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Observational Study

Worldwide suicide mortality trends (2000-2019): A joinpoint regression analysis

Milena Ilic, Irena Ilic

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Abstract

BACKGROUND

Studies exploring suicide mortality on a global scale are sparse, and most evaluations were limited to certain populations.

AIM

To assess global, regional and national trends of suicide mortality.

METHODS

Suicide mortality data for the period 2000-2019 were obtained from the mortality database of the World Health Organization and the Global Burden of Disease Study. Age-standardized rates (ASRs; expressed per 100000) were presented. To assess trends of suicide mortality, joinpoint regression analysis was used: The average annual percent change (AAPC) with the corresponding 95% confidence interval (95%CI) was calculated.

RESULTS

A total of 759028 (523883 male and 235145 female) suicide deaths were reported worldwide in 2019. The global ASR of mortality of suicide was 9.0/100000 population in both sexes (12.6 in males *vs* 5.4 in females). In both sexes, the highest rates were found in the region of Africa (ASR = 11.2), while the lowest rates were reported in Eastern Mediterranean (ASR = 6.4). Globally, from 2000 to 2019, ASRs of mortality of suicide had a decreasing tendency in both sexes together [AAPC = -2.4% per year; 95%CI: (-2.6)-(-2.3)]. The region of the Americas experienced a significant increase in suicide mortality over 2000-2019 unlike other regions that had a declining trend. Out of all 133 countries with a decline in suicide mortality, Barbados (AAPC = -10.0%), Grenada (AAPC = -8.5%), Serbia (AAPC = -7.6%), and Venezuela (AAPC = -6.2%) showed the most marked reduction in mortality rates. Out of all 26 countries with a rise in suicide mortality,

Lesotho (AAPC = +6.0%), Cyprus (AAPC = +5.1%), Paraguay (AAPC = +3.0%), Saudi Arabia (AAPC = +2.8%), Brunei (AAPC = +2.6%), Greece (AAPC = +2.6%), Georgia (AAPC = +2.1%), and Mexico (AAPC = +2.0%), are among those with the highest increase in mortality.

CONCLUSION

Decreasing trends in suicide mortality were observed in most countries across the world. Unfortunately, the mortality of suicide showed an increasing trend in a number of populations. Further research should explore the reasons for these unfavorable trends, in order to consider and recommend more efforts for suicide prevention in these countries.

Key Words: Suicide rates; Mortality; Trends; Average annual percent change; Joinpoint analysis

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Core Tip: Despite a decline in mortality during the last decades, suicides are one of the main health challenges worldwide. About 750000 suicide deaths were recorded in 2019 across the world. Globally, the rate of suicide mortality in 2019 was 9.0/100000 for both sexes together (12.6 in males vs 5.4 in females). Despite the decreasing trends recorded in both sexes in most countries in the world, the mortality of suicide showed an increasing trend in certain populations. Further research should clarify the reasons for these unfavorable trends, in order to provide more effective measures for suicide prevention.

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INTRODUCTION

Suicides present a significant burden for societies around the world[1-3]. According to the 2019 estimates from the World Health Organization (WHO), suicides caused over 700000 deaths worldwide (representing about 1.3% of all deaths globally), making it the 17th leading cause of death in 2019[4]. In 2016, suicide was among the top 10 leading causes of death in Eastern Europe, Central Europe, Western Europe, Central Asia, Australasia, Southern Latin America, and in high-income areas of North America [3]. In the United States of America in 2019, and consistently over the past years, suicides were the 10th leading cause of death in both sexes[5] and 8th leading cause of death in males[6].

Globally, for both sexes, suicide was the 4th leading cause of death in young people aged 15-29 years in 2019[1]. In 2019, in several countries (such as Australia, Belarus, Canada, Finland, Germany, Japan, Kazakhstan, Mongolia, Montenegro, Netherlands, Norway, Republic of Korea, Russian Federation, Singapore, Sweden, Switzerland, and the United Kingdom), self-harm was the 1st leading cause of death in people aged 15-34 years for both sexes[6]. The estimates from the Global Burden of Disease (GBD) Study 2019 ranked self-harm as third among the top causes of disability-adjusted life years in adolescents aged 10-24 years[7].

The majority of suicide deaths (77%) occurred in low- and middle-income countries in 2019[4]. Age-standardized rate (ASR, per 100000) of suicide mortality was 27.5 in Eastern Europe, in high-income Asia Pacific 18.7, in Australasia 10.6, and in Central Europe 13.0 and high-income North America 12.7 in 2016[3]. For both sexes in 2016, the lowest suicide death rates were found in countries in North Africa and the Middle East (4.8/100000). In men in 2016, countries in Eastern Europe recorded the highest suicide mortality rate (50.0/100000), while in women the highest suicide mortality rate was observed in South Asia (12.5/100000)[3].

During the last decades of the 20th century, declining suicide mortality trends were observed in Eastern Europe, the European Union, the United States of America, and in Japan, while suicide mortality increased sharply in the Russian Federation[8]. Since the 2000s, mortality trends from suicide in 28 selected countries across Europe, the Americas, and Australasia showed downward trends in several areas, while in some countries suicide rates increased (in the United Kingdom, Brazil, Mexico, the United States of America, Republic of Korea, and Australia)[9].

WHO and the United Nations Sustainable Development Goals aim to reduce suicide mortality by one third by 2030[10]. Reducing the global suicide mortality rate by a third is both an indicator and a target (the only one for mental health) in the United Nations (UN)-mandated Sustainable Development Goals (SDGs). How the coronavirus disease 2019 pandemic is affecting the burden of suicide is not clear yet, considering the lockdown, increased mental stress, possible delays in mental and other illness

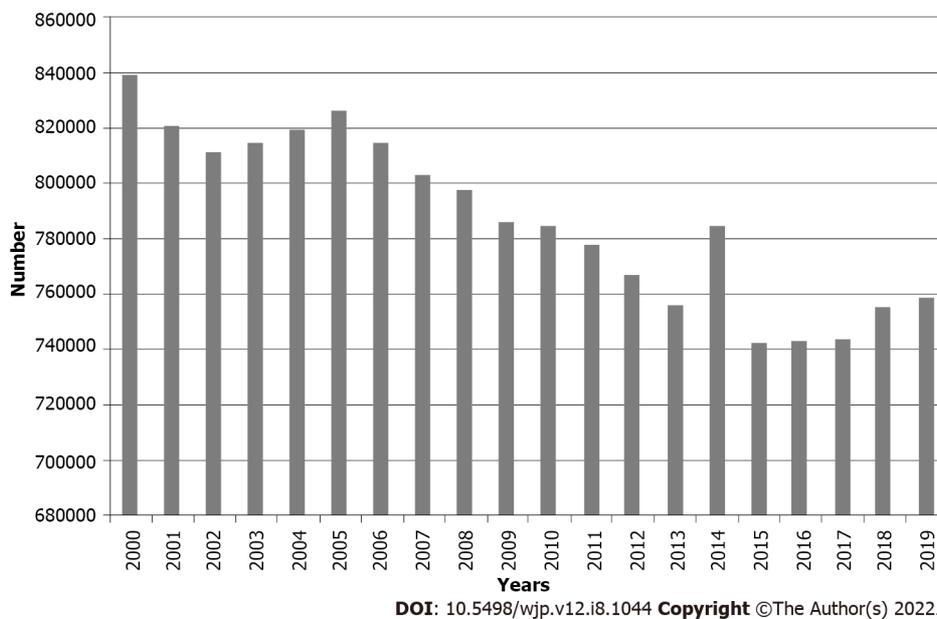


Figure 1 Global suicide deaths, 2000-2019. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

diagnoses, *etc*[11]. Nevertheless, there is a scarcity of studies that explored the mortality of suicide in different areas, as most evaluations are limited to certain populations[8,9]. The aim of this study was to estimate the recent global, regional and national trends of suicide mortality.

MATERIALS AND METHODS

Study design

For this descriptive epidemiological study, annual underlying cause of death data was used to describe trends in mortality from suicide for the period 2000-2019. We also cited high-quality articles in *Reference Citation Analysis* (<https://www.referencecitationanalysis.com>).

Data sources

Figures of suicide mortality were extracted from the WHO database[4] and from the GBD Study[12]. Mortality estimates of suicide covered site codes X60–X84 and Y87.0, based on the 10th revision of the International Classification of Diseases and Related Health Problems to classify death, injury and cause of death[13]. The WHO and GBD databases provide a comprehensive and comparable assessment of mortality of suicide[4,12]. These databases provide high-quality death statistics by national vital registries worldwide, which were derived from death certificates. According to the WHO guidelines, the definition of the underlying cause of death includes a disease or injury that has started a series of diseases or an injury that has triggered a series of disease states that directly led to death. Mortality was recorded at a local civil registry with information on the cause of death. The information was collected by the health authority and reported to the WHO annually. Only mortality cases that were medically certified were reported. The WHO estimates only comprised national mortality data series that meet the minimal inclusion criteria according to the WHO-defined medium data quality level, based on the degree of population coverage, completeness and accuracy[14]. The WHO and GBD estimates have been documented following the Guidelines for Accurate and Transparent Health Estimates Reporting[15].

