Global trends in youth suicide from 1990 to 2020: an analysis of data from the WHO mortality database

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Summary

Background Suicide is a serious but preventable public health concern at the global level, showing relevant geographical differences. This study aims to monitor global temporal and geographical patterns in suicide mortality in pre-adolescents, adolescents, and young adults (i.e., aged 10–24 years), from 1990 to 2020 or the most recent available year.

Methods Using the World Health Organisation mortality database, we conducted an analysis on a subset of 52 countries with valid and high-quality data. We computed age-standardised suicide rates (ASR) by sex, country, and calendar year, and performed a joinpoint regression analysis to identify significant changes in the temporal suicide trends over the studied period.

Findings High variability in suicide rates and trends was observed, with a male-to-female ratio of two to five. Between 1990 and 2020, most European countries reported declining suicide trends, with some exceptions. In particular, alarming trends emerged in the United Kingdom, with annual rises of 2.5% (95% CI: 1.6–3.5) since 2005 among males and 8.5% (95% CI: 4.7–12.6) since 2012 among females. The most favorable trends and lowest suicide rates were in Southern Europe, with 3.1/100,000 persons in Italy (2020) and 3.5/100,000 persons in Spain (2021) among males, and 0.9/100,000 persons in Italy (2020) and 1.1/100,000 persons in Romania (2019) among females. Conversely, the highest rates were in Central-Eastern Europe, with 10.2/100,000 males in the Russian Federation (2019) and 10.0/100,000 males in Poland (2002). Higher suicide rates and significant increases were reported in not European areas. The highest ASR was 15.5/100,000 males in the United States of America, with an annual increase of 3.8% (95% CI: 3.1–4.5) among males in 2009–2020 and 6.7% (95% CI: 5.6–7.8) among females in 2007–2017, followed by a levelling off.

Interpretation Temporal and geographical comparisons of suicide mortality should be interpreted with caution due to potential misclassification or under-reporting of suicide deaths in some countries.

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Keywords: Suicide; Mortality; Official statistics; Global; Trends; Youth

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Research in context

Evidence before this study

We searched relevant published articles in the Medline database from July 31, 2023 to September 30, 2023, with no language restrictions, using the terms related to suicide temporal trends ("suicide*", "mortality", "death*", "trend*", "rates"); geographical area ("global", "worldwide", "northern", "western", "eastern", "southern"); age groups ("child*", "adolescent*", "young", "youth", "10–24 years"); and the interpretation of trends ("risk factor*", "suicide* behaviour*", "mental health", "prevention", "public health", "psychiatr*"). The existing body of published research on suicide rates and temporal trends on a global scale, drawing from official national statistics, remains limited. Prior global analyses revealed significant declines in suicide rates among adolescents aged 15–19 years in most European countries over the past decades, including Germany, France, Italy, and most Nordic countries. In contrast, rising trends are reported from the United Kingdom (UK), Ireland, Portugal, and central-eastern European countries.

The available data showed that the lowest suicide rates are observed in southern Europe, while the highest in eastern Europe, followed by northern countries. Outside Europe, a substantial body of literature highlights upward trends in suicide rates in the United States of America (USA) over recent decades. Similar increases in suicide rates have been reported in South America, Japan, and other parts of Asia. Accurate data on suicide remain challenging to obtain, mainly due to socio-cultural factors. Nonetheless, recognizing these limitations, studying suicide epidemiology in pre-adolescents, adolescents, and young adults provides valuable insights for monitoring this public health issue, which causes the tragic loss of thousands of young lives and inflicts profound suffering in families and communities.

Added value of this study

This study investigated suicide mortality rates and temporal trends worldwide among children, adolescents and young adults (i.e., aged 10–24 years) using the official World Health Organisation mortality database. It revealed significant geographic disparities over the three decades considered. While most European countries showed declining rates, alarming upward trajectories were identified, notably in the UK (rates increasing by 2.5% annually since 2005 among males and by 8.5% annually among females since 2012), and the USA (+3.8% per year in the 2009–2020 among males and +6.7% per year in 2007–2017 among females, followed by a leveling off), alongside increases in countries from Central-Latin America and Australasia. Males exhibit rates 2 to 5 times higher than females.

Implications of all the available evidence

Our research, underpinned by a rigorous methodology, adds a scientific contribution in understanding the burden of this health and societal topic among the youngest populations. It offers guidance for policymakers to develop targeted preventive programs to meet the specific needs of vulnerable groups, like young individuals. Urgent global action is needed to address persistent upward trends, requiring multidisciplinary preventive approaches. Further international collaborations are required to comprehensively understand factors influencing suicide and suicide behaviours, encompassing social, familial, economic, and environmental contexts.

Introduction

Suicide represents a serious public health concern at the global level, resulting in over 700,000 deaths per year and ranking as the fourth leading cause of death among young adults worldwide.[1,2] Although suicide mortality rates are higher in older ages,[3] the impact of suicide on young adults remains alarming.[2]

Previous studies reported suicide mortality rates among the youngest people worldwide.[4,5] In Europe, suicide mortality rates among adolescents aged 15–19 years decreased significantly from 13.1 per 100,000 persons in the 1990s to 10.9 in the 2000s among males (p-value = 0.001), and from 3.9 to 3.3 among females (p-value = 0.05). The decline was evident in several European countries, including Germany, France, Italy, and most Nordic countries.[5] Conversely, published data highlighted concerning rises in suicide rates in the United Kingdom (UK),[6] Ireland, and Portugal, as well as in central and eastern European countries,[5,7] including Poland, Romania, and Russia. The lowest suicide rates were reported in southern Europe, whereas the highest ones in eastern European countries, followed by countries from northern Europe.[5]

Outside Europe, upward trends in suicide rates have also been documented.[8] In the United States of America (USA), rates among the 15–24 age group reached 17.9 per 100,000 in males and 5.4 in females in 2017.[8] As reported by the Centers for Disease Control and Prevention (CDC), persisting increases in suicide rates until 2021 were observed among the younger population.[9] Similarly, South America experienced a 56% increase in rates from 1990 to 2009 among males and 43% among females aged 15–19, as well Japan reported increases of 37% and 63% respectively.[5]

Valid data on suicide trends and patterns are difficult to obtain and they are often largely underestimated mainly due to socio-cultural factors.[10,11] Recognising this limitation, suicide epidemiology in pre-adolescents,

adolescents, and young adults provides valuable information to monitor a public health phenomenon which causes the loss of thousands of young lives and great suffering on their families and relatives.

