

# Climate Change and Risk of Completed Suicide

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**Abstract:** Climate change is increasingly recognized as having multiple adverse mental health effects, many of which are just beginning to be understood. The elevated rates of suicides observed in some communities affected by climate change and rising rates of suicide in the United States as climate change intensifies have suggested the two may be associated. We searched PubMed and PsycInfo using the terms climate change and suicide, and provide here a review of the current literature on climate change and suicide that explores possible associations and methodological issues and challenges in this research.

**Key Words:** Climate, suicide, mental health, psychiatry, environment, disasters  
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Each year and throughout the world, more than 900,000 people die by suicide. In the United States alone, 14 of every 100,000 people died by suicide in 2017, making suicide the 10th leading cause of death in the United States (Murphy et al., 2018). This rate has increased by 33% since 1999 (Curtin and Hedegaard, 2019), and significantly increased from 2016 to 2017 (Murphy et al., 2018). It has increased for both males and females and for all ages 10 through 74 (Curtin and Hedegaard, 2017). Particular groups of concern include adolescents and young adults (Miron et al., 2019).

Although a myriad of psychiatric, psychological, and cultural factors may be involved in the increasing rates of suicide, one less appreciated factor is the role of climate change. Climate change is increasingly recognized as having a profound impact on mental health. Populations especially vulnerable to climate change include the poor and homeless, children, the elderly, and the mentally ill (Berry et al., 2018; Bourque and Cunsolo Wilcox, 2014; Coverdale et al., 2018; Masson-Delmotte et al., 2018). Elevated rates of suicide have been observed in some communities affected by climate change (Hanigan et al., 2012). We searched PubMed and PsycInfo using the terms climate change and suicide, and found no overview of the different contributing factors that have linked climate change to suicide to date.

In this article, therefore, we aim to explore the potential role of climate change in suicide rates and to describe the methodological issues and challenges in this research. There is significant value in correlating suicide rates with climate change, as it may be one indicator of psychic distress among those struggling at the front lines of a changing planet. As the quality of suicide data being reported improves globally (Bachmann, 2018), the outcomes of suicide prevention measures and climate adaptation efforts can be more accurately assessed. We advocate for an increased focus of attention and research on this important public health concern, because the prioritization of action on climate change by the psychiatric field requires good science and evidence.

This review addresses four aspects of anthropogenic climate change and associated findings on suicide rates: 1) air pollution from the burning of fossil fuels, fire smoke, and ozone production; 2) higher temperatures, including ambient temperature and increased frequency of heat waves; 3) habitat changes linked to rising global temperature, including changes in landscape, food source, plant and animal life, and drought; and 4) impacts of ocean warming, including more frequent natural disasters, sea level rise, and associated predicted mass migration. We also include suicide that appears to have arisen directly from a psychological reaction to these climate realities. For the purposes of this review, we do not include changes in suicide associated with the changing epidemiology of infectious diseases and soil-based changes in nutrition. Although changes in the geographical distribution and prevalence of nutritional and infectious disorders will likely influence the rates of suicidal behavior associated with these illnesses, these novel habitat-illness interactions have not yet been studied. Our description here of the literature is not exhaustive but highlights a range of studies with both positive and negative findings to demonstrate the state of the field and suggest areas for further research.

## ASSOCIATION OF SUICIDE RATES WITH AIR POLLUTION

Air pollution is defined by the EPA in terms of six criteria pollutants: lead, ozone, carbon monoxide, nitrogen oxide, particulate matter, and sulfur dioxide. The burning of fossil fuels is considered to be the source of 81% (Philip et al., 2014) of these pollutants. Particulate matter air pollution, defined based on particle sizes of 2.5 µm (PM2.5), 10 µm (PM10), and ultrafine particles (UFPs), now has a robust literature of association with adverse health and mental health effects. Particulate air pollution has been shown to translocate to the brain via olfactory and pulmonary nerves as well as the vascular system, where it causes multiple pathological changes in neurons and glia (Wright and Ding, 2016).

