

Why Are Suicide Rates Increasing in the United States? Towards a Multilevel Reimagination of Suicide Prevention



Gonzalo Martinez-Ales, Daniel Hernandez-Calle, Nicole Khauli, and Katherine M. Keyes

Contents

1	Introduction	2
2	Recent Trends in Suicide and Nonfatal Self-Harm	3
2.1	Global Trends in Suicide and Nonfatal Self-Harm	3
2.2	Trends in Suicide and Nonfatal Self-Harm in the United States	5
2.3	Why Are Suicide Rates Increasing in the United States?	7
3	Individual-Level Suicide Prevention	8
3.1	Individual-Level Suicide Risk Prediction	9
3.2	Individual-Level Interventions for Suicide Risk Prevention	11
4	Population-Level Suicide Prevention	12
4.1	Population-Level Suicide Risk Factors: The Logic in Ecological	12
4.2	Population-Level Suicide Prevention	13
5	Conclusion	15
5.1	Towards a Multilevel Approach to Suicide Prevention	15
	References	16

Abstract Suicide, a major public health concern, takes around 800,000 lives globally every year and is the second leading cause of death among adolescents and young adults. Despite substantial prevention efforts, between 1999 and 2017, suicide and nonfatal self-injury rates have experienced unprecedented increases across the United States – as well as in many other countries in the world. This chapter reviews the existing evidence on the causes behind increased suicide rates and critically evaluates the impact of a range of innovative approaches to suicide prevention. First, we briefly describe current trends in suicide and suicidal behaviors

G. Martinez-Ales (✉)

Columbia University Mailman School of Public Health, New York, NY, USA

Universidad Autónoma de Madrid School of Medicine, Madrid, Spain

e-mail: gm2794@cumc.columbia.edu

D. Hernandez-Calle

La Paz University Hospital, Madrid, Spain

N. Khauli and K. M. Keyes

Columbia University Mailman School of Public Health, New York, NY, USA

and relate them to recent time trends in relevant suicide risk markers. Then, we review the existing evidence in suicide prevention at the individual and the population levels, including new approaches that are currently under development. Finally, we advocate for a new generation of suicide research that examines causal factors beyond the proximal and clinical and fosters a socially conscious reimagining of suicidal prevention. To this end, we emphasize the need for the conceptualization of suicide and suicidal behaviors as complex phenomena with causes at several levels of organization. Future interdisciplinary research and interventions should be developed within a multilevel causal framework that can better capture the social, economic, and political settings where suicide, as a process, unfolds across the life course.

Keywords Multilevel epidemiology · Prevention · Self-harm · Suicide

1 Introduction

Suicide, the “only one really serious philosophical problem” (Camus 1955), is a major public health concern that takes around 800,000 lives globally every year. Death by suicide is the second leading cause of death among youth and accounts for 57% of all violent deaths and roughly 1.5% of all mortality – more than malaria or breast cancer (World Health Organization 2019). Because suicide “is of all modes of death that which leaves in the hearts of the sorrowing survivors the most poignant and the most enduring sting” (Wade 1879), its impact on families and communities is far-reaching: grief, stigma, and subsequent increases in psychiatric conditions and suicide rates reverberate over generations. The question whether suicide is a preventable outcome has been present in the medical literature since the late nineteenth century, when the act of suicide started being considered as caused by mental illness rather than by moral failing (Maris 2000) and it became the subject of medical (Wade 1879; Pacheco 1936) and public health inquiry (Oliven 1954). This chapter outlines recent advances in suicide prevention and critically discusses how several innovative approaches to prevention efforts may potentially impact current trends in suicide and nonfatal self-injury, with a focus on the increasing burden of suicide in the United States. First, we describe recent data on trends in suicide and suicidal behaviors and relate them to recent time trends in relevant suicide risk markers. Then, we review the existing evidence in suicide prevention at the individual and the population levels, including new approaches that are currently under development. Last, we emphasize the need for the conceptualization of suicide and suicidal behaviors as a complex phenomenon, with causes at multiple levels of organization, which requires the development of interdisciplinary research and intervention initiatives within a multilevel causal framework.

2 Recent Trends in Suicide and Nonfatal Self-Harm

2.1 *Global Trends in Suicide and Nonfatal Self-Harm*

2.1.1 Global Trends in Suicide

Suicide ranks currently as the 18th leading cause of death worldwide – 2nd in ages 15 to 29 and 3rd in ages 15 to 45 (World Health Organization 2019). Given the fact that considerable limitations exist in the detection and registration, the number of deaths by suicide is likely underestimated (World Health Organization 2014; AbouZahr et al. 2015). Also of note, even though most research in the suicide prevention field comes from high-income countries, almost eight in every ten suicides take place in low- and middle-income countries (LMIC) (World Health Organization 2018a; Lopez-Castroman et al. 2015). In 2016, countries with the highest suicide rates included those in Eastern European and south sub-Saharan African countries such as Lithuania (31.0 suicides per 100,000 population), Russia (30.6), Lesotho (39.0), and Zimbabwe (27.8) which reported the highest suicide rates overall. High-income countries (HIC) with traditionally high rates include those in the Asia Pacific region, such as South Korea (25.1) and Japan (17.3). Countries with relatively low suicide rates include those in Latin American and East Asian countries, such as Jamaica (2.9), Peru (3.0), Lebanon (2.4), and Kuwait (2.7) (Naghavi 2019). North America and Western Europe show suicide rates that stand at around 11.0 suicides per 100,000, the global age-standardized rate (Turecki and Brent 2016).

While a recent study suggests that the global age-standardized mortality rate due to suicide has decreased by 32.7% between 1990 and 2016 (Naghavi 2019), trends in suicide rates vary substantially between countries. From 195 countries included in Naghavi et al.'s analysis, 63 registered noticeable decreases and 132 reported not significant differences and only 8 increases in suicide rates (Naghavi 2019). Notably, substantial declines in China (–64.1% decrease in age-standardized suicide mortality rate between 1990 and 2016), a country that had constant increases in suicide rates between years 1900 and 1970 (Phillips et al. 2002), and India (–15.2% decrease) drive most of the global decrease in suicide rates, given that these two countries account for approximately 36% of the world population (United Nations, Department of Economic and Social Affairs, Population Division 2017) and 44.2% of deaths by suicide globally in 2016. The countries with the highest observed recent increases in suicide rate are Zimbabwe (+96.2%), Jamaica (+70.9%), Paraguay (+70.4%), Uganda (+61.6%), several western sub-Saharan African countries like Liberia (+45.9%) or Cameroon (+37.6%), and Mexico (+35.6%).

Interestingly, the estimated global male to female ratio in suicide has seemingly increased in the recent decades from 1.40:1 in 1990 to 2.17:1 in 2016 (Naghavi 2019), and suicide mortality between ages 15 and 19, an age stratum where females traditionally displayed higher suicide rates, shows now virtually no age-specific differences (Rhodes et al. 2014; Wasserman et al. 2005). Age distribution of suicide

mortality varies considerably across the globe, but it generally distributes in a bimodal fashion, peaking first around adolescence and again in adults over 70 years of age. There are noticeable differences between low/middle- and high-income countries in this respect. Middle-aged males have higher suicide rates in HIC than their counterparts in LMIC, where suicide rates are higher among adolescents and elderly females (World Health Organization 2014).

2.1.2 Global Trends in Nonfatal Self-Harm

Finally, while suicidal behaviors constitute the most reliable predictor of subsequent suicide risk (Franklin et al. 2017), global nonfatal self-injury rates are difficult to study since no international entity has been able to maintain a systematic registry, and most nationwide or international suicide statistic reports do not include information on nonlethal self-injury (World Health Organization 2014). Based on data available from both regional studies using medical records or surveys and from the World Mental Health Surveys conducted in 21 countries between 2001 and 2007 and using the WHO Composite International Diagnostic Interview (CIDI) (Nock 2012; Kessler and Wang 2008), WHO estimates that over 20 suicide attempts take place globally for each death by suicide (World Health Organization 2018a). However, the number of estimated suicide attempts, as well as the relationship between attempted and completed suicide, varies remarkably across countries. For example, while the United States reported around a 5% 12-month prevalence of suicide attempts, in Italy, the prevalence was just 0.5% for the same time period (Borges et al. 2010). Further, Spain reports 174.4 attempts per death by suicide, a figure that lowers to 64.1 in Italy (Blasco-Fontecilla et al. 2018). Of note, Blasco-Fontecilla et al. have recently proposed the use of a ratio between attempted and completed suicides across countries as a means of evaluation of healthcare delivery for people at high risk of suicide (Blasco-Fontecilla et al. 2018).