Therefore, to monitor this relevant issue, the current study aims to describe and compare temporal and geographical suicide patterns, by computing annual age-standardised mortality rates from suicide in the specific age group 10–24 years at a global level, covering a period from 1990 to 2020 or the most recent available year, using official data provided by the World Health Organisation (WHO).

Methods

Data source and management

We extracted the number of deaths from suicide at ages 10–24 years and estimates of the resident populations, by sex, country, and calendar year since 1990 up to the most recent available year, from the publicly available WHO mortality database.[12] When population data were not available in the database, we retrieved them from the European Union Statistical Office (EUROSTAT)[13] or the Pan American Health Organization (PAHO) databases.[14]

We classified suicide deaths for all calendar years and countries based on the three successive Revisions of the International Classification of Diseases (ICD) used over the studied period (ICD-8: E950-959, ICD-9: E950-959 and ICD-10: X60-X84, Y87.0) according to the Tenth ICD Revision.[15] For deaths coded with the ICD-10 only, we classified suicide deaths by different suicide's means, as detailed in Table S1.

Out of 140 countries included in the WHO mortality database, we considered data from 52 countries (Table S2) according to the availability of a sufficient number of calendar years (i.e., covering at least 90% over the studied period), and mortality data completeness (i.e., at least 95%), according to the documentation provided by the WHO.

Data analysis

For each country, sex and calendar year, using matrices of certified deaths and resident populations, we computed age-specific suicide rates per 100,000 person-years for each subsequent quinquennium of age (i.e., 10–14, 15–19, and 20–24 years), and then obtained the age-standardized suicide rates (ASR) per 100,000, at age 10–24, using the direct method based on the 1960 Segi's world standard population, and corresponding 95% confidence intervals (CI).

We derived ASR also for the European Union (EU) as a whole (27 Member States, excluding Cyprus for which data were available only for a limited number of years), and for the following seven geographic areas: 1) North Europe (including Denmark, Finland, Iceland, Ireland, Norway, Sweden, and the UK); 2) West Europe (including Austria, Belgium, France, Germany, Luxembourg, the Netherlands, and Switzerland); 3) South Europe (including Greece, Italy, Malta, Portugal, and Spain); 4) Centre-East Europe (including Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, North Macedonia, Poland, Republic of Moldova, Romania, Serbia, Slovakia, Slovenia, and Ukraine; 5) North America (including Canada and the USA); 6) Centre-South America (including Argentina, Brazil, Chile, Colombia, Cuba, Dominica, Guatemala, Mexico, Uruguay, and Venezuela); 7) Asia and Oceania (including Hong Kong, Republic of Korea, Japan, Australia, and New Zealand). We considered the Russian Federation separately. Due to the heterogeneity in the last available year among different countries within the same geographic area, we aggregated the data from 1990 up to the most recent year that covered at least 90% of the overall population in each area. As a result, the most recent year was 2020 for most areas, with the exceptions of the EU and West Europe (2017), Centre-East Europe and North America (2019).

For the main analysis, besides the geographical areas, we selected data from 18 (out of 52) major countries worldwide, according to population size (more than three million inhabitants aged 10–24 years). Therefore, we analysed data from France, Germany, Italy, the Netherlands, Poland, Romania, Spain, the Russian Federation, the UK, from Europe; Argentina, Brazil, Canada, Guatemala, Mexico, and the USA, from America; Japan, the Republic of Korea, and Australia, from Australasia. In addition, considering the most recent year for each of the 52 countries, we computed rates by aggregating them according to the predominant religion[16]: Catholic, Orthodox, Protestant, Buddhism, and Judaism.

To identify possible points (i.e., calendar years) when a change in the linear slope (on a log-scale) of the temporal trend of suicide mortality rate occurred, we carried out joinpoint regression models, considering data from 1990 to 2021 or the most recent available year, for each country and geographical area, in males and females, separately. Through a Monte Carlo Permutation method, the analysis starts to test from a minimum number of joinpoints to progressively test if there is a significant change in the time-trend by increasing the number of joinpoints up to a maximum number. For each model, we tested from a minimum of zero joinpoints, i.e., no changes in the trend over the whole study period, to a maximum of four joinpoints, i.e., five time periods (segments) characterised by a change in the trend. Therefore, different numbers of joinpoints (and segments) were chosen for each model (i.e., for each country or area). The estimated annual percent change (APC) and the corresponding 95% CI were then computed for each identified segment by fitting a regression line to the natural logarithm of the ASRs using the calendar year as a regressor variable (i.e., given $y = a + bx$, where y = ln (rate) and x = calendar

year, the APC is estimated as $100 \times (e^b - 1)$).[17] Thus, the APC indicates the annual percentage change in suicide mortality rate over each identified trend.

To perform the analyses, we used the software SAS version 9.4, the software R version 4.1.1, and the Joinpoint Regression Program version 4.9.0.

Ethics statement

This research did not require any written consent since publicly aggregated data were analysed.

Role of the funding source

There was no funding source for this study.

Results

Table 1 (for males) and Table 2 (for females) report number of suicide deaths and ASR per 100,000, at age 10–24 years and the three age groups 10–14, 15–19, 20–24, in the 18 selected major countries worldwide, the EU-27, and the considered geographical area, in the most recent available year. The rates at 10–24 years ordered from the highest to the lowest are displayed in Figure S1 (in Supplementary Material).

Among males (Table 1), the highest recent ASRs at age 10–24 were in North America (14.7/100,000 95% CI: 14.3–15.1, in 2019) and Asia and Oceania (13.0 95% CI: 12.4–13.6, in 2020), while the lowest ones in South Europe (3.0 95% CI: 2.6–3.3, in 2020). The EU-27 rate was 5.8/100,000 (95% CI: 5.6–6.0) corresponding to 2180 male deaths. Looking at the country-specific rates, the highest rate was observed in the USA (15.5/100,000 95% CI: 15.1–15.9, in 2020), followed by Japan (14.1 95% CI: 13.3–14.8) and Australia (11.7 95% CI: 10.4–13.1), whereas the lowest ones were reported in Italy (3.1 95% CI: 2.6–3.6), Spain (3.5 95% CI: 2.9–4.1), and France (4.0 95% CI: 3.5–4.5). The age group 20–24 years accounted for the largest share of deaths from suicide (on average over 60%), with rates varying from 29.0/100,000 (95% CI: 28.7–29.3) in the USA to 6.1 (95% CI: 5.8–6.5) in Italy.

