Research report

Exploring lag and duration effect of sunshine in triggering suicide

Fotios C. Papadopoulos [a,b,*], Constantine E. Frangakis [a,c], Alkistis Skalkidou [a,d],
Eleni Petridou [a,e], Richard G. Stevens [f], Dimitrios Trichopoulos [a,e]

[a] *Department of Hygiene and Epidemiology, Athens University Medical School, 75 M. Asias Str., Goudi, P.O. Box 11527, Athens, Greece*
[b] *Department of General Psychiatry, Uppsala University Hospital, Emmy Rappes väg 10, 75017, Uppsala, Sweden*
[c] *Department of Biostatistics, Office E3642, Johns Hopkins Bloomberg School of Public Health, 615 N Wolfe Str., Baltimore, MD 21205, USA*
[d] *Department of Women's and Children's Health, Uppsala University, Uppsala, Sweden*
[e] *Department of Epidemiology, Harvard School of Public Health, 677 Huntington Ave, MA 02115 Boston, USA*
[f] *Department of Community Medicine, University of Connecticut Health Center, 263 Farmington, Ave., Farmington, CT 06030-6325, USA*

Abstract

Background: Sunshine is considered to have a beneficial impact on mood. Interestingly, it has been consistently found that the incidence of suicide reaches a peak during early summer.

Methods: In order to explore the pattern of sunshine and suicide risk in a time frame of up to nine days and investigate possible lag and duration parameters of sunshine in the triggering of suicide, Greek daily suicide and solar radiance data were analyzed for a 10-year period using logistic regression models.

Results: The solar radiance during the day before the suicide event was significantly associated with an increased suicide risk (OR = 1.020 per MW/m^2). The average solar radiance during the four previous days was also significantly associated with an increased suicide risk (OR = 1.031 per MW/m^2). Differences among genders include the longer sunshine exposure needed in males to trigger suicide, compared to females and a lag period of three to four days that was found to lapse in females till the suicide. The increase in suicide risk in June compared to December, attributable to the daily sunshine effect, varies from 52% to 88%, thus explaining the already known suicide monthly seasonality.

Limitations: No individual data on solar radiance exposure, mental disorders, alcohol consumption or suicide method were available.

Conclusion: The effect of sunshine in the triggering of suicide may be mediated through a mechanism with a specific lag and duration effect, during the nine days preceding suicide. We hypothesize that sunshine acts as a natural antidepressant which first

* Corresponding author. Department of Hygiene and Epidemiology, Athens University, Medical School, 75 M. Asias Str., Goudi, P.O. Box 11527, Athens, Greece. Tel.: +30 210 7462187; fax: +30 210 7462105.

E-mail address: fotis.papadopoulos@gmail.com (F.C. Papadopoulos).

improves motivation, then only later improves mood, thereby creating a potential short-term increased risk of suicide initially upon its application.

1. Introduction

Sunshine is considered to have a beneficial impact on mood and annual total sunshine has been shown to correlate with decreased suicide rates within countries, even after adjusting for confounding factors, such as sociodemographic factors (Nishimura et al., 2004; Preti, 1998; Souetre et al., 1990; Terao et al., 2002). The underlying pathophysiological mechanisms have not been elucidated, but sunshine has been reported to regulate specific hormonal and neurotransmitter levels, such as those of melatonin (Thalen et al., 1997), serotonin (Lambert et al., 2002) and cortisol (Wehr, 1998).

Interestingly, it has been consistently found that the incidence of suicide reaches a peak during spring or early summer (Bazas et al., 1979; Chew and McCleary, 1995; Kevan, 1980; Koskinen et al., 2002; Lambert et al., 2003; Lester and Frank, 1988; Partonen et al., 2004; Petridou et al., 2002; Preti and Miotto, 1998; Souetre et al., 1987). This finding is consistent across countries of both the northern and the southern hemisphere. Moreover, the magnitude of the suicide seasonality pattern, as expressed by the relative risk of committing suicide during the month of maximum versus minimum suicide frequency, is larger in countries with longer sunshine duration during the month of peak suicide incidence (Petridou et al., 2002). A most striking confirmation of this relation was evident in Greece, the country with the longest sunshine duration during the month of peak suicide incidence, which also exhibited the highest relative risk for committing suicide, a 50% increase during June (the month of peak suicide incidence) compared to December (Petridou et al., 2002).

Motivated by this finding, we have focused in this paper on Greek daily suicide and sunshine data, in order to: 1) explore the pattern of sunshine and suicide risk in a time frame of up to nine days before the suicide event, and investigate possible lag and duration parameters of sunshine in the triggering of the suicide, and 2) examine if the indicated pattern of sunshine and suicide risk can explain the monthly suicide variation.

2. Methods

Greek daily suicide data (ICD9: E950-E959) by gender for a ten-year period (1992–2001) was provided by the National Statistical Service of Greece, whereas daily data on solar radiance and temperature, for the same period, was acquired by the National Observatory of Athens. Given that Greece is a relatively small country with a total surface area of 134,000 km^2, we used the latter data as a reasonable approximation of the solar radiance and temperature for the whole country. A total of 3717 suicides (2981 male and 736 female suicides) were included in the analyses.

Data on solar radiance measured in megawatts/square meter (MW/m^2) was available for each day of the year and each hour of the day. The solar radiance dataset included some missing values due to technical problems of the measuring instruments on specific days. For this reason, we excluded the 72 days from 5/2/1992 to 17/2/1992 and from 1/1/1998 to 28/2/1998 from further analyses. Another 91 sporadic non-available values were imputed with a randomly selected value from the respective day and hour of previous years. Subsequently, the daily sum of solar radiance was calculated for each day for all ten years under study. The first ten days of the dataset (1-1-1992 to 10-1-1992) were also excluded from the analyses, since solar radiance data for the preceding ten days, which was necessary for the analyses, was not available.

Solar radiance was chosen as the closest measure to the amount of solar energy that actually reaches the earth surface (Farquhar and Roderick, 2003). Measurements of solar radiance are closely related to those for bright sunshine duration and luminosity.

Initially, we explored the possible relation of suicide with the solar radiance on the same day of suicide by logistic regression, controlling for temperature, month and year. In order to take into consideration a possible lag and duration effect of solar radiance for the nine days previous to the suicide event, a table (Table 1) was designed, for every day (index day), with