2.1.3 Global Trends in Mood and Alcohol Use Disorders

Comorbid psychiatric and substance use disorders – in particular mood and alcohol use disorders – remain the most consistent modifiable predictors of suicide and suicidal behaviors worldwide (Nordentoft et al. 2011; Moscicki 1997; Nock 2012). Studies based on psychiatric autopsies of suicide decedents suggest that affective disorders, present in roughly half of those who die by suicide (Cavanagh et al. 2003; Arsenaault-Lapierre et al. 2004), are a powerful independent risk factor for suicide, especially among the elderly (Conwell et al. 2002). Similarly, recent meta-analyses indicate that acute alcohol use increases the risk of suicide attempts by approximately seven times (Borges et al. 2017) and that the risk of suicidal ideation, suicidal attempts, and death by suicide are each increased by 2–3 times among people with alcohol use disorders (AUD), in comparison with the general population (Darvishi et al. 2015). Hence, global trends in the prevalence of mood disorders and AUD are

of interest when interrogating the evidence behind recent trends in suicide. Much like suicide, there is wide country-level heterogeneity in both the prevalence of psychiatric and substance use disorders, as well as their trends over time, and there is debate as to whether there exists an identifiable international pattern (Steel et al. 2014; Kessler et al. 2011; Whiteford et al. 2013a, b). However, there is consensus that both mood disorders (World Health Organization 2017) and AUD (Manthey et al. 2019) seem to be on the rise across the globe. Until 2025, total alcohol per capita consumption in persons aged 15 years and older is projected to increase in the Americas, Southeast Asia, and the Western Pacific (World Health Organization 2018b). In brief, available evidence indicates that the most salient drivers of prevalence and trends in mood disorders include country-level economic and employment opportunities as well as the morbidity and freedom of women in society (Seedat et al. 2009). Drivers of prevalence of alcohol and other substance use disorders include historical country culture (Skog 1985), and trends in substance use disorders are best predicted by changes in policies as laws such as trade policy, taxes, and restrictions on sales (Anderson et al. 2009; Manthey et al. 2019).

2.2 Trends in Suicide and Nonfatal Self-Harm in the United States

2.2.1 Trends in Suicide in the United States

Suicide rates in the United States declined between 1990 and 1999 (McKeown et al. 2006). However, from 1999 to 2016, suicide rates increased by 30% in 44 of 50 US states and across every age group, though most dramatic increments were observed in men aged 45 to 64 (Stone et al. 2018). This trend was maintained into 2017, with suicide rates increasing from 13.5 per 100,000 to 14.0 per 100,000 (Hedegaard et al. 2018). At the moment, suicide is the second leading cause of death among Americans aged 10 to 34 (Centers for Disease Control 2018a) and generates an estimated national cost of almost \$100 billion per year (Shepard et al. 2016).

Within the United States, high suicide rates correlate with geographic factors such as high elevation (Cheng et al. 2018), as well as demographic factors such as high concentrations of indigenous populations (Leavitt et al. 2018). Occupational exposures also impact suicide risk: for example, risk is particularly heightened among US military members who have experienced active combat and traumatic events (Pompili et al. 2013). Historically, members of the armed forces showed lower death rates, including suicide, than the general population. Notwithstanding, suicide among the US military has escalated markedly since 2004 (Armed Forces Surveillance Center 2012). Following such unprecedented increases among civilians and army members, suicide rates in both populations are now comparable (Naifeh et al. 2012).

2.2.2 Trends in Nonfatal Self-Harm in the United States

Nonfatal self-injury is also increasing in the United States across age. Self-reported suicide attempts across two cross-sectional surveys of adults completed 10 years apart found an increase in prevalence from 0.62% in 2004–2005 to 0.79% in 2012–2013 (Olfson et al. 2017), with adults aged 21–34, those with high school or less education, and those with psychiatric disorders showing the highest increases. Analyses of hospitalization records also indicate that self-injury is on the rise (Mercado et al. 2017; Owens et al. 2006; Ting et al. 2012), especially among middle-aged adults (Olfson et al. 2015).

Adolescents and young adults are evidencing particularly high increases in nonfatal self-injury in the United States. The prevalence of adolescents reporting having “seriously considered attempting suicide” in the past 12 months increased from 14.5% in 2007 to 17.2% in 2017 (Centers for Disease Control 2018b), although we should point out that overall trends since the mid-1990s suggest declines. Emergency visits and hospital admissions coded for suicidal ideation or attempt across 49 children’s hospitals in the United States increased almost tripled between 2008 and 2015 (Plemmons et al. 2018). While the largest increases were observed for 12–14- and 15–17-year-olds, girls, and non-Hispanic whites, significant increases can be identified across age, gender, and race. Burstein et al. (2019) reported that emergency department visits due to suicide attempts or ideation among children and adolescents doubled (from 580,000 to 1.12 million) over the 2007–2015 period.

2.2.3 Trends in Mood and Alcohol Use Disorders in the United States

As mentioned, examining time trends in the prevalence of mood disorders and AUD can provide additional insights when trying to contextualize trends in suicide and suicidal behaviors.

In the United States, mood disorders are also increasing among adolescents – in particular adolescent girls (Mojtabai et al. 2016). Further, a recent increase in depressive symptoms among American girls has been confirmed by studies using national representative US studies, with no or less change among boys (Keyes et al. 2019a). Also, young adults attending college have evidenced increases in anxiety and depressive disorders in the past decade (Oswalt et al. 2018). Whether a similar rise in affective disorders can be identified among adults is less clear. According to Case and Deaton, it seems that middle-aged men with low education have experienced increases in the prevalence of non-specific psychological distress over the 1997–2013 period (2015). Along those lines and during the same time, the socio-economically disadvantaged experienced decreases in life satisfaction, positive affect, and psychological well-being and increases in negative affect (Goldman et al. 2018). Annual nationally representative surveys indicate recent increases in psychological distress and major depressive episodes among adults, especially

among those with low socioeconomic status (Twenge et al. 2019; Mojtabai et al. 2016), a finding in line with other national data (Weinberger et al. 2018). All in all, the small range of observed increases is inconsistent over the life course, and further, sustained surveillance is needed to clarify whether they reflect temporary, time-limited noise in the data or there is a real increasing trend that may underlie changes in suicide risk in the United States.

As for AUD, while some studies indicate slight recent decreases in rates (Center for Behavioral Health Statistics and Quality 2018; Cheng et al. 2018) and overall per capital alcohol consumption (Haughwout et al. 2016), other studies show rates of AUD to be on the rise (Grant et al. 2017). Keyes et al. (2011) have suggested that cohort effects might account for these apparent discrepancies when data are aggregated by time period. The identification of birth cohorts at high risk for alcohol-related problems is key for etiological research, as well as for public health planning (Keyes et al. 2011). For example, recent literature points to a particular increase of alcohol use, AUD, and alcohol-related mortality risk among older adults (Holahan et al. 2014; Han et al. 2017). Gender-specific differences are also present in AUD rates, with men showing higher prevalence of AUD across all life course stages (Grant et al. 2015), and might be experiencing recent changes over time: A recent review of studies on national trends in alcohol consumption suggests that these differences may be diminishing and even reversing for some birth cohorts (Keyes et al. 2019b).

2.3 Why Are Suicide Rates Increasing in the United States?

To sum up, there is substantial evidence that increases in suicide rates somewhat overlap with increases in mood and affective disorders, especially among adolescents. However, we can only speculate on the reasons underlying such increases. Considerable attention has been directed towards the relationship between suicide and opioid overdose, which increased exponentially, in tandem with suicide rates, since approximately 1999 in the United States (Scholl et al. 2018; Bohnert and Ilgen 2019). Opioid overdose and suicide deaths share some demographic and clinical correlates. For example, roughly one in four individuals with opioid use disorder (OUD) also meet criteria for AUD (Hser et al. 2017), and a strong relationship between mood disorders and opioids use/OUD has been documented in nationally representative studies (Martins et al. 2009; Martins et al. 2012). However, it should be noted that the trends are not entirely concordant, given that there are different demographic groups that have had the largest increase in suicide compared to opioid overdose. All in all, similar mechanisms may underlie both increasing trends: First, suicide risk among users of medical opioids increases with opioid dose (Ilgen et al. 2016). Second, communities ravaged by losses due to opioid overdoses may have higher levels of collective trauma and psychological distress that would, in turn, drive a higher risk of suicide (Case and Deaton 2017). Third, access to opioids entails access to a potentially lethal means. Notwithstanding, there is limited

evidence on the use of opioids for suicide completion: in the United States, poisoning accounts for less than 15% of suicides, and opioids are present in a minority of those poisonings (Stone et al. 2018). That said, providing an accurate estimate of the number of unintentional opioid overdoses that may have actually been suicides, especially among people with OUD, is challenging, given evident difficulties in determining the intentionality of death.

