Global, regional, and national burden of suicide, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021

*GBD 2021 Suicide Collaborators**

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Summary

Background Deaths from suicide are a tragic yet preventable cause of mortality. Quantifying the burden of suicide to understand its geographical distribution, temporal trends, and variation by age and sex is an essential step in suicide prevention. We aimed to present a comprehensive set of global, regional, and national estimates of suicide burden.

Methods We produced estimates of the number of deaths and age-standardised mortality rates of suicide globally, regionally, and for 204 countries and territories from 1990 to 2021, and disaggregated these results by age and sex. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 estimates of deaths attributable to suicide were broken down into two comprehensive categories: those by firearms and those by other specified means. For this analysis, we also produced estimates of mean age at the time of death from suicide, incidence of suicide attempts compared with deaths, and age-standardised rates of suicide by firearm. We acquired data from vital registration, verbal autopsy, and mortality surveillance that included 23 782 study-location-years of data from GBD 2021. Point estimates were calculated from the average of 1000 randomly selected possible values of deaths from suicide by age, sex, and geographical location. 95% uncertainty intervals (UIs) were derived from the 2·5th and 97·5th percentiles from a 1000-draw distribution.

Findings Globally, 746 000 deaths (95% UI 692 000–800 000) from suicide occurred in 2021, including 519 000 deaths (485 000–556 000) among males and 227 000 (200 000–255 000) among females. The age-standardised mortality rate has declined over time, from 14·9 deaths (12·8–15·7) per 100 000 population in 1990 to 9·0 (8·3–9·6) per 100 000 in 2021. Regionally, mortality rates due to suicide were highest in eastern Europe (19·2 [17·5–20·8] per 100 000), southern sub-Saharan Africa (16·1 [14·0–18·3] per 100 000), and central sub-Saharan Africa (14·4 [11·0–19·1] per 100 000). The mean age at which individuals died from suicide progressively increased during the study period. For males, the mean age at death by suicide in 1990 was 43·0 years (38·0–45·8), increasing to 47·0 years (43·5–50·6) in 2021. For females, it was 41·9 years (30·9–46·7) in 1990 and 46·9 years (41·2–52·8) in 2021. The incidence of suicide attempts requiring medical care was consistently higher at the regional level for females than for males. The number of deaths by suicide using firearms was higher for males than for females, and substantially varied by country and region. The countries with the highest age-standardised rate of suicides attributable to firearms in 2021 were the USA, Uruguay, and Venezuela.

Interpretation Deaths from suicide remain variable by age and sex and across geographical locations, although population mortality rates have continued to improve globally since the 1990s. This study presents, for the first time in GBD, a quantification of the mean age at the time of suicide death, alongside comprehensive estimates of the burden of suicide throughout the world. These analyses will help guide future approaches to reduce suicide mortality that consider a public health framework for prevention.

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Introduction

Suicide is increasingly recognised as an urgent public health issue.[1–5] Efforts to initiate suicide prevention from a public health perspective have been motivated by WHO's Thirteenth General Programme of Work[4] and Comprehensive Mental Health Action Plan,[6] along with the UN's inclusion in the Sustainable Development Goals of target 3.4.2 to reduce suicide mortality.[7] With recognition by the UN and WHO that suicide is a public health issue, the international discussion on suicide is beginning to acknowledge that suicide often arises from environmental, contextual, social, and biological factors, and must be addressed through the full spectrum of universal, targeted, and indicated public health interventions.[5,8]

Suicide is a complex phenomenon with relationships to various multifaceted issues.[9] Individuals who are living with a mental disorder have increased rates of suicide,

Research in context

Evidence before this study

The Sustainable Development Goals have established a global target to reduce deaths from suicide by a third by 2030 (indicator 3.4.2). WHO's Comprehensive Mental Health Action Plan has also set targets and strategies for reduction by the same year. Timely and detailed assessments of the burden of suicide are needed to track progress towards these initiatives. We searched for articles on PubMed published before May 1, 2024, using the search terms "suicide", or "self-harm", and "burden". Our literature search retrieved numerous contemporary studies investigating deaths from suicide among specific populations, but the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) produces the only comprehensive estimates of suicide mortality at the global, regional, and national levels, disaggregated by age and sex, and inclusive of more than three decades of temporal trends. Other estimates, such as those provided by reports from WHO, are constrained by either more limited location detail or a narrower timeframe.

