

# BMJ Open Systematic review of suicide prevention studies with data on youth and young adults living in low-income and middle-income countries

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## ABSTRACT

**Objectives** This review aimed to provide a summary of peer-reviewed, published literature on suicide preventive interventions with data on youth and young adults in low-income and middle-income countries (LMIC).

**Design** A systematic review was conducted using electronic databases of PubMed/MEDLINE, The Cochrane Library, Cumulative Index to Nursing and Allied Health Literature, PsycINFO, Education Resources Information Center and The Campbell Collaboration databases for English-language articles published between 1 January 1990 and 15 February 2022.

**Eligibility criteria** Interventions of interest could include behavioural, community, clinical/medical or policy studies, or any combination of these, so long as the studies had at least one outcome of interest and at least one control group or control period. Outcomes included suicide ideation, suicide attempt and suicide. Interventions must have been conducted in an LMIC. Studies with individuals ages 0–25 in the sample were included. Articles describing data on individuals over age 25 could be included if individuals ages 0–25 were part of the sample.

**Results** A total of 44 eligible studies were identified, representing a broad range of universal, selective and indicated interventions. Most studies assessed interventions designed to address lethal means or mental health. Most studies were conducted in lower-middle-income or upper-middle-income countries, with the largest proportion in Asia. Assessment of outcomes across studies was heterogeneous and there were few large-scale investigations tailored specifically for youth.

**Conclusions** Most of the published, peer-reviewed suicide intervention research from LMIC is concentrated in a few countries. While geographical coverage to date has been limited, strategies and samples in included studies were diverse, representing populations in clinical, educational and community settings. While current findings hold promise, this review identified a need for large-scale studies designed specifically for youth.

## INTRODUCTION

Globally, there are 3 billion people under age 24—more than ever before—and the youth population is increasing, including in many low-income and middle-income countries (LMIC).<sup>1</sup> Suicide is a leading cause of

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ The review provided a comprehensive summary of controlled interventions with data on youth and young adults from low-income and middle-income countries in the last three decades.
- ⇒ The review identified a wide range of studies representing universal, selective and indicated interventions that addressed suicide ideation, suicide attempt and/or suicide.
- ⇒ The main limitation of this review was that it included only scientific literature published in English.

death among youth.<sup>2 3</sup> The increased risk of suicide during adolescence and young adulthood demarcates this period as an important window for prevention efforts.<sup>4</sup> There is a need for rigorous evidence on effective interventions that can be incorporated into youth suicide prevention strategies globally,<sup>5 6</sup> including in LMIC, where most suicides (79%) occur.<sup>2 7 8</sup> All countries have limited resources for addressing youth suicide. In many LMIC, this issue is compounded by considerable challenges in basic healthcare and public health infrastructure, creating a wide gap between the burden of suicide and the implementation and dissemination of effective prevention programmes.<sup>5</sup> The global literature on suicide has revealed substantial heterogeneity in the relevance and magnitude of risk and protective factors for suicide across cultures and geographies.<sup>9 10</sup> Therefore, researchers and practitioners working in LMIC must carefully delineate for whom and in which conditions interventions work.

In recognition of the complexity and global burden of suicide, the WHO has brought suicide prevention into the mainstream international health agenda over the last two decades. Suicide prevention in LMIC is a key component of this agenda. In 2002, the WHO launched the mental health Gap Action Programme (mhGAP), which

provides a framework for the provision and expansion of mental health services, including suicide prevention, with a focus on LMIC settings.<sup>11</sup> In 2014, the WHO published a landmark report, *Preventing Suicide: A Global Imperative*, emphasising the epidemiological burden of suicide globally and encouraging the development and enhancement of suicide prevention,<sup>5</sup> and in 2021, the WHO published LIVE LIFE, an implementation guide for suicide prevention in all countries.<sup>12</sup> Further, the United Nations Sustainable Development Goals blueprint now includes a key indicator for tracking progress in suicide prevention and targets a one-third reduction in suicides worldwide by 2030.<sup>13</sup> These and other collective efforts have increased awareness about suicide as a public health issue and motivated the development of national prevention strategies in several dozen countries, including LMIC, as of 2018.<sup>14 15</sup>

