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Suicide Following the COVID-19 Pandemic Outbreak: Variation Across Place, Over Time, and Across Sociodemographic Groups. A Systematic Integrative Review

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Abstract

Purpose of review To systematically examine changes in suicide trends following the initial COVID-19 outbreak, focusing on geographical and temporal heterogeneity and on differences across sociodemographic subgroups.

Recent findings Of 46 studies, 26 had low risk of bias. In general, suicides remained stable or decreased following the initial outbreak – however, suicide increases were detected during spring 2020 in Mexico, Nepal, India, Spain, and Hungary; and after summer 2020 in Japan. Trends were heterogeneous across sociodemographic groups (i.e., there were increases among racially minoritized individuals in the US, young adults and females across ages in Japan, older males in Brazil and Germany, and older adults across sex in China and Taiwan). Variations may be explained by differences in risk of COVID-19 contagion and death and in socioeconomic vulnerability.

Summary Monitoring geographical, temporal, and sociodemographic differences in suicide trends during the COVID-19 pandemic is critical to guide suicide prevention efforts.

Keywords Suicide · Suicide trends · Suicide mortality · COVID-19 · Pandemic · SARS-CoV-2

Introduction

The SARS-CoV-2 pandemic has brought about a substantial burden of psychosocial stressors (e.g. bereavement of loved ones, fear of contagion and death, isolation and loneliness, downstream negative economic effects), affecting mental health and psychological wellbeing of the general population [1, 2]. Initial evidence from representative longitudinal surveys suggests that prevalence of symptoms indicative of common mental health conditions, such as symptoms of depression or anxiety, may have increased notably following the onset of the pandemic [3–8]. According to Global Burden of Disease estimates, prevalence of depression and anxiety increased by around 25% across the globe in 2020 [9].

Additionally, early reports also suggested increases in suicidal ideation in the general population [10, 11], leading to concern that suicide deaths would increase following the initial pandemic outbreak [12]. The first available evidence, however, did not confirm such increases [13]. As the pandemic unfolded, however, it became progressively clear that the impact of the pandemic on suicide across the globe is heterogeneous across place and population subgroups as well as over time. For instance, a large study including data through October, 2020 on 21 different locations identified increases in suicide in Vienna, Austria; Puerto Rico; and Japan (suicide remained stable or decreased in the other 18 study locations) [13]. A systematic review based on 9 original reports of population-based suicide mortality data, also highlighted increases in suicide rates in Japan, noticeable after the summer of 2020, with particularly concerning trends among young females [14].

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Variations across place and population subgroups and over time in the impact of the pandemic on suicide should be expected because the intensity of pandemic-related stressors (e.g., COVID-19 incidence and mortality, physical distancing measures, negative downstream economic effects) were also heterogeneous across place and population subgroups and over time. Examining the geographical and temporal variations in suicide trends during the COVID-19 era can enhance our understanding regarding the potential risk or protective role of specific components of the pandemic (e.g., intensity of the initial pandemic outbreak) and contagion containment measures (e.g., stay-at-home mandates). In addition, focusing on the vulnerability to suicide of population subgroups can help identify high-risk individuals and design, implement, and scale-up targeted prevention strategies.

Notwithstanding, no study has systematically reviewed the heterogeneity across place and population groups and over time in variations in suicide during the COVID-19 era, despite potential implications for suicide prevention efforts during the current and future major societal crises. The goal of this review was to systematically examine and summarize the existing evidence on changes in population-based suicide trends during the period following the initial pandemic outbreak, with a focus on assessing geographical and temporal heterogeneity as well as differences across population groups defined by sociodemographic characteristics.

Methods

Search Strategy and Databases

We conducted a systematic integrative literature review, combining the rigor of a systematic review with the flexibility of an integrative review [15]. We searched PubMed, ProQuest Central, and Ebscohost (restricted to PsycInfo and SocINDEX) on July 25, 2022. Search terms were: suicide and (COVID-19 or pandemic or coronavirus or SARS-CoV-2). This review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 guidelines (Supplementary Table S1) [16].

Inclusion and Exclusion Criteria

Supplementary Table S2 outlines the criteria for inclusion in the review. In brief, studies were included if they reported original, peer-reviewed research published between 01/01/2020 and 07/10/2022, and included population-based estimates of suicide counts or suicide mortality rates before and after the initial COVID-19 pandemic outbreak, with or without explicitly estimating the effect of the pandemic on variations in suicide.

Study Screening and Full-text Review

Two independent researchers (GMA, AS) screened all titles and abstracts separately. In 12 out of 8414 (0.1%) papers initially screened and 2 out of 48 (4%) papers reviewed in full-text, reviewers had to discuss appropriateness of study inclusion. Supplementary Fig. S1 is a flowchart representing the manuscript review process.

Data Extraction, Synthesis, and Analysis

We used an abstraction form to capture all relevant study details, including data on general manuscript information (authors, publication year, setting), methods (period examined; definition of the COVID-19 period; outcome measure; additional covariates), and results (main findings and, when appropriate, results by subgroups). We did not assess quality of suicide data as papers did not include such information.

Analyses of time series data where a potential interruption of the time series (e.g., emergence of the COVID-19 pandemic) is of interest are typically referred to as interrupted time-series analyses (ITSA). There are three common threats to validity in ITSA studies: autocorrelation, seasonality, and non-stationarity (for details, see Appendix 1). The abstraction form included specific variables to indicate if autocorrelation, seasonality, and non-stationarity were explicitly assessed and controlled for; papers were assessed as possibly biased if they failed to address these possible threats to validity. Two independent researchers (GMA, AS) performed an evaluation of the risk of bias of the articles, based on work by Hategeka et al. [17] (see Appendix 1 for details). We dichotomized the scale between low and high risk of bias. Because designs were largely similar across studies, the difference between low and high risk of bias was in most cases defined by use of an appropriate ITSA technique (e.g., Autoregressive Integrated Moving Average [ARIMA] models or segmented regression) with explicit control for autocorrelation, seasonality, and non-stationarity.

