Systematic Review: Population and Community-based Interventions to Prevent Suicide

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted health care topics of importance to clinicians, managers, and policymakers as they work to improve the health and health care of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program comprises three ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program and Cochrane Collaboration. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, and interface with stakeholders. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee composed of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, Deputy Director, ESP Coordinating Center at Nicole.Floyd@va.gov.

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Peer Reviewers

The Coordinating Center sought input from external peer reviewers to review the draft report and provide feedback on the objectives, scope, methods used, perception of bias, and omitted evidence. Peer reviewers must disclose any relevant financial or non-financial conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The Coordinating Center and the ESP Center work to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

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ABBREVIATIONS TABLE

Abbreviation	Definitions
ASIST	Applied Suicide Intervention Skills Training
CDC	Centers for Disease Control and Prevention
COE	Certainty of Evidence
ESP	Evidence Synthesis Program
GLS	Garrett Lee Smith
GRADE	Grading of Recommendations, Assessment, Development, and Evaluation
MeSH	Medical Subject Headings
MISP-NV	Multi-Level Intervention for Suicide Prevention in New Zealand
PREVENTS	President's Roadmap to Empower Veterans and End a National Tragedy of Suicide
REACHVET	Recovery Engagement and Coordination for Health – Veterans Enhanced Treatment
RCT	Randomized controlled trial
ROB	Risk of Bias
SEYLE	Saving and Empowering Young Lives in Europe
US	United States
VA	Department of Veterans Affairs
VHA	Veterans Health Administration

EVIDENCE REPORT

INTRODUCTION

Suicide is a national public health problem with 48,344 estimated United States (US) deaths in 2018, making it a top-10 leading cause of death.[1] Despite increased awareness and attention to suicide prevention, suicide rates in the US continue to rise in both the military and general populations. Until 2008, suicides in the general population exceeded US military rates. Presently, however, Veterans are 1.5 times more likely to die by suicide than are members of the general population, after adjusting for age and sex.[2] In 2018, Veterans represented just 8% of the US adult population and accounted for 13.8% of all suicide deaths.[2] Reducing suicide among military populations, therefore, is of particular urgency.

The Department of Veterans Affairs (VA) has made suicide prevention a top priority. Substantial VA initiatives focus on identifying and treating Veterans determined to be at risk for fatal and nonfatal suicidal behavior. These initiatives include the Veterans Crisis line as well as prevention programs through the Veterans Health Administration (VHA) like the REACHVET program, Caring Contacts to Veterans, yearly screenings for suicide risk, and hiring Suicide Prevention Coordinators at Medical Centers.[3,4] These VHA-specific initiatives may account for reduced suicide rates among Veterans who use VA health care compared with those who do not.[5] However, the majority (two-thirds) of the Veteran population do not use the VA for health care. Strategies that rely on health care systems miss opportunities to reach individuals who do not seek health care preceding suicidal behavior or for whom imminent risk is unknown. Accordingly, the *National Strategy for Suicide Prevention* released by the Office of the Surgeon General, the National Action Alliance for Suicide Prevention, VA's *National Suicide Prevention Strategy*,[6] and the President's Roadmap to Empower Veterans and End a National Tragedy of Suicide (PREVENTS) Executive Order[7] all call for a public health approach to the crisis of suicide. Population- and community-based suicide prevention strategies are complimentary to those implemented in health care settings and hold the promise of reducing suicides and suicide attempts across the full spectrum of suicide risk.

We conducted a systematic review of published literature to address key questions related to the effectiveness and harms of community- and population-level interventions for suicide prevention. We focused on studies conducted outside of health care settings and on interventions not related to the treatment of patients (such as drugs or psychotherapy). The topic was nominated by VA Health Services Research & Development Office with the goal of identifying successful programs that might be adaptable for and applied to US Veterans. To facilitate integration of findings from this review with existing efforts to synthesize and disseminate evidence on community-based suicide prevention programs, we grouped interventions according to the Centers for Disease Control and Prevention (CDC) framework for classifying suicide prevention strategies.[11] Findings can inform the development of research priorities as well as efforts to design research-driven community-based and population-level approaches to suicide prevention.

METHODS

TOPIC DEVELOPMENT

The topic was nominated by VA Health Services Research & Development Service. We worked with the Operational Partners and a Technical Expert Panel to refine the scope, key questions, and inclusion/exclusion criteria. We registered a protocol in PROSPERO (ID 188943).

The key questions (KQ) were:

KQ 1: What are the effects of population- and community-based prevention interventions on suicide attempts and suicide deaths?

> **KQ 1a**: What are the key/common components of the most effective interventions?

> **KQ 1b**: What strategies have been used to deliver, sustain, and improve the quality of the most effective interventions?

> **KQ 1c**: How do the effects vary by differences in community/setting and characteristics of individuals targeted?

KQ 2: What are the potential unintended consequences of population- and community-based prevention interventions?

SEARCH STRATEGY

We searched MEDLINE, Embase, PsycINFO, Sociological Abstracts, and the Cochrane Database of Systematic Reviews. The search was limited from January 2010 to the end of November 2020 and references published in English-language. We used Medical Subject Headings (MeSH) and title/abstract terms indicative of suicide outcomes and community-based interventions. Exclusions terms related to elementary schools, youth populations, and hospital settings were used (Appendix 1). We reviewed reference lists of systematic reviews.

