

Think global, act local: Climatic changes have to be studied at the local level.

We were requested to reply to a letter of Dr Dixon and Dr Kalkstein about a recent paper of ours (Preti et al., 2007). We had some difficulty in replying to their letter, because it is really embarrassing. What can we reply to someone who wrote that hot temperature do not relate to higher mortality since in winter months people die more often than in summer months? The next time somebody writes that flu is linked to an enhanced risk of death among the elderly, surely Dr Dixon and Dr Kalkstein will object that this is wrong because elderly people also die by car accident, which is true but irrelevant to the question.

Of course, Dr Dixon and Dr Kalkstein have to admit that higher mortality during winter months is not due to cold temperature, since this occurs even in areas with little or no seasonality in temperatures. So, cold temperature does not lead to death, but hot temperature does, because “periods of extreme heat result in abrupt increases in human mortality” (Dixon and Kalkstein, this issue). We can assure the two writers that extreme temperatures lead to death at both poles, and every year unfortunate people die because of freezing cold in the streets of Western (and non-Western) countries. As for heat, studies detailed the ways and the occurrences whereby heat waves lead to death people who are ill or otherwise sensitive to the effect of temperature (Vandentorren et al., 2006). Humans are more able to cope with cold than with hot temperature, and heat-protected houses still remain a privilege of few people in Western and non-Western countries. For the records, increased mortality during winter months among those who are already ill is likely to depend on infections, particularly viral infections, whose occurrence is more frequent during winter months: when infection hits already ill individuals, their chances of dying by somatic complications increase.

The enrolment of the IPCC panel among those who have explored the multi-dimensionality of suicidal behavior comes as a surprise. Besides, in their letter, Dr Dixon and Dr Kalkstein enlist academic year and agriculture among the risk factors for suicide. Academic year is a new entry in the long list of factors thought to contribute to the uneven distribution by season of the deaths by suicide; as for agriculture (poor dear!), we think they refer to some studies that found farmer to be

more at risk of suicide than other occupations (Koskinen et al., 2002), an evidence that hardly can be imputed to agriculture per se, and mostly due to mechanisms that have no impact on the seasonality of suicide (Simkin et al., 2003). It is true that some other studies found seasonality of suicides to be less pronounced in industrialized countries than in countries principally relying on agriculture (Chew and McCleary, 1995). But this is a likely reflection of health services, and in particular mental health services, to be more visible, accessible and effective in modern industrialized countries than in less developed countries: this is the reason behind the decrease in suicide rates observed in many Western countries in the last twenty years.

So, the “mystery” of decreasing suicide rates in Italy is solved: more accessible and effective psychiatric care makes people more protected as for the risk of suicide is concerned (Tondo et al., 2003, Mann et al., 2005; Szanto et al., 2007). The same mechanism is thought to be involved in the decrease in seasonality reported in some countries in recent years (Rihmer et al., 1998; Oravec et al., 2006; Rocchi et al., 2007a). The risk of suicide is specifically linked to the presence of a mental disorder (Harris and Barraclough, 1998); up to 90% of suicides, according to some studies, occur within an active episode of a mental disorder (Cavanagh et al., 2003). Some mental disorders are more likely to lead to suicidal ideation, the most important antecedent of suicide attempt and completion: symptoms of depression are the most important associated features of suicidal ideation (Rihmer et al., 2002; Mann et al., 2005). The seasonal patterns that characterize episodes of mood disorders are more evident than those observed with other mental disorders (Kim et al., 2004; Valtonen et al., 2006; Rocchi et al., 2007b), and their uneven recurrence by season is thought to contribute to the seasonal dispersion of suicides (Faedda et al., 1993; Maes et al., 1993; Preti, 2002). Therefore, improving the detection and the treatment of affective disorders is likely to result in a decrease in the seasonality of suicides, and in the risk of suicide at large. This was proved in some pioneer studies in Europe (Rihmer et al., 1995; 1998).

