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Association Between Suicide and Environmental Variables in the North of Spain: A 14-Year Analysis

Maite Santurtún[1] · Arturo Sanchez-Lorenzo[2] ·
Álvaro del Real[3] · María T. Zarrabeitia[4] ·
Ana Santurtún[4]

Abstract Suicide is a serious public health problem around the world. Since the nineteenth century, the impact of socio-environmental factors on suicide has attracted much public attention, especially in the context of global climate change. We have performed a retrospective correlation study that analyzes the demographic pattern of suicide in Cantabria, a northern coastland region of Spain. Moreover, we have created a multivariable binomial regression model to study the relationship between suicide and environmental factors (atmospheric pollutants and meteorological variables) among January 1, 2000, and December 31, 2013 in the province. During the 14-year study period, there was a suicide annual incidence of 4.9 cases per 100,000 population in Cantabria. The incidence was highest in adults aged 70–74 years old (11.8 per 100,000 population). The most common method group of suicide was hanging, strangulation and suffocation, accounting for 49.3% of all suicide deaths. When correlating suicide and meteorological variables, a statistically significant association was found with the level of cloudiness (p = 0.007). According to our results, an increase of one eighth of sky cloud-cover correlated to a 7% increase in total deaths by suicide and the association was especially strong during spring.

Keywords Suicide · Meteorology · Cloudiness · Method · Spain

✉ Ana Santurtún
ana.santurtun@unican.es

[1] Nursery Department, University of Cantabria, Santander, Spain

[2] Department of Physics, University of Extremadura, Badajoz, Spain

[3] Department of Medicine and Psychiatry, University of Cantabria, Santander, Spain

[4] Unit of Legal Medicine, University of Cantabria, Av Cardenal Herrera Oria s/n, 39011 Santander, Spain

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Introduction

Suicide is a serious public health problem around the world, being the 15th leading cause of death in 2012 and the second cause of death among those aged $15 - 29$ globally (WHO 2014). Suicide is multifactorially caused, and some of its risk factors are related to the individual's physical and psychological wellbeing and their social and cultural environment. Since the nineteenth century, the impact of socio-environmental factors on suicide has attracted much public attention, especially in past decades in the context of global climate change (Qi et al. 2015; Berry et al. 2010; Fountoulakis et al. 2016).

Consequently, several studies have examined the associations of suicide with air pollutants and meteorological variables during the last years. A positive relationship has been found between mean air temperature and suicide rate in different regions (Page et al. 2007; Helama et al. 2013; Hiltunen et al. 2014).

However, negative correlation has also been reported for other areas (Inoue et al. 2012), as well as a link between suicides and other meteorological variables such as air pressure or surface solar radiation (Hiltunen et al. 2012; Vyssoki et al. 2014), which highlights that the studies show contradictory and not conclusive results regarding the link between climate variability and suicides (Deisenhammer 2003). It is worth mentioning that some of the discrepancies reported in the literature can be due to differences in the climate of the regions, which may influence acclimatization.

In this context, this work has the objective of evaluating the demographic pattern of suicide in Cantabria (northern Spain) and the relationship between suicide and environmental variables for a period of 14 years.

Methods

We have performed a retrospective correlation study that analyzes the relationship between suicide and atmospheric variables in Cantabria, a northern coastland region of Spain which has a humid temperate oceanic climate, and its population amounting to 1.26% of the country.

Data Sources

Data were collected on a daily basis for a period of 14 years between January 1, 2000, and December 31, 2013.

The data source used for suicide information was the Spanish National Institute of Statistics (INE). Death cases were selected if coded as International Classification of Diseases (ICD 10) between X60 and X84 (Mortality by Intentional self-harm).

To analyze the incidence of suicide, data were extracted from Cantabria's population by age groups. The source for this data was the Instituto Cántabro de Estadística (ICANE).

Moreover, we acquired daily data on meteorological variables (solar insolation, air temperature, wind speed and direction, humidity, cloud cover and precipitation) from the Spanish National Meteorological Agency (AEMET) for the entire period studied. We worked with the monitoring station of ''Santander-Airport'' as it contains the most complete historical series in the region and was located near Santander, the capital and most populated city in the region (daily data were available for more than 99,5% of the period for all variables).

Finally, hourly data of air pollutants concentration [carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulphur dioxide (SO_2) and particulate matter with a diameter below 10 microns (PM10)] were obtained from Tetuan, a fixed monitoring station located in the urban center of Santander; it measures are representatives of the exposure of the general population. Data was obtained from the Environmental Investigation Centre of Cantabria [Centro de Investigación y Medio Ambiente de Cantabria (CIMA)].

Statistical Analysis

The annual incidence tendency was calculated by using the nonparametric test of Spearman's Rho.

In order to evaluate the association between suicide and environmental variables, a Binary Logistic Regression Model was performed in which the dependent variable was the number of suicides (1 = suicide; 0 = non-suicide). Exp (β) was used for measuring Odds Ratio (OR) and its confidence interval.

Results

During the 14-year study period, there was a suicide annual incidence of 4.9 cases per 100,000 population. The incidence was higher for men (7.7 per 100,000 population) than for women (2.2 per 100,000 population).

Suicide analysis in five-year age groups shows that the incidence was highest in adults aged 70–74 years old (11.8 per 100,000 population).

Moreover, it is remarkable that no temporal trend was detected during the studied period ($p > 0.05$).

The most common method group of suicide in Cantabria was ICD-10 X70 (hanging, strangulation and suffocation), accounting for 49.3% of all suicide deaths. Jumping from a high place (ICD-10 X80) was the second most common method (22.9%).

When correlating suicide and meteorological variables, a statistically significant association was found with the level of cloudiness ($p = 0.007$) (Fig. 1).