Results

Study Designs and Methodological Variation

Table 1 summarizes the characteristics of the 46 studies. A total of 27 studies used suicide counts as the outcome of interest [13, 18–43]. Of them, the majority examined monthly suicide counts, except for two reports from Nepal not specifying the time window [18, 37], a study examining daily suicides in Maryland, US [21], two studies conducted in Peru assessing biweekly suicide counts [22, 23], and studies examining periods longer than one month [27, 28, 34, 38,

Table 1 Summary, articles examining suicide during the initial phase of the COVID-19 pandemic, systematic integrative review

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Acharya et al. [44]	Nepal	Not reported	After March 24 2020	Direct comparison vs. previous years	Number of suicides	No	None	↑	No	No	No	↑
Acharya et al. [44]	Nepal	July 1, 2017-June 30, 2021	April 1, 2020-June 30, 2021	ITSA via segmented regression	Monthly suicide rate per 100,000 persons	Yes	Region	↑	No	Yes	Yes	↑
Anzai et al. [19]	Japan	January 1, 2013-June 30, 2020	March 1-June 30, 2020	ITSA via segmented regression	Monthly suicide counts	Yes	Age groups	↓	No	Yes	No	↑
Arya et al. [55]	India	January 1, 2010-December 31, 2020	This study compared 2020 and 2017–2019	Joinpoint regression; direct comparison vs. year 2017	Annual suicide rates per 100,000 persons	Yes	Socioeconomic status	↑	No	Yes	No	↑
Barbic et al. [59]	British Columbia, Canada	January 1, 2010-August 31, 2020	March 1-August 31, 2020	ITSA via ARIMA model, adjusted for seasonality	Monthly suicide rate per 100,000 persons	No	None	↓	Yes	Yes	Yes (method is not specified)	↓
Borges et al. [20]	Mexico	January 1, 2010-December 31, 2020	April 1-December 31, 2020	ITSA via segmented regression	Monthly suicides	No	State-level unemployment rate, population density, marginalization index	↑	No	Yes	Yes	↓
Bray et al. [21]	Maryland, United States	January 1, 2017-July 7, 2020	March 5-July 7, 2020	ITSA via segmented regression	Daily suicide counts	No	Race groups (White, Black, Hispanic, Asian, Other)	Only race-specific variations are reported	No	Yes	Yes	↓
Calati et al. [43]	Milan, Italy	January 1, 2016-April 30, 2021	March 1, 2020-April 30, 2021	Direct comparison vs. 2019	Proportion of autopsies corresponding with suicides	No	None	↓	No	No	Yes	↑