Female suicide rates (Table 2) were substantially lower than in males, with similar patterns. The highest female 10–24 years old rates were observed in Asia and Oceania (8.3/100,000 95% CI: 7.8–8.8) and in North America (4.3 95% CI: 4.1–4.6), and the lowest one in South Europe (1.0 95% CI: 0.8–1.3). The EU-27 10–24 years old rate was 1.9/100,000 (95% CI: 1.7–2.0), corresponding to 651 female deaths. Across countries, the highest ASR was registered in the Republic of Korea, with about 10 deaths per 100,000 in 2020, i.e., a value equal to that observed among males (the only country showing the same mortality level in both sexes). Conversely, the lowest rates were registered in Italy (0.9/100,000 95% CI: 0.6–1.2), Romania (1.1 95% CI: 0.5–1.6), France (1.6 95% CI: 1.3–2.0), and Spain (1.7 95% CI: 1.3–2.2). Most female deaths from suicide occurred in the age group 20–24 years (on average almost 50%, Table 2), with rates ranging from 19.3/100,000 (95% CI: 18.6–19.9) in the Republic of Korea to 1.1/100,000 (95% CI: 1.0–1.3) in Italy.

For a global overview, Fig. 1 displays choropleth maps with ASRs of the 52 selected countries in the latest available year, among males (panel A) and females (panel B); corresponding figures are given in Tables S3 and S4.

Regarding rates aggregated by the predominant religion (Figure S2 in Supplementary Material), the highest recent ASR was observed for countries with a predominant Buddhist religion (10.9/100,000), followed by those with a predominant Protestant religion (9.2/100,000).

Fig. 2 shows suicide trends derived from the joinpoint regression models, from 1990 to the most recent available year in the EU-27 and the geographic areas, in males and females, separately. Table S5 reports the corresponding results in terms of estimated APC and corresponding 95% CI, by each period.

The EU-27 ASR among males steadily declined since the mid-1990s to 2017 by 1.9% annually (95% CI: [−2.1, −1.6]), while among females rates declined since 1990 to 2007 by 1.5% annually (95% CI: [−2.0, −1.1]) to then level off. A similar pattern was observed in western Europe, with an estimated APC of −2.8% (95% CI: [−3.0, −2.5]) among males in 1994–2017, and −2.8% (95% CI: [−3.9, −1.6]) among females in 1995–2006 to then level off. In southern Europe, some early rises in male rates were followed by a decline of 4.3% annually (95% CI: [−5.6, −3.0]) in 1996–2007, and then remained stable; females rates significantly declined by 2.3% annually (95% CI: [−3.0, −1.5]) until 2011 and, after an increase from 2011 to 2014, continued to decline until 2020. In northern Europe, male suicide trends remained stable until 2000, then dropped in 2000–2005 (APC: −6.2%, 95% CI: [−11.3, −0.9]), and then stabilised; on the other hand, a rising trend was observed in females, with an estimated rise by 6.1% annually (95% CI: [2.5, 9.9]) since 2013 until 2020. In central-eastern Europe, increases followed by declines were reported in both sexes, with an estimated APC of −5.7% (95% CI: [−7.4, −3.9]) since 2011 among males and −2.1% (95% CI: [−4.1, 0.0]) since 2009 among females. In contrast, mortality from suicide increased in American and Australasian areas. Males trends showed an annual increase of 4.8% (95% CI: [3.3, 6.3]) since 2013 in North America, 3.9% (95% CI: [2.3, 5.6]) since 2015 in Centre–South America, and 4.9% (95% CI: [1.8, 8.0]) since 2016 in Asia and Oceania. Female rates showed an annual increase of 6.3% (95% CI: [4.8, 7.8]) from 2008 to 2017 in North America, and then levelled off in the most recent years. Rates increased by 4.2% (95% CI: [2.1, 6.4]) since 2013 in Centre-South America and by 14.2% (95% CI: [5.7, 23.3]) since 2016 in Asia and Oceania.

	Last year	Males							
		Age group 10–24		Age group 10–14		Age group 15–19		Age group 20–24	
		Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)
Europe									
France	2017	238	4.0 (3.5–4.5)	16	0.8 (0.6–0.9)	74	3.6 (3.3–3.9)	148	8.0 (7.6–8.4)
Germany	2020	379	5.4 (4.8–5.9)	14	0.7 (0.6–0.9)	105	5.2 (4.9–5.6)	260	10.8 (10.4–11.2)
Italy	2020	147	3.1 (2.6–3.6)	5	0.3 (0.2–0.4)	47	3.2 (2.9–3.5)	95	6.1 (5.8–6.5)
Netherlands	2020	95	5.6 (4.5–6.8)	5	1.0 (0.7–1.3)	30	5.7 (5.0–6.4)	60	10.7 (9.9–11.5)
Poland	2020	306	10.0 (8.8–11.1)	4	0.4 (0.3–0.5)	90	9.9 (9.2–10.6)	212	20.9 (20.0–21.7)
Romania	2019	104	6.4 (5.2–7.6)	2	0.4 (0.2–0.5)	35	6.6 (5.8–7.3)	67	12.9 (12.0–13.9)
Spain	2021	137	3.5 (2.9–4.1)	14	1.1 (0.9–1.3)	28	2.2 (1.9–2.5)	95	7.7 (7.2–8.2)
Russian Federation	2019	1137	10.2 (9.6–10.8)	52	1.3 (1.2–1.4)	386	10.7 (10.3–11.1)	699	19.6 (19.1–20.0)
UK	2020	403	6.3 (5.7–6.9)	10	0.5 (0.4–0.6)	125	6.6 (6.2–7.0)	268	12.6 (12.1–13.0)
EU (27)	2017	2180	5.8 (5.6–6.0)	98	0.9 (0.8–0.9)	703	6.0 (5.8–6.1)	1379	11.2 (11.0–11.3)
North Europe	2020	900	6.5 (6.1–6.9)	26	0.6 (0.5–0.7)	278	6.7 (6.5–7.0)	596	12.9 (12.5–13.2)
West Europe	2017	928	5.3 (5.0–5.7)	47	0.9 (0.8–1.0)	318	5.7 (5.5–6.0)	563	9.9 (9.6–10.1)
South Europe	2020	282	3.0 (2.6–3.3)	11	0.4 (0.3–0.4)	82	2.7 (2.5–2.9)	189	6.2 (5.9–6.4)
Centre-East Europe	2019	1047	8.9 (8.3–9.4)	37	0.9 (0.8–1.1)	314	8.8 (8.5–9.2)	696	17.8 (17.4–18.2)
The Americas									
Argentina	2020	616	11.3 (10.4–12.1)	23	1.2 (1.1–1.4)	253	13.9 (13.3–14.5)	340	19.5 (18.9–20.2)
Brazil	2020	1886	7.0 (6.6–7.3)	81	1.0 (1.0–1.1)	720	8.1 (7.9–8.3)	1085	12.3 (12.1–12.5)
Canada	2019	374	10.9 (9.8–12.0)	15	1.5 (1.2–1.7)	128	12.6 (11.9–13.4)	231	19.6 (18.8–20.4)
Guatemala	2020	128	4.5 (3.7–5.3)	9	0.9 (0.7–1.1)	43	4.5 (4.0–4.9)	76	8.6 (8.0–9.2)
Mexico	2020	1629	8.9 (8.4–9.3)	152	2.6 (2.4–2.7)	579	9.7 (9.4–10.0)	898	15.1 (14.8–15.4)
USA	2020	5231	15.5 (15.1–15.9)	377	3.5 (3.4–3.6)	1689	15.6 (15.3–15.8)	3165	29.0 (28.7–29.3)
North America	2019	5498	14.7 (14.3–15.1)	346	2.9 (2.8–3.0)	1826	15.5 (15.3–15.7)	3326	27.1 (26.8–27.4)
Centre-South America	2020	5189	8.2 (7.9–8.4)	338	1.7 (1.7–1.8)	1929	9.3 (9.1–9.4)	2922	14.2 (14.0–14.3)
Asia and Oceania									
Japan	2020	1291	14.1 (13.3–14.8)	64	2.3 (2.2–2.5)	398	13.8 (13.3–14.3)	829	27.5 (26.9–28.1)
Republic of Korea	2020	500	10.4 (9.5–11.3)	23	1.9 (1.7–2.2)	140	10.6 (10.0–11.2)	337	19.7 (19.1–20.4)
Australia	2021	294	11.7 (10.4–13.1)	14	1.7 (1.4–2.0)	100	13.1 (12.2–14.0)	180	21.5 (20.5–22.5)
Asia and Oceania	2020	2155	13.0 (12.4–13.6)	102	2.2 (2.0–2.3)	668	13.4 (13.1–13.8)	1385	24.7 (24.3–25.1)