Nevertheless, in Italy suicide rates have increased in the most recent years, with no relevant change in the provision of psychiatric care to the population. It is true that Italy has faced economic problems, with rising unemployment and underemployment

in the younger classes of age. But this effect is unlikely to have a pronounced seasonal component, and even less likely to be specifically linked to the months that recorded the most important anomalies in temperature. So, some mechanism is affecting the protective effect of improved psychiatric care guaranteed in Italy to the population by the national health system, something that can have an impact on the amplitude of the seasonal effect of suicides still observed in Italy (Rocchi et al., 2007a).

Temperature is linked to aggression (Anderson, 1989): it is still debated whether this link is linear or non-linear (Bushman et al., 2005; Bell, 2005; Cohn and Rotton, 2005). In all likelihood, at extreme temperatures, the effect of hot or cold temperature decreases, as a consequence of humans being unable to behave effectively when the body is impaired by environmental conditions. In the past, the effect of temperature on aggression was thought the main cause of seasonality of suicides, since aggression is linked to suicidal behavior, and people were thought to be pushed to suicide by hot temperature increasing their level of aggressiveness (Lombroso, 1918; Morselli, 1881; note that Lombroso's studies were preceding those of Morselli).

Currently, this direct effect of temperature on suicidal behavior is thought to affect a very limited number of occurrences. Weather, indeed, is thought to affect suicidal behavior in an indirect way, by triggering variation in mood (Wehr and Rosenthal, 1989), or by thermometric shock: extreme temperatures increase the negative impact of body self-harm on the chance of surviving after a suicide attempt.

In their letter, Dr Dixon and Dr Kalkstein blame our use of statistics. We are uncertain of the reason why: maybe they think we were wrong in applying a Gaussian filtering procedure, which is extremely widespread in the climatological literature (see, for example, Auer et al., 2005), or because we made use of rank order coefficients to detect the effect of deviant values. Dr Dixon and Dr Kalkstein seem unaware of the fact that temperature data (when they display a very significant trend, which is the case at least over the last two centuries) and suicide data have a non-normal distribution. So, their "demonstration" that temperature is not linked to suicide in the United States using linear regression, a parametric statistics, is a bit questionable. When investigated with appropriate statistics, the links between temperature and suicide held even when analyzed at a daily level and within season (Salib and Gray,

1997), when the role of the variation of social activities by time of the year is unlikely to be of some relevance. A link with temperature can be seen in the yearly distribution of suicides even when there is no seasonality at all in the time-series (Page et al., 2007). So, the idea of Dr Dixon and Dr Kalkstein that “false correlations are common whenever a variable, such as suicide, displays seasonality as most correlations with temperature likely result in positive results despite no causal relationship” is denied by data, and this in our data, too, especially because our data have been properly de-seasonalised by Gaussian filtering, in order not to take into account the evident and redundant seasonal information.

And, in general, disagreement with researchers is expressed by producing data that conflict with those of others, rather than by accusing them of being “irresponsible” or to inflate data “to draw media attention to their own research”. Moreover, in our paper we made it quite clear, starting from the title (“possibly linked”) that we were investigating this relationship with all the due honesty and criticism that the topic of linking two heterogeneous variables deserves.

By the way, pardon us: do you really think that one hundred and fifty years of research on the links between weather and suicide was done without taking into account the trivial evidence that weather varies as a function of season?