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Calderon-Anyosa et al. [22]	Peru	January 1, 2018-September 26, 2020	March 16-September 26,2020	ITSA via segmented regression	Biweekly suicide rate per 1,000,000 residents	Yes	None	↓	No	Yes	Yes	↓
Calderon-Anyosa et al. [22]	Peru	January 1, 2018-December 31, 2020	March 16-December 31,2020; divided into "lockdown" (March 16-June 30, 2020) and "post-lockdown" (July 1-December 31, 2020)	ITSA via segmented regression	Biweekly suicide rate per 10,000,000 residents	Yes	None	↓	No	Yes	Yes	↓
Chen et al. 2021	Taiwan	January 1, 2017-December 31, 2020	January 1-December 31, 2020	ITSA via segmented regression	Monthly suicide rates per 100,000 persons	No	Age groups	↓	No	No	No	↑
de la Torre-Luque et al. [46]	Spain	January 1, 2019-December 31, 2020	March 1-December 31, 2020	ITSA via segmented regression	Monthly suicide rates per 100,000 persons	No	None	No change in 2020; ↑ (during COVID-19 period)	No	Yes	No	↑
Deisenhammer and Kemmler [24]	Tyrol, Austria	April 1-September 20, 2006–2019 and 2020	April 1-September 30, 2020	ITSA via segmented regression	Total suicide count during the COVID-19 period	No	None	↓	No	Yes	Yes	↓
Dwyer et al. [25]	Victoria, Australia	January 1, 2015-January 31, 2021	January 1, 2020-January 31, 2021	ITSA via segmented regression	Weekly suicide count	No	None	No change	No	Yes	No	↑
Eguchi et al. [26]	Japan	January 1, 2012-November 30, 2020	Not defined	ITSA via segmented regression	Weekly suicide counts	Yes	Age groups	↑ (after July 2020)	No	Yes	Yes	↓
Faust et al. [27]	United States	January 1, 2015-August 31, 2020	March 1-August 31, 2020	ITSA via SARIMA model	Monthly suicide counts	No	None	↓	Yes	Yes	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Faust et al. [27]	Massachusetts, United States	January 1, 2015-May 31, 2020	March 1-May 31, 2020	ITSA via SARIMA model	Suicides between March–May 2020. Incidence rate ratio (IRR) between March–May 2020 vs. 2019	No	None	No change	Yes	Yes	Yes	↓
Garnett [56]	United States	January 1, 2000-December 31, 2020	This study compared 2000 and 2020	Joinpoint regression and pairwise comparison of trends via Z-tests	Annual suicide rates per 100,000 persons	Yes	Age groups, suicide method	↓	No	Yes	No	↑
Horita and Moriguchi [47]	Japan	January 1, 2009-September 30, 2021	April 1-September 30, 2021	ITSA via segmented regression	Monthly suicide rates per 100,000 persons	Yes	Age groups	No change (April-June 2020), ↑ (July 2020-September 2021)	No	Yes	Yes	↓
Isumi et al. [29]	Japan	January 1, 2018-May 31, 2020	March 1-May 31, 2020	ITSA via segmented regression	Monthly suicide rates and monthly suicide counts	No	Study restricted to people aged < 20	↓	No	Yes	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Kegler et al. [57]	United States	Januar 1, 2019-December 31, 2020	This study compared 2019 and 2020	Direct comparison vs. year 2019	Annual firearm suicide rate per 100,000 persons	Yes	Age groups, race-ethnicity (Asian or Pacific Islander, American Indian or Alaska Native, Black, White, Hispanic), US Census Bureau geographic division, urbanization level	No change	No	No	No	↑
Koda et al. [30]	Japan	December 1, 2014-May 31, 2021	January 1, 2020-May 31, 2021	ITSA via segmented regression	Monthly suicide counts	Yes	Age groups	↑ (July-November 2020)	No	Yes	Yes	↓
Leske et al. [48]	Queensland, Australia	January 1, 2015-August 31, 2020	February 1-August 31, 2020	ITSA via segmented regression	Monthly suicide rate per 100,000 persons	Yes	None	No change	No	Yes	Yes	↓
Lin et al., 2021	Taiwan	January 1, 2015-December 31, 2020	January 1-December 31, 2020	ITSA via segmented regression	Monthly suicide counts	No	Age groups	↓	No	Yes	Yes	↓
McIntyre et al. [58]	Canada	March 1, 2010-February 28, 2021	March 1, 2020-February 28, 2021	Direct comparison between the March 1-February 28 periods between 2010 and 2021	Annual suicide rate per 100,000 persons	No	None	↓	No	No	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Mitchell and Li [60]	Connecticut, United States	March 10-May 20, 2014–2020	March 10-May 20, 2020	Direct comparison between March 10-May 20, 2020 and the same period between 2014–2019; comparisons via Chi-square and two sample t tests	Suicide rates per 100,000 person-years	No	Race groups (White vs. Non-White), suicide method	↓	No	No	Yes	↓
Nomura et al. [32]	Japan	December 1, 2010-December 31, 202	Not defined	ITSA via segmented regression	Monthly suicide counts	Yes	None	↑ (After September 2020)	No	Yes	No	↑
Nomura et al. [33]	Japan	December 1, 2010-September 30, 202	Not defined	ITSA via segmented regression	Monthly suicide counts	Yes	None	↑ (July–September 2020, only among women)	No	Yes	No	↑
Orellana and de Souza [34]	Brazil	March 1, 2015-December 31, 2020	March 1-December 31, 2020	ITSA via segmented regression	Bimonthly suicide counts	Yes	Age groups, region, specific bi-monthly periods	No change	No	Yes	Yes	↓
Osaki et al. [49]	Japan	January 1, 2010-December 31, 2020	February 1-December 31, 2020	Direct comparison between 2020 and 2017–2019 period average	Monthly suicide rates per 100,000 persons	Yes	None	↓ (February-June 2020), ↑ (July 2020 onwards among women, October 2020 onwards among men)	No	No	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Osvath et al., 2021	Hungary	January 1 2010-December 31, 2020	March 1-December 31, 2020	ITSA via segmented regression	Monthly suicide counts	Yes	None	↑ (driven solely by men)	No	Yes	Yes	↓
Partonen et al. [50]	Finland	January 1, 2016-December 31, 2020	March 1, 2020-December 31, 2020	ITSA via segmented regression	Monthly suicide rate per 100,000 persons	Yes	None	No change	No	Yes	Yes	↓
Perez et al. 2022	Catalonia, Spain	January 1, 2019-December 31, 2020	This study compared 2019 and 2020	Direct comparison vs. 2019	Annual suicide rate per 100,000 persons	No	None	↓ (April 2020), ↑ (June-October 2020)	No	No	Yes	↓
Pirkis et al. [13]	Several locations*	Varied by location, as far back as January 1, 2016 and until as recently as October 31, 2020	Main analysis: April 1, 2020—July 31, 2020. Secondary analyses: April 1, 2020—October 31, 2020; March 1, 2020—July 31, 2020	ITSA via segmented regression	Monthly suicide counts	No	None	Main analysis: No change. Analysis incorporating data up to October, 2020: ↑in Vienna, Japan, and Puerto Rico	No	Yes	Yes	↓
Pokhrel et al. [37]	Nepal	Not reported	March 1-May31, 2020	Direct comparison vs. 2019	Suicide count during the COVID-19 period	No	None	↑	No	No	No	↑
Qin and Mehlum [38]	Norway	March 1-May 31, 2014–2018 and 2020	March 1-May 31, 2020	Direct comparison vs. the 2014–2018 period	Quarterly and monthly suicide counts	Yes	Age groups	↓ (no confidence intervals)	No	No	No	↑
Radeloff et al. [51]	Leipzig, Germany	January 1, 2010-September 30, 2020	March 1-September 30, 2020	ITSA via segmented regression	Monthly suicide rates per 100,000 persons	No	None	No change	No	Yes	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Rogalska and Syrkiewicz-Switala [39]	Poland	January 1, 2017-December 31, 2020	This study compared 2017, 2018, 2019, and 2020	Direct comparison vs. the 2017–2019 period	Annual suicide counts	Yes	Age groups, marital status	↑ (no confidence intervals)	No	No	No	↑
Rossom et al. [54]	Minnesota and Michigan, United States	January 1, 2019-December 31, 2020	March 1-December 31, 2020	ITSA via segmented regression	Annualized crude suicide rates per 100,000 persons	No	None	↓	No	Yes	No	↑
Sakamoto et al. [52]	Japan	January 1-November 30, 2016–2020	April 1-November 30, 2020	Difference-in-difference analysis	Monthly suicide rates per 100,000 persons	Yes	Age groups, occupational status (self-employed, student, homemaker, unemployed)	↑ (October and November 2020 for men and July-November 2020 for women)	No	Yes	Yes	↑
Schleihauf and Bowes [40]	Nova Scotia, Canada	February 1, 2009-February 28, 2021	March 1, 2020-February 28, 2021	ITSA via segmented regression	Monthly suicide counts (excluding drug toxicity deaths)	Yes	Age groups	↓	No	Yes	Yes	↓
Stene-Larsen et al. [61]	Norway	January 1, 2020-December 31, 2020	March 1-December 31, 2020; divided in first wave (March–May 2020), intermediate period (June–September 2020), and second wave (October-December 2020)	ITSA via segmented regression	Age-standardized quarterly suicide rates per 100,000 persons	Yes	Age groups, region	No change	No	Yes	Yes	↓