This manuscript presents data for 183 WHO Member States, *i.e.*, only members/countries with a population of 90000 or greater in 2019[16]. We extracted data for suicide in men and women for 183 countries worldwide, over the period 2000-2019. Also, suicide mortality was presented within six WHO regions: Africa, the Americas, South-East Asia, Europe, Eastern Mediterranean, and Western Pacific. For this purpose, ASRs (per 100000) calculated by direct method of standardization by age and sex, using the world standard population, were used[17]. Also, specific (age- and sex-specific) mortality rates (expressed per 100000 persons) were presented.

Statistical analysis

The magnitude and direction of temporal trends for suicide mortality were assessed using the joinpoint regression analysis (Joinpoint regression software, Version 4.5.0.1 - June 2017, available through the Surveillance Research Program of the United States National Cancer Institute), proposed by Kim *et al*

[18]. The joinpoint regression analysis detected point(s), the so-called “joinpoints”, where the statistically significant changes of suicide mortality rates occurred (increase or decrease), and determined the trends between joinpoints[18]. The analysis starts with a minimum of zero joinpoints (*i.e.*, a straight line) and tests whether a change in the trend was statistically significant by testing more joinpoints up to the maximum of four joinpoints (five segments). The annual percentage change (APC) for each of the identified trends of suicide rates using the calendar year as a regression variable was determined. For countries worldwide (including the global and regional level), the average APC (AAPC) over the entire considered period was calculated; for each AAPC estimate, the corresponding 95% confidence interval (CI) was determined[19]. In this manuscript, trend of suicide mortality of each country was presented with a straight line in the whole period, even if there were changes in trends in the observed period[18].

The terms “significant increase” or “significant decrease” were used in describing the direction of temporal trends, in order to signify that the slope of the trend was statistically significant ($P < 0.05$, on the basis of the statistical significance of the AAPC compared to zero). For non-statistically significant trends ($P > 0.05$, while AAPC with a 95%CI including zero), the terms “non-statistically significant increase” (for AAPC $> 0.5\%$), and “non-statistically significant decrease” (for AAPC $< -0.5\%$) were used, while the term “stable” was used for AAPC between -0.5% and 0.5% . Disparities in suicide mortality trends according to age and sex were tested by using a comparability test[20]. The objective of the comparability test was to determine whether the two regression mean functions were identical (test of coincidence) or parallel (test of parallelism). A P -value < 0.05 was considered statistically significant.

Ethics statement

This study was approved by the Ethics Committee of the Faculty of Medical Sciences, University of Kragujevac (No. 01-14321).

RESULTS

A total of 759028 (523883 male and 235145 female) suicide deaths were reported worldwide in 2019 (Figure 1). Per annum, the number of suicides ranged from 839548 in 2000 to 742962 in 2015. During the observed period, there were 15.7 million deaths from suicide in the world (10.6 million men and 5.1 million women). Figure 2 shows the global distribution of suicide deaths in 2019 by WHO regions and by sex. In both sexes, most suicide deaths (230453; 31% of the total) were recorded in the South-East Asia region, followed by the region of the Western Pacific (184918; 24%). Almost one fifth of suicide deaths (137266) occurred in the European region. Compared to the distribution for both sexes, the differences in suicide deaths by regions in males are less obvious. In contrast, in females the dominant participation of suicides is evident in the region of South-East Asia (93552; 40% of the total). The female participation in suicide deaths in the European region was twice as low (29008; 12%) compared to men (108268; 21%).

The global ASR of mortality from suicide was 9.0/100000 population in both sexes (Figure 3). The highest rates were found in the region of Africa (11.2/100000), followed by Europe (10.5), South-East Asia (10.2), the Americas (9.0) and Western Pacific (7.2), while the lowest rates were reported in the Eastern Mediterranean (6.4). The global ASR of suicide mortality in 2019 was more than a two-fold higher in males than in females (12.6 in men *vs* 5.4 in women). Suicide mortality in men was the highest in Africa (18.0) and Europe (17.1). The region of South-East Asia (with a rate of 8.1) tended to predominate in the suicide mortality of women across the world. In 2019, the lowest suicide mortality rates in both sexes in 2019 were noted in the Eastern Mediterranean region (9.2 and 3.5, respectively).

There were significant international variations in suicide mortality by sex in 2019 (Figure 4). In men, the suicide mortality rate was the highest in Lesotho (146.9/100000), followed by populations in Eswatini, Guyana, Kiribati (with rates of 78.7, 65.0 and 53.6, respectively), whereas the lowest mortality rates (1.0 or less per 100000 people) were registered in Barbados, Grenada, Antiqua and Barbuda (Figure 4A). Also, there was a great variation in suicide mortality in women across countries: The highest mortality rate was in Lesotho (34.6), followed by populations in Guyana (17.0), and then Zimbabwe, Republic of Korea, Federal States of Micronesia (equally about 13.0/100000 people), while the lowest mortality rate (0.2/100000 people) was observed in Barbados (Figure 4B).

Globally, from 2000 to 2019, ASRs of mortality of suicide had a decreasing tendency in both sexes together [AAPC = -2.4% per year; 95%CI: (-2.6) - (-2.3)] (Figure 5A). Overall suicide mortality rates peaked at 14.0/100000 in 2000, and declined thereafter to 9.0/100000 in 2019. Joinpoint analysis identified two joinpoints, in 2009 and 2016, with three consequent trends. The first and second period showed significantly decreasing trends, with APC of -2.2% [95%CI: (-2.5) - (-2.0)] and -3.0% [95%CI: (-3.4) - (-2.5)], respectively. The trend since 2016 was stable, with APC of -0.5% [95%CI: (-1.9) - 0.9]. Suicide mortality rates in males decreased from 18.9/100000 in 2000 to 12.6/100000 in the last year observed; AAPC = -2.2% , 95%CI: (-2.3) - (-2.1) (Figure 5B). Joinpoint analyses of suicide mortality in males identified two joinpoints in the year 2005 and 2016, with three trends. The first and second period showed significantly decreasing trends, with APC of -1.4% [95%CI: (-2.0) - (-0.9)] and -2.5% [95%CI: (-2.7) - (-2.3)], respectively. The trend since 2016 was characterized by a non-significant decrease, with APC

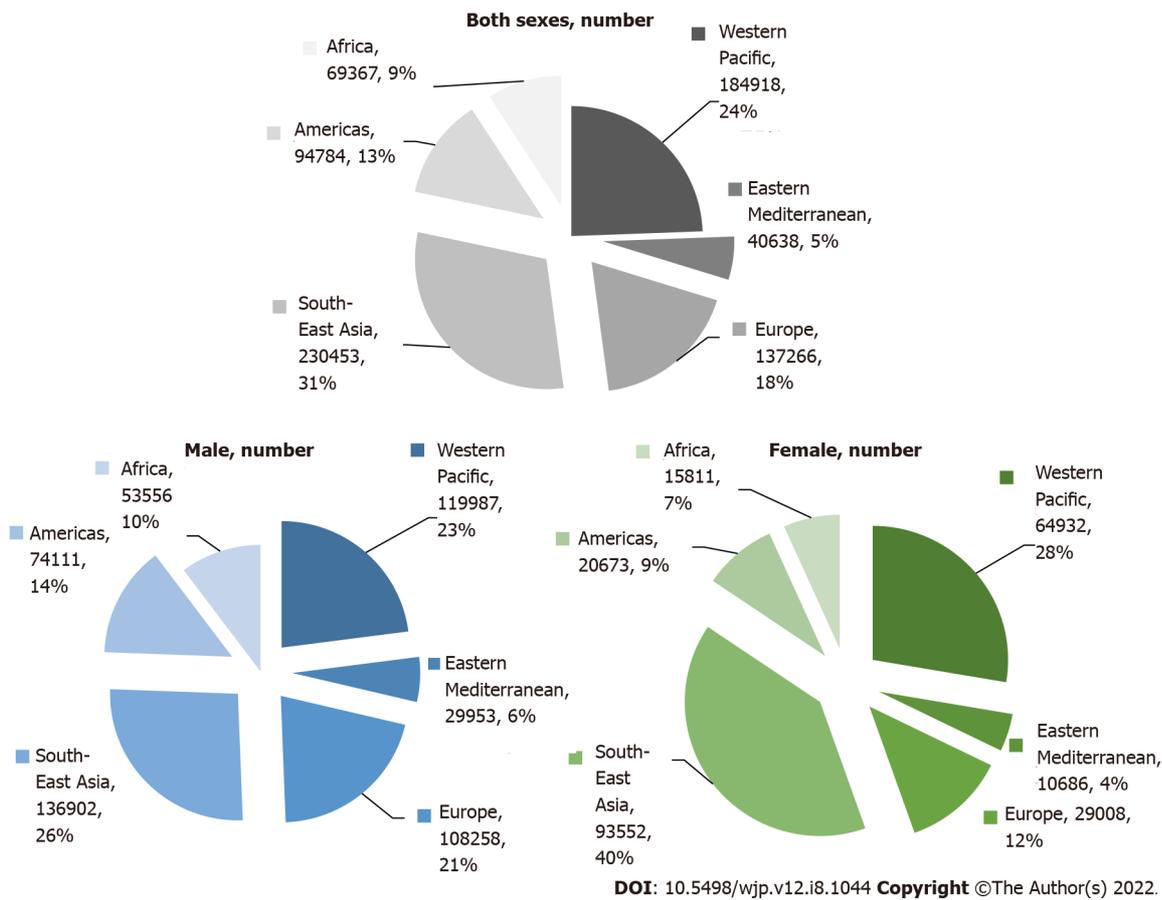


Figure 2 Number of suicide (global and by World Health Organization regions), by sex, 2019. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