Added value of this study

Changing trends in suicide mortality across the world underscore the importance of timely and thorough analyses of its burden. This study provides updated, comprehensive estimates of deaths from suicide, building upon the previously published estimates from GBD 2016, which covered 1990 to 2016. Additionally, we have expanded our analyses to include additional age groups, mean age at the time of death by suicide, frequency of firearm use as a means of suicide, and the incidence of suicide attempts that required medical care compared with suicide deaths. We identified areas and demographic groups most affected by suicide in 2021, along with time trends of suicide mortality by location, age, and sex, from 1990 to 2021. Our estimates provide the most comprehensive analysis of the global burden of suicide to date, with results from 204 countries and territories. To our knowledge, this is the only study to report detailed results of deaths from suicide with this level of time and location detail.

Implications of all the available evidence

Quantifying trends in suicide is essential to provide appropriate and timely action. Despite global improvements in the age-standardised death rate over the past 31 years, certain demographic groups are showing rising rates of suicide, revealing specific locations and age groups that urgently need support and enhanced public health intervention strategies. Our analysis of suicide attempts compared with deaths by sex and location showed that males die from suicide more frequently, even though females are far more likely to attempt it. Such findings have important implications for suicide prevention strategies, particularly for highly lethal means, such as those involving firearms. Suicide is amenable to public health intervention: identifying populations most at risk is an essential component of a comprehensive suicide prevention strategy. Understanding the distribution of suicide mortality is fundamental for directing resources and efforts most effectively.

although the magnitude of this relationship varies based on the population and study methodology.[10–12] Substance use and substance use disorders are also associated with an increased risk of suicide.[13] Victims of interpersonal violence, intimate partner violence, sexual violence, and childhood trauma have a substantial increase in likelihood of suicidality.[14–17] Social isolation has become increasingly recognised as an important risk factor for suicide.[18] Ease of access to lethal means, such as firearms and pesticides, is associated with higher rates of suicide, and restricting access to lethal means can be an effective suicide prevention intervention.[19–21] Poverty and social deprivation are also associated with suicide.[22,23] The combination of these risk factors—mental disorders, substance use, trauma or violence, social and cultural factors, ease of access to lethal means, poverty, and deprivation[10,14,18,19,22,24]—are all important potential contributors to global suicide incidence.

Preventing suicide requires a detailed understanding of existing patterns and trends, and how these vary between locations and demography, yet existing studies on the global burden of suicide of this nature are limited. We used results from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021, which estimated global health loss across 288 causes of disease and injury in 204 countries and territories from 1990 to 2021,[25] to analyse patterns in suicide by age and sex. Additionally, GBD results were reanalysed to calculate, for the first time, the mean age at the time of suicide death, study-specific age groupings, and incidence mortality ratios. The aim of this study is to quantify patterns in suicide across time and by location, age, sex, and fraction of deaths compared with suicide attempts. By identifying populations most at risk for suicide, we can better inform decision makers, stimulate discussion, and spark innovation around targeted suicide prevention efforts. Since data on suicide remain sparse in some locations, these estimates could also motivate improved data collection efforts that would enable us to provide more accurate and comprehensive estimates moving forward, a key step in reducing the burden of suicide around the world. This manuscript was produced as part of the GBD Collaborator Network and in accordance with the GBD Protocol.[26]

Methods

Overview

We analysed GBD 2021 estimates of mortality, incidence, and mean age of death due to suicide for 204 countries and territories from 1990 to 2021. Detailed methods for

GBD have been published previously.[25,27,28] GBD 2021 estimates of deaths attributable to suicide were broken down into two comprehensive categories: those by firearms and those by other specified means. GBD's definition of suicide is "deliberate bodily damage inflicted on oneself resulting in death or injury", and includes ICD-9 codes E950–E959 and ICD-10 codes X60–X64.9, X66–X84.9, and Y87.0. Our suicide estimates do not include assisted suicide or euthanasia.

This study complies with GATHER throughout (appendix 1 p 6).[29] Software packages used in the cause-of-death analysis for GBD 2021 were Python (version 3.10.4), Stata (version 13.1), and R (version 4.2.1).

