Suicide following the COVID-19 pandemic outbreak: variation across place, over time, and across sociodemographic groups. A systematic integrative review

Supplementary Material

Appendix 1: Methodological considerations regarding autocorrelation, seasonality, and non-stationarity

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.

Autocorrelation can be assessed with Durbin-Watson tests or graphically, and controlled for with appropriate modelling techniques.[1]

Seasonality (which should be expected in studies on suicide – for instance, suicide in Western societies typically peaks in spring and summer and decreases in fall and winter) can be controlled for using various strategies – e.g., including month as a correlate, using Fourier terms (pairs of sine and cosine functions), or including time as a spline in segmented regression models, or via differencing in ARIMA models.[2]

Non-stationarity (i.e., variation over time of the statistical properties of a time series, or of the data generating process, such as a pre-existing time trend that has no relation with the interruption of time series of interest – which can also be referred to as *trend non-stationarity*) can be examined graphically or using the Dickey-Fuller test and, if present, data should be stationarized to enhance predictability – e.g., controlling for year in segmented regression models or, again, via differencing in ARIMA models.[3]

Accordingly, the abstraction form included specific variables to indicate if autocorrelation, seasonality, and non-stationarity were explicitly assessed and controlled for. Moreover, as explained in detail below, 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.[4] assessing the following 7 characteristics of ITSA: Was the intervention independent of other changes? Was the shape of the intervention effect pre-specified? Was the intervention unlikely to affect data collection? Was the primary outcome measured objectively? Were incomplete outcome data adequately addressed if applicable? Was the study free of selective outcome reporting? Was the study analyzed appropriately using interrupted time series techniques? 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., ARIMA models or segmented regression) with explicit control for autocorrelation, seasonality, and non-stationarity.

Several ITSA studies based on segmented regression explicitly controlled results for underlying trends (i.e., non-stationarity) including year as a covariate, and for seasonality either including month as a covariate or by design, comparing the same months in different years.

Additional, common approaches to further control for seasonality were inclusion of month-fixed effects[5] and inclusion of Fourier terms.[6–12] Autocorrelation, on the other hand, was not assessed in ITSA studies based on segmented regression.

Only 3 studies implemented ITSA based on seasonal autoregressive integrated moving average models,[13–15] an approach which can effectively control for autoregression, non-stationarity, and seasonality.[4]

In addition, 2 Japanese studies used a difference-in-difference approach: both included appropriate control for seasonality and non-stationarity,[16,17] but only one used clustered standard errors, a commonly used approach to correct autocorrelation in difference-in-difference designs.[17]

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Supplementary Table S1 Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Checklist

Section and Topic	Item #	Checklist item	Page where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	40
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	X
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	38-40
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	40
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	58
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	40
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	40
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	41
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	59
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	59
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	43
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	43
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	59
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	59

Section and Topic	Item #	Checklist item	Page where item is reported
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	42
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	NA
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	41-43, 63
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	42
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	59
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	65
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	65
Study characteristics	17	Cite each included study and present its characteristics.	59
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	59
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	59
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	59
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	NA
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of	50-54

Section and Topic	Item #	Checklist item	Page where item is reported
		other evidence.	
	23b	Discuss any limitations of the evidence included in the review.	55
	23c	Discuss any limitations of the review processes used.	55
	23d	Discuss implications of the results for practice, policy, and future research.	55
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	NA
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	NA
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	NA
Competing interests	26	Declare any competing interests of review authors.	NA
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	42

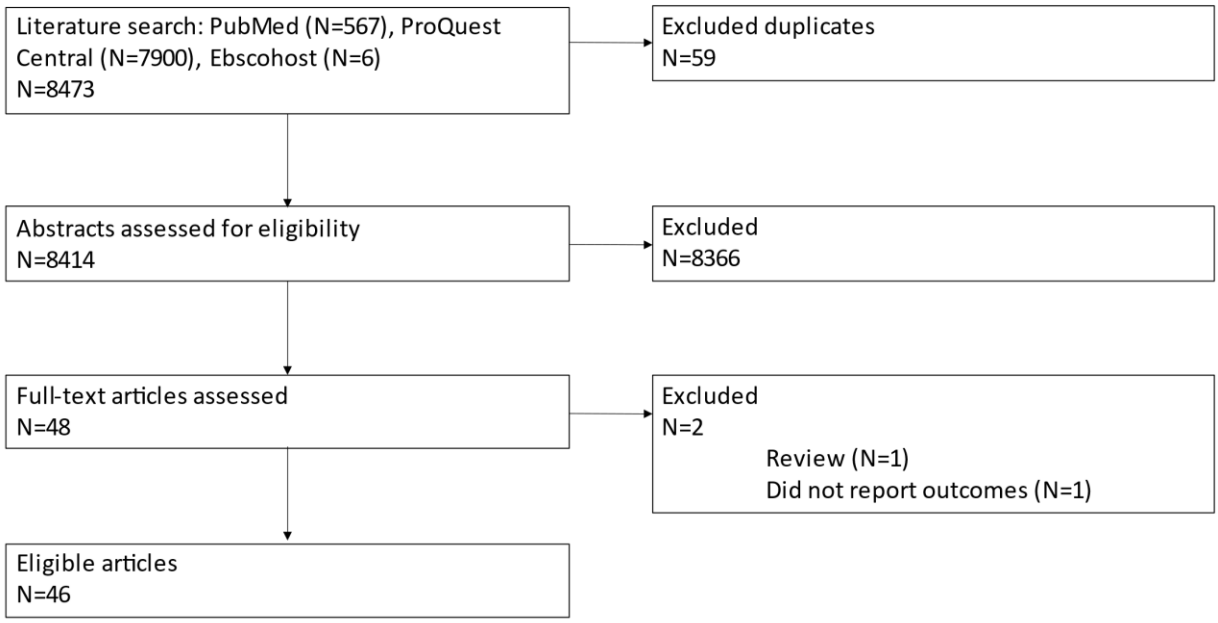
From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

For more information, visit: http://www.prisma-statement.org/

Supplementary Table S2: Inclusion and exclusion criteria, systematic integrative review

Inclusion criteria	Exclusion criteria
- Original research - Peer-reviewed - Published between 01/01/2020 and 07/10/2022 - Written in English, French, or Spanish (or data accessible from an abstract in English, French, or Spanish) - Population-based - Reports suicide counts or suicide mortality rates before and after the initial COVID-19 pandemic outbreak	- Non-original research (e.g., non-research letters, editorials, commentaries, viewpoints, reviews) - Outcome is not suicide counts or suicide mortality rate (e.g., suicidal behaviors, suicide attempts, suicidal ideation) - Outcome is not measured systematically for the whole population included (e.g., studies using single-forensic facility data)

Supplementary Figure S1 Flowchart of included studies



Of a total 8473 articles initially identified, 59 were duplicates and hence were excluded. We screened titles and abstracts of the remaining 8414 articles: 8366 articles were considered irrelevant and excluded for not meeting inclusion criteria at this stage. Of the remaining 48 articles, an additional 2 were excluded because they did not report original results (1 was a narrative review and 1 did not report outcomes at all).