Table 1 (continued)

Author, date	Setting	Time examined	COVID-19 period definition	Statistical approach	Outcome measure	Results by sex	Additional covariates measured	Change in suicide overall	Assessment of			Risk of bias
									Auto-correlation	Non-stationarity	Seasonality	
Tanaka and Okamoto [53]	Japan	November 1, 2016-October 31, 2020	February 1-October 31, 2020	Difference-in-difference analysis	Monthly suicide rates per 100,000 persons	Yes	Age groups, employment	↓ (February-June 2020), ↑ (July–October 2020)	Yes	Yes	Yes	↓
Watanabe and Tanaka [41]	Japan	January 1, 2011-December 31, 2020	This study compared 2020 and 2011–2019	Joinpoint regression and ITSA via segmented regression	Annual suicide counts	Yes	Age groups	↑	No	Yes	No	↑
Wollschlager et al. [42]	Rhineland-Palatinate (Germany) and Emilia-Romagna (Italy)	January 1, 2010-December 31, 2020	This study compared 2010–2019 and 2020	ITSA via segmented regression	Monthly suicide counts	Yes	Age groups, region	No change	No	Yes	No	↑
Zheng et al. [62]	Guandong, China	January 1, 2019-June 30, 2020	January 1, 2020-June 30, 2020	Percentage change: (suicide rate during COVID-19 period—suicide rate during same period in 2019)/suicide rate during same period in 2019	Suicide rate per 100,000 persons during the COVID-19 period	Yes	Age groups	↓	No	No	No	↑

*Data include whole country data from Chile, Croatia, Ecuador, Estonia, Japan, Netherlands, New Zealand, Peru, Poland, South Korea. Regional data from Australia (New South Wales, Queensland, Victoria), Austria (Carinthia, Tyrol, Vienna), Brazil (Botucatu, Maceio), Canada (Alberta, British Columbia, Manitoba), United Kingdom (Thames Valley), Germany (Cologne and Leverkusen, Frankfurt, Leipzig), Italy (Udine and Pordenone), Mexico (Mexico City), Russia (Saint Petersburg), Spain (Las Palmas), United States (California, Illinois, Lousiana, New Jersey, Texas, Puerto Rico)

ITSA = Interrupted Time-Series Analysis, ARIMA = Autoregressive Integrated Moving Average, SARIMA = Seasonal Autoregressive Integrated Moving Average

39, 41]. In 20 studies, the outcome of interest was measured as suicide rate – and expressed as monthly suicide rate [29, 44–54], annual suicide rate [55–58], or suicide rate using a different time window [59–62].

There was between-study variation in the definition of the COVID-19 period, largely due to geographical variation in the timing of the first local case of SARS-CoV-2. While 22 studies defined March 2020 as the beginning of the pandemic, [18, 19, 21–23, 27–29, 34, 36–38, 40, 43, 46, 50, 51, 54, 58–61], 6 studies [13, 20, 24, 44, 47, 52] – including Pirkis et al.'s study featuring data from 21 countries [13], used April 2020, 11 studies used January 2020 [25, 30, 31, 35, 39, 41, 42, 45, 56, 57, 62] and 3 studies February 2020 [48, 49, 53]. The studies by Eguchi et al. [26] and Nomura et al. [32] did not report a specific COVID-19 period.

There was substantial heterogeneity in choice of statistical approach to estimate the difference between expected and observed suicide counts or rates. In general, all approaches aimed at estimating the counterfactual outcome (e.g., monthly suicide count, or monthly suicide rate) had the COVID-19 pandemic outbreak not taken place – in order to then compare expected vs. observed outcomes. The majority of studies adopted an ITSA approach based on some specification of a segmented regression – e.g., Poisson [13, 19, 20, 23, 24, 29, 40, 41, 46, 48, 50, 55, 61], quasi-Poisson [26, 30, 32, 34, 36], negative binomial [31, 42, 51], linear [21, 22, 25, 44, 47], or non-specified segmented regression [45, 54] model with a variety of additional covariables, such as unemployment rate [19], sex [23], intensity of travel restrictions [51], and interaction terms between the covariates [34]. Only 3 studies implemented ITSA based on seasonal autoregressive integrated moving average models [27, 28, 59]. In addition, 2 Japanese studies used a difference-in-difference approach: both included appropriate control for seasonality and non-stationarity [52, 53]. Appendix 1 specifies approaches undertakes to deal with seasonality, non-stationarity, and autocorrelation. All in all, a total of 26 out of 46 included studies (56.5%) were considered at low risk of bias.