Suicide mortality

Suicide mortality data preparation requires an abundance of caution due to the sensitivity of the subject and stigma associated with suicide in many cultures. Some deaths recorded on death certificates do not include ICD codes that fall under a range of codes that belong to a GBD cause, such as those mentioned above, and therefore cannot be directly assigned to a cause of death in the GBD cause hierarchy. Within the GBD framework, these are codes that are used to classify causes of death or morbidity that are either too vague, non-specific, or do not accurately represent a true underlying cause of death or disease.[30,31] According to previously described methods of redistribution, we identified cases of misassignment of suicide and reassigned those to this cause by age, sex, location, and year based on multiple causes of death data (data for which additional cause-of-death codes other than the underlying cause of death are listed) and other statistical analyses.[30] In 2015, in the raw data, there were 303 541 deaths directly assigned to suicide in ICD-9 and ICD-10 vital registration sources. During the redistribution process, 75 149 (25%) deaths were added to these estimates. 82% of deaths that were added to suicide estimates during code redistribution came from ICD codes Y10–Y34, undetermined intent (appendix 1 p 14). Redistribution of deaths assigned to ICD codes Y10–Y33 used a regression method, and deaths assigned to Y34 used a separate method using multiple causes of death data. The strategies for producing redistribution weights for Y10–Y33 and Y34 have been described previously.[25,30]

Estimation models for suicide used data acquired from vital registration, verbal autopsy, and mortality surveillance, including 23 782 study-location-years of data in GBD 2021. After data were redistributed as necessary, estimates for suicide were modelled exclusively using the Cause of Death Ensemble model (CODEm), which is a Bayesian hierarchical spatiotemporal ensemble modelling tool used to estimate causes with continuous, predictable mortality. In addition to observed datapoints, covariates were included to estimate location-years without data (appendix 1 pp 21–22).

We used the GBD standard-population structure to estimate age-standardised mortality rates per 100 000 population.[25] Point estimates were calculated from the average of 1000 randomly selected possible values of deaths from suicide by age, sex, and geographical location. 95% uncertainty intervals (UIs) were derived from the 2·5th and 97·5th percentiles from a 1000-draw distribution.[25]

Suicide incidence

In GBD 2021, there were 212 total data sources available to inform incidence estimates of suicide attempts, such as hospital data on inpatient and outpatient admissions, surveys, and scientific literature.[27] Using these data sources, we estimated the incidence of suicide attempts requiring medical care. These methods are described extensively in previous publications.[27,32] We used DisMod-MR 2.1, a Bayesian meta-regression tool, to estimate the incidence rates for suicide injuries warranting inpatient admission.[27,32] Data sources from non-inpatient data (eg, outpatient or survey data) were adjusted for consistency among the model inputs in terms of case definition.[32]

See Online for appendix 1

In addition to drawing on our incidence data sources, as a compartmental model to reflect the epidemiological pathways of injuries, DisMod-MR 2.1 incorporated estimates of cause-specific mortality rates for suicide and excess mortality rates informed by the Healthcare Access and Quality Index, thereby enhancing the accuracy and consistency of global suicide burden estimates.[27,32] We also estimated the ratio of outpatient to inpatient admissions, and used this information to generate estimates of total incidence of suicide injuries warranting medical care through our non-fatal injury estimation pipeline.[32]

The incidence–mortality ratio was calculated by dividing the number of all suicide attempts, including fatal and non-fatal suicide attempts, by the number of suicide deaths.

Calculation of mean age of death

Calculation of mean age at the time of death from suicide was done using GBD modelled death estimates. GBD produces cause-of-death estimates for every location-year-age group, even when there are no direct cause-of-death data available. GBD uses standard 5-year age groups from 5–9 years to 90–94 years; the remaining non-standard age groups consist of ages 0–6 days, 7–27 days, 1–5 months, 6–11 months, 12–23 months, 2–4 years, and 95 years and older. For this calculation, each GBD age group is assigned a distinct age of death by taking the average age of each age group. For example, the age group 15–19 years can be assigned to have a distinct age of death of 17 years old. The only age group without a discernable average is 95 years and older, which was assigned a distinct age of 95 years.