For Italy, we obtained mortality and population data for the year 2020 from the Italian National Institute of Statistics (ISTAT). [a]Standard population used: Segi's world population.

Table 1: **Number of suicide deaths and age-standardised[a] suicide rates (ASR) per 100,000 males, and corresponding 95% confidence intervals (CI), at different age groups, for the last available calendar year.**

Heterogeneous patterns emerged across countries (Fig. 3 and Table S6). Among European countries, France, Germany and Russia showed the most marked declines in suicide rates over the studied period. In Italy, after an early rise until 1996, male rates steeply decreased until 2006 remaining stable thereafter, while they steadily declined over the whole studied period among females. Of note, increasing trends were observed in the UK, with an estimated APC of +2.5% (95% CI: [1.6, 3.5]) since 2005 until 2020 among males and +8.5% [4.7, 12.6] since 2012 among females. Similarly, suicide rates substantially increased in Brazil (+7.3% [4.0, 10.6] since 2016 among males and +9.4% [6.7, 12.1] since 2014 among females), in the USA (+3.8% [3.1, 4.5] since 2009 among males and +6.7% [5.6, 7.8] in 2007–2017 among females), in the Republic of Korea (+16.7% [7.7, 26.4] since 2015 among females) and in Australia (+3.8% [2.4, 5.2] since 2009 among males). In Japan, opposing trends between males (decrease) and females (increase) were observed over most recent years.

Fig. 4 shows the percentage of deaths by suicide method (out of the overall suicides), by sex separately, registered in the most recent available year, in 12 selected major countries worldwide with available information. Hanging, strangulation, and suffocation, although with different proportions across countries (45–92% among males, 36–91% among females), were the most common methods of suicide in all countries for both males and females, with the exception of the USA, where firearm discharge and explosives were the most frequent means of suicide among males. A higher proportion of suicides by poisoning among females compared to males was observed in all countries.

	Last year	Females							
		Age group 10–24		Age group 10–14		Age group 15–19		Age group 20–24	
		Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)	Suicide deaths	ASR (95% CI)
Europe									
France	2017	94	1.6 (1.3–2.0)	5	0.3 (0.2–0.3)	44	2.3 (2.0–2.5)	45	2.5 (2.3–2.7)
Germany	2020	128	2.1 (1.7–2.4)	10	0.6 (0.4–0.7)	50	2.7 (2.4–2.9)	68	3.1 (2.9–3.3)
Italy	2020	37	0.9 (0.6–1.2)	0	0.0 (0.0–0.0)	21	1.5 (1.3–1.7)	16	1.1 (1.0–1.3)
Netherlands	2020	66	4.1 (3.1–5.1)	4	0.9 (0.6–1.2)	23	4.6 (3.9–5.2)	39	7.2 (6.5–7.9)
Poland	2020	65	2.4 (1.8–2.9)	12	1.2 (1.0–1.5)	31	3.6 (3.1–4.0)	22	2.3 (2.0–2.6)
Romania	2019	16	1.1 (0.5–1.6)	2	0.4 (0.2–0.6)	8	1.6 (1.2–2.0)	6	1.2 (0.9–1.5)
Spain	2021	63	1.7 (1.3–2.2)	8	0.7 (0.5–0.8)	25	2.1 (1.8–2.4)	30	2.6 (2.3–2.9)
Russian Federation	2019	276	2.6 (2.3–2.9)	39	1.0 (0.9–1.1)	138	4.0 (3.8–4.2)	99	2.9 (2.7–3.1)
UK	2020	143	2.4 (2–2.8.0)	8	0.4 (0.3–0.5)	49	2.7 (2.5–3.0)	86	4.3 (4.0–4.6)
EU (27)	2017	651	1.9 (1.7–2.0)	63	0.6 (0.5–0.6)	281	2.5 (2.4–2.7)	307	2.6 (2.5–2.7)
North Europe	2020	343	2.7 (2.4–2.9)	18	0.4 (0.4–0.5)	117	3.0 (2.8–3.2)	208	4.8 (4.6–5.0)
West Europe	2017	348	2.2 (1.9–2.4)	28	0.6 (0.5–0.6)	148	2.9 (2.7–3.0)	172	3.2 (3.1–3.4)
South Europe	2020	89	1.0 (0.8–1.3)	8	0.3 (0.2–0.3)	41	1.5 (1.3–1.6)	40	1.4 (1.3–1.5)
Centre-East Europe	2019	236	2.2 (1.9–2.5)	25	0.7 (0.6–0.8)	103	3.1 (2.9–3.3)	108	2.9 (2.7–3.1)
The Americas									
Argentina	2020	169	3.2 (2.7–3.7)	22	1.2 (1.1–1.4)	77	4.4 (4.0–4.7)	70	4.1 (3.8–4.4)
Brazil	2020	665	2.6 (2.4–2.8)	83	1.1 (1–1.2)	270	3.2 (3.0–3.3)	312	3.6 (3.5–3.8)
Canada	2019	162	5.2 (4.4–6.0)	16	1.6 (1.3–1.9)	71	7.4 (6.8–8.0)	75	6.7 (6.2–7.1)
Guatemala	2020	80	2.9 (2.3–3.5)	23	2.4 (2.1–2.7)	29	3.1 (2.7–3.5)	28	3.2 (2.8–3.6)
Mexico	2020	624	3.6 (3.3–3.9)	122	2.2 (2–2.3)	288	5.0 (4.8–5.2)	214	3.7 (3.5–3.8)
USA	2020	1404	4.4 (4.2–4.6)	203	2.0 (1.9–2.0)	526	5.0 (4.9–5.2)	675	6.5 (6.3–6.6)
North America	2019	1519	4.3 (4.1–4.6)	219	1.9 (1.8–2.0)	582	5.1 (5.0–5.3)	718	6.2 (6.0–6.3)
Centre-South America	2020	1873	3.1 (3.0–3.3)	307	1.6 (1.6–1.7)	808	4.0 (3.9–4.1)	758	3.8 (3.7–3.9)
Asia and Oceania									
Japan	2020	716	8.3 (7.6–8.9)	58	2.2 (2.0–2.4)	244	8.9 (8.5–9.3)	414	14.3 (13.9–14.7)
Republic of Korea	2020	452	10.3 (9.3–11.2)	26	2.3 (2.0–2.6)	125	10.2 (9.6–10.8)	301	19.3 (18.6–19.9)
Australia	2021	140	6.0 (5.0–7.0)	18	2.3 (1.9–2.6)	51	7.1 (6.4–7.8)	71	9.0 (8.4–9.7)
Asia and Oceania	2020	1283	8.3 (7.8–8.8)	94	2.1 (1.9–2.2)	413	8.8 (8.5–9.1)	776	14.7 (14.3–15.0)