According to our results, an increase of one eighth of sky cloud-cover correlated to a 7% increase in total deaths by suicide in Cantabria.

Moreover, we reproduced the analysis taking into account the effect of accumulated cloud cover. To that effect, the 7-day moving average of cloud cover was calculated; no statistically significant relationship was found.
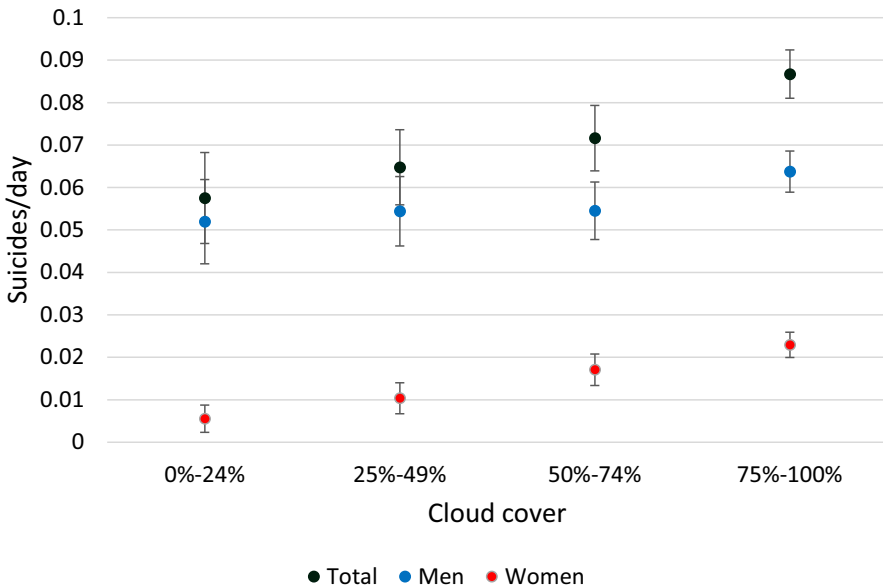
Fig. 1 Average of daily suicide per percentage of cloud covering

Additionally, when repeating the analysis by season of the year, we found that only spring showed a statistically significant association, when an increase of one eighth of sky cloud-cover was correlated to a 16.5% increase in total deaths by suicide in Cantabria ($p = 0.007$).

When performing a Binary Logistic Regression analysis with the rest of atmospheric variables, no statistically significant associations were found.

Discussion

The suicide rate found in Cantabria (4.9 suicides/100,000 pop.) is much lower than both the average rate in Europe [11.93 suicides/100,000 pop, according to WHO data (2017)] and in Spain (9.5 suicides/100,000 pop) (Santurtún and Santurtún 2017).

The differences by sex have been described in several previous epidemiological studies. In developed countries, suicide is approximately 2–4 times more frequent among men which is usually attributed to a higher lethality and availability of suicidal methods, and to cultural acceptance (Värnik et al. 2009). Moreover, Durkheim suggested that suicide is influenced by the characteristics and changes of the society, and males appear to be more affected by external factors, such as economic crisis, than females (Durkheim 1897; Mendez-Bustos et al. 2013).

In reference to the chosen means, national studies on suicide indicate that suicidal behaviour and, in particular, the preferred suicide method varies from

country to country; however hanging is the predominant method in most countries (Ajdacic-Gross et al. 2008), which is consistent with our results.

Nowadays, there is an ongoing debate about the relationship between environmental variables and suicide; in line with that, the most remarkable finding of our study is the significant positive correlation between suicide rates and cloud cover in Northern Spain. However, during the last decade some authors have posited a relationship between solar radiation and suicide rate (Helama et al. 2013; Vyssoki et al. 2014; Jee et al. 2017). Moreover, it is worth noting that a seasonal pattern that peaks around the spring and summer has been described in countries located in the northern hemisphere; specifically, a study developed by Jee et al. (2017) in South Korea between 1992 and 2010 showed that while other factors could change along the long period analyzed (socioeconomic, cultural, or mental health variables), and despite the fact that suicide rates have gradual increases, clear seasonal patterns persisted during the 19 years. The indirect cause of this relationship could lie in the climatological differences between seasons.

Therefore, our results are in disagreement with a large part of the literature that reported positive correlation with sunlight levels (i.e., negative relationship with cloud cover). Nevertheless, some known biological mechanisms support our findings: there is growing observational and experimental evidence that the exposure to sunlight contributes to the regulation of immunomodulation, the formation of nitric oxide, melatonin and serotonin (the imbalance of which has negative effects on an individuals's overall wellbeing), and that it has an important effect on circadian clocks (a strong causal relationship between the circadian rhythm disorders and mood) as well (van der Rhee et al. 2016; Machado et al. 2016). Clouds play multiple roles in the climate system, in particular, they efficiently reflect light to space. Cloud cover is correlated to sunshine duration, and sunlight at any given place and time is influenced by cloud cover (Fleury et al. 2016).

Finally, regarding the specific effect of cloudiness on suicide in the spring, we hypothesize that once winter is over and, generally, the weather begins to improve, individuals are prone to be in a better mood and feel more motivated, a situation that can be truncated on the cloudiest days. This explanation would be in line with the known fact that patients with depression and suicidal tendencies are at heightened risk of suicide as they begin to recover and their energy and motivation return (Mittal et al. 2009).

Due to the fact that suicide deaths represent a concerning worldwide issue, this study opens a new interesting area of research. Further study should be done in locations with similar geographical characteristics to those of Cantabria, in order to verify the reproducibility of our results.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interests.

Ethical Approval This article does not contain any studies with human participants performed by any of the authors.

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