Geographical Variation Between Countries

Figure 1 represents suicide variations following onset of the pandemic across the globe. Regarding North America, evidence indicates that suicides decreased in Canada [58] and the United States [56] but increased in Mexico. In Canada, February–March bimonthly suicide rates were 10.8 and 7.3 per 100,000 persons in 2019 and 2020, respectively; [58] decreases were also reported by studies focused on British Columbia, where a comparison of suicide rates between March-August 2020 vs. the average during the same months during the 2010–2019 period yielded an IRR (95% CI) = 0.92 (0.86, 0.98) [59], (and Nova Scotia, with 30 fewer suicides than expected between March 2020 and February 2021) [40]. In the United States, suicide counts were an estimated (95% CI) 2432 (1071, 3791) lower than expected between March and August 2000 [27]. One study highlighted that firearm suicide rates also did not change in the US in 2020, compared to 2019 [57]. In Mexico, suicide increased by 3% (95% CI = 1%, 6%) between April-December 2020. In South America, studies detected no increases in suicide in

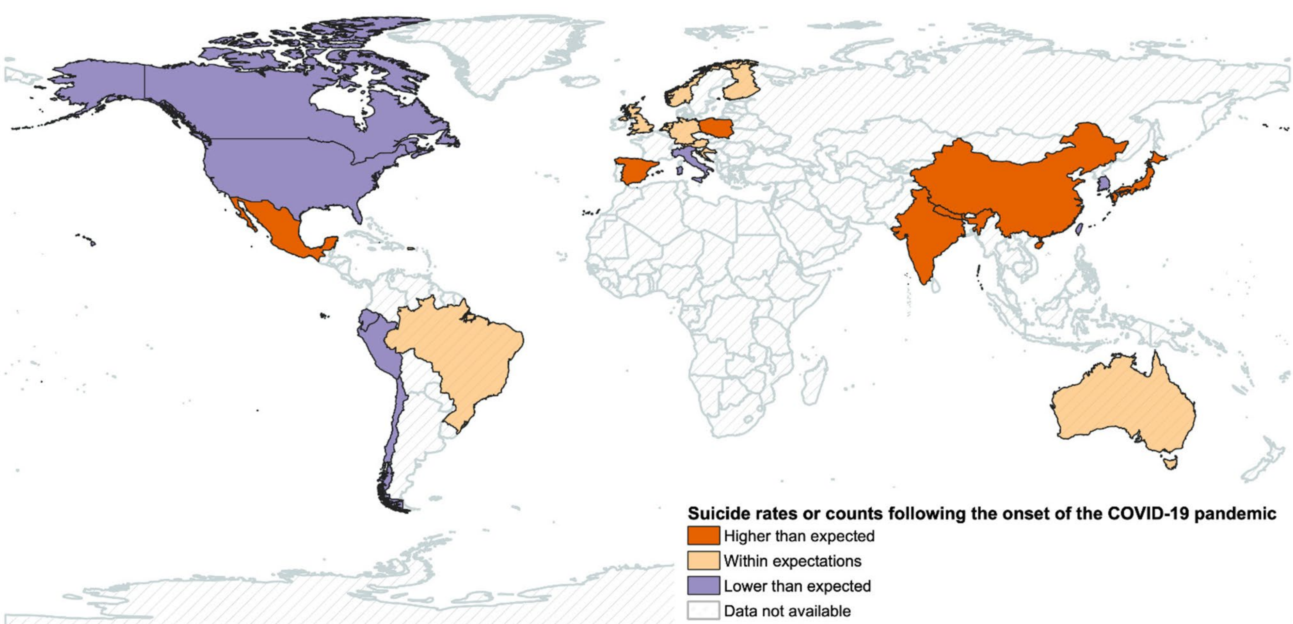

Fig. 1 Worldwide geographical distribution of suicide following the onset of the pandemic, systematic integrative review

Brazil [34] and evidence of an initial decrease following the initial pandemic outbreak in Peru [22, 23]. In Asia, studies also revealed heterogeneity across place. There is some evidence of marked increases in suicide in Nepal (25% in 2020 compared to 2019) [37, 44] and India (15% in 2020 compared to 2017) [55]. In the Chinese region of Guangdong [62] and in Taiwan [31, 45], on the contrary, studies suggest decreases in suicide after January 2020, compared to expected rates: an 18.5% decrease between January and June 2020 in Guangdong [62] and 0.08 fewer suicides per 100,000 persons per month throughout 2020 in Taiwan [45]. Japan has been the subject of extensive reporting regarding suicide rates following the initial pandemic outbreak. Taken together, evidence indicates that suicide decreased between the pandemic outbreak and early summer of 2020 [29, 49, 53] and subsequently increased throughout late summer, fall, and winter 2020–2021. According to the study by Tanaka and Okamoto, suicide rates in Japan first decreased by 14% (95% CI: 10%, 18%) between February and June 2020 and then increased by 16% (95% CI: 11%, 21%) between July and October 2020 [53]. Variation in suicide in Japan were heterogeneous across sex and age groups, as discussed below. [26, 29, 30, 32, 41, 47, 49, 52, 53]

At least two large studies suggest that suicide remained stable in Australia in 2020 [25, 48]. Regarding Europe, evidence is also mixed across place: Suicide decreased during the initial phases of the COVID-19 pandemic in Milan, Italy (in terms of suicide counts and in the proportion of autopsies corresponding with suicides between March–April 2020) [43], and the Austrian region of Tyrol (with around 20 fewer suicides than expected between April-September 2020) [24]. On the other hand, between March and December 2020 there were 7% (95% CI: 2%, 12%) increases in suicide rates in Spain (although an initial decrease was detected in Catalonia) [35, 46], and 16% increases in suicide counts in Hungary [36]; and there were increases in suicide in 2020 compared to 2017 – according to one suboptimal study directly comparing crude annual suicide counts [39]. In Norway [38, 61], Finland [50], the Italian region of Emilia-Romagna [42], and the German regions of Rhineland-Palatinate [42] and Leipzig [51], suicide remained stable during the initial months of pandemic.

Geographical Variation Within Countries

Two studies from Nepal and Mexico reported notable within-country geographical variation – most salient increases took place in Sudurpaschim and Karnali provinces, in Nepal [44], and in Mexico City, in Mexico (in fact suicide decreased in other Mexican states, such as Baja California) [20]. Also, three studies examined specific US states: suicide rates decreased by 13% between March 10 and May 20 2020 (compared to the same period between 2014–2019) in Connecticut [60] and by 0.45 per 100,000 persons per month Minnesota and Michigan [54], though suicide counts remained roughly unchanged in Massachusetts [28].