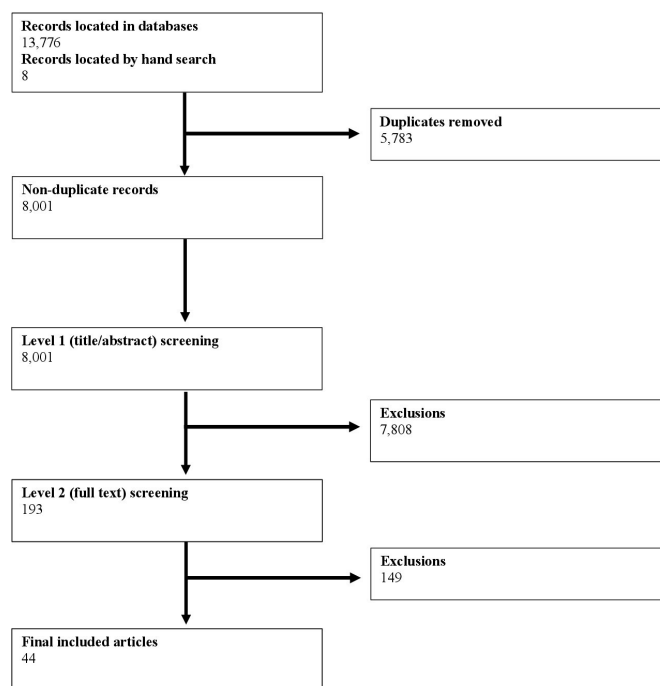
LMIC populations are projected to comprise more than half the global population growth in the next 30 years.<sup>1 16</sup> The number of youth has been projected grow by approximately 3% by 2030,<sup>16</sup> with some of the largest youth populations in LMIC.<sup>17</sup> Given these projections and that most suicides occur in LMIC, youth suicide prevention in these countries is essential to achieve the targeted reduction by 2030. Strategies over the next 10 years must be informed by what has already been achieved. Prior reviews that have included studies of youth suicide prevention in LMIC have focused on randomised controlled trials (RCTs) or studies with a predominantly or exclusively youth samples.<sup>18 19</sup> Strict study design or criteria facilitate direct comparison and meta-analysis yet do not describe the full range of intervention studies that could be relevant to youth suicide prevention efforts in these countries.

Therefore, we conducted a review of the peer-reviewed, published literature from LMIC to explore the spectrum of studies of interventions—universal, selective, indicated—that include youth and young adults. Our objective was to summarise the scope of the controlled interventions with data on youth from these countries in the last three decades as well as to identify gaps and opportunities for future work in this area. This review can inform researchers, practitioners and policymakers about strategies that may reduce youth suicide in LMIC.

## METHODS

### Search strategy and selection criteria

We conducted a systematic review of the peer-reviewed, published literature. We searched PubMed/MEDLINE, The Cochrane Library, Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, Education Resources Information Center (ERIC) and The Campbell Collaboration databases for English language articles and abstracts. Searches were conducted to identify literature published between 1 January 1990 and 15 February 2022. The search strategy (see online supplemental file) was based on key terms identified by the research team (eg, suicide, attempt, prevention). Using



**Figure 1** Record search and screening flow chart.

Boolean and truncation operators, we tested and refined the search strategy to be sure that it included several published studies we knew should be captured in the search. We also incorporated terms from subject headings (eg, ‘MeSH’ terms in PubMed). In addition to the database searches, we also hand searched the reference lists of the final included articles. The literature search identified a total of 13 784 records. After excluding duplicate records, a total of 8001 records were screened (figure 1).

We specified a priori inclusion criteria (table 1). Interventions of interest could include behavioural, community, clinical/medical or policy studies, or any combination of these, so long as the studies had at least one outcome of interest and at least one control group or control period. Outcomes included suicide ideation, suicide attempt and suicide, or any combination of these. Interventions must have been conducted in an LMIC. We used the World Bank Country and Lending Groups classification tables to determine country income status at the time each intervention was conducted.<sup>16</sup> We included interventions that sampled individuals ages 0–25. Articles describing data on individuals over age 25 could be included if individuals ages 0–25 were part of the sample.

Exclusion criteria included: not a study of humans; no data on individuals ages 0–25; no suicide-related outcome; intervention took place in a high-income country only; abstract only; no original data; no control group or period; no statistical comparison between intervention and control group or period; qualitative study only. We specified no inclusion/exclusion criteria for study sample size or setting (eg, schools, jails, hospitals, outpatient centres, military bases, suicide prevention hotlines, entire communities).

