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REVIEW

Suicide risk around the world: a meta-analysis of longitudinal studies

E. M. Guzmán[1] · C. B. Cha[1] · J. D. Ribeiro[2] · J. C. Franklin[2]

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Abstract

Purpose Suicidal thoughts and behaviors (STBs) have been a persistent problem worldwide. Identifying risk factors for STBs across distinct areas of the world may help predict *who* or *where* requires the greatest attention. However, risk factors for STBs are infrequently explored cross-nationally. The present study examined whether psychopathology prospectively predicts STBs across different areas of the world, and whether certain country-level factors moderate the degree of risk conferred.

Methods We conducted a meta-analysis of 71 longitudinal studies from 30 different countries that featured psychopathology-related variables predicting STB outcomes. Meta-regression was used to evaluate whether the following country-level factors modified risk: geographic region, income level, and degree of mental health structural stigma.

Results Over 90% of studies had been conducted in North America and Europe. When assessed by country income level, it was found that only one longitudinal study on psychopathology and STB was conducted outside of a high-income country. Moreover, less than 10% of studies were conducted in high structural stigma contexts. Meta-regression findings revealed that the variation in risk effect sizes across studies was not explained by models including country-level factors.

Conclusions Our findings show critical underrepresentation of low- and middle-income countries, which account for a large proportion of global suicide deaths. This reveals a need to broaden the scope of longitudinal research on STB risk, such that countries across more regions, income levels, and degrees of structural stigma are fully accounted for. Such lines of research will improve generalizability of findings, and more precisely inform prevention efforts worldwide.

Keywords Suicide · Risk factors · Mental illness stigma · Prospective study

Introduction

Suicide is a complex problem that affects millions of people worldwide. Approximately 800,000 people die by suicide around the world each year. Cross-national research shows that up to 15.9% of people have ever engaged in suicidal thoughts and behaviors (STBs), including suicide ideation, attempt, and death [1]. STB prevalence rates within individual countries have remained fairly stable, as have between-country differences in these rates [2–7]. The prevalent and persistent nature of suicidal ideation, attempt, and death across countries, therefore, calls for STBs to be examined on a global scale.

Cross-national studies about STBs tend to involve the one-time assessment of suicidal ideation, attempt, or death and related factors across multiple countries. These studies are typically cross-sectional in design, and have helped establish how widespread STBs are in different countries (i.e., prevalence rates) and identify individual characteristics associated with STBs (i.e., correlates). These efforts have improved understanding around the widespread nature of STBs, and have identified specific demographic (e.g., age, gender [1, 8–10]), and psychiatric factors (e.g., mood disorders, anxiety disorders, substance use disorders, and personality disorders [1, 11–15]) that are associated with STBs. Furthermore, they have revealed key differences in prevalence rates and correlates across countries (e.g., Eastern European countries have a higher male-to-female suicide ratio in comparison with Western Europe [16]).

Despite these advances, *suicide risk* has rarely been studied on a global scale. By "risk," we refer to factors that are

✉ C. B. Cha
cbc2120@tc.columbia.edu

[1] Department of Counseling and Clinical Psychology, Teachers College, Columbia University, 525 West 120th Street, Box 102, New York, NY 10027, USA

[2] Department of Psychology, Florida State University, 1107 West Call Street, Tallahasee, FL 32306, USA

both associated with and temporally precede STB outcomes [17]. Studying correlates through cross-sectional designs can reveal what is associated with STB outcomes, yet this research cannot determine how or why these associations exist. For instance, cross-sectional studies linking psychopathology with STBs [18–21] cannot determine whether these psychiatric symptoms and/or disorders precede (vs. co-occur with or result from) STBs. In contrast, using longitudinal designs to study risk factors can help establish whether psychopathology was present prior to the development of a STB outcome, thus aiding in the prediction and potential prevention of STBs. It is, therefore, important to prioritize the utilization of prospective longitudinal research on the study of STB risk around the world.