For Italy, we obtained mortality and population data for the year 2020 from the Italian National Institute of Statistics (ISTAT). [a]Standard population used: Segi's world population.

Table 2: **Number of suicide deaths and age-standardised[a] suicide rates (ASR) per 100,000 females, and corresponding 95% confidence intervals (CI), at different age groups, for the last available calendar year.**

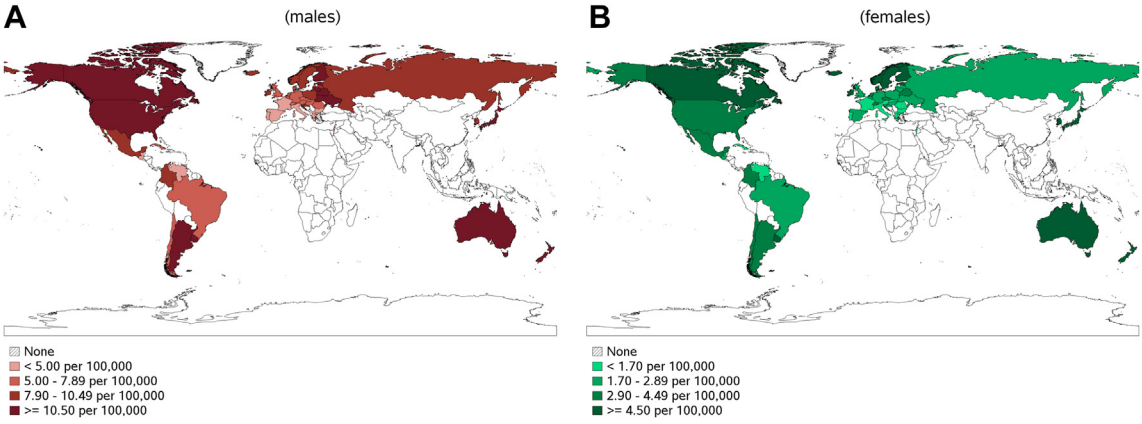

Fig. 1: Age-standardised (world population) suicide rates (ASR) per 100,000 males (panel A) and females (panel B) aged 10–24 years in 2020 or the last available year, in 52 countries worldwide.