**Table 1** Inclusion criteria for studies

Criterion	Description
<i>Populations</i>	▶ Study includes data on individuals ages 0–25 (longitudinal follow-up after age 25 is acceptable).
<i>Interventions</i>	▶ Behavioural, community, clinical, policy or wellness-promoting interventions, or any combination of these interventions. ▶ Interventions must have targeted at least one of the outcomes.
<i>Comparisons</i>	▶ Any control group (including usual care) or control time period, as relevant to the study design.
<i>Outcomes</i>	▶ Suicide ideation (reported within 12 months of intervention). ▶ Suicide attempt (reported any time post-intervention). ▶ Suicide (reported any time post-intervention).
<i>Timing</i>	▶ Publication date: 1990 or later.
<i>Settings</i>	▶ Study conducted in low-income and/or middle-income country/countries. ▶ Any setting (community settings, schools, home, hospitals or other healthcare facilities, military bases, refugee camps, juvenile justice systems, child welfare systems, suicide hotlines, etc).

### Screening and data extraction

DistillerSR<sup>20</sup> was used to conduct the screening in two stages—first on titles/abstracts and then on full-text articles. At least two authors screened each record independently at each stage. DistillerSR flagged discordant screening decisions, which the authors resolved through discussion until reaching consensus. The following data were extracted from included articles: first author, publication year, country, country income classification, sample description, intervention description, intervention level (universal, selective, indicated), summary of main findings and risk of bias assessment. Intervention levels were based on the Institute of Medicine prevention framework: universal interventions, which aim to reach all persons without regard to the level of risk exposure; selective interventions, which focus on persons who are at high risk; and indicated interventions, which focus on persons who have mental or behavioural health problems, such as suicidal ideation and attempt.<sup>21</sup>

### Assessment of bias

Two authors independently assessed each study for risk of bias for the purpose of determining an overall risk level for each study. Any discordant assessments were resolved by team discussion until reaching consensus. Assessments were conducted using tools of the Cochrane Collaboration—the revised Risk of Bias for Randomised Trials (ROB2) to assess randomised trials and the Risk of Bias In Non-randomised Studies of Interventions (ROBINS-I) for non-randomised studies.<sup>22 23</sup> The ROB2 facilitates a

structured assessment of bias for different aspects of trial design, conduct and reporting. Signalling questions in each domain and an algorithm guide the indication of risk of bias as low, moderate (‘some concerns’) or high. The ROBINS-I is based on the ROB2 and has a similar structure comprising domains, signalling questions and an algorithm to guide the determination of risk of bias as low, moderate, serious, critical or insufficient information.

### Synthesis

A qualitative synthesis was conducted to summarise and integrate the findings. Studies were categorised by the type of approach (universal, selective or indicated) according to Institute of Medicine classification guidelines<sup>21</sup> as well as by intervention type (psychological interventions, means restriction, public awareness campaign, biomedical treatments or multiple interventions (multimodal or multicomponent studies)). When more than one article described the same intervention in the same population, the article with the most detailed assessment of effect was used. A meta-analysis was not conducted due to broad methodological, statistical and clinical heterogeneity across studies.

### Statement on patient and public involvement

This study reviewed previously published studies and did not entail patient or public involvement.

## RESULTS

A total of 44 eligible studies of interventions were identified from research conducted in 15 countries (online supplemental table 1).<sup>24–67</sup> Most studies were conducted in upper-middle-income (n=22; 50%) or lower-middle-income countries (n=13; 30%; table 2). Most studies were conducted in Asia: Bangladesh (n=1), China (n=7), India (n=8), Iran (n=14), Nepal (n=1), Pakistan (n=1), Sri Lanka (n=6) and Türkiye (n=1). Two studies (5%) were cross-national. Studies that were conducted exclusively in urban areas (n=27; 61%) were more common than those conducted exclusively in rural areas (n=4; 9%) or in a mix of rural and urban areas (n=10; 23%). More than half of the studies (55%) were psychological interventions targeting individuals already at risk for suicide. The other studies focused on restrictions on lethal means (n=8; 18%), biomedical treatments (n=7; 16%) or public awareness campaigns (n=1; 2%). Four studies (9%) that incorporated or compared more than one intervention approach or method were categorised as multimodal studies. Five studies (11%) exclusively sampled individuals under age 26.

