A Role of Sunshine in the Triggering of Suicide

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Abstract: Several reports indicate that suicide follows a seasonal pattern with a dominant peak during the month of maximum daylight. The purpose of this study was to evaluate the hypothesis that sunshine exposure may trigger suicidal behavior. We found a remarkably consistent pattern of seasonality with peak incidence around June in the northern hemisphere and December in the southern hemisphere. Moreover, there was a positive association between the seasonal amplitude of suicide (measured by relative risk) and total sunshine in the corresponding country. These findings indicate that sunshine may have a triggering effect on suicide, and suggests further research in the field of sunshine-regulated hormones, particularly melatonin. (EPIDEMIOLOGY 2002;13:106–109)

Keywords: suicide, seasonality, sunshine, serotonin, melatonin, latitude.

It has been reported that the incidence of suicide reaches a peak during the early summer.[1,2] This finding has been very difficult to explain and, in fact, seems to be counterintuitive, given the impression of most people that their mood deteriorates during fall and winter. It has been suggested that sunshine exposure may affect suicide risk through regulation of serotonin[3,4] or melatonin[5] levels, but supportive empirical evidence is lacking. We have evaluated the hypothesis that sunshine may trigger suicide by collecting data on the monthly distribution of suicide deaths in countries with reliable statistics and by estimating sunshine exposure during the corresponding months.

Methods

Data

In order to insure reliable data, we have focused on countries-members belonging to the Organisation for Economic Co-operation and Development (OECD). A thorough Internet search was performed for each of the 29 OECD countries. No Internet site was found for Portugal and Poland. For the 27 remaining countries, e-mails were sent and on-line forms were submitted, some times more than once, to officials or webmasters responsible for the data. For four countries (Belgium, Ireland, Luxembourg, and the United Kingdom), an answer was received that the requested data were not available, whereas no answer was received from three countries (Italy, Korea, and Turkey). Thus, distribution of suicide deaths by month was sent from 20 OECD countries for a period covering 4 to 24 of the most recent years.

For the calculation of sunshine during the months with the highest density of suicide deaths, we have retrieved data from two Internet sites. Daylight duration data for every country were retrieved from the Internet web site www.sunrisesunset.com. Total sunshine per month was calculated by multiplying total daylight duration during the particular month by the average fraction of time during the month that the sun was not obstructed by clouds. This fraction was derived using "WINDISP4," a Map and Image Display and Analysis System which was downloaded from the Internet web site of the Food and Agriculture Organisation of the United Nations. All months were evaluated on an equal duration basis.

Statistical Analysis

Parameters of seasonality within countries were estimated using the Poisson regression variant of the circular normal distribution[6] (appendix) which is an analog of the classic Edward's procedure. This procedure efficiently estimates the month of peak suicide incidence, the relative risk of committing suicide during the month

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TABLE 1. Seasonal Variation of Peak Suicide Incidence within Countries of Both Hemispheres

Country	Relative Risk	95% CI	Month of Peak Suicide	95% CI
Austria	1.21	1.10, 1.34	June	May, June
Canada	1.14	1.03, 1.27	June	May, June
CzechRep	1.23	1.11, 1.36	May	May, June
Denmark	1.14	1.03, 1.27	May	April, May
Finland	1.18	1.07, 1.31	June	June, July
France	1.13	1.02, 1.25	May	May, June
Germany	1.16	1.04, 1.28	May	May, June
Greece	1.50	1.35, 1.67	June	May, June
Hungary	1.43	1.29, 1.59	June	May, June
Ireland	1.10	1.00, 1.23	May	May, June
Japan	1.21	1.09, 1.34	May	April, May
Mexico	1.15	1.03, 1.27	June	May, June
Netherlands	1.10	1.00, 1.21	April	April, May
Norway	1.11	1.00, 1.23	May	April, May
Spain	1.25	1.13, 1.39	May	April, June
Sweden	1.13	1.02, 1.25	June	May, June
Switzerland	1.15	1.04, 1.28	May	April, May
USA	1.08	1.00, 1.20	June	May, June
Australia	1.21	1.10, 1.34	December	December, January
New Zealand	1.13	1.02, 1.25	November	October, November

Relative risk is maximum over minimum frequency.

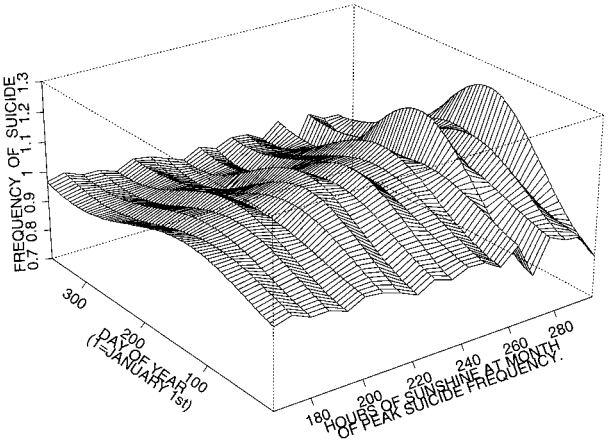

FIGURE 1. Variation of suicide frequency in 20 OECD countries (fitted circular normal[6]) in relation to day of year (1 to 365) and hours of sunshine at month of peak suicide. For the two countries of the southern hemisphere only, the months 1–6 are replaced for this graph by the months 7–12 and vice versa.

of peak incidence (compared with the minimum incidence during the whole year), and confidence intervals for those measures. The advantage of this analysis within countries is that it eliminates confounding factors that differ across countries but remain reasonably constant within a country over the study time. For correlation analyses across countries, Spearman' s correlation coefficient was used.