Dr Dixon and Dr Kalkstein also show some sort of candid attitude when treating of global warming, which they imagine as something that is cooking up the planet, and it is awaited to linearly impact on human behavior, as a consequence of the progressive increase of surface temperature. Global warming, however, is the synthetic expression (accepted by the quasi-totality of climatologists) to indicate the (geophysically speaking) recent expression of climate change that has affected the whole planet surface (both continents and oceans) at least over the last two centuries, and it is widely attributed (with level of confidence  $\geq 95\%$ ) as being an effect of human actions, principally industrialization and consequent variations of atmospheric concentration of greenhouse gases. It is however not just a matter of temperatures going up, even though they are, globally speaking, rising everywhere on the planet (please, see one more the IPCC, 2007, report: the whole surface of the planet has been

warming over the last two centuries or so; there might be very limited local places to have experienced a not so evident warming trend, but such are merely a result of local geographical features, certainly not invalidating the extremely clear and well investigated warming signal all over the planet). The rising temperatures are the most evident, unquestionable and measurable change; moreover, the term Global Warming is the correct term to be used when discussing the significant rising trends in temperatures everywhere in the planet: there's no such a term as an Italian or an Australian warming; well, such term could actually exist, but they would be as redundant as defining, when discussing earthquakes in Italy or Australia, an Italian or Australian plate tectonics with respect to the Global Plate Tectonics.

Climate affect human behavior in many ways, and these effects can be studied only at a local level, since climate effects are a matter of local downscaling of global effects: the use of Italian data, which are the local expression of Global Warming, can be read exactly in this context. How much local should the study be? This is a matter of statistics. Suicide, fortunately, is a rare phenomenon, so to investigate meaningful effects one has to use aggregate data. However, this is a serious problem, since in dealing with aggregate data there is no chance to disentangle the influences of a variable at the individual's level. For example, in many Western countries suicides decrease in December (Carley and Hamilton, 2004). Is this an effect of people going around to hug suicidal people and replying to their requests, since Christmas time is arriving (Ajdacic-Gross et al., 2008)? Or it depends on those at risk of suicide specifically more likely to be admitted in hospital just before major holidays or during period with bad weather (Catalano et al., 2003), as December is in many northern hemispheres countries?

In Italy, people aged 14 to 24 years old, who are less likely to be hospitalized for mental disorders than other classes of age, show a peak of suicides in December, whereas those more aged show the classic decrease (Preti and Miotto, 1998). As they stand, aggregate data show the incongruence, but are less likely to indicate the reason.

Italy is a country extending over 10 degrees of latitude, with climatic differences along the North-South axis, so it cannot be excluded that some areas have contributed to the results more than others. Nevertheless, we feel right to have dedicated the title

of our study to global warming, since we studied the effects on suicide of climate changes in Italy, and forwarded explanations that include both biological effects of temperature and social effects as well. So, we feel no inconsistency in considering the possible effects of climate changes on the social network of the suicidal people. In a paper published after the completion of our study, the same effects of heat wave on the risk of suicide, with the same males/females differences, were found in England (Page et al., 2007). Independent replication of these results, across the world, will produce the global picture Dr Dixon and Dr Kalkstein are awaiting for.

We can assure Dr Dixon and Dr Kalkstein that we did not name “Global warming” in our paper to make the public more aware of our own research. There is no one, among lay people, who is interested in the biometeorology of suicidal behavior. Our target was the small group of investigators who are interested in discussing the factors that may affect the risk of suicide, principally to the aim of prevention.

We are less able to replies to other observations of Dr Dixon and Dr Kalkstein: however, our colleagues are enough skeptics on the usefulness of biometeorology for the understanding of suicidal behavior, to have us further involved in such a kind of debate.

Best regards,

Antonio Preti

Genneruxi Medical Center, Cagliari – Italy

e-mail: [apreti@tin.it](mailto:apreti@tin.it)

Gianluca Lentini

Istituto di Fisica Generale Applicata, Università degli Studi di Milano, via Celoria 16,  
20133 Milano – Italy

e-mail: [gianluca.lentini@unimi.it](mailto:gianluca.lentini@unimi.it)