### Studies of psychological interventions

There were 10 studies—all RCTs—to reduce one or more suicide-related outcomes following a brief intervention and contact (BIC) protocol.<sup>31 33 34 43 44 46 47 58 60 62</sup> Studies implemented the contact component either in person or remotely via postcards or telephone. Most of these studies

**Table 2** Number of included studies by intervention type, country income group and setting

Type	Total	World Bank country income group*					Setting			
		Upper-middle	Lower-middle	Low	Multiple or transitioned†	Urban	Rural	Urban and rural	Refugee camp	Unknown
Psychological	24	13	8	2	1	20	0	3	1	0
Means restriction	8	1	3	0	4	1	2	5	0	0
Public campaign	1	0	1	0	0	1	0	0	0	0
Biomedical	7	5	0	0	2	5	1	0	0	1
Multimodal	4	3	1	0	0	0	1	2	0	1
Total	44	22	13	2	7	27	4	10	1	2

\*Income classifications are based on World Bank Country Groups. As of 2022, the World Bank considers the term country to be interchangeable with the term economy.  
†Several studies included in the review were conducted in multiple countries or during periods in countries whose income classification changed (eg, from low-income to lower-middle-income).

were indicated interventions with individuals seen at a hospital or clinical setting after a suicide attempt. One of the studies examined BIC in a cross-national sample from LMIC.<sup>31</sup> One study examined BIC in combination with safety planning in a refugee camp to reduce suicidal behaviours.<sup>58</sup> Two studies of BIC interventions found significant effects on suicide as an outcome,<sup>31 60</sup> while three studies found significant effects on suicide attempt as an outcome, compared with controls.<sup>33 43 58</sup> In four studies, BIC interventions significantly reduced suicide ideation compared with controls.<sup>33 44 46 47</sup>

There were 12 studies of counselling interventions based on cognitive or behavioural strategies delivered over multiple sessions.<sup>25 28 35 36 41 48 51 53 63 65–67</sup> Approximately half of these studies had largely or exclusively youth samples.<sup>25 36 41 65–67</sup> Ten of the studies showed a significant reduction in suicide ideation compared with controls.<sup>25 28 35 36 41 51 63 65–67</sup> Four studies examined the effect of intervention on suicide attempt or suicide.<sup>35 48 63 66</sup> A study with patients with depression in India found that a multisession counselling programme based on behavioural activation indicated significant reduction in suicide attempts compared with enhanced usual care.<sup>63</sup>

A study conducted in South Africa examined the effect of a single-session psychosocial counselling intervention delivered to individuals who had received a positive HIV test. Compared with standard counselling after an HIV test, the study showed the psychosocial intervention did not significantly reduce suicide ideation at follow-up.<sup>32</sup>

One study examined the effectiveness of a 5-year depression-management educational programme for general practitioners in a mainly rural area in Hungary.<sup>56</sup> The annual suicide rate in the intervention region significantly decreased from the 5-year preintervention average of 59.7 to 49.9 per 100 000 population; this decrease was not significantly different from that observed in the control region. However, the annual suicide rate in the intervention region was significantly lower than the rate observed in the broader county and the entire country.

### Studies of means restriction

This review included eight studies of means restriction to prevent suicide.<sup>27 30 39 40 55 59 64 68</sup> All of these studies were conducted in Asia (Bangladesh, India, Iran and Sri Lanka) and focused on the effects of limiting access to pesticides or reducing pesticide toxicity. In these countries, self-poisoning accounts for a high proportion of total deaths by suicide.<sup>30 68</sup>

Four means restriction studies examined the effect of regulations on the import or sale of pesticides implicated in self-poisoning suicides. In Bangladesh, a national ban on WHO Class 1 pesticides in 2000 resulted in a 37% reduction in fatalities from self-poisoning; it was estimated the ban prevented nearly 35 000 pesticide suicides between 2001 and 2014.<sup>30</sup> In India, a study of a national ban on endosulfan in 2011 found there were approximately 28 600 fewer suicides by pesticide poisoning

than expected in 2011–2014, based on previous trends. However, it was also reported that the decrease in suicides by pesticide poisoning were offset by increases in suicide by other means (eg, hanging [approximately 19 000 more than expected] and other poisoning [approximately 11 000 more than expected]) over the same period.<sup>27</sup> In Sri Lanka, a series of bans on Class 1 pesticides in the 1980s and 1990s and on paraquat, dimethoate and fenthion in the 2000s also reduced pesticide suicides over time and across age groups, including youth. Following the first bans in the 1980s, there were yearly declines in suicide rates among 17–25-year-olds.<sup>39</sup> A subsequent Sri Lankan study of the bans of paraquat, dimethoate and fenthion in 2008–2010 demonstrated a 50% reduction in pesticide suicides from 2011 to 2015.<sup>40</sup> In contrast, a hospital-based study in Iran found that the number of aluminium phosphide self-poisonings increased following a national ban on that substance in 2007.<sup>55</sup>

