDP is mainly related to the overall national economy, and probably the real economic conditions of the population are not necessarily reflected in GDP.

4.2. Mental Health-Related Variables

Focusing now on the mental health-related variables, it is known from many studies that organic and non-organic mental disorders are associated with high rates of suicide [11,12], especially in patients who previously underwent inpatient treatment [12,13]. Schizophrenia and organic mental disorders in inpatients [12,13,33], and depression [13,33,34], and substance-related disorders [33] in outpatients have been determined as highly significant risk factors for suicide. However, in our study, no association was found with the SDR of overall mental disorders, organic and non-organic psychoses, and alcohol dependence syndrome. The lack of association may be due to the low levels of mortality of these conditions [21], as shown in Supplementary Materials S2. In some regions and years, the number of events may be zero or very small, and therefore, there may be corresponding observations that are misleading and inappropriate to produce statistically significant results in correlation and regression analyses. However, looking at the numbers in Table 3 and Supplementary Materials S2, we found that after 2012, a sharp increase in mental disorder mortality was recorded. This increase may be related to the rise in suicide mortality, but it cannot be statistically supported. The observation of a greater impact on suicidality than on mental morbidity might be related to the phenomenon of “deaths of despair”, which has attracted attention during the recent years [35]. Attempting to further explore the possible effect of mental morbidity on suicide variation, by exploring the association of suicide rates with the average per capita consumption of total psychotropic drugs, antipsychotics and antidepressants, taking them as indirect measures of the prevalence of overall mental morbidity, psychoses, and depression disorders, respectively. However, we did not find any correlation of suicide mortality with any of them. A reasonable explanation could be that crude psychotropic consumption is probably not a reliable measure of the prevalence of mental disorders because it is affected by the mix of drugs, treatment patterns, potential abuse, etc. Furthermore, several studies from Greece [36,37] and other countries [38–40] found that mental morbidity increased significantly after economic crisis, and that is expected to have an impact on suicides [11–13].

The present study adds certain new elements in the suicide literature. It explores for the first time the differences in suicide rates among Greek regions, which were found to be significant, but did not widen during crisis. In addition, apart from traditional indicators (e.g., unemployment and GDP) we used new indicators like “Change in per capita GDP”, “per capita disposable household income (DHI)”, and “long-term unemployment”, which seems to be more sensitive in describing the socio-economic impact and provide some additional tools in exploring determinants of suicide mortality. It is likely that the two former indicators could better measure the living standards than the per capita GDP. Finally, it is the first study to our knowledge to explore the correlation of suicidality with mental disorder mortality rates, providing evidence that financial crises may affect suicidality independently and more severely than mental morbidity.

Our study has several limitations. First, the ecologic design based on aggregate data poses the risk of the ecological fallacy. Nevertheless, despite the shortcoming of ecological studies, it has been suggested that they are a suitable and practical choice for the investigation of the impact of economic crisis on health. Similarly, the associations with socio-economic and mental health-related factors are based on statistical correlations, which do not allow directly attributing a suicide to a particular cause. Regarding the quality of data, these were based on death certificates. However, there are no indications for unreported suicide cases in Greece. In contrast, there is evidence that Greek suicide records are of good quality [16] and therefore, the potential losses, if any, are not at a degree that could affect rates and trends.

Our results have several policy implications. First, the findings indicate the need for the development of surveillance systems to obtain data on suicide deaths and other measures important for suicide prevention (e.g., suicide attempts, hospital and emergency room data) at regional and national level. Second, there is a need to increase the relevance of regional and local epidemiology research efforts to gain insight into determinants of elevated regional suicide mortality and differential distribution of mortality. Third, there are several lines of evidence that active labor market programs can contribute to offset the impact of economic crisis, especially unemployment, on suicide risk [2,3].

In conclusion, our study revealed that increased suicide mortality during the economic crisis in the vast majority of Greek regions, but with considerable variation, were significantly correlated with unemployment rate and income reduction. Our findings underline the need for local and regional research on suicide mortality, which would shed light on suicidality and its determinants.

Supplementary Materials: The following are available online at <http://www.mdpi.com/2076-3417/10/17/6117/s1>.

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