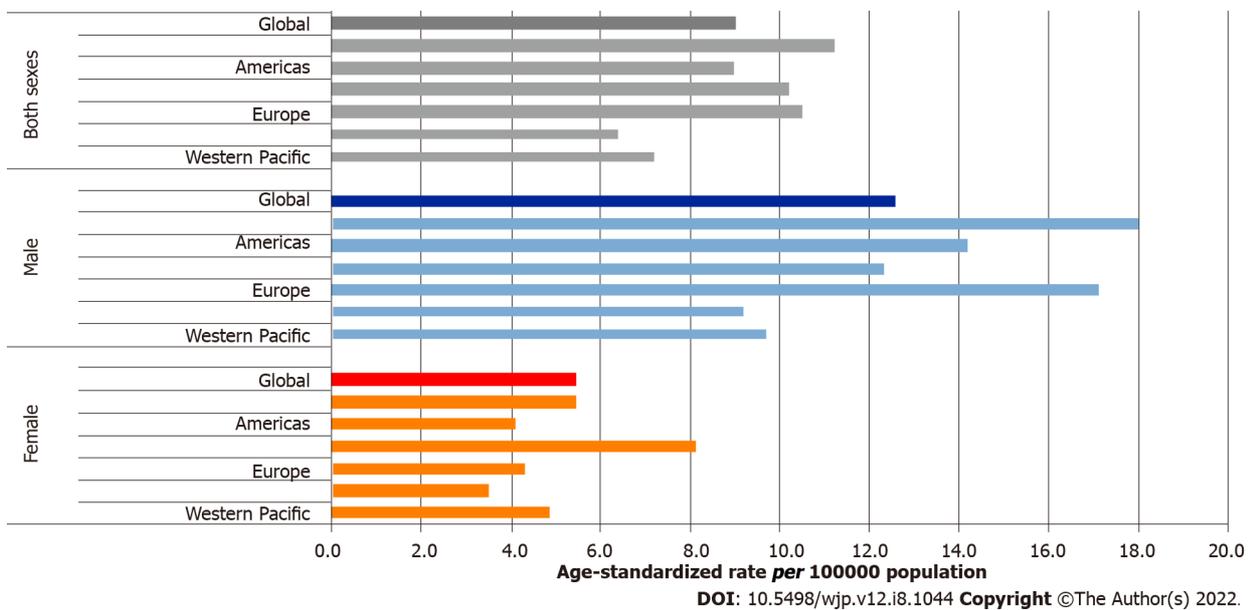


Figure 3 Age-standardized suicide mortality rates (global and by World Health Organization regions), by sex, 2019. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

of -1.3% [95%CI: (-2.6)-0.0]. In females, suicide mortality rates decreased from 9.5/100000 in 2000 to 5.4/100000 in the last year observed; AAPC = -3.0%, 95%CI: (-3.2)-(-2.8). Also, joinpoint analyses of suicide mortality in females identified two joinpoints in the year 2011 and 2016, with three trends. The first and second period showed significantly decreasing trends, with APC of -3.0% [95%CI: (-3.3)-(-2.7)]

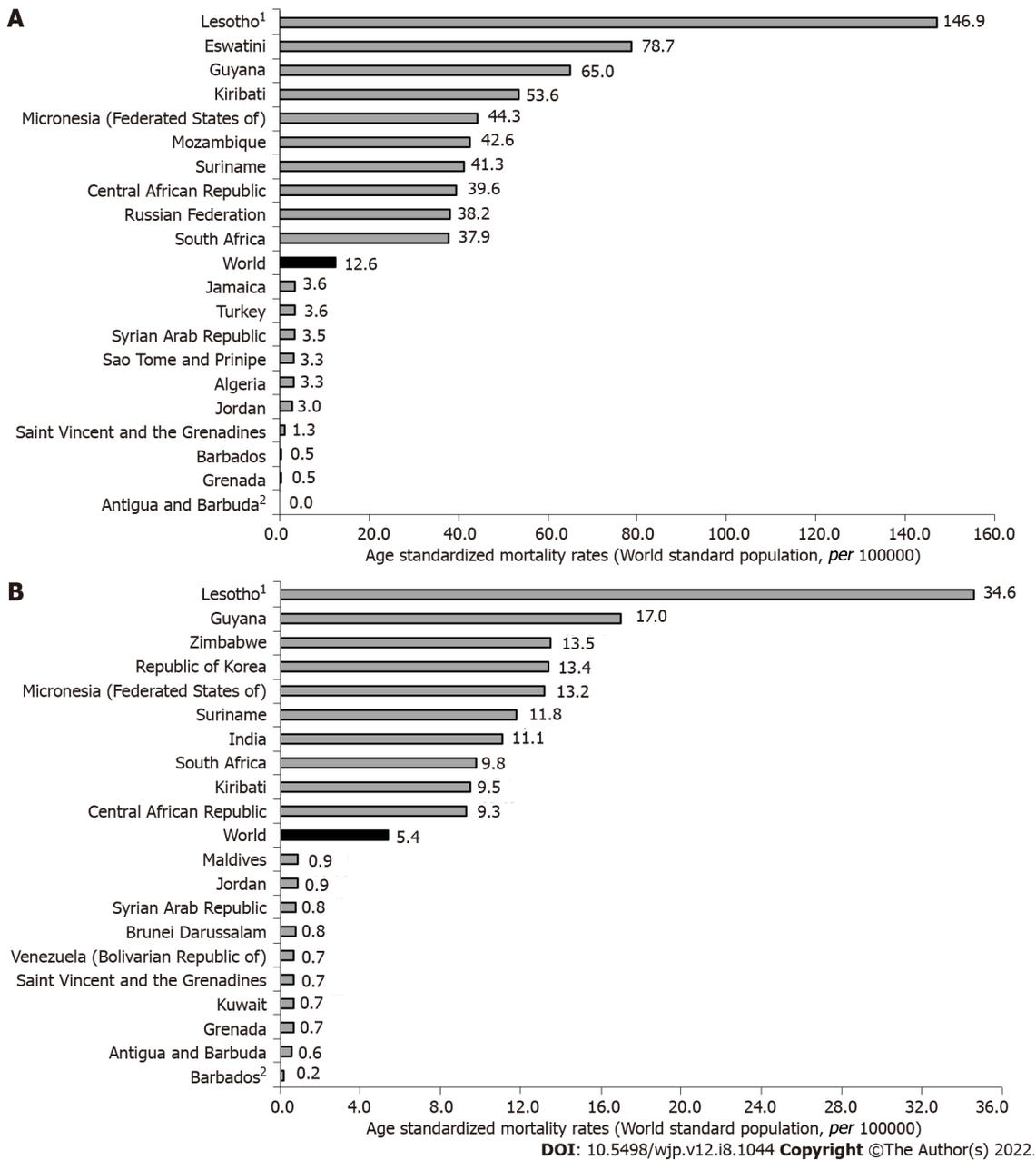
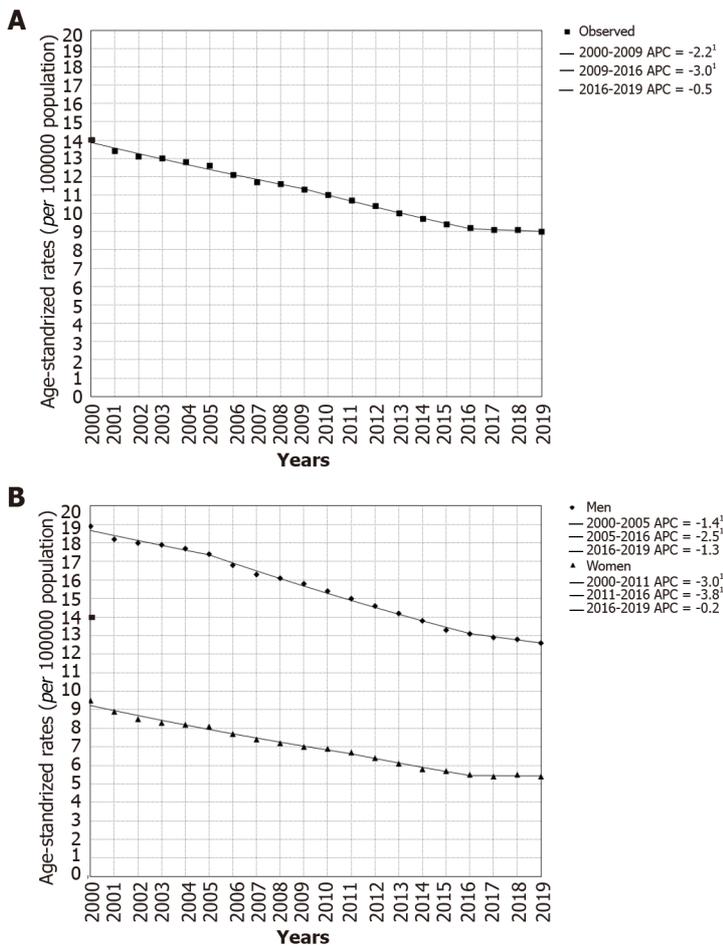