On another front, a brief discussion on recent trends in access to lethal means is warranted. Changes in access to means have been considered a faithful predictor of changes in suicide rates elsewhere (Gunnell and Eddleston 2003). Because firearm suicide is the most common method of suicide in the United States, accounting for one in two suicides among males and one in three among females, suicides would be expected to closely relate to access to firearms. However, even though this suicide method represents a plurality of suicide deaths in the United States, recent data suggest that firearm ownership is decreasing, rather than increasing, in the United States (Smith et al. 2015). In addition, between the 1999–2007 and the 2008–2015 periods, the increase in suicides by firearm was less pronounced than the increase in suicides by other means, such as suffocation (Centers for Disease Control 2018a). Given that no evidence suggests a recent increase in access to suffocation means in the United States, variations in access to lethal means do not seem to have had a tangible role in current increases in suicide.

Case and Deaton (2017) have suggested the provocative hypothesis that increases in suicide rates, OUD, opioid overdose, AUD, and alcohol-related deaths can be framed as the result of a long process of erosion of the American middle class, especially regarding middle-aged men and those with low educations, by means of the progressive loss of key components of the well-being of the working class, such as job stability. However, it has been difficult to provide compelling evidence to back such hypotheses. For example, Masters et al. (2018) found that the age groups where drug overdose rates have recently peaked do not mirror trends for the other contributors to America's "deaths of despair," such as suicide. Hence, it seems plausible that factors driving deaths by suicide may be at least partially different from those determining trends in opioid overdose. Further, while measures of economic decline at the county level, such as unemployment, can predict suicide, they explain less than 1% of the variation in rates over time (Ruhm 2018).

3 Individual-Level Suicide Prevention

Over the last decades, most of the attention in the field of suicide prevention has been directed towards either improving the ability of clinicians at identifying individuals at high risk of suicide and suicidal behaviors (individual-level suicide risk prediction) or developing and scaling up interventions to reduce the risk of suicide among those at high risk. Notwithstanding, suicide risk prevention remains a largely unmet clinical need. The following section reviews the existing evidence regarding

individual-level suicide risk prevention and interventions, discusses main existing challenges, and proposes potential next steps to overcome those challenges.

3.1 Individual-Level Suicide Risk Prediction

3.1.1 The Role of Clinical Expertise, Risk Factors, Scales, and Computer Science

In most clinical settings, mental health professionals are in charge of estimating the probability that a patient will attempt suicide in the future in order to inform appropriate clinical decision-making. The clinician's assessment of a patient's suicide risk is largely based on a combination of prior clinical expertise and a series of biological, behavioral, and social risk factors (Mann et al. 1999; Brent et al. 1993; Dube et al. 2001; Roy 1982; for a review, see Franklin et al. 2017). In addition, there is a range of available suicide assessment scales to support decision-making in the clinical context (e.g., Posner et al. 2011; Beck et al. 1997; for a review, see Runeson et al. 2017).

Pokorny (1960) pioneered the use of clinical and sociodemographic factors to predict suicide risk in a case-control study featuring 44 veterans who died by suicide. Several risk factors for suicide and suicidal behaviors have since been determined, including a range of psychiatric disorders (especially mood disorders), substance use disorders (especially those related to alcohol use), being admitted to a psychiatric hospital, having attempted suicide in the past, being male, widowed, living alone, etc. (Franklin et al. 2017). However, several limitations undermine the contribution of suicide risk factor identification to effective prevention efforts (Owens and Kelley 2017).

While most accepted risk factors for suicide are highly prevalent, suicide behaviors and especially death by suicide are relatively rare events, something Hawton (1987) famously referred to as the "base-rate problem". Hence, even among those classified as "high-risk," most will never engage in suicidal behaviors, and attempts to identify particular persons who will commit suicide tend to yield striking false-positive rates (Pokorny 1983). MacKinnon and Farberow (1976) calculated the positive predictive value (PPV) of a hypothetical test with 99% sensitivity and 99% specificity in a hypothetical sample with an incidence of 250 per 100,000. Their estimate of a PPV of just 0.25% indicates a false-positive rate of 99.75%. Of note, actual clinical scales have around 80% sensitivity and 46% specificity (Chan et al. 2016).

Although most mentioned attributes, such as substance use disorders or psychiatric conditions, are present in most people who attempt or die by suicide, they are also present to a variable extent among people who do not report engaging in suicidal behaviors. For example, while 90% people who die by suicide in Western countries have diagnosable mental disorders, only 2% of psychiatric patients actually die by suicide – 4% in the case of affective conditions (Bertolote et al. 2004; Bostwick and Pankratz 2000). Along those lines, Large et al. (2011) evaluated the

clinical utility of high-risk patient selection through a large meta-analysis. They found that 56% of suicides occurred in high-risk patient groups, while 44% occurred among low-risk ones, something near the 50–50% percent chance of flipping a coin. This is also true for the most accepted risk factor for death by suicide, namely, suicidal behaviors. Owens et al. (2002) reviewed 90 studies that followed cohorts of suicide attempters for a long period of time. They found that, while their relative risk of dying by suicide was remarkably high compared to the general population, the rate of suicide after a 9-year follow-up stood around just 7%.

Last, even most accepted suicide risk assessment scales seem to perform modestly when applied to clinical samples. A recent meta-analysis evaluating all available risk scales found that a pooled 96.3% of those who tested positive would never go on to die by suicide (Carter et al. 2017). As a result of the inherent limitation of using suicide risk factors and scales to estimate the probability of patients engaging in suicidal behaviors, Wang et al. (2016) concluded that even highly trained psychiatrists roughly achieve a 10.3% PPV when predicting subsequent suicide attempts in a 6-month longitudinal study of suicide attempters.

Computer science and the use of machine learning algorithms for clinical prediction have yielded a number of promising findings in the field of suicidology. Using clinical and administrative records to extract clinical, sociodemographic, and administrative data of 53,796 hospitalized soldiers who had psychiatric diagnoses, Kessler et al. (2017) obtained regression tree-driven estimates of suicide risk following hospital discharge, reporting an area under the curve (AUC) of 0.85. Other researchers have focused on less selected samples, used different statistical tools (e.g., neural network methods), and obtained comparable AUC values (DelPozo-Banos et al. 2018; Simon et al. 2018). In a recent comprehensive review, Belsher et al. (2019) ran several simulations to study the variation of the PPV of different developed algorithms in hypothetical populations with a variety of suicide rates. Even though these methods outperformed clinical assessments in terms of sensitivity and AUC, they concluded that their resulting false-positive rates remained too high to be currently useful for the clinical practice. Finally, further innovations in technology-aided suicide prevention, including techniques such as speech analysis or cell phone geolocation, are currently under development (Vahabzadeh et al. 2016).

3.1.2 When Is Suicide Risk Highest?

Time variations in suicide risk pose an additional challenge for prediction in suicidology. Even if we accepted that a suicide risk score can be derived from the combination of a set of the abovementioned characteristics, there is still a long way to go when it comes to determining *when* this risk is higher, a key limitation that greatly undermines effective intervention planning. Large et al. (2011) estimated that, if an ultra-high-risk patient has a 5.5% suicide mortality risk of over a period of 5 years, the probability of suicide per week is roughly 0.02%. In fact, many accepted risk factors remain stable over time, like family history of suicide or gender (Hawton

2002), or take a long time to establish and resolve, like a disadvantaged socioeconomic status (Glenn and Nock 2014). While most prospective studies have relied mainly on assessments of the association between characteristics of participants at baseline and subsequent suicide and suicidal behaviors, in real life these “risk factors” interact in hard-to-capture complex hierarchical networks and undertake dramatic variations over time. As an example, studies trying to understand the excess suicide risk among people living with schizophrenia have shown that, compared to counterparts with good premorbid functioning, patients with low premorbid life functioning may have higher suicide rates after disease onset but lower long-term risk (Madsen and Nordentoft 2012; Ayesa-Arriola et al. 2015).

One of the most targeted time-varying risk factors for suicide is suicidal ideation (SI), because it necessarily antecedes suicidal acts (Kessler et al. 1999). Notwithstanding the marked within-person variations that suicidal thoughts undertake over extremely short periods of time (Kleiman and Nock 2018), most studies have used single-point measurements of SI, leading to interestingly mixed results. For example, one study estimated that suicidal “ideation” entailed a lower risk of transitioning to an attempt than suicide “planning” (Kessler et al. 1999), while another study found the risk of “active” and “passive” suicidal ideation to be roughly the same (Baca-Garcia et al. 2010), and a third one concluded that attempting suicide was more frequent than planning it among suicidal ideators (Lee et al. 2007).