In GBD estimates, each modelled death falls into one of these age groups and can be assigned a distinct age of death. Distinct ages are then summed together for

	Males					Females				
	Suicide deaths (thousands)	Incident cases* (thousands)	Incidence–mortality ratio†	Suicide deaths from firearms		Suicide deaths (thousands)	Incident cases* (thousands)	Incidence–mortality ratio†	Suicide deaths from firearms	
				Count (thousands)	Percentage of all suicide deaths				Count (thousands)	Percentage of all suicide deaths
Global	519 (485–556)	2210 (1860–2590)	4·27 (3·54–5·16)	50·3 (40·1–62·1)	9·7% (7·9–12·0)	227 (200–255)	3270 (2730–3910)	14·47 (11·31–18·11)	6·6 (5·0–8·1)	2·9% (2·1–3·7)
Andean Latin America	2·46 (1·98–2·89)	6·13 (5·17–7·10)	2·52 (1·96–3·26)	0·1 (0·1–0·2)	5·3% (3·7–7·3)	0·783 (0·608–0·956)	8·59 (7·37–9·95)	11·11 (8·30–14·81)	0·0 (0·0–0·0)	1·3% (0·8–1·9)
Australasia	2·96 (2·78–3·12)	14·2 (12·8–15·6)	4·81 (4·31–5·37)	0·2 (0·2–0·2)	7·2% (6·9–7·5)	0·940 (0·892–0·982)	18·7 (16·7–20·8)	19·85 (17·56–22·34)	0·0 (0·0–0·0)	0·7% (0·7–0·8)
Caribbean	3·42 (2·99–3·86)	6·11 (5·43–6·75)	1·79 (1·51–2·12)	0·2 (0·1–0·3)	5·8% (4·1–8·1)	0·951 (0·794–1·12)	7·85 (6·78–9·06)	8·32 (6·54–10·36)	0·0 (0·0–0·0)	2·5% (1·5–3·4)
Central Asia	7·09 (6·43–7·77)	38·1 (34·8–41·6)	5·39 (4·68–6·13)	0·2 (0·2–0·2)	2·5% (2·3–2·8)	2·13 (1·89–2·39)	36·7 (32·7–41·1)	17·25 (14·53–20·21)	0·0 (0·0–0·0)	0·4% (0·4–0·5)
Central Europe	12·8 (11·9–13·6)	58·8 (52·3–65·5)	4·60 (4·01–5·28)	0·8 (0·6–1·0)	6·0% (4·7–7·4)	2·88 (2·61–3·17)	41·9 (36·9–47·3)	14·58 (12·40–16·95)	0·0 (0·0–0·0)	1·1% (0·8–1·5)
Central Latin America	14·0 (12·6–15·6)	29·8 (24·3–36·1)	2·14 (1·67–2·67)	1·9 (1·6–2·2)	13·5% (12·6–14·4)	3·17 (2·78–3·54)	31·2 (25·2–37·9)	9·89 (7·67–12·26)	0·2 (0·1–0·2)	4·9% (4·5–5·3)
Central sub-Saharan Africa	8·54 (6·46–11·8)	20·2 (16·9–23·6)	2·42 (1·65–3·35)	0·3 (0·1–0·8)	3·8% (1·4–7·7)	2·48 (1·70–3·64)	16·7 (13·7–20·4)	6·96 (4·28–9·90)	0·2 (0·1–0·3)	6·2% (2·5–12·4)
East Asia	81·7 (64·4–104)	364 (299–435)	4·53 (3·34–6·17)	0·0 (0·0–0·1)	0·1% (0·0–0·1)	55·5 (43·2–74·4)	571 (475–676)	10·50 (7·21–13·87)	0·0 (0·0–0·0)	0·0% (0·0–0·0)
Eastern Europe	39·6 (35·7–43·5)	204 (169–243)	5·18 (4·18–6·19)	1·4 (1·3–1·6)	3·6% (3·5–3·7)	9·10 (8·18–10·2)	133 (111–157)	14·65 (11·81–18·03)	0·0 (0·0–0·0)	0·3% (0·3–0·3)
Eastern sub-Saharan Africa	22·0 (18·9–27·0)	53·4 (44·1–63·5)	2·44 (1·83–3·09)	1·0 (0·4–2·0)	4·6% (1·7–8·5)	6·54 (5·22–8·15)	53·6 (43·7–65·6)	8·32 (6·01–11·25)	0·5 (0·2–0·9)	7·2% (3·0–12·6)