Figure 4 Suicide mortality, by countries, 2019. ¹Country with the highest rates; ²Country with the lowest rate. A: Men; B: Women. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

and -3.8% [95%CI: (-5.2)-(-2.4)], respectively. The trend since 2016 was stable, with APC of -0.2% [95%CI: (-2.5)-2.2]. The trends in suicide mortality in men and women were not parallel and not coincident according to the comparability test ($P < 0.05$).

When the suicide mortality trend was analyzed by six WHO regions, in males (Figure 6A) significantly decreasing trends were observed in five regions: In Africa (AAPC = -1.5%), South-East Asia (-2.1%), Europe (-3.4%), Eastern Mediterranean (-0.6%), and Western Pacific (-2.9%); the only exception was the region of the Americas, with a significantly increasing suicide mortality trend (+0.6%). Also, significantly decreasing trends were noted in women in five regions: In Africa (-2.3%), South-East Asia (-2.4%), Europe (-2.3%), Eastern Mediterranean (-1.7%), and Western Pacific (-5.1%); the only exception was the region of the Americas, with an unfavorable suicide mortality trend (+1.2%) (Figure 6B).

In comparison to males, suicide mortality rates were lower in females in countries across the world in 2019: The only exception was for females in Grenada and Antigua and Barbuda in whom suicide mortality rates higher than in men were recorded (Table 1). In both sexes together, a total of 133 of 183 countries showed a significantly decreasing trend in suicide mortality. Among the 133 countries where a decline in mortality of suicide was observed, Barbados (AAPC = -10.0%), Grenada (AAPC = -8.5%), Serbia (AAPC = -7.6%), and Venezuela (AAPC = -6.2%) had the most marked reductions. In total, 26 countries had a significant increase in mortality of suicide and 24 countries reported stable trends. Out



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Figure 5 Joinpoint regression analysis of global suicide mortality. ¹Indicates that the Annual Percent Change is significantly different from zero at the alpha = 0.05 level. Final selected model: 2 joinpoints. A: Both sexes, 2019: 2 joinpoints; B: By sex, 2019: Men: 2 joinpoints vs women: 2 joinpoints. APC: Annual percent change. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

of all 26 countries with a rise in suicide mortality, Lesotho (AAPC = +6.0%), Cyprus (AAPC = +5.1%), Paraguay (AAPC = +3.0%), Saudi Arabia (AAPC = +2.8%), Brunei (AAPC = +2.6%), Greece (AAPC = +2.6%), Georgia (AAPC = +2.1%), and Mexico (AAPC = +2.0%), were among those with the highest increase in mortality. Other countries with an increasing trend were (in alphabetical order) Bahamas, Brazil, Dominican Republic, Guinea, Guyana, Jamaica, Micronesia, Mozambique, Netherlands, Niger, Papua New Guinea, Philippines, Syria, Tajikistan, United States of America, Uruguay, Viet Nam and Zimbabwe.

Trends in suicide mortality were increasing significantly in both sexes in several countries - Brazil, Dominican Republic, Greece, Guinea, Jamaica, Lesotho, Mexico, Micronesia, the Netherlands, Papua New Guinea, Paraguay, Philippines, Saudi Arabia, Solomon Islands, Tajikistan, and United States of America. Some countries have shown a significant increase in suicide mortality trends only in females - Australia, Canada, Equatorial Guinea, Nepal, Portugal, and Sierra Leone. On the other hand, several countries showed a significant increase in suicide mortality trends only among men - in Bahamas, Cyprus, Georgia, Haiti, Iraq, Lebanon, Mozambique, Niger, and Syria.

Suicide death rates increased with age both in males and females (Table 2). In both sexes, suicide mortality rates were almost three times higher in people aged 70 or older than in people under 70. Age-specific suicide mortality rates in males were two to three times higher than rates in females in all age groups, with only one exception for males and females in younger age groups of 10-19 years. Suicide mortality rates were decreasing significantly in all age groups in both men and women from 2000 to 2019. The trends in suicide mortality by age were not parallel and not coincident according to comparability test ($P < 0.05$) in either sex.

DISCUSSION

This study presents global, regional and national trends in suicide mortality in 183 countries worldwide

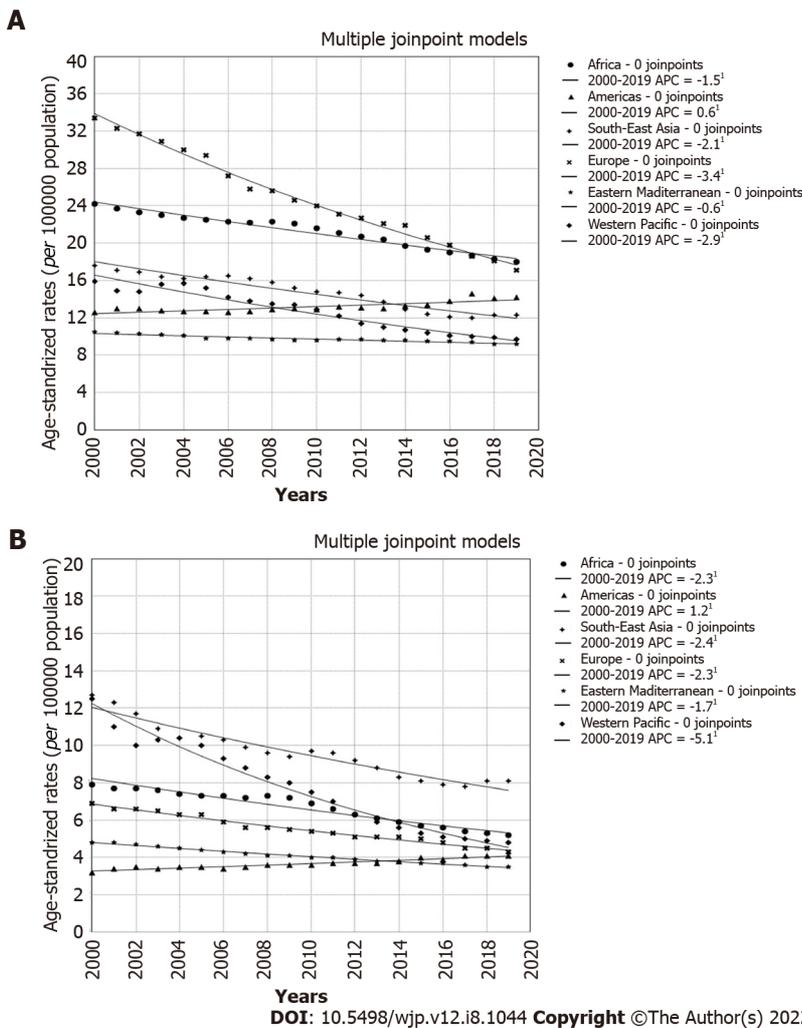


Figure 6 Suicide mortality trends (World Health Organization regions), 2000-2019; a joinpoint analysis. ¹Statistically significant trend. A: In males; B: In females. APC: Annual percent change. Source: World Health Organization[6] and Global Burden of Disease estimates[7].

over the last two decades. Although a decrease in suicide mortality trends was seen in both sexes and in all age groups in most of the areas, increasing suicide mortality trends were reported in 26 countries. Worldwide, an estimated 759028 deaths from suicide occurred in 2019, with an ASR of 9.0/100000 people. Globally, compared to 2000, in 2019 there were approximately 80000 fewer deaths from suicides (less by about 18000 cases in males and about 62000 cases in females). In males, the decrease in number of total suicide deaths can be primarily attributed to the decrease in suicide deaths among men in the European region (from 153973 cases, *i.e.*, with a share of 28.4% in the total number of suicides among men in 2000 to 108258 deaths - 20.7% in 2019). In females, the decrease in number of total suicide deaths can be primarily attributed to the decrease in suicide deaths among women in the Western Pacific region (with 112377 cases, *i.e.*, with a share of 37.8% in the total number of suicides among women in 2000 to 64932 deaths by suicide - 27.6% in 2019).