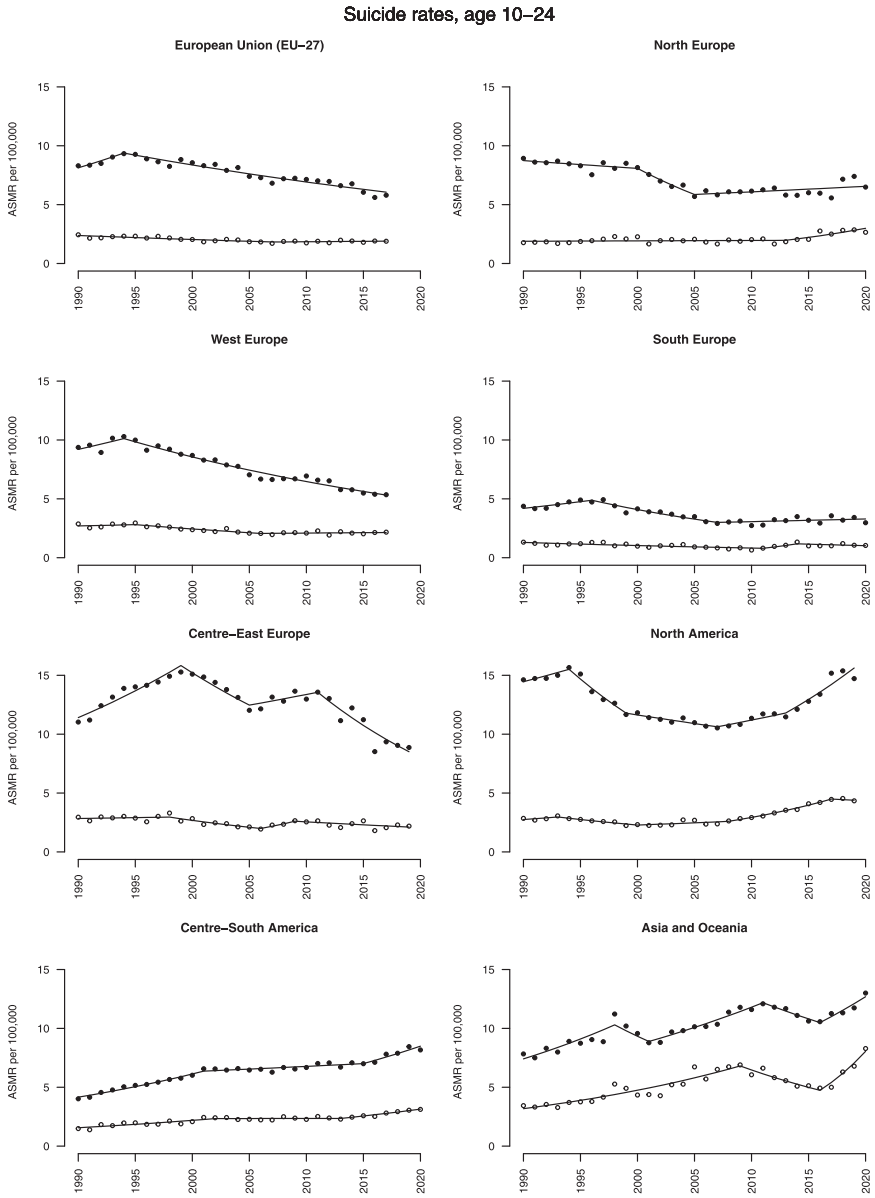

Fig. 2: Suicide trends (age 10–24 years) derived by joinpoint regression models from 1990 to 2020, according to geographical areas worldwide, in men (solid dot) and females (empty dot) separately.

Discussion

To our knowledge, this is the most up-to-date descriptive study on suicide rates and trends among pre-adolescents, adolescents and young adults worldwide, based on the official WHO mortality database. Notable geographical disparities in suicide rates and trends emerged over the past 30 years, with male showing rates 2 to 5 times higher than females. While most European countries reported favourable patterns with declining rates, with the exception of the UK, rising suicide rates were observed in the USA as well as in most Central-Latin America and Australasia.

Our findings are broadly consistent with previous analyses.[5] However, the interpretation of such data is challenging and very complex. Understanding risk factors and potential underlying mechanisms is fundamental to adequately support and guide specific preventive and clinical strategies.

Mood disorders including depression are well-established risk factors for suicide behaviours.[18]

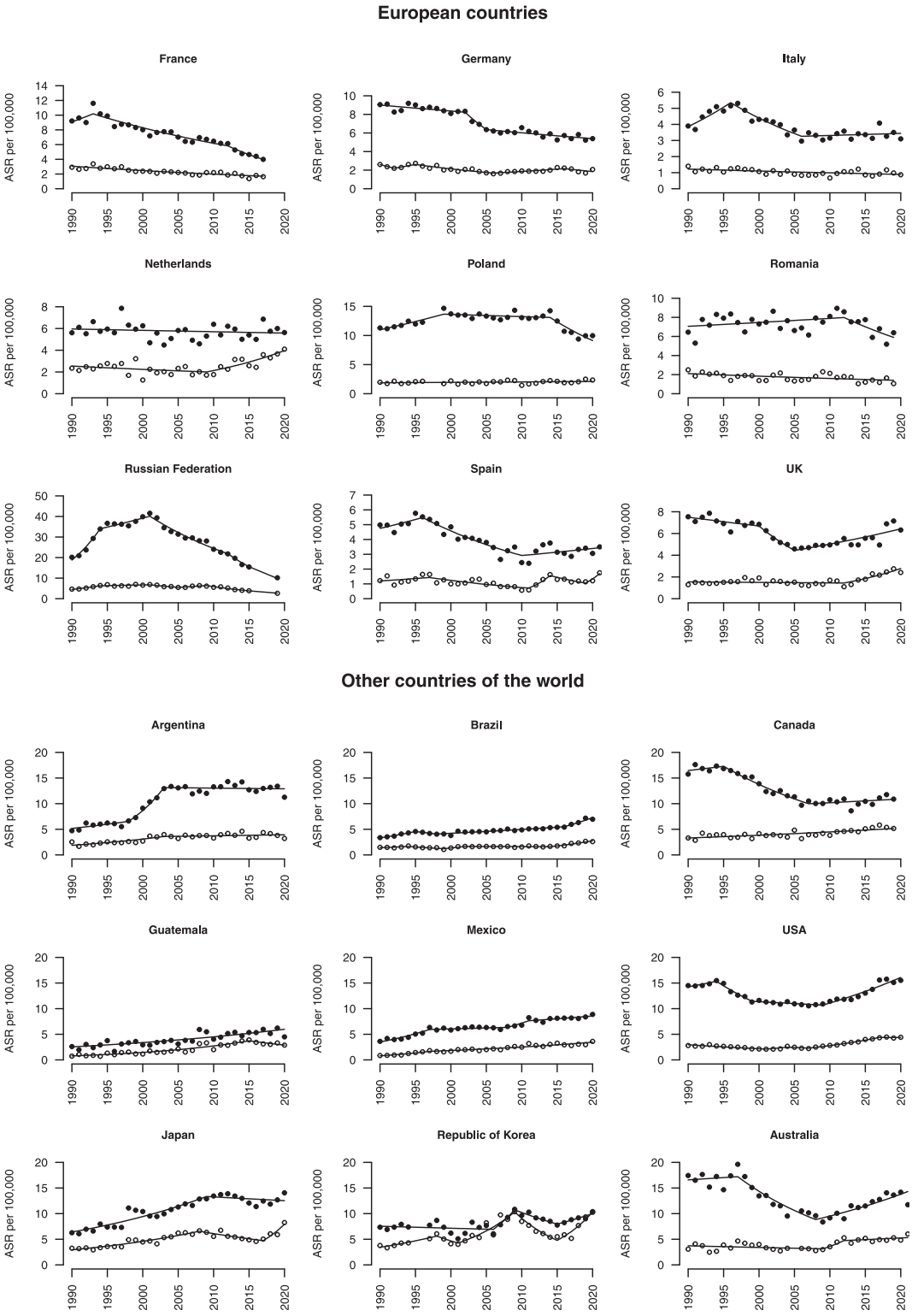

Fig. 3: Suicide trends (age 10–24 years) derived by joinpoint regression models from 1990 to 2021 or the most recent available year, in the 18 selected major countries worldwide, in men (solid dot) and females (empty dot) separately, with country-specific scales.