Studying STB risk at a global scale would also allow the evaluation of country-level factors, or potential moderators, that may influence the degree of risk conferred. Prior research has demonstrated that context (i.e., local environment) may influence individual-level risk. For example, the risk associated with having a marginalized identity has been shown to increase only for those living in regions, where there was a low concentration of similar-status individuals [22]. One prominent example of a context-level moderator is *structural stigma*, which is defined as "societal-level conditions, cultural norms, and institutional policies that constrain opportunities, resources, and well-being of the stigmatized" [23] (p. 2). Structural stigma has been shown to fluctuate across different populations and higher levels have been associated with a variety of mental health outcomes for stigmatized groups. Studies in this body of work have shown an association between structural stigma, as it pertains to immigration status [24], sexual minority status [25, 26], and psychiatric diagnoses [27] with poorer mental health outcomes. In a relevant example, Schomerus and colleagues [27] showed that countries endorsing greater social distance from persons with psychiatric disorders were also the areas with higher national suicide death rates. This is especially concerning, since exclusionary sentiments towards individuals with psychiatric disorders have been shown to be endorsed by the public, even in countries, where the population appears to be well-informed about mental health [28]. Structural stigma may thereby be an important country-level moderator that affects STB risk.

Despite the potential gains of studying STB risk prospectively across diverse global populations, there are a number of feasibility concerns. First, longitudinal research is more challenging than cross-sectional research in several ways. Resources (e.g., time, expenses, and logistics) required to maintain data collection for an extended period of time have been identified as deterrents for conducting this type of research [29, 30]. Participant drop-out, for instance, is a major concern in research with extended follow-up periods, thus requiring researchers to recruit larger samples and to implement potentially costly retention strategies [31]. The inherent difficulties of longitudinal studies may become prohibitive with the added complexity involved in conducting research in multiple sites across different countries around the world. These limitations may explain why the few longitudinal studies conducted across different countries have seldom spanned different geographical regions [32–38]. Multiple challenges remain to be resolved before it is possible to study cross-national risk factors at a global scale, and evaluate whether country-level factors or potential moderators, may exacerbate or buffer the degree of risk.

One way of addressing these challenges is to synthesize prospective studies conducted across many individual countries. Meta-analytic methods can be used to aggregate data across multiple studies from different parts of the world. In addition, it is also possible to make direct statistical comparisons between studies with different characteristics (e.g., study location), to evaluate the effects of these variations on risk factor magnitude—all the while curtailing the methodological challenges and costs of conducting a multi-site cross-national longitudinal study. Thus, a meta-analysis can provide an efficient and informative way to study differences in risk factors across different areas of the world, and evaluate whether specific country-level factors moderate risk.

The present study addresses several knowledge gaps by meta-analyzing STB risk studies conducted around the world. There are three aims. The first aim is to identify where exactly published STB risk research has been conducted around the world. This will determine the extent to which current findings used to inform policy, practice, and research represent global STB risk. In addition, it may potentially identify understudied populations and opportunities for future research. The second aim is to meta-analyze whether psychopathology, a commonly studied risk factor, prospectively predicts STBs when assessed across many individual countries. This would complement cross-sectional research findings and more firmly establish this as a risk factor. The third and final aim is to examine how country-level moderators such as mental health structural stigma may affect the risk conferred by psychopathology on STBs. Given that structural stigma has been associated with adverse mental health outcomes, we expect that studies conducted in high structural stigma contexts will yield larger effect size magnitudes for psychopathology predictors of STBs, as compared to studies conducted in low structural stigma contexts. We also explored the potential moderating effects of geographic region and income level.

Method

Literature search

A systematic search of longitudinal studies that examined risk factors for STBs was conducted using electronic databases (e.g., PubMed, PsycInfo, Google Scholar). The search terms employed included permutations of the words "longitudinal" and "suicidal thoughts and behaviors," as well as related terms. Refer to Franklin et al. [39] for additional details. Publications were included if they met selection criteria, which required that the study (1) did not have a primary purpose of evaluating treatment effects, (2) included an effect size predicting suicide ideation, attempt or death, (3) established a longitudinal association between the risk factor and the suicide outcome, (4) reported the necessary statistical information to convert risk factor effect sizes to odds ratios, (5) reported information to ascertain geographic location, and (6) examined psychopathology predictors (i.e., presence or number of psychiatric diagnoses and symptoms, internalizing psychopathology, psychotic symptoms, prior self-injurious thoughts and behaviors, or prior mental health treatment) for STBs. In addition, studies conducted prior to 2005 and after 2014 were not included, since data for structural stigma were not available outside of this timeframe. The present meta-analysis included 71 studies [40–110]. Refer to Fig. 1 for PRISMA diagram.