Mortality rates from suicide were approximately 2.5 times higher in men than in women in 2019 (12.5/100000 men and 5.4/100000 women). In males in 2019, the regions of Africa (18.0/100000), Europe (17.1) and Americas (14.2) had suicide mortality rates which were higher than the global average. In females in 2019, only the South-East Asia region (8.1/100000) had suicide rates which were higher than the global average. For both men and women, the countries of the African region were ranked in the 3 leading places among the countries with the highest suicide rate in the world in 2019. These findings are consistent with previous research[3,8,9,21-25]: Men had higher rates of suicide at all time points, for all age groups. Divergence in male and female suicide rates could be due to the changes in availability and lethality of commonly used methods of suicide: Domestic gas poisoning was the most commonly used method of suicide in males, while in females drug overdose dominated as the method for suicide (an explanation of this trend could be replacement of barbiturates by the less toxic benzodiazepines which usually result in lower lethality, *etc*)[23,24]. In Canada[21] and in 16 countries participating in the European Alliance Against Depression[26], hanging was the most prevalent method of suicide in both males (followed by firearms and poisoning by drugs) and females (followed by poisoning by drugs and jumping from a high place). In the Republic of Korea, from 1991 to 2015, with a traditionally high rate of

Table 1 Suicide mortality trends, by countries and sex, 2000-2019; a joinpoint analysis: Age-standardized rates (per 100000 population, world standard population)[6,7]

Countries ¹	Both sexes			Male			Female		
	2000	2019	Trend ²	2000	2019	Trend ²	2000	2019	Trend ²
Afghanistan	7.7	6.0	-1.8 ^a	7.6	6.2	-1.7 ^a	7.8	5.7	-2.1 ^a
Albania	5.2	3.7	-2.0	7.6	5.3	-2.0 ^a	2.9	2.2	-2.0
Algeria	4.7	2.6	-3.4 ^a	5.9	3.3	-3.3 ^a	3.5	1.9	-3.4 ^a
Angola	17.6	12.6	-2.1 ^a	30.0	21.7	-2.0 ^a	6.2	4.7	-2.0 ^a
Antigua	2.0	0.3	-	4.5	0.0	-	0.0	0.6	-
Argentina	9.2	8.1	-0.7 ^a	16.0	13.5	-0.8 ^a	3.4	3.3	-0.6
Armenia	3.3	2.7	-0.3	5.5	4.9	-0.2	1.7	1.0	-0.3
Australia	11.8	11.3	+0.6	18.8	17.0	+0.2	5.0	5.6	+1.6 ^a
Austria	15.8	10.4	-1.8 ^a	24.9	16.6	-1.9 ^a	7.9	4.6	-2.1 ^a
Azerbaijan	3.4	4.0	-0.1	5.8	6.6	-0.1	1.3	1.5	-0.5
Bahamas	2.5	3.4	+1.5 ^a	4.2	5.8	+1.6 ^a	1.1	1.2	+0.1
Bahrain	7.0	7.2	-1.9 ^a	10.2	9.9	-2.1 ^a	2.5	2.3	-2.4 ^a
Bangladesh	6.9	3.9	-3.5 ^a	10.0	6.0	-3.1 ^a	3.5	1.7	-4.3 ^a
Barbados	2.6	0.3	-10.0 ^a	4.9	0.5	-8.7 ^a	0.5	0.2	-
Belarus	37.3	16.5	-4.7 ^a	69.3	30.1	-4.8 ^a	9.5	5.3	-3.5 ^a
Belgium	18.3	13.9	-1.3 ^a	27.0	19.6	-1.6 ^a	10.1	8.4	-0.6 ^a
Belize	10.0	7.7	-0.9 ^a	17.2	13.6	-0.7	2.9	1.8	-2.6 ^a
Benin	14.7	12.7	-0.8 ^a	23.6	20.3	-0.8 ^a	7.5	6.1	-1.1 ^a
Bhutan	6.9	5.1	-1.6 ^a	8.6	6.8	-1.2 ^a	5.0	3.1	-2.6 ^a
Bolivia	8.4	6.8	-0.7 ^a	11.8	9.6	-0.8 ^a	5.2	4.2	-0.7 ^a
Bosnia and Herzegovina	8.1	8.3	-0.3	13.3	13.5	-0.3	3.5	3.4	-0.3 ^a
Botswana	46.3	20.2	-4.4 ^a	76.2	35.5	-4.0 ^a	20.6	7.8	-5.3 ^a
Brazil	4.5	6.4	+1.6 ^a	7.4	10.3	+1.5 ^a	1.8	2.8	+2.0 ^a
Brunei	1.7	2.5	+2.6 ^a	3.0	4.2	+1.9	0.4	0.8	-
Bulgaria	14.0	6.5	-3.9 ^a	21.8	10.6	-3.7 ^a	7.1	2.9	-4.5 ^a
Burkina Faso	16.9	14.4	-0.5 ^a	27.6	24.5	-0.2 ^a	9.2	6.5	-1.6 ^a
Burundi	23.4	12.1	-3.3 ^a	35.5	18.9	-3.0 ^a	13.6	6.4	-4.1 ^a
Cabo Verde	18.2	15.2	-0.8 ^a	33.3	27.4	-1.1 ^a	6.8	5.1	-1.3 ^a
Cambodia	6.8	5.5	-1.2 ^a	9.2	8.4	-0.5 ^a	5.0	3.1	-2.7 ^a
Cameroon	19.1	15.9	-1.2 ^a	29.8	25.2	-1.1 ^a	9.7	7.6	-1.5 ^a
Canada	10.7	10.3	+0.1	16.6	15.3	-0.1	5.0	5.4	+0.8 ^a
Central African Republic	32.5	23.0	-1.2 ^a	53.7	39.6	-1.0 ^a	14.6	9.3	-2.1 ^a
Chad	15.7	13.2	-0.9 ^a	24.8	20.2	-1.1 ^a	7.7	6.9	-0.4 ^a
Chile	10.5	8.0	-1.1 ^a	19.0	13.4	-1.5 ^a	2.9	3.0	+0.4
China	14.9	6.7	-4.5 ^a	15.5	8.6	-3.4 ^a	14.5	4.8	-6.0 ^a
Colombia	5.3	3.7	-1.5 ^a	8.4	6.0	-1.3 ^a	2.6	1.7	-2.4 ^a
Comoros	10.9	8.5	-1.1 ^a	14.5	11.3	-1.0 ^a	7.6	5.8	-1.3 ^a
Congo	24.7	11.6	-3.4 ^a	38.5	18.3	-3.4 ^a	14.1	6.1	-3.7 ^a
Costa Rica	6.9	7.6	-0.4	12.3	13.3	-0.6	1.6	1.9	+0.4