As with any climate variable, studying the effects of a particular element of air pollution on the brain is complex, and scientists must delineate each from other types of air pollution and from other air factors, such as seasonal variations in wind flow, fires, dust, pollen, temperature, moisture, and sunshine.

Particulate matter and the criteria pollutants ozone, sulfur dioxide, and nitrogen oxide have been the most studied for their mental health impacts. All have been associated either with a direct increase in suicide risk or with neuropsychiatric conditions known to increase suicidality: autism (Volk et al., 2013), dementia (Cacciottolo et al., 2017), depression (Gu et al., 2019; Kiourmourtzoglou et al., 2017), and bipolar disorder (Khan et al., 2019). Increased suicide risk and increased rates of neuropsychiatric disorders associated with suicide have also been found under a variety of spatial and temporal conditions, including proximity to coal plants, traffic, and freeways, and chronic and acute air pollution events (Cacciottolo et al., 2017; Gu et al., 2019; Khan et al., 2019; Perera, 2017; Volk et al., 2013).

Overall, studies have revealed increased suicide rates of 1% to 2% per day of poor-quality air. It is important, however, for psychiatrists to feel secure with the depth and breadth of the science supporting a link of air pollution to mental disorders (reviewed in Buoli et al., 2018), as it

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is frequently a target for critique and has significant import for our patients. Therefore, we present this literature in greater detail.

One of the most comprehensive studies (Kim et al., 2018) examined 10 cities in Asia, each with a population of over 2 million, for time spans of 10 to 30 years. This study controlled for sunshine, temperature, barometric pressure, and precipitation, and used a time-controlled case-crossover design to control for trends in air pollution and suicide over time. All criteria pollutants were studied individually and in association with each other. The study assessed relationships between 9-day average pollution and suicide rates 0 to 5 days later. An association was found for relative risks of suicide per worse quartile air quality following these 9 days ranging from 1.016 (PM1) to 1.019 (nitrogen oxide, PM10–2.5), to 1.02 (sulfur dioxide). No association was found for PM2.5.

Similar designs have been used to study cardiovascular patients in South Korea (Kim et al., 2015), the city of Guangzhou, China (Lin et al., 2016), Tokyo (Ng et al., 2016), and Salt Lake City, Utah (Bakian et al., 2015). Each study spanned 10 years. In these studies, associations of air pollution and suicide were found for PM2.5 (10% increase) and PM10 (9% increase) (Kim et al., 2015), for NO<sub>2</sub> (7% increase) and PM2.5 and SO<sub>2</sub> (11% increase) (Lin et al., 2016), and PM2.5 (odds ratio, 1.05) and NO<sub>2</sub> (odds ratio, 1.20) (Bakian et al., 2015). Taken together, these studies demonstrate an increase in the rate of suicide that ranges from 2% to 20% depending on the pollutant studied, time frame, and other factors.

The pathophysiology of air pollution associated suicide risk is hypothesized to be neuroinflammatory, with air particulates acting as irritants that generate systemic and local inflammatory responses (Costa et al., 2014). The hypothesis that pollution triggers a neuroinflammatory response is supported by findings of increased rates of inflammatory vascular and pulmonary disorders, including asthma, strokes, and heart attacks, in association with poor quality air (Wright and Ding, 2016).

This hypothesis is also supported by Min et al. (2018) whose results stratified the risk of suicide with worse air pollution by using a national health survey sample that identified the presence or absence of a physical or mental disorder. Min found a large increase in suicide risk associated with PM10 (hazards ratio [HR], 3.09), NO<sub>2</sub> (HR, 1.33), and SO<sub>2</sub> (HR, 1.15). Illness further increased this suicide risk. In the top quartile of air pollution, PM10 and NO<sub>2</sub> pollutants were associated with an HR of 4.35, particularly in metropolitan areas (HR, 4.93 for PM10, 1.89 for NO<sub>2</sub>). Although unfortunately this study could not isolate those with mental disorders from other illnesses, it demonstrates the profound impact of air pollution on suicide rates in those already vulnerable to air pollution health impacts because of preexisting medical illnesses, including those associated with inflammatory responses.