Data extraction and coding

Co-authors examined all studies in the sample and extracted relevant data. Effect sizes were deemed relevant if a psychopathology-related variable was used to predict subsequent STBs. A total of 378 relevant effect sizes were extracted and included in the present study. Study characteristics such as clinical severity of sample, publication year, and follow-up length were also coded for each individual study. In addition, coders were trained to extract information for the geographic location (i.e., country) of each STB risk factor study. Location was extracted from the full-article text and usually found in the method, introduction, or discussion sections. When this information was not reported in the full text, location of the primary affiliation of the first author was used.

Location information was used to sort studies into overarching categories based on *geographic region* (i.e., Africa, Asia, Australia, Europe, North America, and South America), *income level* (i.e., low, middle, and high), and *mental health structural stigma level* (i.e., low and high). Assignment of income level was determined based on the World Bank World Development Indicators [111], matched with each study's geographic location and approximate year of data collection. Assignment of mental health structural

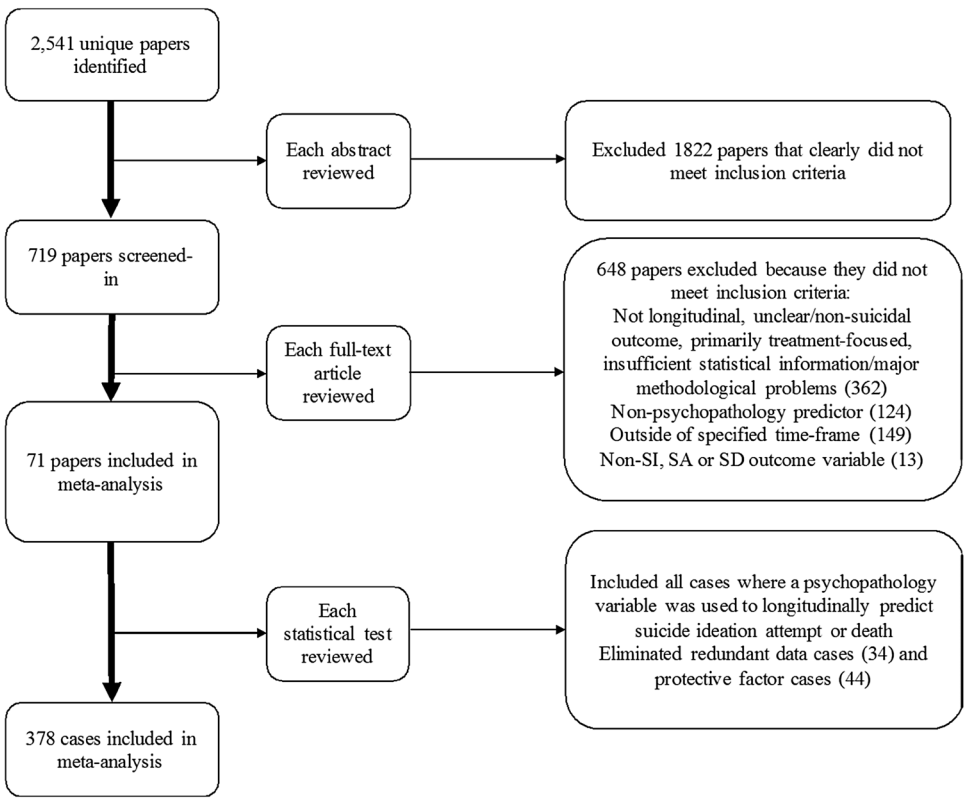

Fig. 1 PRISMA diagram for the selection of studies included in the present meta-analysis

stigma level was determined based on the World Health Organization (WHO) Mental Health Atlas [112–114], and also matched to each study's geographic location and year of data gathering. Similar to prior investigations [24], mental health structural stigma was operationalized as the *presence or absence of dedicated mental health legislation*, defined by the WHO [114] as "human rights protections for people with mental disorders, involuntary admission and treatment, guardianship, professional training and service structure" (p. 26). The presence of mental health legislation denoted a lower level of structural stigma, while the absence of this protective legislation denoted a higher level of structural stigma.