Ecologic momentary assessment (EMA), a novel technology that allows for the collection of data using smartphone-delivered assessments “in the natural contexts of daily life” (Husky et al. 2014), seems particularly promising to study the variation of suicidal thoughts and how they relate to suicide risk. By measuring a participant’s domains of interest repeatedly, EMA can accurately characterize variations in SI and relate them to a range of potential triggers and subsequent outcomes (e.g., Rodriguez-Blanco et al. 2018; Davidson et al. 2017; Kleiman and Nock 2018). For example, Hallensleben et al. (2018) recently portrayed the mentioned variation of SI experienced by high-risk individuals over short periods of time, and Husky et al. (2017) linked suicidal thoughts to a range of daily life predictors.

3.2 Individual-Level Interventions for Suicide Risk Prevention

Developing, implementing, and scaling up effective suicide prevention strategies is critical to obtain improvements in individual-level suicide prevention efforts. In fact, a range of interventions in clinical settings, including psychotherapeutic as well as pharmacological strategies, have proved effective at lowering suicide risk in high-risk psychiatric patients (for comprehensive reviews, see Mann et al. 2005; van der Feltz-Cornelis et al. 2011; Zalsman et al. 2016). Here, we will focus on the role of brief contact interventions, a particularly cost-effective psychosocial approach to suicide risk reduction.

3.2.1 Brief Contact Interventions

Recently, an emerging body of literature suggests that evidence-based psychotherapeutic treatments (e.g., dialectical-behavior therapy or interpersonal therapy) (Linehan et al. 2006; Heisel et al. 2015) do not outperform more feasible programs simply seeking to ensure contact between the patient and treatment providers over a sustained period of time (Martínez-Alés et al. 2019). In a notable example, a meta-analysis of randomized controlled trials found that the WHO Brief Intervention and Contact program, a flexible schedule of telephone and in-person repeated follow-ups initiated shortly after discharge following a suicide attempt, was more effective at lowering subsequent suicide risk than an intervention based on cognitive-behavioral therapy (Riblet et al. 2017).

Because patients discharged from the hospital after a suicide attempt tend to experience low adherence rates to treatment during follow-up due to a variety of barriers in access to outpatient care, actively enhancing their contact with mental health providers seems intuitive. In a pioneer randomized trial including 843 suicide attempters who did not engage in follow-up treatment, Motto and Bostrom (2001) assigned half of participants to receive personalized letters over the following 5 study years. After just 2 years, the suicide rate among the control group doubled that of those assigned to the intervention. Variations of this approach include the use of short text messages, postcards, telephone calls, etc. (Hassanian-Moghaddam et al. 2011; Cebria et al. 2013; Kaput et al. 2014; Vaiva et al. 2018). The Safety Planning Intervention is an interesting evidence-based augmentation of brief contact strategies that is widely implemented across the globe that seeks to reduce the patient's access to lethal means, prioritize the most adequate coping strategies during suicidal crises, and enhance outreach to mental health providers (Stanley and Brown 2012).

4 Population-Level Suicide Prevention

4.1 *Population-Level Suicide Risk Factors: The Logic in Ecological*

Suicide rates are determined, at least partially, by causal factors that affect entire societies and thus operate beyond the level of the individual, but impact individuals within those societies. Durkheim's (1966) seminal book *Le Suicide* captured these "(causes) of suicide as a collective phenomenon," "whose action is felt by society as a whole". Rose (2001) discussed such population-level effects when discussing blood pressure with "why some individuals have high blood pressure is a different question than why some populations have more burden of high blood pressure?". Echoing Durkheim and Rose's work, while we term "individual-level factors" those that predict who will die by suicide and who will not within a population, we also term "group-level factors" those that predict which populations will have higher or

lower suicide rates. Over the twentieth century, these group-level factors have been commonly used to explain health outcomes in psychiatric epidemiology: Morris (1957) referred to this as the “ecology of mental disorders” in his *Uses of Epidemiology*. For instance, in a classic study, Faris and Dunham described a direct correlation between level of urbanicity and rate of schizophrenia in Chicago (1939), a finding that leads to a century of hypotheses and empirical data analysis regarding environmental risk factors of psychotic disorders (Plana-Ripoll et al. 2018).

Mervyn Susser coined the term “integral variables” (Susser 1994a) to refer to variables that are shared by a whole social group, such as economic downturns or urban dwelling. By definition, a comparison between individuals who comprise the target social group will not allow to estimate the causal effect of an integral variable. Instead, ecologic designs that consider the whole group as a legitimate unit of analysis and perform between-groups comparisons are required (Susser 1994b, 1972). In words of Durkheim (1966), “the social rate must be taken directly as the object of analysis”. For example, the tenfold difference in suicide rates between Lithuania or Russia and Peru or Lebanon (Naghavi et al. 2019) can illustrate the need of the conceptualization of suicide using an ecological perspective. Similarly, remarkable differences can be found across countries within Europe (Organization for Economic Co-operation and Development 2019), states and regions within the United States (Kegler et al. 2017), or areas within the city of London (Rezaeian et al. 2005). Such variation prompts questions about how a region’s political, socioeconomic, and cultural context might impact suicide risk.

Notwithstanding, traditional and innovative prediction efforts have characteristically approached suicide from an individual-level perspective (e.g., Roy 1982; Ursano et al. 2014; Vahabzadeh et al. 2016) and may be overlooking central determinants of risk that include country-level and area-level social and political factors, such as general area industry and employment, past suicide rates in the geographic area, and economic growth and contraction (Fountoulakis et al. 2016). Further, beyond geopolitical concerns are actual environmental factors that influence risk, including temperature, elevation, both synthetic and natural chemical exposures, and other topographical and toxicological features of the physical environment (Deisenhammer et al. 2003; Akkaya-Kalayci et al. 2017; Fountoulakis et al. 2016).

4.2 Population-Level Suicide Prevention

Several population-level interventions have proved effective for suicide risk reduction. In general terms, they fall within three main categories: education campaigns, regulations in mass media coverage, and restriction of access to means. Among evidence-based educational approaches, we would like to highlight the implementation of school-based programs for suicide prevention (Zenere 3rd and Lazarus 1997; Wasserman et al. 2015) and “gatekeeper training” strategies, directed towards individuals who have high probability of contacting suicidal individuals but are not

designated specifically as mental health professionals, such as teachers or general practitioners (Isaac et al. 2009).

Media reporting of high-profile suicides has a large evidence base as a causal catalyst to subsequent increases in population-level suicide rates (Sisask and Varnik 2012; Pirkis et al. 2006a, b; Fink et al. 2018). This phenomenon is sometimes referred to as the “Werther effect,” after the protagonist of a 1774 German novel who dies by suicide, prompting so-called “copycat” suicides reported throughout Europe at the time. Increases in suicide after widespread media coverage of a suicide event are framed within the broader behavioral contagion theory (Gould 2001). Notably, recent studies point out the importance of the social context at shaping the harmful, neutral, or protective impact of suicide media portrayals (VanderWeele et al. 2019). Opportunities for effective suicide prevention at this level generally consist in a variety of reporting recommendation guidelines seeking to enhance responsible, non-sensationalist coverage of suicide and related events (American Association of Suicidology 2019).

Mass media also plays a role in the regulation of a population’s “cognitive-access” to suicide means and methods (Florentine and Crane 2010; Fink et al. 2018). However, the term “means reduction” usually refers to evidence-based interventions aimed at preventing the population from physically accessing potentially lethal means (e.g., Gunnell and Eddleston 2003; for a review, see Pirkis et al. 2015). This approach builds on empirical studies providing a substantial body of evidence that ease of access greatly impacts the risk of attempting suicide (Marzuk et al. 1992) and the method choice (Eddleston and Gunnell 2006), especially in impulsive suicidal behaviors – the most frequent type (Hawton et al. 2013). Of note, Deisenhammer et al. estimated that half of suicide attempt survivors report an interval between the onset of a serious suicidal thought and subsequent suicide attempt of 10 min or less (Deisenhammer et al. 2009).

While reductions in access to lethal means are associated with lives saved, there remains concern about substitution of method as an additional risk for suicide. Indeed, reducing the access to lethal means is more effective if an alternative method available for substitution has a lower associated lethality – this can be due to a higher ability to abort mid-attempt or to a lower inherent deadliness. Firearms, present in almost 33% of homes in the United States and in 51% of total suicides in the United States, entail 50 times the potential lethality of drug overdose (Marzuk et al. 1992). A range of epidemiological studies have confirmed higher suicide rates in states with higher gun ownership levels (Miller et al. 2007) and higher suicide risk for people living in a household with firearms (Brent et al. 1993; Kellermann et al. 1992).