Two other studies on means restriction examined the use of pesticide storage lockers to prevent self-poisoning suicides in rural communities. A cluster RCT involving more than 50 000 households in northern Sri Lanka showed that communities with households randomised to receive pesticide storage boxes had fewer pesticide suicides than control communities over 3 years. However, this difference was not statistically significant.<sup>50</sup> A smaller RCT exploring the effectiveness of a central storage facility for reducing pesticide suicides in farming villages in India found a significant difference in pesticide-related suicide attempts and deaths between the intervention and control communities at follow-up.<sup>59</sup>

One study examined the effectiveness of means restriction by reducing pesticide toxicity. In 2004, Sri Lanka approved the sale of a novel paraquat formulation (INTEON) developed to decrease paraquat's toxicity. A study of 586 patients admitted to hospitals for paraquat ingestion estimated 3-month survival improved by approximately 9% among individuals who ingested INTEON compared with those who had ingested the more toxic (standard) formulation.<sup>64</sup>

### Studies of public awareness campaigns

One study of an intervention to prevent suicide through a public awareness campaign was identified.<sup>24</sup> Conducted in two cities in Iran, the study examined the effectiveness of a video-based intervention to discourage self-immolation, with a focus on self-immolation among young women. In the intervention city, the rate of self-immolation suicide attempts by self-immolation significantly decreased at follow-up. The rate in the control city increased over the same period.

### Studies of biomedical treatments

We found seven studies examining biomedical interventions to reduce suicide-related outcomes.<sup>37 38 45 49 52 54 57</sup>

Five studies examined different pharmacotherapies. The largest of these studies was an RCT comparing the effectiveness of clozapine versus olanzapine in 980

individuals with schizophrenia or schizoaffective disorder in 11 countries, including 5 LMIC. Significantly fewer attempted suicides were reported in the clozapine group after 2 years of follow-up (results were not disaggregated by country).<sup>45</sup> A study of 510 individuals with schizophrenia living in one of six rural townships in China found no significant differences in suicide attempts between those who had ever versus never used any antipsychotic medication.<sup>52</sup> Finally, an RCT in Iran with 43 depressed individuals showed no significant difference in suicide ideation between the group that received citalopram and the group that received citalopram supplemented with vitamin C.<sup>54</sup> Two studies examined the effectiveness of ketamine for suicide ideation. One study compared ketamine and esketamine (the active comparator) and found that both treatments reduced suicide ideation, with no significant difference between groups.<sup>57</sup> Another study found that both intramuscular and oral ketamine significantly reduced suicide ideation compared with electroconvulsive therapy (ECT; active comparator) on the first day and at the second week of the intervention period, but the differences between groups were not significant at the final follow-up.<sup>38</sup>

An RCT with 73 participants with depression in Iran showed that ECT and repetitive transcranial magnetic stimulation (rTMS) were both efficacious in reducing suicidal behaviour at follow-up. ECT was more efficacious than rTMS.<sup>37</sup> A smaller RCT with a predominantly youth sample also found that rTMS was effective at reducing suicide ideation.<sup>49</sup>

### Studies examining multiple interventions

Four articles described studies examining effects of more than one intervention.<sup>26 29 42 61</sup> A cohort study in Nepal examined the effect a mental health service package, which used WHO mhGAP guidelines<sup>11</sup> for mental health-care, delivered by non-specialist primary care workers. The study found that suicide ideation declined over time among participants in both treatment and comparison cohorts; the treatment cohort was found to have a faster reduction of suicide ideation, while the participants receiving standard care had a more gradual reduction in suicide ideation over the same period time.<sup>26</sup> The Saving and Empowering Young Lives in Europe Study (SEYLE) was a school-based RCT conducted in 10 European countries, including one middle-income country (Romania). SEYLE assigned schools to a control group or one of three interventions: Question, Persuade, Refer (QPR); Youth Aware of Mental Health (YAM); or screening and referral (ProfScreen). No significant differences among groups were recorded at the 3-month follow-up. At the 12-month follow-up, YAM was associated with a significant reduction in incident suicide attempts and severe suicide ideation. QPR and ProfScreen did not have significant effects.<sup>61</sup> Country-specific outcomes for YAM were not reported due to sample size limitations.