Data analysis

Descriptive statistics

Frequency values were calculated to ascertain the number of studies conducted by geographic region, income level, and structural stigma level.

Mean effect analysis for psychopathology

We conducted an overall mean effect analysis, to estimate how well psychopathology predicted STB outcomes across different countries of the world. Odds ratios were the primary metric in the present analysis, since most effect sizes were reported in metrics that could be converted into odds ratios (e.g., Cohen's *d,* means and standard deviations, Chi-squared analyses). We calculated a mean weighted odds ratio estimate and the confidence intervals to summarize the overall effect size across our sample of studies. We also examined heterogeneity in the sample of studies using metrics such as the 95% prediction interval and I^2 estimates [115, 116].

Across the final set of studies, many authors reported multiple effect sizes from the same sample of participants, and used measures of predictors that may have been correlated (e.g., separate measures of depression and anxiety to predict STBs). To account for dependence among effect sizes, we used robust variance estimation methods (RVE) with inverse variance weights for correlated effects [117, 118]. The summary effect size for psychopathology predictors for STBs, as well as aforementioned heterogeneity metrics, was estimated with RVE and small-sample corrections using *robumeta* [119] and *clubSandwich* [120] packages in R.

Moderation analyses

We used meta-regression analyses to examine whether mental health structural stigma levels affected the degree of association between psychopathology and STBs. We implemented meta-regression using RVE methods with inverse variance weights for correlated effects and small-sample adjustments to calculate the linear coefficient for the effect of structural stigma and the 95% confidence intervals of the estimate. By modeling the dependence structure in the data, these methods ensured appropriate degrees of freedom for the analysis [120].

The meta-regression model included covariates which could also explain differences in effect sizes across studies, outside of the study's location. Selected covariates captured different study characteristics (i.e., follow-up length and sample clinical severity), the type of suicide outcome assessed (i.e., suicide ideation, attempt, or death), and the type of psychopathology predictor used (i.e., presence or number of psychiatric diagnoses and symptoms, internalizing psychopathology, psychotic symptoms, prior self-injurious thoughts, and behaviors or prior mental health treatment). While it was not the primary aim of this study, we also tested geographic region and income level as moderators in separate regression models using the same data-analysis methods.

Publication bias analyses

Publication bias estimates were included to evaluate the robustness of the overall mean effect size analysis. We examined bias in relation to funnel plots by assessing whether there was asymmetry in our sample of studies. We also calculated two indices of asymmetry. First, we used Egger's test to check for a statistical significant effect, which would indicate the presence of publication bias. Second, we used Duval and Tweedie's trim and fill analysis to determine how the summary meta-analytic effect size would be changed by adding potentially missing studies to the analysis. Findings were not specific to RVE effect size estimates, because these analyses were ran using a random effects model. However, observed patterns were used to make broad inferences about the potential influence of publication bias within the body of the literature used for these analyses.

Results

Descriptive statistics

The collection of 71 studies spanned across 30 different countries (Table 1). When studies were assessed by geographic region, it was found that most STB risk factor research had been conducted in North America and Europe. Specifically, 66.2% of studies were conducted in the U.S. and Canada, 25.4% were conducted in Europe of which a large majority was based in Western European countries

Table 1 Global representation of suicide risk studies (k=71)

	%	k
Geographic region		
Africa	0.0	0
South America	0.0	0
Asia	4.2	3
Australia	4.2	3
Europe	25.4	18
North America	66.2	47
Income level		
Low income	1.4	1
Middle income	0.0	0
High income	98.6	70
Stigma level		
Low	91.6	65
High	8.5	6

k number of studies

(e.g., England, Scotland, Switzerland, and Sweden), and 4.2% were conducted in Asia, and Australia. Out of the final set of 71 prospective studies, none were conducted in Africa or South America.

When studies were assessed by income level, it was found that nearly, all STB risk factor research had been conducted in high-income countries. While 70 studies within our sample were conducted in high-income countries, none were conducted in middle-income countries, and only one STB risk study was conducted in a low-income country.