In sum, the contribution of population-level causes of suicide is significant, as well as in terms of their potential to reduce the burden of harm, quite influential when taken seriously. As suicide prevention efforts continue, a sustained and serious focus on population-level effects is critical.

5 Conclusion

Suicide is an avoidable tragedy with a devastating impact on individuals, families, and communities. Despite substantial prevention efforts, it remains a major global contributor to causes of death, especially among youth. Suicide and nonfatal self-injury are increasing at an unprecedented rate in the United States, as well as in many other places across the globe, raising questions about their causes and how to better intervene on them. As mentioned, prevention and treatment are often pointed towards high-risk groups, such as those with repeated suicide attempts, who are at increased risk of dying by suicide, but may miss the majority of suicide decedents who do not come into contact with the mental healthcare system and act impulsively. Moreover, even among those classified clinically as high-risk, little is known as to when is that risk actually higher – when should mental health professionals intensify their interventions? In addition, it seems eminently plausible that different effective clinical interventions, such as psychotherapy or brief contact programs, may not be equally useful for different profiles of individuals at high risk, and further research should enhance precision in clinical decision-making. Last, suicide prevention efforts tend to use an individual-level approach to understand and intervene on suicide risk (e.g., Roy 1982; Ursano et al. 2014; Vahabzadeh et al. 2016), probably failing to adequately acknowledge determinants at other, supra-individual levels. Potential future suicide prevention initiatives should acknowledge that suicide is a complex multilevel process.

5.1 *Towards a Multilevel Approach to Suicide Prevention*

To study the causes of suicide, researchers need to select a frame of reference that will define a finite set of potential causes (Susser 1972). Logically, each researcher's knowledge field will shape this frame of reference: for example, a sociologist and a psychiatrist will consider different sets of potential causes. The process of discarding all factors outside the frame of reference generates a useful asymmetry that permits cause-effect directionality (Pearl 2009). As a result, the way we consider potential causal relationships within our research field will be determined by our scope of interest and the frame of reference. Hence, although characterizing the entire field of risk is of interest, we usually reduce complex systems to simpler thought models and exclude dynamic interactions between ecological and individual factors. The fact that causal relations tend to be ascertained at a particular level of organization, usually the individual level, in the case of suicide (e.g., Roy 1982), limits their generalizability to other levels of organization, as well as the ascertainment of salient potential points of intervention.

In reality, "systems never exist in isolation" (Susser 1972), but they relate to each other in an enveloping hierarchy best represented by Susser and Susser's Chinese box metaphor (Susser and Susser 1996). As George Engel synthesized in his

celebrated bio-psycho-social model (Engel 1977), molecular, individual, and social levels of causation interact in shaping mental suffering, disease, and illness. More recently, Metzl and Hansen have used the notion of “structural competency” to encourage the recognition of how “institutions, neighborhood conditions, market forces, public policies, and healthcare delivery systems shape symptoms and disease” (Metzl and Hansen 2018).

Multilevel epidemiology has emerged as a response to the growing interest in the study of how macro-level characteristics affect outcomes independently of individual variables, as well as how both levels interact (Diez-Roux 1998). The arena of multilevel epidemiology, both a thinking framework and a set of analytical tools, allows for the careful consideration of a hierarchic range of levels of causation. We believe that innovative analytic tools for suicide risk prediction, such as those based on new technologies (Husky et al. 2014), data science initiatives (Torous et al. 2018), and machine learning approaches (Kessler et al. 2019), can be enhanced by partnering with broader conceptual models to include multiple levels of organization and capture the social, economic, and political settings where suicide, as a complex process, unfolds across the life course (Martínez-Alés and Keyes 2019). Examining causal factors beyond the proximal and clinical will be critical to allow for a socially conscious reimagining of suicide prevention.

References

- Armed Forces Health Surveillance Center (AFHSC) (2012) Deaths by suicide while on active duty, active and reserve components, U.S. Armed Forces, 1998–2011. *MSMR* 19(6):7–10
- AbouZahr C, de Savigny D, Mikkelsen L et al (2015) Towards universal civil registration and vital statistics systems: the time is now. *Lancet* 386(10001):1407–1418
- Akkaya-Kalayci T, Vyssoki B, Winkler D et al (2017) The effect of seasonal changes and climatic factors on suicide attempts of young people. *BMC Psychiatry* 17(1):365
- American Association of Suicidology (2019) Suicide reporting recommendations: media as partners toolkit. <https://www.suicidology.org/Resources/Recommendations-for-Reporting-on-Suicide>
- Anderson P, de Bruijn A, Angus K et al (2009) Impact of alcohol advertising and media exposure on adolescent alcohol use: a systematic review of longitudinal studies. *Alcohol Alcohol* 44(3):229–243
- Arsenault-Lapierre G, Kim C, Turecki G (2004) Psychiatric diagnoses in 3275 suicides: a meta-analysis. *BMC Psychiatry* 4:37
- Ayasa-Arriola R, Alcaraz EG, Hernandez BV et al (2015) Suicidal behaviour in first-episode non-affective psychosis: specific risk periods and stage-related factors. *Eur Neuropsychopharmacol* 25(12):2278–2288
- Baca-García E, Perez-Rodríguez MM, Keyes KM et al (2010) Suicidal ideation and suicide attempts in the United States: 1991–1992 and 2001–2002. *Mol Psychiatry* 15(3):250–259
- Beck AT, Brown GK, Steer RA (1997) Psychometric characteristics of the scale for suicide ideation with psychiatric outpatients. *Behav Res Ther* 35(11):1039–1046
- Belsher BE, Smolenski DJ, Pruitt LD et al (2019) Prediction models for suicide attempts and deaths: a systematic review and simulation. *JAMA Psychiatry* 76:642
- Bertolote JM, Fleischmann A, De Leo D et al (2004) Psychiatric diagnoses and suicide: revisiting the evidence. *Crisis* 25(4):147–155

- Blasco-Fontecilla H, Artieda-Urrutia P, de Leon J (2018) A proposal for using the ratio of attempted to completed suicides across several countries worldwide. *Epidemiol Psychiatry Sci*:1–5
- Bohnert ASB, Ilgen MA (2019) Understanding links among opioid use, overdose, and suicide. *N Engl J Med* 380:71–79. <https://doi.org/10.1056/NEJMr1802148>
- Borges G, Nock MK, Haro Abad JM et al (2010) Twelve-month prevalence of and risk factors for suicide attempts in the World Health Organization world mental health surveys. *J Clin Psychiatry* 71(12):1617–1628
- Borges G, Bagge CL, Cherpitel CJ et al (2017) A meta-analysis of acute use of alcohol and the risk of suicide attempt. *Psychol Med* 47(5):949–957
- Bostwick JM, Pankratz VS (2000) Affective disorders and suicide risk: a reexamination. *Am J Psychiatry* 157(12):1925–1932
- Brent DA, Perper JA, Moritz G et al (1993) Firearms and adolescent suicide. A community case-control study. *Am J Dis Child* 147(10):1066–1071
- Burstein B, Agostino H, Greenfield B (2019) Suicidal attempts and ideation among children and adolescents in US emergency departments, 2007–2015. *JAMA Pediatr* 173(6):598–600. <https://doi.org/10.1001/jamapediatrics.2019.0464>
- Camus A (1955) *Myth of sisyphus, and other essays*. Hamish Hamilton
- Carter G, Milner A, McGill K et al (2017) Predicting suicidal behaviours using clinical instruments: systematic review and meta-analysis of positive predictive values for risk scales. *Br J Psychiatry* 210(6):387–395
- Case A, Deaton A (2015) Rising midlife morbidity and mortality, US whites. *Proc Natl Acad Sci* 112(49):15078–15083. <https://doi.org/10.1073/pnas.1518393112>
- Case A, Deaton A (2017) Mortality and morbidity in the 21(st) century. *Brookings Pap Econ Act* 2017:397–476
- Cavanagh JT, Carson AJ, Sharpe M et al (2003) Psychological autopsy studies of suicide: a systematic review. *Psychol Med* 33(3):395–405
- Cebria AI, Parra I, Pamiás M et al (2013) Effectiveness of a telephone management programme for patients discharged from an emergency department after a suicide attempt: controlled study in a Spanish population. *J Affect Disord* 147(1–3):269–276
- Center for Behavioral Health Statistics and Quality (2018) 2017 National survey on drug use and health: detailed tables. Substance Abuse and Mental Health Services Administration, Rockville, MD
- Centers for Disease Control (2018a) Suicide rates in the United States continue to increase. <https://www.cdc.gov/nchs/data/databriefs/db309.pdf>
- Centers for Disease Control (2018b) Trends in the prevalence of suicide-related behaviors national YRBS: 1997–2017. In: Youth risk behavior survey. Data summary and trends report, 2007–2017. <https://www.cdc.gov/healthyyouth/data/yrbs/pdf/trendsreport.pdf>
- Chan MK, Bhatti H, Meader N et al (2016) Predicting suicide following self-harm: systematic review of risk factors and risk scales. *Br J Psychiatry* 209(4):277–283
- Cheng N, Rahman MM, Alatawi Y et al (2018) Mixed approach retrospective analyses of suicide and suicidal ideation for brand compared with generic central nervous system drugs. *Drug Saf* 41(4):363–376
- Conwell Y, Duberstein PR, Caine ED (2002) Risk factors for suicide in later life. *Biol Psychiatry* 52(3):193–204
- Darvishi N, Farhadi M, Haghtalab T et al (2015) Alcohol-related risk of suicidal ideation, suicide attempt, and completed suicide: a meta-analysis. *PLoS One* 10(5):e0126870
- Davidson CL, Anestis MD, Gutierrez PM (2017) Ecological momentary assessment is a neglected methodology in Suicidology. *Arch Suicide Res* 21(1):1–11
- Deisenhammer EA, Kemmler G, Parson P (2003) Association of meteorological factors with suicide. *Acta Psychiatr Scand* 108(6):455–459
- Deisenhammer EA, Ing CM, Strauss R et al (2009) The duration of the suicidal process: how much time is left for intervention between consideration and accomplishment of a suicide attempt? *J Clin Psychiatry* 70(1):19–24