## ASSOCIATION OF SUICIDE RATES WITH RISING TEMPERATURES

Global temperatures are projected to increase between 2.6°C and 8.5°C by the end of this century, depending on the total greenhouse gases emitted under either stringent or high emissions scenarios (Masson-Delmotte et al., 2018). Present estimates, with implementation of currently endorsed unconditional policies around the world, project a two-thirds probability of temperatures rising approximately 2.9°C to 3.2°C (Climate Action Tracker: Warming Projections Global Update, 2019). The overall increase in heat-related suicides that would be predicted by such a 3°C increase is in the range of 2.1% to 6.3% (Burke et al., 2018).

Since before the 19th century, a seasonal pattern to suicide rates has been observed, with rates tending to increase in late spring and early summer compared with the fall and winter. Although the etiology of these fluctuations has been difficult to elucidate, these seasonal patterns of suicide have been reported in the literature from an array of countries and geographic areas (Galvão et al., 2018; Likhvar et al., 2011), and likely represent a heterogeneous phenomenon related to variations in temperature, daylight exposure, chronobiological aspects of mood disorders,

and socioeconomic factors (Ajdacic-Gross et al., 2010; Kevan, 1980). Historical data suggest a decreasing trend in seasonal variability of suicide rates, particularly in Western countries, which may be due in part to change in access to violent suicide methods (Ajdacic-Gross et al., 2010). This will be important to keep in mind and to elucidate further when analyzing suicide data alongside rising global temperatures. Since climate change is defined over longer periods, researching climate-related suicides over large populations and longer periods is more likely to capture trends and minimize confounding factors, such as seasonal variation. Recent studies taking this approach have indeed found suicide rates increase with hotter temperatures (Bando et al., 2017; Burke et al., 2018; Carleton, 2017; Fountoulakis et al., 2016; Luan et al., 2019). This association holds true for both of the main impacts of climate change on ambient temperature: a greater total number of hotter days and more frequent acute heat waves.

A significant study (Burke et al., 2018) examined the effect of local ambient temperature in the United States and Mexico on suicide by using vital statistics over large geographic areas, larger populations than other studies (United States N = 851,000; Mexico N = 611,366), and longer periods (decades). They found that, between 1990 and 2010, suicide rates increased 0.7% in United States and 2.1% in Mexico for every 1°C increase in monthly average temperature. They concluded that if climate change proceeds unmitigated under the “business as usual” scenario that the IPCC technically refers to as “Representation Concentration Pathway (RPC) 8.5,” it will add an estimated 9,000 to 40,000 additional suicide deaths by 2050. Their data indicate a relatively linear response of suicide rates to monthly average temperatures. Unlike the effect of temperature on other all-cause mortality, there was no increased risk as the temperature grew colder, and the effects did not diminish in those with higher incomes and more prevalent air conditioning. Furthermore, they did not find evidence of decreased sensitivity to temperature in populations more frequently exposed to high temperatures.

Linkages between suicide rates and elevated temperatures have also been observed in large urban populations. In China, the relative risk for suicide deaths, measured from 2009 to 2013 in 31 capital cities amounting to a population of 300 million, was 1.37 (95% confidence interval) for high temperatures, defined as the 95th percentile of ambient temperature (Luan et al., 2019). A time-stratified case-crossover study of multiple cities in three East Asian countries found a positive association between temperature and suicide rates, ranging from 3.9% to 7.8% for approximately a 4°C increase in temperature (Kim et al., 2016). A noted limitation was that air pollution was not accounted for in the data analysis. A time-series study in San Paolo, Brazil, revealed a 2.28% increase in suicides with each 1°C increase in weekly averages of minimum temperature. These findings were significant for men only (Bando et al., 2017). Studying annual rates of suicide attempts and suicides per 100,000 inhabitants in Thessaloniki, Greece, between 2000 and 2012 (Fountoulakis et al., 2016), it was found that male suicide rates correlate significantly with high mean annual temperature and accounted for 51% of the variance of male suicide rates.