Côte d'Ivoire	24.0	15.7	-1.9 ^a	37.5	25.7	-1.6 ^a	8.4	5.0	-2.3 ^a
Croatia	16.3	11.0	-2.0 ^a	27.1	17.7	-2.1 ^a	6.9	5.1	-1.7 ^a
Cuba	15.6	10.2	-1.5 ^a	22.7	16.7	-1.0 ^a	8.9	4.1	-3.3 ^a
Cyprus	1.9	3.2	+5.1 ^a	2.6	5.3	+6.3 ^a	1.2	1.1	+0.6
Czechia	13.4	9.5	-1.2 ^a	22.6	15.4	-1.5 ^a	5.1	3.8	-0.8 ^a
DPR Korea	10.3	8.2	-0.7 ^a	12.3	10.6	-0.2	8.9	6.3	-1.4 ^a
DR Congo	14.5	12.4	-1.0 ^a	24.9	20.7	-1.1 ^a	5.7	5.0	-1.0 ^a
Denmark	12.5	7.6	-2.3 ^a	18.9	11.1	-2.3 ^a	6.4	4.2	-2.3 ^a
Djibouti	12.1	11.9	+0.1	17.1	16.3	-0.2	7.5	7.6	+0.2
Dominican Republic	4.9	5.1	+1.1 ^a	8.3	8.5	+1.1 ^a	1.6	1.9	+1.3 ^a
Ecuador	6.8	7.7	+0.2	9.6	11.9	+0.8	4.2	3.6	-1.3 ^a
Egypt	3.6	3.4	-0.3	4.7	4.7	+0.2	2.7	2.2	-1.1 ^a
El Salvador	6.7	6.1	-0.9	10.6	11.1	-0.4	3.4	2.1	-2.4 ^a
Equatorial Guinea	19.4	13.5	-0.9 ^a	31.0	18.5	-1.7 ^a	7.8	8.8	+1.3 ^a
Eritrea	23.4	17.3	-1.3 ^a	38.4	27.2	-1.5 ^a	9.6	8.3	-0.5 ^a
Estonia	25.0	12.0	-3.8 ^a	43.1	20.2	-4.0 ^a	9.6	4.5	-3.2 ^a
Eswatini	40.6	40.5	-0.8	65.5	78.7	+0.4	20.9	6.4	-7.5 ^a
Ethiopia	18.4	9.5	-3.8 ^a	25.9	14.2	-3.3 ^a	11.2	5.2	-4.6 ^a
Fiji	11.7	9.5	-0.6 ^a	15.3	13.1	-0.2	8.2	6.0	-1.4 ^a
Finland	21.7	13.4	-2.5 ^a	33.3	20.1	-2.7 ^a	10.4	6.8	-2.1 ^a
France	15.8	9.7	-2.6 ^a	24.2	15.2	-2.3 ^a	8.3	4.5	-3.3 ^a
Gabon	19.4	13.1	-1.5 ^a	33.2	23.3	-1.2 ^a	7.5	3.8	-3.4 ^a
Gambia	11.1	9.6	-0.9 ^a	15.3	13.3	-1.0 ^a	7.1	6.2	-0.8 ^a
Georgia	6.6	7.7	+2.1 ^a	11.9	14.0	+2.3 ^a	2.2	2.2	+0.3
Germany	11.2	8.3	-1.4 ^a	17.6	12.8	-1.6 ^a	5.3	3.9	-1.3 ^a
Ghana	9.8	10.5	+0.3	17.2	20.0	+0.7	2.9	1.8	-3.0 ^a
Greece	2.9	3.6	+2.6 ^a	4.6	5.9	+2.5 ^a	1.2	1.5	+3.4 ^a
Grenada	2.1	0.6	-8.5 ^a	3.8	0.5	-	0.6	0.7	-
Guatemala	13.5	6.2	-5.5 ^a	24.0	10.3	-6.0 ^a	4.1	2.5	-3.4 ^a
Guinea	9.7	12.3	+1.6 ^a	13.7	18.4	+1.9 ^a	6.7	8.0	+1.3 ^a
Guinea-Bissau	17.5	12.4	-1.6 ^a	28.7	19.8	-1.8 ^a	8.8	6.7	-1.3 ^a
Guyana	35.8	40.9	+0.5 ^a	57.6	65.0	+0.5	14.5	17	+0.4
Haiti	12.7	11.2	-0.4 ^a	14.7	14.9	+0.5 ^a	11.1	8.0	-1.5 ^a
Honduras	3.0	2.6	+0.2	5.1	4.4	+0.3	1.1	1.0	-0.8 ^a
Hungary	26.6	11.8	-3.7 ^a	44.7	19.1	-3.9 ^a	11.0	5.5	-3.1 ^a
Iceland	12.7	11.2	-0.2	19.3	18.7	+0.6	6.0	3.5	-3.1 ^a
India	19.1	12.9	-2.3 ^a	20.9	14.7	-2.2 ^a	17.4	11.1	-2.4 ^a
Indonesia	3.8	2.6	-2.2 ^a	5.5	4.0	-2.0 ^a	2.1	1.2	-3.1 ^a
Iran	8.0	5.1	-1.5 ^a	10.1	7.5	-0.3	5.9	2.8	-3.7 ^a
Iraq	5.3	4.7	+0.0	7.2	7.3	+0.6 ^a	3.4	2.4	-1.3 ^a
Ireland	12.1	8.9	-1.4 ^a	19.8	14.3	-1.4 ^a	4.4	3.6	-1.1 ^a
Israel	6.8	5.2	-1.4 ^a	11.0	8.3	-1.5 ^a	2.8	2.1	-1.3 ^a
Italy	5.5	4.3	-0.8 ^a	8.7	6.7	-0.9 ^a	2.7	2.1	-0.9 ^a

Jamaica	2.1	2.3	+1.1 ^a	3.3	3.6	+1.0 ^a	0.9	1.0	+1.3 ^a
Japan	18.1	12.2	-1.9 ^a	26.8	17.5	-2.2 ^a	9.6	6.9	-1.4 ^a
Jordan	3.5	2.0	-3.4 ^a	4.5	3.0	-2.5 ^a	2.4	0.9	-6.0 ^a
Kazakhstan	39.4	18.1	-4.2 ^a	71.7	30.9	-4.5 ^a	11.4	6.9	-2.9 ^a
Kenya	15.8	11.0	-1.7 ^a	24.8	18.1	-1.5 ^a	8.2	5.3	-2.0 ^a
Kiribati	35.6	30.6	-0.6 ^a	62.6	53.6	-0.6 ^a	11.1	9.5	-0.6 ^a
Kuwait	3.1	2.7	-0.9 ^a	4.1	3.8	-0.3	1.5	0.7	-4.5 ^a
Kyrgyzstan	17.6	8.3	-3.5 ^a	30.7	13.5	-3.8 ^a	5.5	3.5	-1.9 ^a
Lao PDR	8.7	6.0	-2.0 ^a	11.0	8.6	-1.3 ^a	6.5	3.5	-3.5 ^a
Latvia	29.6	16.1	-3.0 ^a	54.3	29.0	-3.0 ^a	9.4	4.6	-3.9 ^a
Lebanon	3.0	2.8	-0.2	3.7	3.9	+0.6 ^a	2.4	1.7	-1.8 ^a
Lesotho	42.6	87.5	+6.0 ^a	73.9	146.9	+5.7 ^a	16.0	34.6	+6.1 ^a
Liberia	8.8	7.4	-0.7 ^a	11.0	9.4	-0.6 ^a	6.7	5.5	-0.7 ^a
Libya	5.3	4.5	+0.1	7.1	6.1	+0.2	3.3	2.9	+0.3
Lithuania	45.8	20.2	-3.4 ^a	80.7	36.1	-3.4 ^a	15.3	6.2	-3.4 ^a
Luxembourg	13.4	8.6	-2.8 ^a	20.3	11.8	-3.6 ^a	7.1	5.4	-1.2
Madagascar	10.8	9.2	-1.0 ^a	15.5	13.3	-0.9 ^a	6.1	5.4	-0.8 ^a
Malawi	19.2	10.6	-2.4 ^a	31.8	20.0	-1.8 ^a	8.4	3.3	-4.1 ^a
Malaysia	6.1	5.8	-0.5 ^a	9.1	9.0	-0.3	3.1	2.4	-1.3 ^a
Maldives	5.3	2.8	-3.1 ^a	8.1	4.1	-3.4 ^a	2.3	0.9	-4.9 ^a
Mali	8.8	8.0	-0.4 ^a	10.6	10.5	+0.0	7.2	5.7	-1.0 ^a
Malta	6.0	5.3	+0.2	9.8	8.4	+0.5	2.4	2.3	-0.6
Mauritania	6.4	5.5	-0.8 ^a	8.2	7.4	-0.6 ^a	4.9	3.9	-1.2 ^a
Mauritius	11.5	8.8	-0.8	18.4	15.0	-0.5	4.9	2.5	-2.1 ^a
Mexico	3.9	5.3	+2.0 ^a	6.9	8.7	+1.7 ^a	1.1	2.2	+3.6 ^a
Micronesia	28.0	29.0	+0.3 ^a	43.4	44.3	+0.2 ^a	13.0	13.2	+0.3 ^a
Mongolia	23.6	18.0	-1.5 ^a	37.6	31.1	-1.1 ^a	10.2	5.6	-2.8 ^a
Montenegro	18.9	16.2	-0.8 ^a	28.9	25.4	-0.7 ^a	9.8	7.9	-1.1 ^a
Morocco	10.8	7.3	-2.3 ^a	13.9	10.1	-2.0 ^a	8.0	4.7	-2.8 ^a
Mozambique	20.9	23.2	+0.9 ^a	36.2	42.6	+1.2 ^a	8.8	8.9	+0.6
Myanmar	5.1	3.0	-2.8 ^a	8.1	5.1	-2.2 ^a	2.6	1.1	-5.0 ^a
Namibia	27.5	13.5	-4.1 ^a	47.5	24.9	-3.9 ^a	11.4	4.4	-4.8 ^a
Nepal	10.9	9.8	-0.3	19.4	18.6	+0.2	2.8	2.9	+0.5 ^a
Netherlands	8.1	9.3	+1.1 ^a	11.2	12.5	+0.9 ^a	5.2	6.1	+1.3 ^a
New Zealand	12.4	10.3	-0.9 ^a	20.8	15.4	-1.2 ^a	4.4	5.4	+0.0
Nicaragua	6.3	4.7	-1.7 ^a	9.3	7.8	-1.5 ^a	3.6	1.9	-2.4 ^a
Niger	9.5	10.1	+0.3 ^a	12.6	14.1	+0.6 ^a	6.7	6.4	-0.2 ^a
Nigeria	9.2	6.9	-1.7 ^a	13.7	10.1	-1.7 ^a	5.1	3.8	-2.0 ^a
North Macedonia	8.7	7.2	-1.6 ^a	12.5	11.0	-1.5 ^a	4.9	3.5	-1.9 ^a
Norway	13.0	9.9	-1.0 ^a	19.9	13.4	-1.5 ^a	6.1	6.3	+0.1
Oman	6.7	4.5	-2.5 ^a	10.1	6.4	-2.9 ^a	2.0	1.1	-3.1 ^a
Pakistan	11.1	9.8	-0.8 ^a	16.1	14.6	-0.7 ^a	5.7	4.8	-1.2 ^a
Panama	5.9	2.9	-4.4 ^a	10.4	4.8	-4.5 ^a	1.5	1.0	-3.6 ^a