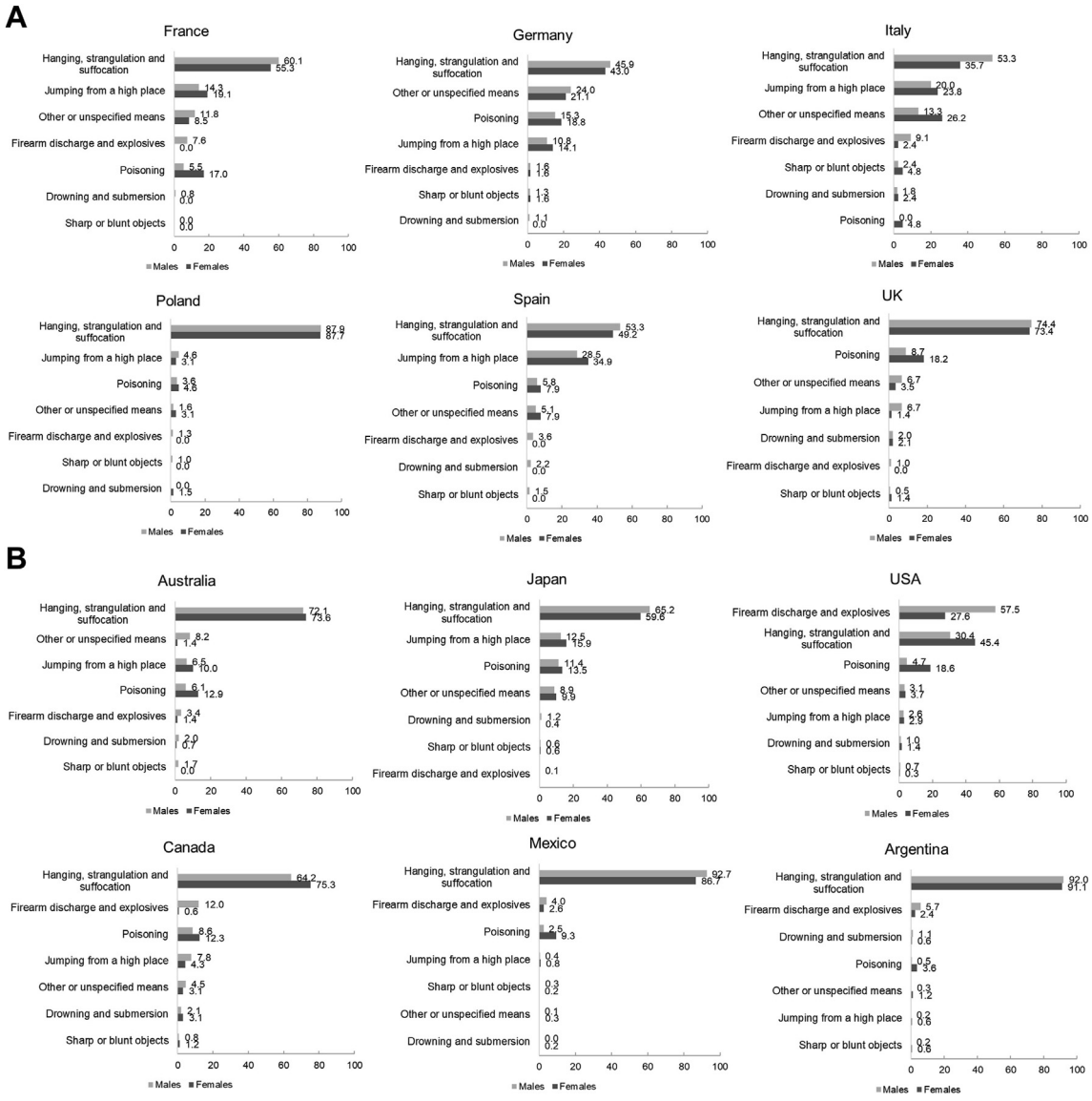

Fig. 4: Proportion of suicides (age 10–24 years) by means in 12 selected major countries worldwide (i.e., with more than 20 million of inhabitant and coverage >90%), males and females separately, in 2020 or the last year. Panel A shows European countries; panel B shows not European countries.

Suicidal risk was estimated ten times higher among young people with mental disorders, and a specific association between suicidal attempts and affective disorders was reported.[18] In general, suicidality is linked to different patterns of both psychiatric[18] and physical conditions.[19] The surveillance of the seasonal affective disorder (SAD) prevalence can provide valuable insights for interpreting suicide trends and understanding driving factors, particularly in Nordic countries where unfavourable patterns already emerged, as compared to other EU countries. Several estimates from both retrospective and prospective studies revealed a relatively high occurrence of SAD in those regions.[20]

Rising rates of psychiatric disorders can partly explain the alarming upward suicide trends observed in countries like the UK and USA over the last decades.[21,22] In the USA, about a doubling in depressive symptoms was estimated among adolescents from 8.1% in 2009 to 15.8% in 2019.[22] Another US study reported a two to five-fold increase in paediatric emergency department (ED) visits for mental health between 2011 and 2020.[23] In particular, CDC analysed trends in ED visits for suicide attempt, an important suicide risk factor,

reporting about a 51% increase among American adolescent girls in 2021 than 2019.[24] On one hand, these data highlight the importance of increasing attention and prevention measures for this group of the population; on the other hand, an increase in ED visits for suicide attempts does not necessarily imply an increase in suicide deaths.

Other factors explain the increases in suicide, including the opioid epidemic, access to drugs and firearms, socioeconomic factors or psychiatric-related disorders.[18,25] The association between illicit opioid use and suicide mortality has been observed particularly at younger ages in a large study conducted in England.[26] Nonetheless, available evidence does not allow consistent interpretations.

The relationship between substance abuse—alone or in combination with mental disorders—and suicide has been extensively studied.[27] Substance abuse can worsen underlying mental health problems, leading to a higher likelihood of suicidal thoughts and self-harming behaviours, and to significant implications for psychosocial, medical, and potential legislative actions.[28] This was reflected in the increases occurred in Italy in the early 1990s, partly explained by known patterns of illegal substance abuse, specifically among males who were more vulnerable to drugs than females,[28] as well as for most eastern Europe, such as Russia and Poland. Substance use has detrimental effects on the clinical course of mental disorders, ranging from depression to the ultimate act of suicide. In addition, the vulnerability of the developing brain during this crucial age makes it even more concerning. Besides mental disorders and substance use, suicide trends in the youngs can be linked to multifaceted factors and their interaction, including socioeconomic, cultural, educational and environmental contexts, as well as genetic characteristics and family history of psychiatric disorders.[27] An inverse association between education and suicide rates was documented. A high education, that is inversely associated to disease risk and specifically to psychiatric disorders, helps to develop a more stable social and family context, as well as improved access to economic, material, social, and health resources. Environmental factors can influence several aspects of both physical and mental health outcomes, including its indirect effects on mental health, as reported for climate changes.[29] This suggests that climate-related factors may contribute to rising suicide rates, offering a possible explanation for trends observed in the USA and Mexico. Climate change—if not addressed—could led to additional 9 to 40 thousand suicides across the USA and Mexico by 2050, a magnitude comparable to the estimated impact of economic recessions.[29]

Among social factors, the massive diffusion of social media has introduced new challenges in investigating mental disease risk factors, particularly among adolescents. Emerging evidence suggests that social media can worsen adolescents' well-being, by inducing feelings of loneliness, depression and suicide-related outcomes.[27] Alongside known risk factors, studying this relatively new phenomenon will help to understand suicide and suicide behaviours, especially among the youngest people.