Results

We studied three different issues that are relevant to our hypothesis of the triggering role of sunshine on suicide.

Within-Country Seasonality

Of the 20 OECD countries in the study, 18 are in the northern hemisphere (Austria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Japan, Mexico, Netherlands, Norway, Spain, Sweden, Switzerland, and the United States of America) and 2 are in the southern hemisphere (Australia and New Zealand). For all 20 countries, there was evidence of seasonality of suicide rates, with relative risk estimates varying from 8% to 50%, and with peak incidence in May or June in the countries of the northern hemisphere and November or December in the two countries of the southern hemisphere (Table 1).

Across-Countries Analysis

Figure 1 shows the positive association between the relative risk of suicide during the month of peak incidence in the 20 examined OECD countries and the average sunshine in hours during this month in the corresponding country. Spearman's correlation coefficient for this association is +0.7. Correlation taking into account as weights the corresponding population sizes generates a Spearman's correlation coefficient of +0.6.

Exclusion of Summer Months

It is possible that the excess suicide risk during the summer months could be associated with behavioural changes of the persons not attributed directly to sunshine. The most important such factor is that people tend to take their vacation from work in the summer months, so that suicide risk could be affected by factors associated with more free time rather than more sunshine. To address this possibility, we also analyzed the data within each country by removing the three summer months (June-August for northern hemisphere, December-February for southern hemisphere). Seasonality was assessed with our procedure for the remaining 9 months. All 18 countries in the northern hemisphere showed a peak suicide rate in May or April, whereas Australia and New Zealand showed peak rates in October and November respectively. Exclusion of four consecutive spring-summer months had no effect either.

Discussion

This is the first time that the early summer peak incidence of suicide has been documented across many countries, through a demonstrably unbiased process (inclusion of all OECD countries), although many earlier studies have indicated the existence of this pattern in individual populations and at least one important inves-

tigation included several countries.[7] Further, our data indicate that the degree of seasonality, that is, the amplitude of the seasonal variation in Figure 1, can be largely explained in terms of monthly sunshine, both within and across countries. Last, our analyses indicate that the relation between sunshine and suicide risk is not a by-product of the covariable of vacation time.

There are concerns when an ecological approach has to be used for the investigation of a phenomenon, and these concerns have been reviewed by Morgenstern.[8] The applicability of climatological/meteorological data becomes more questionable as the geographical size of a country increases, and there is no way to examine whether sunshine or a climatological correlate of this variable is the one more relevant. Nevertheless, the consistency of an early summer excess incidence of suicide around the world, and the further association of suicide with hours of sunshine, strongly suggest that a physical environmental factor plays an important role in the triggering of suicide.

The evidence presented concerns triggering of suicide and just one dominant pattern in the distribution of suicides over time. Other time patterns, *eg*, within week[9] place patterns (latitude,[10] urban/rural[11,12]) and personal characteristic patterns (age,[13] gender,[13,14] social class,[15] family status,[13,16,17] etc.) may have different explanatory factors, as it is common in diseases with multifactorial etiology. It should be pointed out that the overall rate of suicide in the northern hemisphere increases with latitude and this is likely due to social factors or to more complete reporting of suicide in these countries. The indicated factors, however, are unlikely to have a seasonal pattern and thus, are unlikely to confound the seasonal pattern of suicides across the world.

It is not obvious how sunshine or correlated aspects of it, including short-term variability, could affect the decision to commit suicide. Melatonin is affected by sunshine[18–22] and plays a role in mood regulation,[6,23–24] but no attempt has been made to investigate a possible sequence of events. Other hormones, such as cortisol[25] and serotonin,[26] as well as L-tryptophan,[27] are also known to show sunshine dependence, and singling out melatonin at this time is probably premature. There should be no doubt however, that the seasonality of suicide is a striking epidemiological characteristic of this phenomenon that could have substantial preventive implications, *eg*, by administering melatonin, the secretion of which is suppressed by sunshine. Further progress could be made by switching from ecological to individual based investigations[28] or by focusing on daily variations of sunshine and number of suicides, with allowance for possible lag time between exposure and outcome.

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Appendix

Because the number of days in each month varies slightly, we used the circular distribution procedure, which is analogous to but more flexible than Edwards' procedure. The frequency of the circular normal distribution at a certain date is proportional to the periodic factor $e^{k \cos 2\pi (\text{date} - \text{maxdate})/\text{totaldate}}$, where totaldate is the total length of time under consideration, maxdate is the date of maximum frequency, e^k is the ratio of maximum over expected frequency, and e^{2k} is the ratio of maximum over minimum frequency.[6] When $k = 0$ there is no seasonality. For the 12 months in our study, we estimated the risk and date of peak by taking the number of suicides for each month as a Poisson count with frequency proportional to the above factor, adjusted in the exponent for the different number of days in each month.

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