Temporal Variation

Some studies provide evidence that suicide rates changed dynamically over the months following onset of the pandemic. In several locales, an initial decrease in suicide was followed by a subsequent increase – yet the duration of the initial decrease was highly variable across place. In Peru, biweekly suicide counts dropped during the initial weeks of the pandemic, with a slope (95%CI) of 0.9 (0.8, 1.1), for a subsequent increase of 1.2 (0.9, 1.5) that ended up by the end of the stay-at-home mandate in June 2020, with suicide reaching back levels comparable to 2019. In Milan, Italy, compared to the same months in 2019, suicide counts were lower between April 2020 and March 2021, and higher in April 2021. In Catalonia, Spain, compared to 2019, suicide counts decreased in April 2020 for an Incidence Rate Ratio (IRR) (95% CI) = 0.64 (0.41, 1.02) but increased between June and September 2020, with IRRs ranging between 1.14 and 1.31 (95% CIs not reported) [35]. The initial analysis by Pirkis and colleagues in 21 countries, including April-July 2020 data, did not reveal increases in any locale – however, inclusion of data up to October 2020 indicated increases in suicide in Vienna (Austria), Puerto Rico, and Japan – IRRs (95% CI) = 1.31 (1.08, 1.59), 1.29 (1.05, 1.58), and 1.05 (1.04, 1.07), respectively. In fact, the largest body of evidence indicating temporal variation in the impact of COVID-19 on population suicide comes from a series of Japanese studies. Two initial studies including data up to June 2020, indicated a downward trend in suicide in Japan [19, 29]. Notwithstanding, subsequent studies revealed higher-than-expected suicide counts between July and November 2020 [26, 32, 33, 47, 52], with a peak excess 25.8% suicides in October 2020 [30], driving an overall 10% higher-than-expected suicide count in 2020 compared to 2019 [41]. Studies cited the following potential explanations for initial reductions in suicide during the pandemic: a temporal increase in social cohesion, positive effects of remote work and home schooling, or implementation of economic stimulus aid. Subsequent increases in suicide in specific locations were largely attributed to socioeconomic stress.

Variation By Sociodemographic Variables

Several studies report heterogeneity in the effect of COVID-19 on suicide by sociodemographic characteristics. Variations by the most frequent variable of stratification, sex, are summarized in Table 1. All other results stratified by sociodemographic variables, including groups defined by sex and age, are summarized in Table 2. In most settings, effects were homogeneous across sex. However, there were exceptions. In

Table 2 Variation in suicide across sociodemographic variables, systematic integrative review

Author, date	Setting	Sex and age groups	Racialized groups	Socioeconomic status (SES)	Other
Acharya et al. [44]	Nepal				Geographical variation: ↑↑ in Sudurpaschim and Karnali provinces
Anzai et al. [19]	Japan	↑ especially young females			
Arya et al. [55]	India			↑↑ males from low SES states	
Borges et al. [20]	Mexico				Geographical variation: e.g., ↑ in Mexico City and ↓ in Baja California
Bray et al. [21]	Maryland, USA		↑ Black but ↓ White residents		
Chen et al., 2021	Taiwan	↑only persons aged > 64			
Eguchi et al. [26]	Japan	↑ especially females aged 40–49 and males aged 20–29			Occupation: ↑ in housewives, no change in self-employed persons
Garnett [56]	United States	↑ only females aged 15–24; ↓ males aged 45–75			
Horita and Moriguchi [47]	Japan	↑ in males aged 20–29 and females aged 20–79			
Kegler et al. [57]	USA		↑ in American Indian and Alaska Natives, Black Non-Hispanics, and Hispanics of any race		
Lin et al. 2021	Taiwan	↓ across groups except for ↑ in persons aged > 64			
Mitchell and Li [60]	Connecticut, USA		↑ Non-White, ↓ White persons		
Orellana and de Souza [34]	Brazil	↑ in males aged > 59 and females aged 30–59 (Northern region) and in women aged > 59 (North-eastern region)			
Qin and Mehlum [38]	Norway	Age groups assessed: no change found			
Rogalska and Syrkiewicz-Switala [39]	Poland	Age groups and marital status assessed: no change found			
Sakamoto et al. [52]	Japan	↑ in women aged > 30			
Schleihauf and Bowes [40]	Nova Scotia, Canada	Age groups assessed: no change found			
Stene-Larsen et al. [61]	Norway	Age groups assessed: no change found			
Tanaka and Okamoto [53]	Japan	↑ especially females and children and adolescents			
Watanabe and Tanaka [41]	Japan	↑ males aged 20–29 and females of all ages			
Wollschlager et al. [42]	Rhineland-Palatinate (Germany) and Emilia-Romagna (Italy)	↑ males aged > 69			
Zheng et al. [62]	Guandong, China	↑ males and females aged < 15 and > 70			

Studies from Nepal, Mexico, and the United States reported within-country geographical heterogeneity. Data used for the map on suicide in Australia, Austria, China, Canada, Germany, and Italy are not nationally representative but come from population-based studies restricted to specific region

Peru, initial decreases resulted in one fewer female suicide and two fewer male suicides per million residents per month [22]. In Japan, excess suicides between July and October 2020 were entirely driven by increases in female suicide [26, 49]; with male suicide increasing only after October 2020 [32, 52]. In October 2020 in Japan, suicide went up by 61% among women, but only by 6% among men [30]. Between July 2020 and September 2021, the increase was of 31% among women but only 17% among men [47].