When studies were assessed by mental health structural stigma level, it was found that only 9% of studies were conducted in countries classified within our sample as having high structural stigma. Only 6 out 71 studies were located in countries without dedicated mental health legislation or with mental health legislation enacted before 1990—a date that the WHO uses as a cutoff for legislation considered to meet criteria for up-to-date methods of treatment and service delivery [112].

Overall effect of psychopathology on STB

The RVE model with small-sample correction indicated that the odds of experiencing suicidal thoughts and behaviors increased with the presence of psychopathology, as compared to the absence of these conditions (wOR = 2.10, 95% CI = 1.84–2.38, τ^2 = 1.18). Sensitivity analysis suggested that results were not influenced by the within-study effect size correlation assumed (ρ = .80), and that Type I error was not increased. Heterogeneity among effect sizes was high (I^2 = 92.26%, 95% PI = 0.92–4.77). Thus, we proceeded to examine the effect of moderator variables that could account for some of the observed variability across studies.

Potential moderators

Mental health structural stigma

Contrary to hypotheses, meta-regression results for mental health structural stigma were not significant. There was no evidence that the full model testing mental health legislation as a moderator, while controlling for covariates, performed better than the intercept-only model at explaining variance in the data (F = 1.44, df = 15.10, p = 0.25). In addition, there was a high level of heterogeneity that remained in the data after fitting this model (residual I^2 = 90.03%), indicating that the moderator and covariates were not successful at explaining the variance in effect sizes across studies.

Consistent with this finding, mental health structural stigma did not have an individual moderating effect (Table 2). The magnitude of effect sizes did not differ between studies conducted in countries, where mental health legislation was absent, in comparison with studies in countries, where this protective legislation was present (wOR = 1.85, df = 5.71, 95% CI = 0.80–4.28).

Geographic region and income level

Meta-regression by geographic region examined the effect sizes of studies conducted in North America compared to those in Europe, and to studies in other geographic regions. Overall findings for the model including geographic region and relevant covariates did not perform significantly better than the intercept-only model at explaining variance in the data (F = 1.85, df = 16.50, p = 0.13). Heterogeneity also remained high (residual I^2 = 89.96%), suggesting that the model was not effective at explaining the observed differences in effect sizes across studies.

Despite null findings for the full model, geographic region showed an individual moderating effect. In fact, studies conducted in Europe had larger effect sizes, in comparison with those conducted in North America (wOR = 1.61, df = 22.36, 95% CI = 1.18–2.20). The magnitude of effect sizes did not differ for studies conducted in other regions outside of North America and Europe. Initially, we also planned to assess income level as a moderator, but this was not possible given the few studies conducted in low- and middle-income countries.

Publication bias

Visual inspection of the funnel plot indicated asymmetry, suggesting that studies with higher standard errors were more likely to produce larger odds ratio estimates in comparison with more precise studies with lower standard errors (Fig. 2 and 3). Duval and Tweedie's trim and fill analysis determined that 119 effect sizes were missing

Table 2 Results from RVE meta-regression modeling for effects of structural stigma on the risk conferred by psychopathology on STB (n=378, k=71)

RVE meta-regression model					
Moderator	OR (95% CI)[a]	*df*	Wald test for moderator	τ^2 for overall model	Residual I^2 for overall model
Mental health structural stigma		**5.70**	**3.26**	1.28	90.03%
Absence of mental health legislation	1.85 (0.80, 4.28)	5.65			
Geographic region		**12.50**	**4.68**	* 1.37	89.96%
Europe	1.61 (1.18, 2.20)	22.36		*	
Other	1.02 (0.68, 1.53)	6.35			

n number of effect sizes, k number of studies, τ^2 between-study variance, ρ assumed 0.80

*$p<0.05$, **$p<0.01$

Bold font indicates overall moderator

[a]Analyses controlled for study characteristics, type of suicide outcome and type of psychopathology predictor. Reference category for mental health structural stigma moderator is presence of mental health legislation. Reference category for geographic region moderator is North America. Moderation analysis was not conducted for income level due to insufficient power, since only one study was located outside of a high-income country