Carleton (2017) explored the effects of exposure to temperature and rainfall in India, a developing country that accounts for over one quarter of suicides worldwide, and where suicides rates have doubled since 1980. The causes of the increased rates have been a source of debate, as factors such as lower crop yields from higher temperatures causing economic strain could also lead to higher rates of suicide. This study found that fluctuations in climate, in particular, high temperatures during the growing season, correlate positively with suicide rates. On days above 20°C, a day's increase of 1°C during the growing season added 0.008 suicides per 100,000 persons annually, amounting to a total of 59,300 additional deaths by suicide since 1980. There was no association between temperature and suicide rates in the nongrowing season. These findings are significant given the extent to which rising global temperatures will impact agricultural communities in developing countries.

## ASSOCIATION OF DROUGHT AND SUICIDE

As the study by Carleton highlights, increased temperatures contribute to drought, resulting in lower crop yields. The likelihood that anthropogenic climate change is increasing drought is very high across all continents (Masson-Delmotte et al., 2018). It is therefore important to consider whether drought is a separate risk factor for climate change suicide, and how temperature, drought, and social factors such as agricultural incomes together may increase suicide rates.

Drought is defined as a period of abnormally dry weather that depletes water resources, including lake, reservoir, and groundwater. The resultant lower soil moisture and stream flow lead to erosion, habitat degradation, more wildfires, and water quality decline (Yusa et al., 2015). Droughts have a slow, vague onset, indirect manifestations, certain but unpredictable recurrence, and a severity of impact determined partly by the behaviors of people nearby. All of these parameters both increase the total mental stress of a drought and make it more difficult to isolate the elements of this complex drought-associated psychology that impact mental well-being.

Most studies of the impact of drought on mental health have been conducted in Australia, a country with the world's widest climatic fluctuation and a large rural and indigenous population. Studies have generally shown an increase in psychic distress overall (OBrien et al., 2014) and suicide specifically, although only under specific drought conditions and among rural farmers.

Anecdotal reports of completed suicide in association with drought exist at least before 1915 (Alpino et al., 2016). One early study of suicide in Australia that spanned 1901 to 1998 showed that drought was a general risk factor for suicide over these 100 years at the population level, with RR of 1.07 (Page et al., 2002).

A more recent study of drought-related suicides in New South Wales, Australia, found that suicide rates from 1970 to 2007 rose in rural males aged 30 to 49 by 15% when the drought index increased from the first to third quartile (Hanigan et al., 2012). This study also demonstrated an additional separate suicide rate increase of 3% in the general population with each 1.6°C increase over average annual temperature during this drought period. This increase in suicide with temperature is similar to the other temperature-related suicide studies cited. Female suicides did not increase in association with drought. Another study by this group looked at the same region from 1964 to 2001, both during and not during long droughts. They demonstrated an 8% increased risk of suicide for every 300-mm decrease in rainfall, a measure similar to that of water resource strain (Nicholls et al., 2006), but different in that there is both drought and an awareness of changes in weather. Both of these studies controlled for overall trends in suicide rates during the years in question. Another study (Guiney, 2012) did not demonstrate an increase in frequency of suicide over the drought years of 2001 to 2007 in Victoria, Australia. However, it did not adjust for downward trends in suicide rates in Australia over the years in question, and included employment groups less likely to have suffered drought-related economic losses.

## ASSOCIATION OF INDIGENOUS POPULATIONS AND SUICIDE

Proportionally higher rates of suicide have long been recognized in indigenous populations compared with nonindigenous populations (Cunsolo Wilcox et al., 2014; Qi et al., 2009). A recent meta-analysis affirms this finding, although noting high variability between different indigenous groups independent of climate conditions. This variability, along with extremes in the climate conditions that will be experienced by indigenous groups around the world, will make conclusions about general climate effects difficult (Pollock et al., 2018).

A qualitative study (Cunsolo Wilcox et al., 2014) of an Inuit population found that changes in the environment and climate, when combined with other stressors, were implicated in increased suicidal ideation,

as did a study of suicidal thoughts in Swedish group of reindeer herders (Omme et al., 2013). Furthermore, preservation of community institutions and practices was found to be roughly inversely associated with suicide rates and group distress in a study of Canada's indigenous groups (Chandler and Lalonde, 1998). However, there is not yet more direct evidence of climate change impacts on completed suicide itself within indigenous populations.