Two studies in Iran examined whether multicomponent, regionally implemented suicide prevention

programmes could reduce overall suicide rates in the areas where the programmes were implemented.<sup>29 42</sup> One study incorporated a registration system, screening-and-referral service, training of primary care providers and a consultation office where high-risk individuals could visit a psychologist. After 1 year of the intervention, the suicide attempt rate increased in both the intervention and control regions, but the suicide rate was lower in the intervention region.<sup>42</sup> Another study incorporated gatekeeper training, a community health worker intervention for at-risk individuals, and educational and life skills training sessions targeting adolescents and parents with children. Compared with the period before the intervention was implemented, the number of suicides declined during each year of the intervention implementation; the difference between the control and intervention periods were not evaluated for significance.<sup>29</sup>

### Risk of bias

Risk of bias across studies was heterogeneous. In assessment of RCTs, overall risk of bias was low in 9 studies,<sup>31 45 48 50 54 60 61 63 66</sup> moderate in 10 studies,<sup>25 33 36 38 49 53 57 59 65 67</sup> and high in 11 studies.<sup>28 34 35 37 41 43 44 46 47 51 62</sup> High and moderate risk of bias ratings were due primarily to concerns about missing outcome data and measurement of the outcome. None of the randomised studies included in this review were found to have high risk of bias in domains related to the randomisation process or selection of reported results.

The overall risk of bias was found to be serious in all 14 non-randomised studies included in the review.<sup>24 26 27 29 30 32 39 40 42 52 55 56 58 64</sup> Higher risk of bias ratings were primarily due to potential confounding of the effect of intervention and missing outcome data.

## DISCUSSION

This review identified peer-reviewed controlled studies with data on youth and young adults that tested interventions for suicide-related outcomes, including suicide ideation, suicide attempt and suicide, in LMIC. Most studies were conducted in Asia. While geographical coverage to date has been limited, included samples were diverse, representing populations in clinical, educational and community settings. Interventions have been conducted in rural, urban and peri-urban locations. Interventions varied in their approach, ranging from universal to indicated approaches to prevention. Most of the studies assessed interventions designed to reduce suicide-related outcomes by either restricting lethal means or improving mental health.

Overall, the number of intervention studies with data on youth and young adults in LMIC does not correspond with the magnitude of suicide as a public health problem among youth in these countries. Worldwide, overall scientific output on the subject of suicide has grown substantially, particularly since the year 2000, but most of this growth has come from high-income countries.<sup>69</sup>

Publications on suicide in LMIC are rare, even as international collaborations among countries and regions on the problem of suicide have become more common. Of the 44 studies included in our review, 77% were published in the past 10 years. The recent growth of suicide prevention research to address youth suicide in LMIC is encouraging. However, while all studies in this review included youth and young adults in their samples, we found that few studies recruited exclusively youth samples (<10%) or were designed specifically for youth. Further, in studies with individuals in multiple age groups, disaggregation of results by age group was uncommon. Thus, there is not only a gap in the volume of suicide prevention research in LMIC populations, but also a gap in the body of research that focuses on the youth developmental period. Adolescence and young adulthood are developmental stages that require special consideration, and the reporting of results by age strata in studies with mixed age samples would help advance the evidence base on youth suicide prevention in LMIC. Data disaggregation in intervention research is a critical element to be addressed in future global health research in these populations.<sup>4 70</sup>

The relatively high number of mental health interventions identified in this review reflects the abundant research on the relationship between mental illness and suicide.<sup>4 71</sup> Among the psychological interventions included in this review, the most consistent positive effect was for suicide ideation as an outcome. Twelve of 17 studies assessing this specific outcome demonstrated significant effects of the interventions relative to control conditions. The greater variation in the findings for intervention effects on suicide attempts and deaths as outcomes may be explained by implementation or methodological challenges common to suicide prevention research, such as small sample sizes and study attrition. Interventions demonstrating significant reductions in suicide attempts, for example, tended to have larger samples. Duration of follow-up in some interventions was perhaps too brief to collect sufficient data on low frequency endpoints like suicide attempt and suicide. This low base rate problem is an enduring challenge for suicidology, including in countries with established surveillance systems.<sup>14</sup> Enhancing the use of electronic health records in healthcare facilities would provide a potentially valuable tool for addressing this challenge in LMIC.<sup>72</sup>