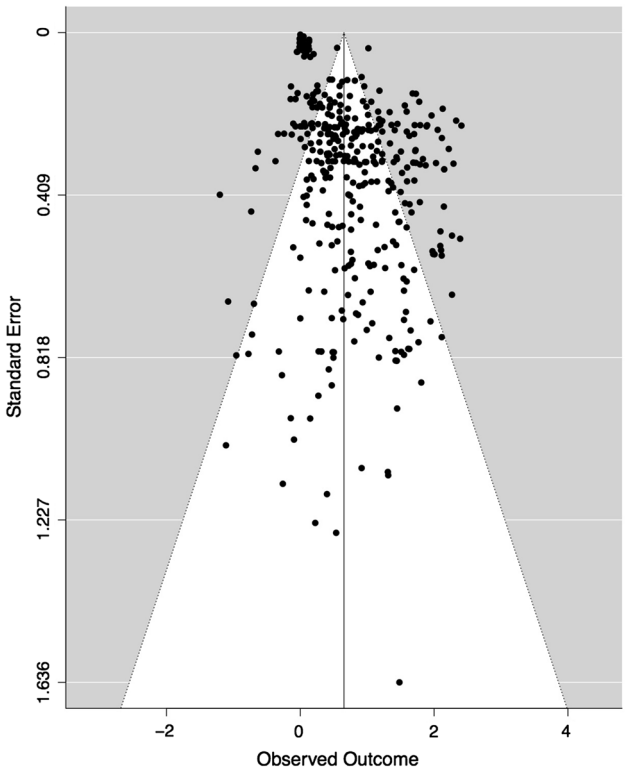

Fig. 2 Funnel plot for effect sizes included in present meta-analysis

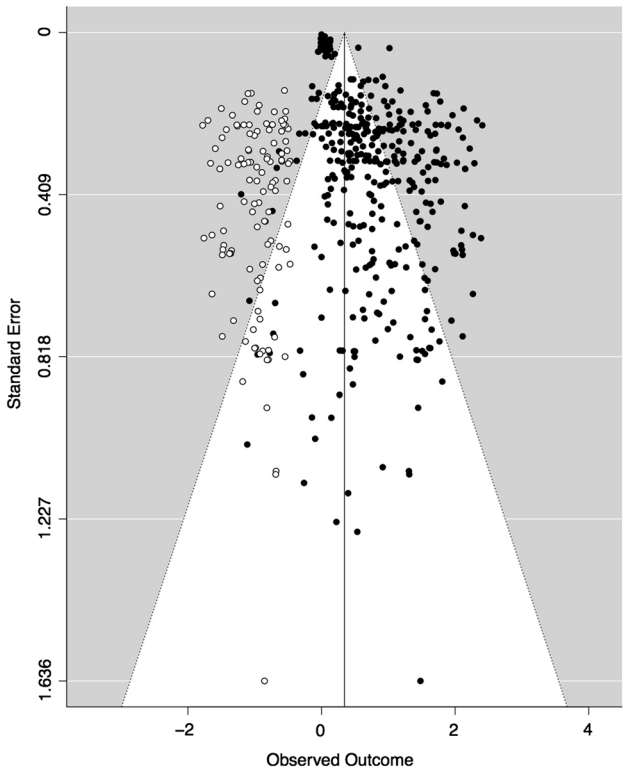

Fig. 3 Trim and fill analysis for effect sizes included in present meta-analysis

below the mean. If these effect sizes had been published and factored into the analyses, it is estimated that the mean odds ratio for the random effects model would have dropped to 1.41 (Fig. 2 and 3). Egger's test of intercept showed a significant association between standard error and effect size magnitude ($z=15.30$, $p<0.0001$). Taken together, these findings show significant publication bias, suggesting that effect sizes in this body of literature may be biased by an overrepresentation of small less precise studies with larger effects.

Discussion

The present study yields three key findings. First, suicide research is being conducted in highly select parts of the world. Certain geographical regions such as South America and Africa were not represented in the present sample of studies. In addition, only one study was conducted outside of a high-income country. This is concerning, since 78% of suicide deaths occur in low- and middle-income countries [121] and higher levels of mental health stigma are also observed in lower income regions. This suggests that failing to account for these populations may lead to potential underestimation of risk, as shown in related areas of study (e.g., underestimating the influence of maternal depression on child *failure to thrive*; [122, 123]). Underrepresentation of diverse populations in the STB risk literature may lead to gaps in knowledge about risk, as well as missed opportunities for intervention and prevention.