## References

- Ajdacic-Gross, V., Lauber, C., Bopp, M., Eich, D., Gostynski, M., Gutzwiller, F., Burns, T., Rössler, W., 2008. Reduction in the suicide rate during Advent—a time series analysis. *Psychiatry Res.* 157, 139-146.
- Auer, I., Boehm, R., Jurkovic, A., Orlik, A., Potzmann, R., Schoener, W., Ungersboeck, M., Brunetti, M., Nanni, T., Maugeri, M., Briffa, K., Jones, P., Efthymiadis, D., Mestre, O., Moisseline, J.M., Begert, M., Brazdil, R., Bochnicek, O., Cegnar, T., Garjic-Capka, M., Zaninovic, K., Majstorovic, Z., Szalai, S., Szentimery, T., Mercalli, L., 2005. A new instrumental Precipitation Dataset for the Greater Alpine Region for the period 1800-2002. *Int. J. Climatol.* 25, 139-166.
- Anderson, C., 1989. Temperature and aggression: ubiquitous effects of heat on occurrence of human violence. *Psychol. Bull.* 106, 74-96.
- Bell, P.A., 2005. Reanalysis and perspective in the heat–aggression debate. *J Person Soc Psychol* 89, 71-73.
- Bushman, B.J., Wang, M.C., Anderson, C.A., 2005. Is the curve relating temperature to aggression linear or curvilinear? Assaults and temperature in Minneapolis reexamined. *J Person Soc Psychol* 89, 62-66.
- Carley, S., Hamilton, M., 2004. Suicide at Christmas. *Emerg. Med. J.* 21, 716-717.
- Catalano, R., McConnell, W., Forster, P., McFarland, B., Thornton, D., 2003. Psychiatric emergency services and the system of care. *Psychiatr Serv* 54, 351-355.
- Cavanagh, J.T., Carson, A.J., Sharpe, M., Lawrie, S.M., 2003. Psychological autopsy studies of suicide: a systematic review. *Psychol. Med.* 33, 395-405.
- Chew K.S.Y., McCleary R., 1995. The spring peak in suicides: a cross-national analysis. *Soc. Sci. Med.* 40, 223-230.

Cohn, E.G., Rotton, J., 2005. The curve is still out there: A reply to Bushman, Wang, and Anderson's (2005) "Is the curve relating temperature to aggression linear or curvilinear?" *J Person Soc Psychol* 89, 67-70.

Faedda, G.L., Tondo, L., Teicher, M.H., Baldessarini, R.J., Gelbard, H.A., Floris, G.F., 1993. Seasonal Mood Disorders: Pattern of seasonal recurrence in mania and depression. *Arch. Gen. Psychiatry* 50, 17-23.

Harris, E.C., Barraclough, B.M., 1998. Excess mortality of mental disorder. *Br. J. Psychiatry* 173, 11-53.

Koskinen, O., Pukkila, K., Hakko, H., Tiihonen, J., Väisänen, E., Särkioja, T.R.P., 2002. Is occupation relevant in suicide? *J. Affect. Disord.* 70, 197-203.

Kim, C.D., Lesage, A.D., Seguin, M., Chawky, N., Vanier, C., Lipp, O., Turecki, G., 2004. Seasonal differences in psychopathology of male suicide completers. *Compr. Psychiatry* 45, 333-339.

Lombroso, C., 1918. *Crime: its causes and remedies*. Boston, Little, Brown and Co.

Maes, M., Meltzer, H.Y., Suy, E., De Meyer, F., 1993. Seasonality in severity of depression: relationships to suicide and homicide occurrence. *Acta Psychiatr. Scand.* 88, 156-161.

Mann, J.J., Apter, A., Bertolote, J., Beautrais, A., Currier, D., Haas, A., Hegerl, U., Lonnqvist, J., Malone, K., Marusic, A., Mehlum, L., Patton, G., Phillips, M., Rutz, W., Rihmer, Z., Schmidtke, A., Shaffer, D., Silverman, M., Takahashi, Y., Varnik, A., Wasserman, D., Yip, P., Hendin, H., 2005. Suicide prevention strategies: a systematic review. *JAMA* 294, 2064-2074.