## ASSOCIATION OF NATURAL DISASTERS AND SUICIDE

Although hurricanes and other disasters can have severe health consequences (Beaglehole et al., 2018; Lane et al., 2013), a direct relationship between a disaster and its impact on mental health is difficult to establish, as many other factors also contribute to the severity of its impact on an individual or group (Hammer, 2018). There is also not a consensus that climate change has influenced hurricane frequency (Landsea et al., 2006; Patricola and Wehner, 2018). It has, however, been amply demonstrated that climate change has increased the average and extreme rainfall of hurricanes, and will, in the future, increase wind speed (Patricola and Wehner, 2018).

One systematically conducted review identified 14 articles of varying designs that assessed the relationship between hurricanes and other forms of disasters on suicidal behaviors (Kölvä et al., 2013). This review found variability in outcomes across all studies, in part because of the varying methodologies employed and lengths of follow-up. Only two of the articles concerning the impact of hurricanes addressed suicide mortality (Castellanos et al., 2003; Lew and Wetli, 1996) but sample sizes were small. These findings included an insignificant increase in youth suicide rates and a small increase in homicide-suicides after Hurricane Andrew.

In another study prehurricane and posthurricane, annual average suicide rates in 24 counties affected by a single severe hurricane in the United States increased, but not significantly so (Krug et al., 2002). We found no studies concerning suicide rates after wildfires.

## SUICIDALITY AMONG REFUGEES AND IMMIGRANTS

The 1951 United Nations Convention on the Status of Refugees defines a "refugee" as a displaced person who must have "a well-founded fear of persecution because of their race, religion, nationality, membership of a social group or political opinion; and be unable or unwilling to return to the country for fear of persecution" (McColl et al., 2008). Some countries also designate a category of "asylum-seeker" to someone who has applied for refugee status. Those who leave their home because it has become uninhabitable due to global warming do not fit easily under this definition. For this reason, and because there are relatively few studies on suicide in refugees and asylum seekers, we include "immigrants" in our literature search, to better assess suicide rates associated with moving from one home country to another or leaving one's home under diverse situations of threat.

According to a 2017 United Nation Development Programme report, projected estimates of climate-related displaced persons by 2050 range from 25 million to 1 billion people per year. In comparison, there are currently an estimated 70.8 million displaced persons from all causes worldwide (Opitz et al., 2017). Reasons for displacement from one's home country due to climate change will include both direct climate impacts such as flooding and indirect climate impacts such as political or economic instability, violence, or disease.

The earliest studies on immigrant suicide by (Sainsbury and Baraclough, 1968) established a statistically robust correlation between suicide in country of origin and country of emigration across multiple nations, establishing both that one's cultural predisposition to suicide holds true regardless of location and that methods of recording suicide are sufficiently consistent across national boundaries to study this topic. These were uncontrolled studies that showed widely variable differences in rates of suicide with immigration.

Stack (1981) assessed the population rate of suicide compared with the rate of immigration in 34 countries in the year 1970 and found a 0.13% increase in national suicides for every 1% increase in immigration. Stack controlled for age older than 65 years and percentage of women in the work force, which he took to be confounding variables for population isolation and role conflict that might influence suicide rates in a similar way to immigration stress.

More recent studies on suicidality among refugees and immigrants come mostly from Northern Europe. A study of immigrant suicides in Sweden from 1987 to 1991 (Ferrada-Noli, 1997) found that immigrants from 60% of origin countries were, on average, 50% more likely to complete suicide than native Swedish residents. Immigrants from 90% of those origin countries were more likely to complete suicide than those from their home country. A study of asylum-seekers in the Netherlands from 2002 to 2007 (Goosen et al., 2011) found that men in this group were twice as likely to complete suicide and had a relative risk of 1.42 for hospital-treated suicidal behavior compared with Dutch natives. In a negative study based on data from the Danish Immigration Service from 1993 to 1999, refugees had a lower suicide rate than native-born Danes, but this result was low-powered (29 completed suicides) (Norredam et al., 2013). Neither Goosen nor Norredam controlled for suicide rate in country of origin.