Self-poisoning accounts for approximately one-fifth of suicides worldwide.<sup>73</sup> Many of these suicides occur among people living in rural areas in LMIC. This review found consistent evidence that regulations to restrict access to highly lethal pesticides is an effective universal suicide prevention strategy. Some pesticide control policies implemented in LMIC have led to long-term reductions in suicide rates, including among youth specifically in some cases, in areas where bans are implemented.<sup>30 39 40</sup> Prior reviews of pesticide ban policies provide additional support for these findings.<sup>68 74</sup> Although studies of regulatory action to reduce pesticide suicides in LMIC are concentrated in Asia, bans are considered to be effective

across country income groups.<sup>75</sup> Regulatory bans do not necessarily mean, however, that the toxic pesticides are unavailable on the market. As long as toxic pesticides are sold and accessible, secondary and tertiary interventions to prevent suicide will remain necessary.

The WHO has stated that a comprehensive initiative to control pesticide suicides requires simultaneous actions in policy, surveillance, medical management and community-based programmes on access and education (eg, safe handling of pesticides).<sup>76</sup> In addition to the studies of policy, we found that efforts are being made in LMIC regarding these other recommended actions.<sup>50 59 64</sup> More information on these approaches is needed, including how to overcome local implementation challenges. For example, individuals' decisions to use community pesticide storage lockers may be shaped by awareness and predominating cultural attitudes about suicide.<sup>59</sup> While national bans can lower suicide rates, it is less clear what reduction in the rate should be expected from safe storage practices for youth in particular. The benefits of national policies, as well as of more downstream approaches like storage programmes, are difficult to quantify or evaluate in the absence of rigorous surveillance.

The majority of young people worldwide receive at least some formal education.<sup>77</sup> However, this review identified little research from school and after-school settings in LMIC, despite high rates of school attendance in many LMIC settings. SEYLE was one exception, and the results of its YAM intervention underscored the potential benefits of implementing universal suicide preventive intervention in schools.<sup>61</sup> Further, given that not all youth at risk of suicide have access to a healthcare facility, interventions implemented in schools and other settings where youth are found (eg, religious institutions, online communities or places where young adults work) are an important opportunity to reach youth outside the healthcare system.<sup>78–81</sup>

We also found sparse evidence on interventions for high-risk subpopulations. For example, we found no studies on gender minority youth and only one study each on HIV-positive individuals<sup>32</sup> and refugees.<sup>58</sup> The general lack of suicide prevention research with these groups is noteworthy in light of the large literature on refugee mental health globally<sup>82–84</sup> and the mental health of people in LMIC living with HIV/AIDS.<sup>85 86</sup> The WHO Mental Health Action Plan 2013–2020 highlights the need for suicide prevention efforts dedicated to higher risk subpopulations.<sup>7</sup>

Regarding risk of bias, we found variation in randomised and non-randomised interventions. Few interventions had low risk of bias in all domains. Studies were rarely reported according to standardised protocols (eg, Consolidated Standards of Reporting Trials).<sup>87</sup> Insufficient or incomplete reporting of methodology limits the application of bias assessments. In non-randomised studies, the absence of randomisation makes it difficult to overcome 'potential' confounding, leading ratings on the

ROBINS-I to skew toward higher bias, especially for policy studies whose investigators typically have little control over the availability of regional or national data on potential confounders. Further, a longstanding challenge in suicidology is how to study treatment effects when it is not ethically permissible to use randomisation.<sup>88</sup>

The risk of bias results should be viewed in conjunction with matters we observed pertaining to study quality, such as exclusion of 'actively' suicidal persons from samples, abridged description of intervention components and insufficient differentiation of outcomes. Heterogeneity of intervention components and measures used to assess outcomes impedes the comparison of effects across studies. These issues are common in suicide prevention research.<sup>88</sup> Based on this review, the knowledge base on intervention effects in LMIC would also benefit from efforts to reduce attrition and use consistent measures across studies. This would facilitate meta-analyses to improve confidence that purported changes in outcomes following delivery of an intervention are due to the intervention's true effect over time.<sup>89</sup>