Regarding a possible link between religion and suicide,[30] Asiatic studies suggested a positive association between Buddhist belief and suicide risk, consistent with our findings. However, the role of religiosity and spirituality on suicide risk is difficult to measure. Although a protective role of religion was reported, consensus has not yet been reached.[30] Religion may also influence registration of violent deaths and suicide, introducing hardly quantifiable biases in cross-countries comparisons.

The years of adolescence and early adulthood are also associated with a higher risk of deliberate self-harm (DSH).[31] DSH refers to intentional, self-directed, and non-socially acceptable behaviors that are intended to cause destruction or impairment of the body, performed with or without conscious suicidal intention. DSH frequency is the strongest predictor of suicide after suicidal ideation.[32] Considering DSH at one extreme of a continuum and suicide at the other, DSH is an antechambers of suicide, representing an independent risk factor for suicidal behavior.[33] It is important to consider also factors contributing to favourable suicide trends. The most important factor is the progress in psychiatric disorders management.[27,34] In particular, more effective strategies for identifying, diagnosing, and treating mental health conditions played a role in reducing clinical outcomes, like major depression and suicide.[27] However, further efforts in managing adolescent depression, particularly in primary care settings are needed. As stated by an US analysis, besides the examination of the number of psychiatric hospital beds, a greater attention should be directed towards understanding how the available number of beds are used rather than to increase them.[35] In addition, integrating a multidisciplinary approach into primary care, including psychosocial support (e.g., psychotherapy), provides favourable outcomes in treating adolescent depression.[27]

As the study's strengths, our figures are based on the WHO mortality database, the most reliable source for global comparative studies on cause-specific mortality. Handling large data files (e.g., over 2 million records) required rigorous automated and standardized processes and programs, ensuring the possibility to analyse and monitor suicide mortality with a comparable approach. In addition, the study's inclusion criteria led to select countries with high-quality vital registration data. Finally, our choice to include individuals up to the age of 24 in our study, consistent with the WHO's previous recommendation for studying youth suicide rates,[2] allows for meaningful comparisons with earlier literature.

While our analysis provides valuable insights at a population level, ecological fallacy poses a limitation in drawing individual-level conclusions from aggregated data. Temporal and geographical comparisons of suicide mortality are affected by different degrees of accuracy in reporting suicide deaths across countries, potentially leading to biases in the statistics due to misclassification or under-reporting. Factors like differences in registration procedures, cultural stigma, and the illegality of suicidal behaviours particularly in some countries[2] can affect suicide statistics differentially. Furthermore, while acknowledging the importance of considering religious diversity within countries, relying solely on predominant religion might overlook the intricate interplay of various religious and cultural factors on the observed suicide trends. Finally, any evaluation of the COVID-19 impact on suicide is limited due to the short observation period since the pandemic's onset. Thus, caution should be paid when interpreting such data.

Suicide statistics suffer from several selection bias. With regard to England and Wales, since 2001, the increased use of narrative verdict by coroners rather than giving a short form verdict, had significant effects on the estimation of national suicide rates.[36] Because of coding difficulties for the Office of National Statistics, when suicide intent was unclear such deaths were coded as accidents resulting in a consequent underestimation of suicides.[37] Moreover, the high burden of proof required by coroners to determine the official cause of death, may have determined a further underestimation of the true number of deaths by suicide. However, in 2018, based on a decision of the High Court, the standard of proof required for a suicide conclusion became the civil standard–balance of probabilities–rather than the previous criminal standard, beyond reasonable doubt.[38] It is reasonable to imagine that lowering the threshold could lead to an increase in deaths registered as suicide.

Still, our findings have important public health implications. Taking into account gender-specific characteristics and geographical disparities, they can help and guide policymakers to create targeted preventive programs and interventions to address specific needs of vulnerable groups.[27,39] In fact, for example, previous studies suggested common and gender-specific risk factors for suicidal behaviour in adolescents and young adults.[40] However, further evidence is needed. Community-based approaches and educational settings, such as schools, can provide a road for implementing suicide prevention interventions. A large number of young people can be reached in order to provide them the necessary knowledge and skills to recognize mental health issues and seek help.

In addition, it is crucial to monitor the COVID-19 long-term effects with particular regard to mental health, and possible impact on suicide rates.[41] Experiencing prolonged isolation and loneliness is a risk factor for mental health worsening, and it may contribute to increased vulnerability to suicidal ideation and related behaviours.[42] Evidence exists about a worsening in mental health indicators due to the pandemic effects among children and adolescents as well as young adults.[43] The pandemic also caused an infodemic, characterized by an excess of information, including false and misleading content, which has created consequently a sense of overwhelming and uncertainty.[44] Monitoring and addressing the long-term mental health consequences of the pandemic are essential to ensure the well-being of individuals and prevent future evolutions of mental health issues.[45]

In conclusion, geographical heterogeneity in suicide mortality patterns among young individuals and the worrying upward trends in some countries highlight the importance of addressing this complex issue, on a global scale, with a multidisciplinary approach.[46] Additional research and international collaborations are needed to understand the underlying factors, including socioeconomic and familial contexts. It is important to promote social activities and reinforce affective relationships, especially between peers, and mental health awareness. Early detection and tailored interventions are crucial in mitigating suicide risk while reinforcing assistance to the affected children, adolescents, and their families.

Contributors

AA and PB conceived and designed the study. PB conducted and performed the statistical analyses. PB have directly accessed and together with EG verified the underlying data reported in the manuscript. PB and AA wrote the first draft of the manuscript. CLV, AC, AA, IB, GS, MM, MP, and AO contributed to reviewing and editing. AO supervised the project. All authors provided important contributions for the interpretation of findings and contributed to the final version of the manuscript. All authors carefully revised the final version of the manuscript. All the authors read and approved the last version of the manuscript.

Data sharing statement

Publicly available datasets were analysed in this study. Specific datasets used in this study are available upon reasonable request by research oriented institutions. All authors had full access to all the data in the study and accept responsibility to submit for publication.

Declaration of interests

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.eclinm.2024.102506.

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