Two much larger studies of suicides in immigrants, however, show similarly contrasting results. The first was conducted using WHO data from 1989 to 2003 for all of Europe. It revealed that suicide attempt rates were significantly higher in immigrants than in their host country counterparts for 27 of 56 countries of origin. Suicide attempt rates in the new country correlated positively with suicide completion rates in the country of origin for 14 of 19 countries. Four immigrant groups—those from Chile, Iran, Morocco, and Turkey—had a high suicide attempt rate despite relatively low home country suicide completion rate (Lipsicas et al., 2012).

The second study (Ikram et al., 2016) uses data from the Migrant and Ethnic Health Observatory Project, a database of countries in the European Union, and controlled for suicide risks in country of origin with a measure weighted for length of emigration. This study showed lower risk of suicide (mortality rate ratio, 0.36–0.60) in all groups studied with the exception of those from North Africa (mortality rate ratio, 1.42).

Taken together, the consistency of the findings that suicide attempts and completions correlate with those in country of origin as well as the fact that certain immigrant groups surpass their expected suicide and suicide attempt rate suggest that cultural norms in country of origin and risks embedded in the immigration experience all contribute to variability in suicide risk.

Uncovering these risk factors with so many potential variables and a relatively small number of completed suicides is challenging. One attempt (Hagaman et al., 2016) involved performing psychological autopsies of 14 completed suicides between 2009 and 2012 among Bhutanese refugees to the United States. The suicide rate among these refugees is roughly twice that of the US population overall. Most of the 14 examined were married men without a regular income, some with poor health. Most had not previously attempted suicide, and about half seemed to have symptoms of a mood disorder or PTSD. Focus groups in a subsequent analysis (Brown et al., 2019) involving 83 Bhutanese refugees, including children, revealed common themes of loss and isolation, as well as a taboo against communicating suicidal thoughts to each other.

Many populations displaced by climate change can be expected to flee from one developing country to another, with little access to infrastructure and mental health support when they arrive and throughout the immigration experience. This already occurs throughout the world, among populations fleeing violence and political instability. Thirty-six percent of 297 mothers interviewed at an Afghan refugee camp in nearby Pakistan screened positive for a mental disorder in 2002, and 91% of that group endorsed suicidal thoughts in the previous month (Rahman and Hafeez, 2003). In a Nigerian refugee camp composed

mostly of Liberians studied in 2012, 27% of residents endorsed at least passive suicidal ideation in the previous month, compared with 17% of the host population. Suicidal thoughts correlated most strongly with a poor quality of life and being unskilled or unemployed (Akinyemi et al., 2015).

Much remains unanswered. It is reasonable to suspect, however, that populations displaced by climate change will face an even higher burden of mental distress and suicidality than other migrant groups, given the predicted increase in their numbers and lack of resources available.

## CLIMATE CHANGE AS AN EXISTENTIAL THREAT

It has been recognized that climate change negatively influences mental health through an array of interwoven pathways (Berry et al., 2010) and that distress over climate change can contribute to nonsuicidal, self-destructive behavior (Bodnar, 2008). Bodnar details psychoanalytic cases of self-destructive behavior by young adults related to environmental distress, arguing that the natural world is an attachment figure in development and speculating that such behavior expresses in vulnerable individuals our changed relationship with the natural world. The high-profile suicide in 2018 of environmental advocate and attorney David Buckel via immolation (Conroy, 2019; Mays, 2018) is the only report of existential concern over climate change as a contribution to completed suicide. He emailed the New York Times of his intent, “Most humans on the planet now breathe air made unhealthy by fossil fuels, and many die early deaths as a result—my early death by fossil fuel reflects what we are doing to ourselves.” His statement, “[My] privilege” is “feeling heavier than responsibility met,” is suggestive of the “ecological debt” experience described in psychoanalytic literature (Randall, 2013). There was not a formal psychological autopsy in this case. Although there is a growing literature about climate anxiety, there is not yet evidence beyond the incomplete knowledge of the Buckel case of a climate change contribution to completed suicide via guilt or distress over climate change itself.

