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Review

Ambient temperature, sunlight duration, and suicide: A systematic review and meta-analysis



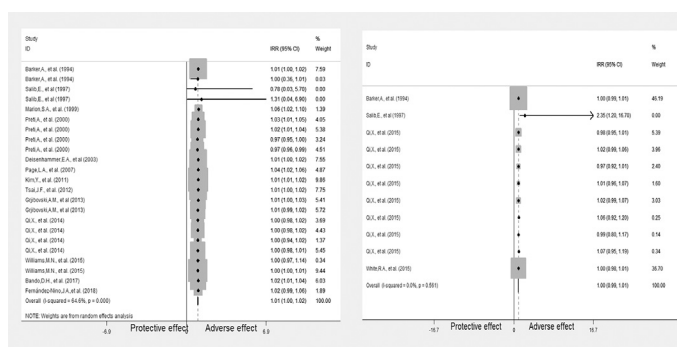
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HIGHLIGHTS

- Temperature rise increases suicidal risk and current studies don't support the positive link between sunshine and suicide.
- Rising temperature has a greater impact on completed suicide than suicide attempt.
- It is more effective to measure the relationship between temperature rise and suicide risk on a daily or weekly time scale.
- Populations in tropical and temperate zones or at middle-income countries are particularly vulnerable to temperature rise.

GRAPHICAL ABSTRACT



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ABSTRACT

Background: The relationship between sunlight hours, temperature, and suicide has been investigated in many previous studies, but with inconsistent findings. We conducted this meta-analysis aiming at providing clear evidence about whether sunlight hours and temperature can affect the risk of suicide.

Methods: Relevant literature published before 7 Jul 2018 was searched in three electronic database of PubMed, Web of science and Cochrane. Between-study heterogeneity in the effect estimates were examined by study design (i.e., exposure time resolution, temperature measure and suicide classification) and population vulnerability (i.e., sex, national income level, climate zone and study location).

Results: Regarding temperature-suicide association, we identified 14 studies that provided 23 effect estimates for meta-analysis. Our random-effects model showed that each 1 °C increase in temperature was significantly associated with a 1% increase in the incidence of suicide (Incidence Rate Ratio (IRR) = 1.01; 95%CI = 1.00–1.02; $p < 0.05$). As for sunlight duration and suicide, 11 effect estimates from 4 studies were pooled using a fixed-effects model. Significant association between sunlight duration (per 1 h increase) and the risk of suicide was not observed, and the pooled IRR was 1.00 (95%CI = 0.99–1.01; $p > 0.05$). There was significant heterogeneity between previous studies' effect estimates, and significantly lower heterogeneity was noted for the female group, for studies that did analyses at daily scale, and for studies using mean temperature as the exposure indicator.

Conclusion: Our findings suggest a significant and positive association between temperature rises and incidence of suicide, and a non-significant association between sunlight duration and incidence of suicide. Populations living in tropical and temperate zones or at middle-income level may be particularly vulnerable to temperature increase.

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1. Introduction

Suicide is an important public health issue universally. According to the American National Center for Mental Health's classification, suicide contains completed suicide (CS), suicide attempt (SA) and suicidal ideation (SI). The latest report issued by world health organization (WHO) (<http://www.who.int/news-room/fact-sheets/detail/suicide>) shows that >800,000 people die of suicide every year and there exist much more attempted suicide. Suicide has now become the second leading cause of death among people aged 15–29.

There are many causes or triggers for suicide, and some of which are related to socioeconomic factors and meteorological conditions. The WHO declares that males, those aged 15–44 or over 75, those living in extremely poor areas, urban residents, those experiencing unemployment and social isolation are at higher risk of suicide. Besides, some recent studies have revealed that climate factors play an important role in the occurrence of suicides. For example, a survey conducted by Fountoulakis et al. reported that climate variables explained 37.6% of variation in suicide rate among males and 28.1% among females, which are consistently larger than the figures (26.9% and 11.5%) explained by economic variables (Fountoulakis et al., 2016a). Among these climate factors, temperature and sunlight duration are most often investigated. An effect of latitude on suicide rates was found in Japan which suggested sunlight duration was a protective factor for suicide (Terao et al., 2002). Furthermore, studies looking at the association between temperature and suicide showed that 26.6%–60% of variation in suicides could be explained by temperature variation (Fountoulakis et al., 2016b; Helama et al., 2013; Ishii et al., 2013). However, the results of those studies on how temperature and sunlight hours affect suicide are inconsistent. Most studies indicated that suicide rates went up with increasing temperature and sunlight (Grjibovski et al., 2013; Dixon and Kalkstein, 2018; Dixon et al., 2014; Doganay et al., 2003; Likhvar et al., 2011; Qi et al., 2014; Toro et al., 2009). Previous studies found that suicide rates peaked in spring and early summer (Akkaya-Kalayci et al., 2017; Doganay et al., 2003; Hiltunen et al., 2014; Holopainen et al., 2014; Ruuhela et al., 2009). One possible mechanism is that after the cold nights in spring and early summer, human body, experiencing warmth in the daytime, can cause the overactive

temperature-responsive brown fat tissue, and an intensification of anxiety and mental activity and finally increase the risk of suicide (Helama et al., 2013; Holopainen et al., 2014; Zukotynski et al., 2010; Vaughan and Bartness, 2012). Another explanation is that elevated temperature can increase impulsive and aggressive behavior through high serotonin levels (serotonin or 5-HT receptors) (Doleski et al., 2010; Lambert et al., 2002; Maes et al., 1995; Molteni et al., 2010; Olivier et al., 2010; Stefulj et al., 2004). Additionally, peaks of suicide rate in cold weather also documented in some regions (Souetre et al., 1990; Tietjen and Kripke, 1994; Linkowski et al., 1992; Thorson and Kasworm, 2007; Tsai, 2010). A possible reason may be that the reduced frequency of social intercourse in winter months could have a negative effect on how a depressed individual copes with stress, and then increase the risk of suicide (Lester, 1995). Considering the possible mechanisms for climate factors and suicide, and mixed findings on the association so far, we conducted a meta-analysis of previous findings to examine whether or to what extent temperature and sunlight affect the risk of suicide.

2. Method and materials

2.1. Search strategy and study criteria

We conducted a systematic literature search in three database (PubMed, Web of science and Cochrane library) up to 7 Jul 2018. The keywords and search strategy used in PubMed were (“temperature” or “sunlight” or “sunshine” or “heat wave” or “cold spell” or “humidity” or “rainfall” or “precipitation” or “pressure” or “climate” or “meteorolog*” or “weather” or “air pollution” or “pollutants” or “polluting” or “particulate” or “smog”) AND (“suicide*” or “suicidal” or “suicidality” or “attempted suicide” or “suicide attempt”). Additionally, we manually checked the reference of all included literature.

Studies meeting the following five criteria were included in our meta-analysis: (i) the outcome measure could be incidence or counts of suicide, or attempted suicide or fatal self-harm at monthly or more precise time resolution. All cases must be diagnosed by the medical institution and in accordance with International Classification of Diseases (ICD-8 and ICD-9: E950.9–959.8, ICD-10: X60–X68). Other disease confirmation methods were also allowed, but strong evidence must be

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