Second, as expected, psychopathology increases STB risk across countries. This extends prior findings from global cross-sectional studies by showing that psychopathology is not only associated with STB, but may in fact precede these outcomes and increase their likelihood of occurrence. Psychiatric symptoms may be used to help identify individuals who are more likely to engage in STBs, thereby improving risk assessment and potentially informing intervention and prevention efforts. The risk effects for psychopathology observed in the present study are not surprising, since our sample included a selection of studies from prior meta-analyses which reported similar effects [39, 124].

Finally, neither of the meta-regression models with country-level factors successfully explained the variation in risk across studies. On one hand, this finding may indicate that the risk effects of psychopathology may not differ across studies conducted in distinct geographic regions or in locations with varying degrees of mental health structural stigma. On the other hand, we caution interpretation of this finding as there was a restrictive range of countries in which STB risk has been examined—regardless of whether the studies were assessed by structural stigma level, geographic region, or income level. It remains possible, for instance, that mental health structural stigma may have a moderating effect on risk when examined in a more globally representative way. These null findings should, therefore, be interpreted within the constraints of the narrow scope covered by the studies published to date.

Limitations

The present findings should be interpreted in light of several limitations. First, the geographic location of each study was sometimes approximated. While study location was typically ascertained based on information provided in the full-article text (e.g., method, introduction, and discussion), some studies did not include this information, in which case location was coded according to the first author's primary affiliation. Of course, it remains possible that studies missing location information may have not been conducted in the same place as the first author's primary affiliation. Thus, our results are only as accurate as the information reported by authors. This limitation is not uncommon of meta-analyses, where findings are highly contingent on the quality and completeness of the information reported by the authors of individual studies [125]. However, given that the location of data collection was frequently reported and that author affiliation typically coincides with study location, we deem the potential gains from coding and meta-analyzing studies in this manner to be worthwhile.

Second, mental health structural stigma was narrowly operationalized. It is possible that government reports to the World Health Organization (WHO) do not capture the unwritten customs, procedures, or informal practices that may underlie stigma processes. For instance, while the U.S. was identified as a country with relatively low mental health structural stigma due to the presence of dedicated mental health legislation, studies assessing public opinion have shown that the majority of Americans continue to harbor stigmatizing opinions towards those with mental health conditions (e.g., unwillingness to have someone with depression marry into the family or be a child care provider) [28]. Relatedly, mental health structural stigma data were extracted at the country level, and thus, analyses failed to capture possible local nuances of cities or regions. Authors studying the effects of structural stigma on health outcomes recommend using community- or state-level data given how widely stigma processes can vary across populations within the same country (e.g., [126]). Future research examining the effects of mental health structural stigma on suicide risk would benefit from including non-governmental sources of data, as well as using finer-grained information about the local context.

Third, we did not include unpublished articles. It is possible that the present meta-analysis could have had a more globally representative sample of studies by expanding criteria to include grey literature, such as dissertations and conference reports. Nevertheless, constraining the sample to only published articles was purposeful to examine the representativeness of findings used to inform policy, practice, and research worldwide. Thus, despite this limitation, current findings remain important in revealing a bias in the field and in the information available to decision-makers worldwide: it is largely limited to samples in Western, high-income countries with generally low mental health structural stigma.

Conclusions

The present study represents a key step towards assessing STB risk on a global scale. This investigation capitalized on and aggregated existing prospective studies conducted across 30 countries overall. In doing so, we identified specific places—defined by global region, income level, and structural stigma level—that have gone unaccounted for in the past years of STB risk research. Our findings point to an urgent need to deliberately include and diversify samples assessed. These conclusions, albeit sobering, help justify new and exciting future directions in suicide research. For instance, developing longitudinal studies in low- and middle- income areas will improve generalizability of STB risk findings to populations that account for a high proportion of suicides worldwide. These lines of research would also allow for the continued consideration of broader contextual factors that may either directly confer risk or moderate the impact of known risk factors. Overall, this approach could help inform suicide risk assessment, intervention, and prevention efforts worldwide.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standards The manuscript does not contain clinical studies or patient data.

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