Morselli, E., 1881. *Suicide: An Essay on Comparative Moral Statistics*. London, Paul & Co.



Oravec, R., Rocchi, M.B.L., Sisti, D., Zorko, M., Marusic, A., Preti, A., 2006. Changes in the seasonality of suicides over time in Slovenia, 1971 to 2002. *J. Affect. Disord.* 95, 135-140.

Page, L.A., Hajat, S., Kovats, R.S., 2007. Relationship between daily suicide counts and temperature in England and Wales. *Br. J. Psychiatry* 191, 106-112.

Preti, A., 2002. Seasonal variation and meteorism in suicide. Clinical relevance of findings and implications for research. *Acta Neuropsychiatr.* 14, 17-28

Preti, A., Miotto, P., 1998. Seasonality in suicides: The influence of suicide method, gender and age on suicide distribution in Italy. *Psychiatry Res.* 81, 219-231.

Preti, A., Lentini, G., Maugeri, M., 2007. Global warming possibly linked to an enhanced risk of suicide: Data from Italy, 1974-2003. *J. Affect. Disord.* 102, 19-25

Rihmer, Z., Rutz, W., Pihlgren, H., 1995. Depression and suicide on Gotland: an intensive study of all suicides before and after a depression-training programme for general practitioners. *J. Affect. Disord.* 35, 147-152.

Rihmer, Z., Rutz, W., Pihlgren, H., Pestaliti, P., 1998. Decreasing tendency of seasonality in suicide may indicate lowering rate of depressive suicides in the population. *Psychiatry Res.* 81, 233-240.

Rihmer, Z., Belso, N., Kiss, K., 2002. Strategies for suicide prevention. *Curr. Opin. Psychiatry* 15, 83-87.

Rocchi, M.B.L., Sisti, D., Cascio, M.T., Preti, A., 2007a. Seasonality and suicide in Italy: Amplitude is positively related to suicide rates. *J. Affect. Disord.* 100, 129-136.

Rocchi, M.B.L., Sisti, D., Miotto, P., Preti, A., 2007b. Seasonality of suicide: Relationship with the reason for suicide. *Neuropsychobiology*, 56, 86-92.

Salib, E., Gray, N., 1997. Weather conditions and fatal self-harm in North Cheshire 1989-1993. *Br. J. Psychiatry* 170, 473-477.

Simkin, S., Hawton, K., Yip, P.S.F., Yam, C.H.K., 2003. Seasonality in Suicide: A Study of Farming Suicides in England and Wales. *Crisis* 24, 93-97.

Szanto, K., Kalmar, S., Hendin, H., Rihmer, Z., Mann, J.J., 2007. A Suicide Prevention Program in a Region With a Very High Suicide Rate. *Arch. Gen. Psychiatry* 64, 914-920.

Tondo, L., Isacson, G., Baldessarini, R.J., 2003. Suicidal behaviour in bipolar disorder: Risk and prevention. *CNS Drugs* 17, 491-511.

Valtonen, H., Suominen, K., Patonen, T., Ostamo, A., Lönnqvist, J., 2006. Time patterns of attempted suicide. *J. Affect. Disord.* 90, 201-207.

Vandentorren S., Bretin P., Zeghnoun A., Mandereau-Bruno L., Croisier A., Cochet C., Ribeéron J., Siberan I., Declercq B., Ledrans, M., 2005. August 2003 Heat Wave in France: Risk Factors for Death of Elderly People Living at Home. *Eur. J. Public Health* 16, 583-591.

Vandenbroucke J.P., von Elm E., Altman D.G., Gøtzsche P.C., Mulrow C.D., Pocock S.J., Poole C., Schlesselman J.J., and Matthias Egger M., for the STROBE Initiative., 2007. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Explanation and Elaboration. *Epidemiology* 18: 805-835.

Wehr, T.A., Rosenthal, N.E., 1989. Seasonality and affective illness. *Am. J. Psychiatry* 146, 829-839.