There is no one-size-fits-all approach to preventing suicide. Most studies identified in this review tested the effects of single interventions, although there is some evidence available from studies implementing multi-component service packages or multiple interventions simultaneously.<sup>26 29 42 61</sup> Interventions can be implemented across the risk environment.<sup>8 68 90</sup> Universal, top-down approaches are considered more likely to shift the occurrence of suicide-related outcomes on a population level, while bottom-up approaches are needed to address individual-level risk. On the other hand, approaches and interventions should be reviewed carefully for best fit with local needs, culture and context. For example, there is wide geographical variation in the prevalence of psychiatric disorders among suicide decedents in LMIC,<sup>91</sup> and the interplay between poverty and suicide in these countries is little understood.<sup>92</sup> Limitations on healthcare resources that are more evidenced in LMIC, such as barriers to health information exchange, smaller workforce levels, fewer professionally trained mental health providers and limited mental health system governance, also affect the resources available for the identification, treatment and support of people in crisis.<sup>93–96</sup> Further, legal systems that criminalise suicidal behaviour may deter suicidal individuals from seeking care and obstruct the collection of data that are essential for understanding local drivers of suicide and crafting culturally-guided, evidence-informed prevention strategies.<sup>97</sup> Situation analysis by public health professionals, policymakers and other stakeholders is an essential step for determining the optimal approaches to suicide prevention for a given culture and context.<sup>12</sup>

The global proliferation of mental health applications, the internet and internet-connectable devices may offer a way to reach more youth globally than previously possible. Worldwide, 71% of youth ages 15–24 are online, the most 'connected' of all age groups, and some youth prefer



digital media to traditional ways of receiving information about health.<sup>98</sup> A frontier in suicidology is figuring out how to harness technology and digital media to prevent youth suicide in LMIC. The COVID-19 pandemic, for example, has challenged conventional strategies of providing and receiving care yet also created opportunities for technological innovation in the delivery of public health and healthcare to prevent suicide.<sup>99</sup> Other key structural barriers to care, such as professional healthcare workforce shortages, could be addressed through innovative task-sharing or task-shifting approaches.<sup>26 48 63 100</sup>

### Strengths and limitations

This review had several limitations. First, the review included only scientific literature published in English since 1990. The literature search was restricted to the past three decades due to limits on abstractable information prior to 1990. Older publications as well as publications in other languages or in the grey literature may describe relevant studies that this review did not capture. However, by using broad inclusion criteria, we were able to identify a wide range of interventions and strategies that may be relevant to youth suicide prevention in LMIC. Another limitation was that no quantitative synthesis was conducted because of the substantial heterogeneity among included studies; the evidence synthesis was necessarily qualitative. To ensure a minimum of methodological quality, we a priori excluded uncontrolled studies from the review. However, as indicated by the results of the risk of bias assessments among the included (controlled) studies, overall, the evidence base from LMIC has considerable methodological limitations, which necessitate a cautious interpretation of findings. Among the included studies, the quality and level of detail of reporting on the study design, procedures, results and potential limitations varied extensively. While we attempted to systematise the assessment of risk of bias by using standard tools (ROB2 and ROBINS-I), we recognise that methodological evaluation and judgement of potential bias are limited to the precision and extent that relevant details are reported in study publications or source documents. While this review focused on evidence from quantitative studies, qualitative studies could provide additional information on relevant interventions. Finally, the review was not prospectively registered. However, we did not alter our screening criteria or protocols during the course of the review.

Key strengths of this review were that it did not place restrictions on inclusion criteria related to intervention type, intervention setting or geography, except that each study had to have been conducted in at least one LMIC. The review also incorporated studies that reported on a range of suicide-related outcomes. Thus, this review summarised an extensive collection of peer-reviewed, controlled studies from LMIC.

### CONCLUSION

High suicide rates in LMIC highlight the need to determine what works to prevent suicide in these countries, particularly among youth, an understudied population. This review identified several successful and innovative strategies that have been empirically tested in LMIC contexts. While this literature holds promise for youth suicide prevention efforts in LMIC, most of the evidence is concentrated in a few countries and comes from small studies that were not designed specifically for youth populations. Thus, there is a need for evidence from large-scale, youth-focused research to inform local and national youth suicide prevention efforts in LMIC.

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