Papua New Guinea	2.8	3.6	+1.1 ^a	4.4	5.2	+0.9 ^a	1.4	1.9	+1.4 ^a
Paraguay	3.6	6.2	+3.0 ^a	4.8	9.0	+3.5 ^a	2.5	3.3	+1.5 ^a
Peru	3.4	2.7	-0.8 ^a	4.6	4.1	-0.2	2.4	1.4	-2.3 ^a
Philippines	2.3	2.5	+1.4 ^a	3.5	3.9	+1.6 ^a	1.1	1.3	+1.5 ^a
Poland	15.3	9.3	-1.9 ^a	26.8	16.5	-1.8 ^a	4.7	2.4	-2.9 ^a
Portugal	5.5	7.2	+0.4	9.5	11.6	+0.1	2.1	3.5	+1.3 ^a
Qatar	7.6	4.7	-2.8 ^a	10.0	5.7	-3.3 ^a	2.6	1.7	-2.1 ^a
Republic of Korea	13.9	21.2	+1.1	20.4	29.7	+1.0	8.2	13.4	+1.0
Moldova	16.3	12.2	-1.9 ^a	30.7	22.1	-2.0 ^a	4.2	3.3	-2.0 ^a
Romania	11.3	7.3	-2.1 ^a	19.4	12.6	-2.1 ^a	3.7	2.4	-2.4 ^a
Russian Federation	48.9	21.6	-4.1 ^a	88.8	38.2	-4.3 ^a	13.4	7.2	-3.1 ^a
Rwanda	25.6	9.5	-4.9 ^a	38.8	14.8	-4.7 ^a	14.0	5.0	-5.2 ^a
Saint Lucia	8.1	6.9	-0.4	14.5	12.5	-0.4	2.1	1.5	-1.1 ^a
Saint Vincent	6.5	1.0	-	12.6	1.3	-	0.5	0.7	-
Samoa	16.3	14.6	-0.5 ^a	24.1	20.9	-0.7 ^a	7.8	7.8	+0.2
Sao Tome and Principe	2.2	2.2	-0.2	3.2	3.3	-0.1	1.4	1.2	-0.8 ^a
Saudi Arabia	3.8	5.4	+2.8 ^a	5.7	7.8	+2.6 ^a	1.4	1.9	+3.2 ^a
Senegal	14.4	11.0	-1.3 ^a	23.5	18.5	-1.1 ^a	6.8	5.2	-1.2 ^a
Serbia	18.9	7.9	-7.6 ^a	29.0	12.2	-8.1 ^a	10.1	3.9	-6.9 ^a
Seychelles	9.8	7.7	-1.2 ^a	18.4	14.0	-1.5 ^a	1.7	1.3	-1.4 ^a
Sierra Leone	10.1	11.3	+0.2	14.4	14.8	-0.2	6.5	8.2	+0.9 ^a
Singapore	11.4	9.7	-2.0 ^a	15.2	12.7	-1.9 ^a	7.8	6.4	-2.7 ^a
Slovakia	12.6	9.3	-1.8 ^a	21.9	16.7	-1.7 ^a	4.3	2.6	-2.2 ^a
Slovenia	25.6	14.0	-3.4 ^a	40.4	22.7	-3.3 ^a	12.6	5.5	-4.2 ^a
Solomon Islands	17.4	17.4	+0.3	32.0	32.2	+0.3 ^a	2.1	2.4	+1.3 ^a
Somalia	16.8	14.7	-0.8 ^a	26.0	22.8	-0.8 ^a	7.9	7.1	-0.5 ^a
South Africa	26.6	23.5	-0.8 ^a	42.7	37.9	-0.6 ^a	11.6	9.8	-1.5 ^a
South Sudan	7.9	6.7	-0.9 ^a	12.4	10.4	-1.0 ^a	3.9	3.4	-0.8 ^a
Spain	6.6	5.3	-0.8 ^a	10.5	7.9	-1.1 ^a	3.0	2.8	+0.0
Sri Lanka	27.4	12.9	-3.7 ^a	41.5	20.9	-3.3 ^a	14	6.1	-3.9 ^a
Sudan	5.6	4.8	-0.8 ^a	7.2	6.3	-0.7 ^a	4.0	3.3	-0.9 ^a
Suriname	25.0	25.9	-0.3 ^a	38.8	41.3	-0.2	11.8	11.8	-0.1
Sweden	12.2	12.4	+0.1	17.1	16.9	-0.1	7.5	7.7	+0.4
Switzerland	15.9	9.8	-2.8 ^a	23.7	14.2	-2.7 ^a	8.6	5.7	-3.0 ^a
Syria	2.0	2.1	+0.5 ^a	3.2	3.5	+0.7 ^a	0.9	0.8	+0.1
Tajikistan	5.1	5.3	+0.7 ^a	7.3	7.4	+0.4 ^a	2.9	3.4	+1.5 ^a
Thailand	11.6	8.0	-2.1 ^a	16.4	13.9	-1.2 ^a	7.1	2.3	-5.4 ^a
Timor-Leste	4.9	4.5	-0.2	6.5	6.7	+0.4	3.3	2.4	-1.7 ^a
Togo	17.3	14.8	-1.0 ^a	27.0	24.0	-0.8 ^a	8.6	6.5	-1.7 ^a
Tonga	5.1	4.4	-0.2	6.7	5.9	-0.1	3.6	2.9	-0.5 ^a
Trinidad and Tobago	16.2	8.3	-3.2 ^a	26.4	13.1	-3.5 ^a	6.3	3.7	-1.8 ^a
Tunisia	3.9	3.2	-1.6 ^a	5.2	4.6	-1.1 ^a	2.6	1.8	-2.3 ^a
Turkey	4.2	2.3	-2.9 ^a	6.7	3.6	-3.2 ^a	1.9	1.2	-2.2 ^a

Turkmenistan	13.8	6.1	-5.9 ^a	23.7	9.4	-6.5 ^a	4.6	2.9	-3.6 ^a
Uganda	21.7	10.4	-4.5 ^a	38.6	19.4	-4.2 ^a	8.6	3.7	-5.4 ^a
Ukraine	33.5	17.7	-3.7 ^a	62.7	32.7	-3.8 ^a	8.5	4.7	-3.2 ^a
United Arab Emirates	8.0	5.2	-2.4 ^a	9.3	6.3	-2.3 ^a	4.7	2.6	-3.1 ^a
United Kingdom	7.7	6.9	+0.0	12.0	10.4	-0.1	3.6	3.4	+0.2
Tanzania	15.6	8.2	-3.1 ^a	24.5	13.5	-2.8 ^a	8.1	3.7	-3.7 ^a
United States of America	10.0	14.5	+1.9 ^a	16.4	22.4	+1.6 ^a	4.0	6.8	+2.7 ^a
Uruguay	14.5	18.8	+1.5 ^a	25.7	31.1	+1.4 ^a	5.1	7.7	+1.3 ^a
Uzbekistan	12.0	8.3	-1.5 ^a	19.6	11.8	-2.2 ^a	4.8	4.9	+0.7 ^a
Vanuatu	23.2	21.0	-0.4 ^a	36.0	33.1	-0.3 ^a	10.1	9.0	-0.6 ^a
Venezuela	6.4	2.1	-6.2 ^a	11.3	3.7	-6.2 ^a	1.7	0.7	-5.6 ^a
Viet Nam	7.2	7.2	+0.4 ^a	9.4	10.6	+1.1 ^a	5.2	4.2	-1.0 ^a
Yemen	8.5	7.1	-1.1 ^a	10.5	9.0	-1.0 ^a	6.5	5.3	-1.3 ^a
Zambia	24.0	14.4	-2.2 ^a	35.9	25.7	-1.4 ^a	14.5	5.3	-4.4 ^a
Zimbabwe	20.0	23.6	+1.9 ^a	28.2	37.8	+2.7 ^a	14.2	13.5	+0.8

^aStatistically significant trend ($P < 0.05$).

¹Joinpoint results are not shown for mortality in some countries, because no case of suicide occurred in at least 1 year in the observed period.

²For full period presented average annual percent change.

pesticide suicide, female suicide victims were significantly more often of a lower educational level, unmarried/divorced/widowed and unemployed compared to males[27]. By contrast, studies in South Korea and Japan suggested that female suicide rates were less affected by the economic crisis than rates in males[28,29].