In terms of age, several studies reporting age group-stratified results found no relevant results to report. Notwithstanding, a study examining data from Rhineland-Palatinate, in Germany, and Emilia-Romagna, in Italy, revealed increases in suicide among men aged 70 and older [42]. Similarly in Guangdong, China, suicide rates during the COVID-19 period increased only among males and females aged 0–15 (increasing by 150% in males and 127% in females) and 70–79 (increasing by 21% in males and 12% in females) [62]. Further, suicide rates went down in all age groups but older adults in Taiwan – in fact, older adults in Taiwan experienced 40% increases in suicide in August (RR, 95% CI = 1.41, 1.08–1.82) and October 2020 (RR, 95% CI = 1.44, 1.11–1.88) [45]. In Japan, on the contrary, even though suicide increased across sex and age group after October, 2020, increases occurred earlier among females of all ages and young males [41] and were particularly salient among females aged 20–39 (i.e., suicide went up by 94% in June 2020 among females aged 20–29) [19, 52]. Tanaka and Okamoto, in addition, also detected suicide increases among Japanese adolescents [53]. In Brazil, increases affected especially men aged 60 and older and women aged 30–59 in the Northern region, and women aged > 59 in the Northeastern region [34].

Evidence is scarce regarding socioeconomic status (SES): only the study by Arya et al. in India reported that increases were fivefold higher among males residing in low SES states [55]. Along these lines, Eguchi et al. reported results by job type – finding no variation in suicide among self-employed residents and increases in suicide throughout all pandemic periods among housewives (a specific category for females not employed outside of the home) [26].

Last, there is some evidence that suicide dynamics during the initial phases of the pandemic were affected by racial and ethnic minoritization in the United States: a study using state-wide data from Connecticut found that between March 10 and May 20, 2020 suicide increased by 60% among non-White individuals (a group that, in this study, included individuals of Black, Hispanic, Asian, and "Other" ethno-racial background), while it decreased to a 6-year low among White counterparts [60]. Likewise, in Maryland mean daily suicides increased by 94% among Black but decreased by 45% among White residents in 2020 compared to the 2017–2019 period, and after March 5, 2020 suicide had an increasing slope in Black residents (0.30) but a decreasing one in White counterparts (-0.19) [21]. Studies considered increases in suicide among socially and racially minoritized groups, females, young males, and older individuals as supportive of a potential role of socioeconomic stress on suicide risk with higher impact on disadvantaged groups.

Discussion

This systematic integrative literature review included all population-based estimates of changes in suicide during the months after the onset of the COVID-19 pandemic accessible using scientific databases and reported in English, Spanish, or French. We focused on describing heterogeneity in suicide variation across place and over time, as well as across population groups defined by sociodemographic characteristics. We did this for two reasons: first, the experience of the pandemic and of pandemic-related mental health stressors varied markedly across geographical and temporal contexts and persons – that is, "pandemic" as an exposure is ill-defined and, as such, of limited use to guide public health decision-making [63, 64]. Focusing on differences across geographical or temporal contexts or population groups in suicide during the pandemic can guide identification of potential specific pandemic-related stressors (e.g., universal stay-at-home mandates without stimulus payments) or effect measure modifiers (e.g., level of uptake of remote work) that may function as actionable drivers of despair and suicide rates. Second, specific sociodemographic groups may have particularly high suicide risk during the pandemic and should be identified for prioritization of targeted interventions. The main finding was that, even though increases in suicide following the initial pandemic outbreak were not detected in most study locations, changes in suicide during the COVID-19 era varied geographically, temporally, and across population groups.

We found that during the initial months of the pandemic, suicide decreased or remained unchanged in all locations with published data. This is in keeping with a previous systematic review including data up to July 2021 [14]. Interpreting this finding is challenging, given that many experts expected increases in suicide driven by pandemic-related stressors [12], and in light of increases in population prevalence of mental health symptoms [3–8] and suicidal thoughts [11] in several contexts. In many studies, reductions in suicide during the pandemic period were partially attributed to a temporal increase in social cohesion generated by the social disruption driven by the pandemic [13, 25, 34, 51]. This phenomenon, sometimes referred to as "pulling together effect" and initially described in the work of Emile Durkheim [65], has been previously reported in the aftermath of natural wars [66], disasters [67], pandemics [65, 68], and other major societal crises. Additional proposed explanations for lower-than-expected suicide rates included: a greater surveillance of youth due to extended stays at home with adult family members [29, 34], reduced access to means such as pesticides or medications [23], crisis response strategies including bolstering mental health services to maintain access [13, 50], extended unemployment benefits and stimulus aids [25, 28], campaigns of mental health awareness bolstering videocall contact [28], reductions in time living alone [23], reductions in commuting time due to work-from-home policies [19, 53], reduction in stress among children and adolescents due to home schooling [19, 29, 53], and in the particular case of Taiwan lack of need for physical distancing measures [31, 45].

As the pandemic evolved, however, subsequent increases in suicide were reported in specific locations: there were higher-than-expected suicide rates in Mexico, Puerto Rico, Japan, Vienna (Austria), Spain, Hungary, and Poland. In studies reporting monthly variation of suicide rates, higher-than-expected suicide rates started to be detected around 3–5 months after the initial outbreak [23, 30, 32, 35, 49, 52, 53]. For instance, several authors found suicide in Japan to have decreased between February and June 2020, with subsequent increases from July 2020 onwards [49, 52, 53]. Two observations stand out regarding suicide increases among specific population groups during the pandemic. First, increases were sex- and age-patterned in some locations. In Japan, increases in suicide took place earlier and were more marked among females (especially young females) than males [26, 30, 32, 49, 52, 53]. In Guangdong (China) [62], Rhineland-Palatinate (Germany) and Emilia-Romagna (Italy) [42], and Taiwan [45], on the contrary, suicides went up only among older adults (especially older men). Second, markers of minoritization and social disadvantage also played a role in suicide variation. For instance, in the United States, although suicide decreased after the initial outbreak in the general population, the decline was driven by decreases among White persons, with immediate increases reported among non-White residents in Connecticut [60] and Black residents in Maryland [21].