- DelPozo-Banos M, John A, Petkov N et al (2018) Using neural networks with routine health records to identify suicide risk: feasibility study. *JMIR Ment Health* 5(2):e10144
- Diez-Roux AV (1998) Bringing context back into epidemiology: variables and fallacies in multilevel analysis. *Am J Public Health* 88(2):216–222
- Durkheim E (1966) *Suicide: a study in sociology*. Free Press, New York
- Eddleston M, Gunnell D (2006) Why suicide rates are high in China. *Science* 311(5768):1711–1713
- Engel GL (1977) The need for a new medical model: a challenge for biomedicine. *Science* 196(4286):129–136
- Faris REL, Dunham HW (1939) Mental disorders in urban areas: an ecological study of schizophrenia and other psychoses
- Feltz-Cornelis CM, Sarchiapone M, Postuvan V et al (2011) Best practice elements of multilevel suicide prevention strategies: a review of systematic reviews. *Crisis* 32(6):319–333
- Fink DS, Santaella-Tenorio J, Keyes KM (2018) Increase in suicides the months after the death of Robin Williams in the US. *PLoS One* 13(2):e0191405
- Florentine JB, Crane C (2010) Suicide prevention by limiting access to methods: a review of theory and practice. *Soc Sci Med* 70(10):1626–1632
- Fountoulakis KN, Chatzikosta I, Pasiadis K et al (2016) Relationship of suicide rates with climate and economic variables in Europe during 2000–2012. *Ann General Psychiatry* 15(1):19
- Franklin JC, Ribeiro JD, Fox KR et al (2017) Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. *Psychol Bull* 143(2):187–232
- Franklin JC, Huang X, Fox KR et al (2018) What suicide interventions should target. *Curr Opin Psychol* 22:50–53
- Glenn CR, Nock MK (2014) Improving the prediction of suicidal behavior in youth. *Int J Behav Consult Ther* 9(3):7–10
- Goldman N, Gleit DA, Weinstein M (2018) Declining mental health among disadvantaged Americans. *Proc Natl Acad Sci U S A* 115(28):7290–7295
- Gould MS (2001) Suicide and the media. *Ann N Y Acad Sci* 932:200–221; discussion 221–204
- Grant BF, Goldstein RB, Saha TD et al (2015) Epidemiology of DSM-5 alcohol use disorder: results from the National Epidemiologic Survey on alcohol and related conditions III. *JAMA Psychiat* 72(8):757–766
- Grant BF, Chou SP, Saha TD et al (2017) Prevalence of 12-month alcohol use, high-risk drinking, and DSM-IV alcohol use disorder in the United States, 2001–2002 to 2012–2013: results from the National Epidemiologic Survey on alcohol and related conditions. *JAMA Psychiatry* 74(9):911–923
- Gunnell D, Eddleston M (2003) Suicide by intentional ingestion of pesticides: a continuing tragedy in developing countries. *Int J Epidemiol* 32(6):902–909
- Hallensleben N, Spangenberg L, Forkmann T et al (2018) Investigating the dynamics of suicidal ideation. *Crisis* 39(1):65–69
- Han X, Xiao L, Yu Y et al (2017) Alcohol consumption and gastric cancer risk: a meta-analysis of prospective cohort studies. *Oncotarget* 8(47):83237–83245
- Hassanian-Moghaddam H, Sarjami S, Kolahi AA et al (2011) Postcards in Persia: randomised controlled trial to reduce suicidal behaviours 12 months after hospital-treated self-poisoning. *Br J Psychiatry* 198(4):309–316
- Haughwout SP, Harford TC, Castle IJ et al (2016) Treatment utilization among adolescent substance users: findings from the 2002 to 2013 National Survey on drug use and health. *Alcohol Clin Exp Res* 40(8):1717–1727
- Hawton K (1987) Assessment of suicide risk. *Br J Psychiatry* 150:145–153
- Hawton K (2002) Studying survivors of nearly lethal suicide attempts: an important strategy in suicide research. *Suicide Life Threat Behav* 32:76–84
- Hawton K, Casanas ICC, Haw C et al (2013) Risk factors for suicide in individuals with depression: a systematic review. *J Affect Disord* 147(1–3):17–28

- Hedegaard H, Curtin SC, Warner M (2018) Suicide mortality in the United States, 1999-2017. *NCHS Data Brief* 330:1–8
- Heisel MJ, Talbot NL, King DA et al (2015) Adapting interpersonal psychotherapy for older adults at risk for suicide. *Am J Geriatr Psychiatry* 23(1):87–98
- Holahan CJ, Schutte KK, Brennan PL et al (2014) Episodic heavy drinking and 20-year total mortality among late-life moderate drinkers. *Alcohol Clin Exp Res* 38(5):1432–1438
- Hser YI, Mooney LJ, Saxon AJ et al (2017) High mortality among patients with opioid use disorder in a large healthcare system. *J Addict Med* 11(4):315–319
- Husky M, Olie E, Guillaume S et al (2014) Feasibility and validity of ecological momentary assessment in the investigation of suicide risk. *Psychiatry Res* 220(1–2):564–570
- Husky M, Swendsen J, Ionita A, Jaussent I, Genty C, Courtet P (2017) Predictors of daily life suicidal ideation in adults recently discharged after a serious suicide attempt: a pilot study. *Psychiatry Res* 256:79–84
- Ilgen MA, Bohnert AS, Ganoczy D et al (2016) Opioid dose and risk of suicide. *Pain* 157(5):1079–1084
- Isaac M, Elias B, Katz LY et al (2009) Gatekeeper training as a preventative intervention for suicide: a systematic review. *Can J Psychiatr* 54(4):260–268
- Kaput J, van Ommen B, Kremer B et al (2014) Consensus statement understanding health and malnutrition through a systems approach: the enough program for early life. *Genes Nutr* 9(1):378
- Kegler SR, Stone DM, Holland KM (2017) Trends in suicide by level of urbanization – United States, 1999-2015. *MMWR* 66(10):270–273
- Kellermann AL, Rivara FP, Simes G et al (1992) Suicide in the home in relation to gun ownership. *N Engl J Med* 327(7):467–472
- Kessler RC, Wang PS (2008) The descriptive epidemiology of commonly occurring mental disorders in the United States. *Annu Rev Public Health* 29:115–129
- Kessler RC, Borges G, Walters EE (1999) Prevalence of and risk factors for lifetime suicide attempts in the National Comorbidity Survey. *Arch Gen Psychiatry* 56(7):617–626
- Kessler RC, Aguilar-Gaxiola S, Alonso J et al (2009a) The global burden of mental disorders: an update from the WHO world mental health (WMH) surveys. *Epidemiol Psychiatr Soc* 18(1):23–33
- Kessler RC, Aguilar-Gaxiola S, Alonso J et al (2009b) The WHO world mental health (WMH) surveys. *Psychiatrie (Stuttg)* 6(1):5–9
- Kessler RC, Cox BJ, Green JG et al (2011) The effects of latent variables in the development of comorbidity among common mental disorders. *Depress Anxiety* 28(1):29–39
- Kessler RC, Stein MB, Petukhova MV et al (2017) Predicting suicides after outpatient mental health visits in the Army study to assess risk and resilience in Servicemembers (Army STARRS). *Mol Psychiatry* 22(4):544–551
- Kessler RC, Bossarte RM, Luedtke A, Zaslavsky AM, Zubizarreta JR (2019) Machine learning methods for developing precision treatment rules with observational data. *Behav Res Ther* 120:103412. <https://doi.org/10.1016/j.brat.2019.103412>
- Keyes KM, Hatzenbuehler ML, Hasin DS (2011) Stressful life experiences, alcohol consumption, and alcohol use disorders: the epidemiologic evidence for four main types of stressors. *Psychopharmacology* 218(1):1–17
- Keyes KM, Gary D, O'Malley PM et al (2019a) Recent increases in depressive symptoms among US adolescents: trends from 1991 to 2018. *Soc Psychiatry Psychiatr Epidemiol* 54:987
- Keyes KM, Rutherford C, Miech R (2019b) Historical trends in the grade of onset and sequence of cigarette, alcohol, and marijuana use among adolescents from 1976-2016: implications for "gateway" patterns in adolescence. *Drug Alcohol Depend* 194:51–58
- Kleiman EM, Nock MK (2018) Real-time assessment of suicidal thoughts and behaviors. *Curr Opin Psychol* 22:33–37
- Large M, Sharma S, Cannon E et al (2011) Risk factors for suicide within a year of discharge from psychiatric hospital: a systematic meta-analysis. *Aust N Z J Psychiatry* 45(8):619–628