Globally, a substantial decrease in suicide mortality trends was observed both in males and females. But, the region of the Americas experienced a significant increase in suicide mortality in both sexes over 2000-2019, unlike other WHO regions that had a declining trend. Also, a total of 26 countries had an increase in suicide mortality: Although they were mostly less developed countries, there were also several more developed countries such as the United States, Mexico, Brazil, and the Netherlands. The reasons for substantial international differences in suicide mortality rates and trends since 2000 are not completely elucidated. Epidemiological studies suggested an association between suicide and socio-economic instability, particularly poverty, unemployment, limited educational achievement, homelessness, divorce rate, birth rate, female labor force participation, alcohol consumption and general practitioners *per* 100000 people[9,29,30], although these findings were inconsistent[29,31,32]. Also, according to the WHO mortality data, suicide methods between countries and world regions vary considerably: Pesticide poisoning was common in many countries in Asia and Latin America, firearm suicide dominated in the United States, poisoning by drugs was common in both Nordic countries and the United Kingdom, hanging was a common method of suicide in Eastern Europe and China, jumping from a high place in Hong Kong, and suicide by charcoal burning in some East/Southeast Asian countries[33]. Although the importance of suicide methods is not well understood yet, it is considered that suicide method is linked to occupation, mental illness, chronic physical illness accompanied by pain, lower educational level, gun laws, and type of medication prescription.

Significant geographic differences in suicide mortality could be explained by different prevalence of the main risk factors (such as mental and behavioral disorders, chronic pain, alcohol and drug abuse), variations in suicide prevention, medical and other resources and management in health expenditure [34,35]. Studies on suicide by recently discharged mental health patients have reported a high frequency of affective disorder (bipolar disorder and depression), personality disorder, schizophrenia and other delusional disorders, and other primary diagnosis (anxiety disorders, dementia, eating disorders)[34, 35]. Alcohol abuse is among the reasons explaining the very high suicide rates in Russia and the former Russian states; but the 2006 alcohol regulation decreased spirits consumption by 33% in the Russian Federation, and this was reflected in decline in suicides[36].

The implementation of national guidelines for suicide prevention only in some countries might, at least in part, explain the observed international differences in suicide mortality rates and trends[37]. Additionally, variations in suicide mortality within some countries described among certain indigenous groups (such as high death rates in the Aboriginal population in Australia and the Inuit in Canada) can help in better understanding of the epidemiology of suicides[38]. Besides, it is always a question whether the differences in suicide mortality are real or partially mirror differences in quality of data

Table 2 Joinpoint regression analysis: global trends in age-specific suicide mortality rates (per 100000), by sex, 2000-2019

Age ¹	Males			Females		
	Age-specific rates ² (2000)	Age-specific rates ² (2019)	AAPC (95%CI)	Age-specific rates ² (2000)	Age-specific rates ² (2019)	AAPC (95%CI)
10-19	6.7	4.5	-2.0 ^a [(-2.2)-(-1.8)]	6.7	3.8	-3.0 ^a [(-3.2)-(-2.7)]
20-29	21.4	15.7	-1.8 ^a [(-1.9)-(-1.6)]	14.9	7.9	-3.3 ^a [(-3.8)-(-2.8)]
30-39	23.4	17.6	-1.6 ^a [(-1.7)-(-1.5)]	12.6	6.3	-3.6 ^a [(-4.0)-(-3.2)]
40-49	27.6	17.8	-2.6 ^a [(-2.8)-(-2.4)]	11.0	6.4	-2.7 ^a [(-2.9)-(-2.5)]
50-59	31.0	19.6	-2.5 ^a [(-2.6)-(-2.4)]	11.6	7.8	-2.3 ^a [(-2.7)-(-2.0)]
60-69	33.7	21.8	-2.5 ^a [(-2.6)-(-2.3)]	13.7	9.2	-2.3 ^a [(-2.6)-(-2.0)]
70-79	46.0	31.1	-2.3 ^a [(-2.5)-(-2.1)]	21.4	13.6	-2.8 ^a [(-3.2)-(-2.4)]
80 +	71.5	52.3	-1.7 ^a [(-1.9)-(-1.6)]	29.4	19.1	-2.7 ^a [(-3.1)-(-2.3)]

^aStatistically significant trend.

¹Joinpoint results are not shown for the subgroups aged < 10 years for mortality, because fewer than 5 cases of suicide cases occurred in each of the decennium in any year.

²Average annual, per 100000 people. AAPC: Average annual percent change; CI: Confidence interval.

worldwide, in the registering causes of death process or under-reporting[14,16,17].

With the aging and growing population, the increasing prevalence of many risk factors (disorders considering mental health, alcohol abuse or non-communicable diseases), and with the fact that suicide prevention strategies have been implemented in only a few countries so far, it would be difficult to expect the UN-SDG's goal of reducing suicide mortality by one-third by 2030 to be achieved[1,4,6,37]. The differences between the regional and national rates and trends of suicide mortality indicate further opportunities to reduce mortality from suicide and also point to the necessity of improving the public health approach to suicide prevention worldwide. Therefore, the preventive strategies need to be tailored by different countries according to the burden of suicides, available medical and other resources, as legal, religious, and political circumstances.

Strengths and limitations

This study reported comprehensive global, regional and national trends of suicide mortality in the last two decades. This study analyzed suicide mortality data for 183 WHO member countries. Therefore, the results of this study could be generalized to the entire world. The presented trends could be essential for monitoring and assessing the epidemiological characteristics of suicides around the world, as well as for assessing the effects of preventive measures. The international variations in rates and trends in mortality from suicides underline the necessity of improving the public health approach to suicide prevention around the world.

Still, this study had some limitations. First, a possibility of under-reporting of suicide, particularly in developing countries, could introduce bias in the assessment of suicide mortality. Also, the quality of mortality statistics (considering coverage, accuracy, and completeness of data) varies substantially across the countries, which may introduce bias in comparison of suicide mortality rates between countries. Further, the validity of death certification for suicide is a major issue in some countries, due to a share of suicides classified as undetermined intent or accident or violent deaths. Finally, the WHO and GBD estimates partly resulted from adjustments of mortality data for countries without high-quality vital statistics (for example, for under-reporting of deaths, unknown age and sex, and ill-defined cause of death) and were computed using standard methods in order to provide cross-country comparability (using other data, e.g., household surveys, verbal autopsy, sample or sentinel registration systems, special studies, etc)[4,12]. Besides, our analysis did not cover countries with a population of less than 90000 in 2019, i.e., it did not include 11 WHO members - Andorra, Cook Islands, Dominica, Marshall Islands, Monaco, Nauru, Niue, Palau, Saint Kitts and Nevis, San Marino, Tuvalu. Certainly, it is important to continue the efforts for improving the quality of mortality statistics of suicide across countries in the world.

CONCLUSION

Globally, suicide mortality rates are declining, but this has not been observed in all countries. A total of 26 out of 183 countries reported a significant increase in suicide mortality, while in 24 countries suicide mortality trends were stable. However, further epidemiological studies are necessary in order to better elucidate the disparities of suicide mortality worldwide.

ARTICLE HIGHLIGHTS

Research background

Suicides are an important public health problem in the world.

Research motivation

Studies exploring the mortality of suicide on a global scale are sparse, and most evaluations were limited to certain populations.

Research objectives

The objective of this manuscript was to evaluate global, regional and national patterns and temporal trends of suicide mortality between 2000 and 2019.

Research methods

Suicide mortality data were obtained from the World Health Organization and Global Burden of Disease mortality database. Age-standardized rates [(ASRs), expressed per 100000] were presented. To assess trends of suicide mortality, joinpoint regression analysis was used: The average annual percent change (AAPC) with the corresponding 95% confidence interval (CI) was calculated.

Research results

A total of 759028 (523883 male and 235145 female) suicide deaths were reported worldwide in 2019. The global ASR of suicide mortality was 9.0/100000 population in both sexes (12.6 in males *vs* 5.4 in females). Globally, from 2000 to 2019, age-standardized suicide mortality rates had a decreasing tendency in both sexes together [AAPC = -2.4% per year; 95%CI: (-2.6)-(-2.3)]. Out of all 133 countries with a suicide mortality decline, Barbados (AAPC = -10.0%), Grenada (AAPC = -8.5%), Serbia (AAPC = -7.6%), and Venezuela (AAPC = -6.2%) had the most marked reductions. Out of all 26 countries with a rise in mortality from suicide, Lesotho (AAPC = +6.0%), Cyprus (AAPC = +5.1%), Paraguay (AAPC = +3.0%), Saudi Arabia (AAPC = +2.8%), Brunei (AAPC = +2.6%), Greece (AAPC = +2.6%), Georgia (AAPC = +2.1%), and Mexico (AAPC = 2.0%), are among those with the highest increase in mortality.

Research conclusions

Decreasing trends in suicide mortality were observed in most countries across the world. Unfortunately, the mortality of suicide showed an increasing trend in a number of populations.

Research perspectives

Further research should explore the reasons for these unfavorable trends, in order to consider and recommend more efforts for suicide prevention.

FOOTNOTES

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Informed consent statement: The study was conducted using publicly available data. No patient approvals were sought nor required for this study. The data used for inputs and analysis were derived from public sources (such as websites) and published literature. Our research question for estimating the trends of suicide mortality was based on the number of suicide mortality figures in the world from 2000 to 2019. However, as our model-based analysis used data from published sources such as publications, websites and modelling methods, patients were not involved in

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