Considering all available evidence, this review supports a potential role of (i) differences in risk of COVID-19 contagion and mortality and (ii) minoritization and socioeconomic disadvantage on suicide rates and trends during the pandemic. As mentioned, suicide rates increased disproportionately among older individuals and especially older males in some locations. COVID-19 incidence and mortality were also much higher in older adults than for the rest of the population during the initial phases of the pandemic [69], likely contributing to increased fear of contagion and death, bereavement of partners and close friends, and loneliness due to isolation measures, stressors more acutely affecting older adults compared to their working-age counterparts. Death of a partner or close relative is a major risk factor for suicide in the short-term [70]: the increase in suicide risk following death of a spouse is highest in older adults [71] – especially among older males [72]. Importantly, while differences in risk of COVID-19 contagion and mortality may explain excess suicides among older adults, there are no clear differences between locations with and without increases in suicide among older individuals.

The potential role of minoritization and socioeconomic disadvantage as important actionable effect measure modifiers of the association between pandemic-related stressors and suicide is partially supported by observations from this review. First, suicide did not increase in countries where economic stimulus efforts were rapidly deployed (e.g., Australia [48], United States [57]) but did increase in countries without such policies (e.g., Spain [46], Mexico [20]) – suggesting that market protection measures can moderate increases in suicide rates during major societal crises. Moreover, in Japan, authors highlighted that economic relief policies implemented right after the initial pandemic outbreak were discontinued after June 2020 – which was followed by upward trends in suicide [53]. Second, higher-than-expected suicide rates affected sociodemographic groups at higher economic vulnerability (i.e., at higher risk of unemployment, overrepresented in the hospitality and tourism industries, with lower access to remote job opportunities), such as young males and females of all ages in Japan [26, 41, 52, 53]. Regarding increases in female suicide in Japan, the impact of the pandemic on burden for caregivers [30, 53] (especially following school closures [53]) and on rising rates of domestic violence [26, 32, 33] may also have played a relevant role. All these factors are deeply intertwined, as overall increases in precarious and informal work typically re-establish women as an economically dependent flexible labor supply [73], increasing the gender gap in socioeconomic vulnerability. In the United States suicide increased only among ethno-racially minoritized residents [21, 60], the group with (i) the highest excess COVID-19 mortality [74], (ii) the highest exposure to unemployment, and (iii) the lowest uptake of work-from-home policies [75]. In Mexico, researchers cited overcrowding as a potential cause for excess suicide mediated by excess COVID-19 incidence and mortality, as suicide increases were highest in Mexico City [20]. In Brazil, Orellana and de Souza emphasized that increases took place among older individuals in the Northern and Northeastern regions – the population groups with the lowest access to the Internet [34].

The findings of this review have three important implications for public health decision-making. First, disproportionate increases in suicide among older individuals underscore the importance of targeting older individuals at high-risk for suicide (e.g., following loss of a partner or close friend), reducing social disconnectedness through early, proactive social care evaluation [76] and deploying older age-friendly suicide prevention strategies (e.g., within geriatric facilities). Also, this finding highlights the importance of further assessing differences in policies regulating safety nets for older adults between countries with and without suicide increases in this age group. Second, the enhancing role of minoritization and socioeconomic disadvantage for suicide risk during the pandemic suggests that additional protective socioeconomic measures (e.g., prolonged unemployment subsidies) should be put in place for individuals working low-wage, informal, and contingency jobs, and those with reduced access to work-from-home positions. Third, suicide trends overall and by sociodemographic group should continue to be monitored across the globe, ideally reducing the lag between deaths take place and mortality data are available, given that suicide drivers can vary dramatically over time (e.g., firearm sales have recently gone up in the United States) [77] and to guide early identification of emerging high-risk groups.

This study has strengths worth noting. We based the review on an extensive search strategy that included multiple large databases. In addition, we used multiple reviewers to increase reliability of study selection and data extraction procedures, as well as of assessments of risk of bias. On the other hand, there were important methodological differences across studies (e.g., differences in the temporal definition of the COVID-19 or the control periods or in choice of statistical approach) that may account for part of the observed heterogeneity in results. Most studies, however, defined the COVID-19 period based on the date of the first confirmed case locally, used the previous 1–4 years as control period, and chose appropriate statistical methods for time-series analyses where an intervention (onset of the pandemic) is under consideration (i.e., interrupted time-series analysis using segmented regression or ARIMA models with appropriate adjustment for autocorrelation, seasonality, and non-stationarity). Moreover, the subset of studies examining suicide in Japan during the pandemic used a variety of designs but found overall similar results, suggesting relative robustness to choice of statistical approach.

In conclusion, this systematic integrative review including all population-based studies assessing changes in suicide following the onset of the pandemic found suicide trends during the pandemic to be heterogeneous across place and population subgroups and over time – though suicide rates remained unchanged or decreased in most locations. These findings support a relevant role of two factors modifying suicide risk among specific population groups during the pandemic. First, risk of COVID-19 contagion and mortality, as well as of bereavement and loss due to COVID-19, may explain the excess risk of suicide among older adults and especially males in several places – although explanations to why suicide among older adults only increased in some locations remain elusive. Second, socioeconomic vulnerability (e.g., vulnerability to unemployment, barriers to work-from-home jobs) may explain increases in suicide following interruption of stimulus aids and the excess risk of suicide among females and young males in Japan. Moreover, both factors affected ethno-racially minoritized persons in the United States, whose suicide risk also increased disproportionately. These findings highlight the importance of targeting social disconnectedness and deploying appropriate suicide prevention for older persons, ensuring access to labor market protection measures for socioeconomically vulnerable groups, and maintaining continued monitoring efforts to improve early detection of changes in suicide trends.

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Declarations

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