- Leavitt RA, Ertl A, Sheats K et al (2018) Suicide among American Indian/Alaska natives – national violent death reporting system, 18 states, 2003-2014. *MMWR* 67(8):237–242
- Lee S, Fung SC, Tsang A et al (2007) Lifetime prevalence of suicide ideation, plan, and attempt in metropolitan China. *Acta Psychiatr Scand* 116(6):429–437
- Linehan MM, Comtois KA, Murray AM et al (2006) Two-year randomized controlled trial and follow-up of dialectical behavior therapy vs therapy by experts for suicidal behaviors and borderline personality disorder. *Arch Gen Psychiatry* 63(7):757–766
- Lopez-Castroman J, Blasco-Fontecilla H, Courtet P et al (2015) Are we studying the right populations to understand suicide? *World Psychiatry* 14(3):368–369
- MacKinnon DR, Farberow NL (1976) An assessment of the utility of suicide prediction. *Suicide Life Threat Behav* 6(2):86–91
- Madsen T, Nordentoft M (2012) Suicidal changes in patients with first episode psychosis: clinical predictors of increasing suicidal tendency in the early treatment phase. *Early Interv Psychiatry* 6(3):292–299
- Mann JJ, Oquendo M, Underwood MD et al (1999) The neurobiology of suicide risk: a review for the clinician. *J Clin Psychiatry* 60(Suppl 2):7–11; discussion 18-20, 113-116
- Mann JJ, Apter A, Bertolote J et al (2005) Suicide prevention strategies: a systematic review. *JAMA* 294(16):2064–2074
- Manthey J, Shield KD, Rylett M et al (2019) Global alcohol exposure between 1990 and 2017 and forecasts until 2030: a modelling study. *Lancet* 393:2493
- Maris RW (2000) *Comprehensive textbook of suicidology*. Guilford Press
- Martínez-Alés G, Keyes K (2019) Fatal and non-fatal self-injury in the United States: current trends and innovations in prevention. *Curr Psychiat Rep* 21:104. <https://doi.org/10.1007/s11920-019-1080-6>
- Martínez-Alés G, Angora R, Barrigon ML et al (2019) A real-world effectiveness study comparing a priority appointment, an enhanced contact intervention, and a psychotherapeutic program following attempted suicide. *J Clin Psychiatry* 80(2)
- Martins SS, Keyes KM, Storr CL et al (2009) Pathways between nonmedical opioid use/dependence and psychiatric disorders: results from the National Epidemiologic Survey on alcohol and related conditions. *Drug Alcohol Depend* 103(1–2):16–24
- Martins SS, Fenton MC, Keyes KM et al (2012) Mood and anxiety disorders and their association with non-medical prescription opioid use and prescription opioid-use disorder: longitudinal evidence from the National Epidemiologic Study on alcohol and related conditions. *Psychol Med* 42(6):1261–1272
- Marzuk PM, Leon AC, Tardiff K et al (1992) The effect of access to lethal methods of injury on suicide rates. *Arch Gen Psychiatry* 49(6):451–458
- Masters RK, Tilstra AM, Simon DH (2018) Explaining recent mortality trends among younger and middle-aged white Americans. *Int J Epidemiol* 47(1):81–88
- McKeown RE, Cuffe SP, Schulz RM (2006) US suicide rates by age group, 1970-2002: an examination of recent trends. *Am J Public Health* 96(10):1744–1751
- Mercado MC, Holland K, Leemis RW et al (2017) Trends in emergency department visits for nonfatal self-inflicted injuries among youth aged 10 to 24 years in the United States, 2001-2015. *JAMA* 318(19):1931–1933
- Miller M, Lippmann SJ, Azrael D, Hemenway D (2007) Household firearm ownership and rates of suicide across the 50 United States. *J Trauma* 62(4):1029–1035. <https://doi.org/10.1097/01.ta.0000198214.24056.40>
- Metzl JM, Hansen H (2018) Structural competency and psychiatry. *JAMA Psychiat* 75(2):115–116
- Mojtabai R, Olfson M, Han B (2016) National trends in the prevalence and treatment of depression in adolescents and Young adults. *Pediatrics* 138(6):e20161878
- Moscicki EK (1997) Identification of suicide risk factors using epidemiologic studies. *Psychiatr Clin North Am* 20(3):499–517
- Motto JA, Bostrom AG (2001) A randomized controlled trial of postcrisis suicide prevention. *Psychiatr Serv* 52(6):828–833

- Naghavi M (2019) Global, regional, and national burden of suicide mortality 1990 to 2016: systematic analysis for the global burden of disease study 2016. *BMJ* 364:194
- Naifeh JA, Tull MT, Gratz KL (2012) Anxiety sensitivity, emotional avoidance, and PTSD symptom severity among crack/cocaine dependent patients in residential treatment. *Cognit Ther Res* 36(3):247–257
- Nock MK (2012) Future directions for the study of suicide and self-injury. *J Clin Child Adolesc Psychol* 41(2):255–259
- Nordentoft M, Mortensen PB, Pedersen CB (2011) Absolute risk of suicide after first hospital contact in mental disorder. *Arch Gen Psychiatry* 68(10):1058–1064
- Olfson M, Wang S, Blanco C (2015) National trends in hospital-treated self-harm events among middle-aged adults. *Gen Hosp Psychiatry* 37(6):613–619
- Olfson M, Blanco C, Wall M et al (2017) National Trends in suicide attempts among adults in the United States. *JAMA Psychiat* 74(11):1095–1103
- Oliven JF (1954) Suicide prevention as a public health problem. *Am J Public Health Nat Health* 44(11):1419–1425
- Organization for Economic Co-operation and Development (2019) Data: suicide rates. Accessible at: <https://data.oecd.org/healthstat/suicide-rates.htm>
- Oswalt SB, Lederer AM, Chestnut-Steich K et al (2018) Trends in college students' mental health diagnoses and utilization of services, 2009–2015. *J Am Coll Heal*:1–11
- Owens PL, Fingar KR, Heslin KC et al (2006) Emergency department visits related to suicidal ideation, 2006–2013: statistical brief #220, in healthcare cost and utilization project (HCUP) statistical briefs. Rockville, MD
- Owens D, Horrocks J, House A (2002) Fatal and non-fatal repetition of self-harm. Systematic review. *Br J Psychiatry* 181:193–199. <https://doi.org/10.1192/bjp.181.3.193>
- Owens D, Kelley R (2017) Predictive properties of risk assessment instruments following self-harm. *Br J Psychiatry* 210(6):384–386
- Pacheco JNJ (1936) Suicide: its causes and prevention. *Indian Med Gazette* 71(12):720
- Pearl J (2009) *Causality*. Cambridge University Press
- Phillips MR, Yang G, Zhang Y, Wang L, Ji H, Zhou M (2002) Risk factors for suicide in China: a national case-control psychological autopsy study. *Lancet* 360(9347):1728–1736. [https://doi.org/10.1016/S0140-6736\(02\)11681-3](https://doi.org/10.1016/S0140-6736(02)11681-3)
- Pirkis J, Blood RW, Beautrais A et al (2006a) Media guidelines on the reporting of suicide. *Crisis* 27(2):82–87
- Pirkis JE, Burgess PM, Francis C et al (2006b) The relationship between media reporting of suicide and actual suicide in Australia. *Soc Sci Med* 62(11):2874–2886
- Pirkis J, Too LS, Spittal MJ et al (2015) Interventions to reduce suicides at suicide hotspots: a systematic review and meta-analysis. *Lancet Psychiatry* 2(11):994–1001
- Plana-Ripoll O, Pedersen CB, McGrath JJ (2018) Urbanicity and risk of schizophrenia-new studies and old hypotheses. *JAMA Psychiat* 75(7):687–688
- Plemmons G, Hall M, Doupnik S et al (2018) Hospitalization for suicide ideation or attempt: 2008–2015. *Pediatrics* 141(6):e20172426
- Pokorny AD (1960) Characteristics of forty-four patients who subsequently committed suicide. *AMA Arch Gen Psychiatry* 2(3):314–323
- Pokorny AD (1983) Prediction of suicide in psychiatric patients. Report of a prospective study. *Arch Gen Psychiatry* 40(3):249–257
- Pompili M, Sher L, Serafini G et al (2013) Posttraumatic stress disorder and suicide risk among veterans: a literature review. *J Nerv Ment Dis* 201(9):802–812
- Posner K, Brown GK, Stanley B et al (2011) The Columbia–Suicide Severity Rating Scale: initial validity and internal consistency findings from three multisite studies with adolescents and adults. *Am J Psychiatry* 168(12):1266–1277
- Rezaeian M, Dunn G, St Leger S, Appleby L (2005) The ecological association between suicide rates and indices of deprivation in English local authorities. *Soc Psychiatry Psychiatr Epidemiol* 40(10):785–791