High-income Asia Pacific	25·6 (21·5–26·8)	127 (108–148)	4·99 (4·17–6·20)	0·0 (0·0–0·0)	0·1% (0·1–0·1)	10·5 (8·81–11·3)	178 (156–201)	16·93 (14·49–20·41)	0·0 (0·0–0·0)	0·0% (0·0–0·0)
High-income North America	43·1 (41·7–44·4)	270 (224–319)	6·28 (5·18–7·52)	22·5 (21·7–23·3)	52·3% (51·8–52·8)	12·4 (11·9–12·8)	380 (315–449)	30·69 (25·25–36·51)	3·5 (3·7–3·3)	28·2% (27·5–28·9)
North Africa and Middle East	15·5 (12·8–17·9)	103 (85·6–122)	6·70 (5·26–8·60)	1·5 (0·6–2·3)	9·9% (4·7–15·7)	5·71 (4·37–6·87)	134 (110–163)	23·83 (17·93–32·20)	0·3 (0·4–0·1)	4·9% (2·3–7·3)
Oceania	0·471 (0·398–0·561)	2·92 (2·32–3·58)	6·26 (4·48–7·99)	0·0 (0·0–0·0)	4·6% (1·6–7·1)	0·187 (0·148–0·282)	2·40 (1·97–2·95)	13·12 (7·99–17·17)	0·0 (0·0–0·0)	0·0% (0·0–0·1)
South Asia	131 (112–149)	491 (388–603)	3·78 (2·92–4·96)	11·1 (4·5–20·9)	8·4% (3·6–15·5)	81·6 (63·2–94·9)	1230 (975–1530)	15·22 (11·41–20·69)	1·2 (0·4–2·2)	1·4% (0·5–2·6)
Southeast Asia	25·4 (21·4–29·5)	134 (113–157)	5·34 (4·21–6·70)	0·7 (0·3–1·4)	2·9% (1·4–5·4)	8·20 (6·67–10·4)	124 (103–148)	15·31 (11·17–19·60)	0·0 (0·0–0·1)	0·4% (0·2–0·9)
Southern Latin America	6·08 (5·78–6·39)	34·8 (31·4–38·3)	5·73 (5·15–6·40)	1·0 (1·0–1·1)	17·0% (16·3–17·6)	1·41 (1·33–1·50)	33·7 (29·7–37·8)	23·93 (20·82–27·52)	0·1 (0·1–0·1)	7·2% (6·6–8·0)
Southern sub-Saharan Africa	10·0 (8·63–11·5)	30·4 (23·6–37·6)	3·06 (2·30–4·14)	0·4 (0·1–0·6)	3·6% (1·3–6·0)	2·55 (1·97–3·17)	22·6 (17·9–27·8)	8·96 (6·27–12·25)	0·1 (0·0–0·1)	2·6% (0·9–4·5)
Tropical Latin America	13·7 (13·2–14·3)	19·7 (15·5–24·3)	1·44 (1·13–1·79)	1·4 (1·3–1·4)	10·0% (9·6–10·4)	3·83 (3·66–3·98)	19·9 (16·0–23·9)	5·21 (4·19–6·32)	0·1 (0·1–0·2)	3·8% (3·6–4·0)
Western Europe	34·4 (32·8–35·9)	145 (132–158)	4·22 (3·83–4·66)	4·3 (4·0–4·6)	12·5% (12·1–12·9)	10·9 (10·2–11·4)	170 (151–189)	15·57 (13·77–17·70)	0·2 (0·2–0·2)	1·6% (1·5–1·6)
Western sub-Saharan Africa	19·5 (15·6–23·1)	58·4 (48·1–69·4)	3·04 (2·33–4·04)	1·1 (0·3–2·0)	5·8% (1·9–9·4)	5·56 (3·72–7·22)	61·7 (50·2–75·5)	11·40 (8·19–17·29)	0·2 (0·1–0·3)	3·9% (2·1–5·6)

Counts are presented to 3 significant figures. *Includes suicide deaths and non-fatal suicide attempts that resulted in medical care. †Number of incident cases divided by number of deaths.

Table 1: **Numbers of deaths due to suicide and suicide attempts, incidence–mortality ratios, and number and percentage of suicide deaths that occurred from firearms, for males and females, globally and by region, 2021**