## DISCUSSION

There is convincing evidence that the impacts of the greenhouse gases, air pollution, and higher global temperatures directly increase suicide risk, making this an issue of global concern for psychiatry.

Existing studies suggest a population-wide increased risk of suicide of up to 3% 2 to 3 days after episodes of significantly worsened air quality. The data so far also show that the risk of suicide is significantly worse when the air is particularly polluted, as, for example, in the three studies that show a threefold to fourfold increase in suicides for the worst quartile air compared with acceptable averages (Kim et al., 2015; Lin et al., 2016; Ng et al., 2016). Of further concern, these studies may have underestimated the risks of polluted air. It has only recently been possible to measure UFPs at air quality stations and in the brain, yet they are the most common particle type. UFPs may therefore play an important role that has yet to be measured (Donaldson et al., 2005) in the neuroinflammatory changes that are hypothesized to contribute to risk of suicide.

The consistency of the association between temperatures above 37°C and suicide across both middle-income and developed countries and across different climate types suggests a similar possible unifying neurobiology (Burke et al., 2018; Dixon et al., 2014). The use of depressive language on United States in social media posts, which also increases with rising temperatures, suggests a direct effect of temperature on mental wellbeing. Linkages between temperature and violent conflict have been observed for decades, where heat increases rates of interpersonal as well as intergroup conflict (Hsiang et al., 2013). More violent methods of suicide form a larger proportion of suicides methods connected to rising temperatures, compared with suicides not stratified by temperature (Bando et al., 2017; Lin et al., 2008). These findings suggest that heat-driven biological pathways lead to increased human aggression, both against the self and against others, and underscore

the need for ongoing research into the underlying causal pathways of temperature-linked suicides. Burke et al. (2018) note that their predicted increase in suicide due to heat in this century will neutralize the gains of all current suicide-reduction programs in the United States, highlighting the significance of this impact for psychiatry.

Although no population subgroup is immune from global climate impacts, climate change disproportionately increases the psychosocial stressors that contribute to suicide in vulnerable populations: indigenous people, whose way of life is tied to natural resources; refugees fleeing countries impacted by sea-level rise, resource depletion, and climate-related conflict; socioeconomically disadvantaged populations less able to adapt to heat, food, and water shortages; as well as children, women, the elderly, and the mentally ill will be particularly vulnerable to mental health issues. The interplay of factors linking drought to suicide in Australian studies is a good example of complexity of these climate stresses (Bhise and Behere, 2016; Ellis and Albrecht, 2017; Kunde et al., 2017). These psychological autopsy studies support the hypothesis that ecoterritorial distress, such as solastalgia, loss of cherished land and animals, socioeconomic stress from drought-related debt and bankruptcy, and feelings of personal failure increase the likelihood of suicide. These vulnerable groups deserve imminent attention to their mental health needs.

Much of the risk of climate suicide, however, is likely to transcend social class, and has yet to be explored. Intense emotional reactions including hopelessness about the future, shame, guilt, and grief, as well as panic about personal survival amidst interpersonal hostility and geopolitical conflicts, will increasingly contribute to suicide risk, as they do elsewhere. Existential anxiety as Western lifestyles come under threat, and a sense of betrayal by older generations may further contribute to suicide risk. Given the unexplained rise in suicide rates in today's youth and the evidence that environmental factors may be the most important risk for suicide in some studies, it is incumbent on future suicide research to take climatic factors into account.

Although we focus mostly on suicide as a hard data point that is more easily measured at this global scale, the biological, intrapsychic, and psychosocial influences that contribute to climate suicide will also contribute to overall mental morbidity. Climate effects on the incidence and vulnerabilities associated with major psychiatric diseases such as schizophrenia, autism, and dementia will be of greater overall impact than completed suicide itself. It behoves psychiatrists to become familiar with the climate mental health literature and to implement preventative measures for all climate mental health risks in their lives and practices.

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## DISCLOSURE

The authors declare no conflict of interest.

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