- Rhodes AE, Boyle MH, Bridge JA et al (2014) Antecedents and sex/gender differences in youth suicidal behavior. *World J Psychiatry* 4(4):120–132
- Riblet NBV, Shiner B, Young-Xu Y et al (2017) Strategies to prevent death by suicide: meta-analysis of randomised controlled trials. *Br J Psychiatry* 210(6):396–402
- Rodriguez-Blanco L, Carballo JJ, Baca-Garcia E (2018) Use of ecological momentary assessment (EMA) in non-suicidal self-injury (NSSI): a systematic review. *Psychiatry Res* 263:212–219
- Rose G (2001) Sick individuals and sick populations. *Int J Epidemiol* 30(3):427–432
- Roy A (1982) Risk factors for suicide in psychiatric patients. *Arch Gen Psychiatry* 39(9):1089–1095
- Ruhm CJ (2018) Drug mortality and lost life years among U.S. midlife adults, 1999–2015. *Am J Prev Med* 55(1):11–18
- Runeson B, Odeberg J, Pettersson A et al (2017) Instruments for the assessment of suicide risk: a systematic review evaluating the certainty of the evidence. *PLoS One* 12(7):e0180292
- Scholl L, Seth P, Kariisa M et al (2018) Drug and opioid-involved overdose deaths – United States, 2013–2017. *MMWR Morb Mortal Wkly Rep* 67(5152):1419–1427
- Seedat S, Scott KM, Angermeyer MC et al (2009) Cross-national associations between gender and mental disorders in the World Health Organization world mental health surveys. *Arch Gen Psychiatry* 66(7):785–795
- Shepard DS, Gurewich D, Lwin AK et al (2016) Suicide and suicidal attempts in the United States: costs and policy implications. *Suicide Life Threat Behav* 46(3):352–362
- Simon GE, Johnson E, Lawrence JM et al (2018) Predicting suicide attempts and suicide deaths following outpatient visits using electronic health records. *Am J Psychiatry* 175(10):951–960
- Sisask M, Varnik A (2012) Media roles in suicide prevention: a systematic review. *Int J Environ Res Public Health* 9(1):123–138
- Skog OJ (1985) The collectivity of drinking cultures: a theory of the distribution of alcohol consumption. *Br J Addict* 80(1):83–99
- Smith PN, Currier J, Drescher K (2015) Firearm ownership in veterans entering residential PTSD treatment: associations with suicide ideation, attempts, and combat exposure. *Psychiatry Res* 229(1–2):220–224
- Stanley B, Brown GK (2012) Safety planning intervention: a brief intervention to mitigate suicide risk. *Cogn Behav Pract* 19:256–264
- Steel Z, Marnane C, Iranpour C et al (2014) The global prevalence of common mental disorders: a systematic review and meta-analysis 1980–2013. *Int J Epidemiol* 43(2):476–493
- Stone DM, Simon TR, Fowler KA et al (2018) Vital signs: trends in state suicide rates – United States, 1999–2016 and circumstances contributing to suicide – 27 states, 2015. *MMWR Morb Mortal Wkly Rep* 67(22):617–624
- Susser M (1972) Agent, host and Environment as an ecological system. *Causal thinking in the health sciences*
- Susser M (1994a) The logic in ecological: II. The logic of design. *Am J Public Health* 84(5):830–835
- Susser M (1994b) The logic in ecological: I. The logic of analysis. *Am J Public Health* 84(5):825–829
- Susser M, Susser E (1996) Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. *Am J Public Health* 86(5):674–677
- Ting SA, Sullivan AF, Boudreaux ED et al (2012) Trends in US emergency department visits for attempted suicide and self-inflicted injury, 1993–2008. *Gen Hosp Psychiatry* 34(5):557–565
- Torous J, Larsen ME, Depp C et al (2018) Smartphones, sensors, and machine learning to advance real-time prediction and interventions for suicide prevention: a review of current Progress and next steps. *Curr Psychiatry Rep* 20(7):51
- Turecki G, Brent DA (2016) Suicide and suicidal behaviour. *Lancet* 387(10024):1227–1239
- Twenge JM, Cooper AB, Joiner TE et al (2019) Age, period, and cohort trends in mood disorder indicators and suicide-related outcomes in a nationally representative dataset, 2005–2017. *J Abnorm Psychol* 128(3):185–199

- United Nations, Department of Economic and Social Affairs, Population Division (2017) World population prospects: the 2017 revision, key findings and advance tables. Working paper no. ESA/P/WP/248
- Ursano RJ, Colpe LJ, Heeringa SG et al (2014) The Army study to assess risk and resilience in servicemembers (Army STARRS). *Psychiatry* 77(2):107–119
- Vahabzadeh A, Sahin N, Kalali A (2016) Digital suicide prevention: can technology become a game-changer? *Innov Clin Neurosci* 13(5–6):16–20
- Vaiva G, Berrouiguet S, Walter M et al (2018) Combining postcards, crisis cards, and telephone contact into a decision-making algorithm to reduce suicide reattempt: a randomized clinical trial of a personalized brief contact intervention. *J Clin Psychiatry* 79(6)
- VanderWeele TJ, Mathur MB, Chen Y (2019) Media portrayals and public health implications for suicide and other behaviors. *JAMA Psychiatry* 76:891
- Wade WF (1879) On the prevention of suicide. *Br Med J* 2(979):533
- Wang Y, Bhaskaran J, Sareen J et al (2016) Clinician prediction of future suicide attempts: a longitudinal study. *Can J Psychiatry* 61(7):428–432
- Wasserman D, Cheng Q, Jiang GX (2005) Global suicide rates among young people aged 15-19. *World Psychiatry* 4(2):114–120
- Wasserman D, Hoven CW, Wasserman C et al (2015) School-based suicide prevention programmes: the SEYLE cluster-randomised, controlled trial. *Lancet* 385(9977):1536–1544
- Weinberger AH, Gbedemah M, Martinez AM et al (2018) Trends in depression prevalence in the USA from 2005 to 2015: widening disparities in vulnerable groups. *Psychol Med* 48(8):1308–1315
- Whiteford HA, Degenhardt L, Rehm J et al (2013a) Global burden of disease attributable to mental and substance use disorders: findings from the global burden of disease study 2010. *Lancet* 382(9904):1575–1586
- Whiteford HA, Harris MG, McKeon G et al (2013b) Estimating remission from untreated major depression: a systematic review and meta-analysis. *Psychol Med* 43(8):1569–1585
- World Health Organization (2014) Preventing suicide: a global imperative. World Health Organization, Geneva
- World Health Organization (2017) Depression and other common mental disorders: Global Health Estimates. World Health Organization, Geneva
- World Health Organization (2018a) National suicide prevention strategies: progress, examples and indicators. World Health Organization, Geneva
- World Health Organization (2018b) Global status report on alcohol and health. World Health Organization, Geneva
- World Health Organization (2019) Latest data on suicide. https://www.who.int/mental_health/suicide-prevention/en/
- Zalsman G, Hawton K, Wasserman D et al (2016) Suicide prevention strategies revisited: 10-year systematic review. *Lancet Psychiatry* 3(7):646–659
- Zenere FJ 3rd, Lazarus PJ (1997) The decline of youth suicidal behavior in an urban, multicultural public school system following the introduction of a suicide prevention and intervention program. *Suicide Life Threat Behav* 27(4):387–402