STUDY SELECTION

We included studies evaluating population- and community-based interventions for suicide prevention in persons high-school age or older and reporting suicide attempts, suicide deaths, or possible unintended consequences. We excluded studies focused on healthcare systems. We also excluded postvention and media reporting guidelines about suicide because these strategies involve interventions delivered after a suicide has occurred (*eg*, targeting bereaved families, friends, and their peers). Suicidal ideation was not included as an outcome because the progression from ideation to attempts are distinct phenomena[69] and community-based interventions tend to focus on prevention of suicide attempts and death. We reported on the following possible unintended or unanticipated consequences: suicide-related stigma, caregiver burden, and switching means of suicide, when applicable. Studies reporting suicide-related stigma among the target population as well as stigma in those who were trained as gatekeepers were included. We required the stigma outcome to be reported based on a scale score, such as the Stigma of Suicide scale, that measured stigmatizing attitudes towards suicidal persons or acts.

We required study designs to be randomized controlled trials (RCTs), observational studies with a concurrent control group, or pre-post observational studies. We included studies conducted in the general community, workplace, schools, military settings, prisons, or suicide hotspots. The inclusion and exclusion criteria are presented in Table 2.

Two investigators independently reviewed titles and abstracts; studies considered possibly eligible by at least 1 reviewer were forwarded for full-text screening. Two investigators independently reviewed full-text articles to determine if they met eligibility criteria. Differences in screening decisions were resolved by consensus or, if needed, discussion with a third reviewer. Studies were screened in DistillerSR (Evidence Partners Inc, Ottawa, Canada).

Table 2. Inclusion and Exclusion Criteria

PICOTS	Inclusion Criteria	Exclusion Criteria
Population	Veteran and non-Veteran populations of high school age or older	
Intervention	Population- and community-based interventions to prevent suicide	Pharmacotherapy Psychotherapy delivered in-person or online Therapeutic interventions that can be delivered only by licensed health care professionals Legislation enacted to reduce suicide risk factors Postvention/suicide bereavement support Media reporting guidelines Multi-strategy interventions that relied predominantly on the above excluded interventions
Comparison	Pre-intervention Concurrent control group	
Outcomes	*Primary outcomes:* suicide attempts suicide deaths *Possible unintended consequences:* stigma towards suicide caregiver burden switching suicide means	
Timing	Any	
Setting	Community-based settings (*ie*., schools, workplace, prisons, military settings, suicide hotspots, general community) Countries with very high Human Development Index	
Study Design	RCTs Observational study with pre-post data and/or concurrent control	Case reports Narrative reviews Systematic reviews Editorials and commentary

PICOTS=population, intervention, control, outcomes, timing, setting/study design; RCT=randomized controlled trial

QUALITY ASSESSMENT

We assessed risk of bias of studies using instruments applicable to the study design. RCTs were assessed using the Cochrane Risk of Bias 1.0 tool, which includes domains for random sequence generation, allocation concealment, blinding, attrition, and selective outcome reporting.[8] Cluster RCTs were assessed with several additional domains (*ie*, recruitment bias, baseline imbalance, and incomplete cluster data). Observational studies were assessed for quality using a modified version of the Joanna Briggs Institute Critical Appraisal Tool for Quasi-Experimental Studies (Appendix 2).[9] The overall risk of bias of each RCT and observational study was classified as High, Moderate, or Low. We did not extract and analyze the studies classified as high risk of bias. One reviewer independently rated risk of bias and a second reviewer verified. We did not asses risk of bias for studies that only examined stigma towards suicide as an outcome among the participants who were trained as gatekeepers and did not report other eligible outcomes.

DATA ABSTRACTION

We abstracted information on study characteristics, participants, setting, intervention, control, and outcomes. Our primary outcome was suicide deaths. Additional outcomes were suicide attempts, unintended consequences of the intervention (*ie,* caregiver burden, stigma towards suicide, and switching suicide means), and cost. We also abstracted suicide attempts and suicide deaths outcomes in any population subgroups of interest, which were sex, age, race, military status, housing status, socioeconomic status, and mental health condition/history of suicide behavior. From the studies that found an intervention to be effective, we abstracted the strategies to deliver, sustain, and improve the intervention. Effective was defined as reducing suicide deaths or attempts based on at least low certainty of evidence. One reviewer abstracted data and a second reviewer verified.

DATA SYNTHESIS

We modified the CDC framework of summary of strategies and approaches to prevent suicide to categorize the interventions.[11] Modifications included: 1) adding a category for "public awareness and education campaigns" and a category for "screening for at-risk individuals (outside a health care setting)"; and 2) removing CDC strategies and approaches irrelevant to the current review. Definitions of the CDC strategies and approaches to prevent suicide are in Appendix 3. Interventions were classified as multi-strategy when they spanned more than 1 CDC strategy. We also categorized studies by the setting in which they were delivered. As per the CDC framework, suicide prevention programs targeting "closed communities" such as workplace or military were categorized under *Organizational policies and culture.* However, we acknowledge that these programs could also have been categorized as multi-strategy. Findings were narratively synthesized across studies due to the heterogeneity in populations, interventions, settings, and outcome reporting. When able to, we calculated risk ratios (RR), absolute risk differences (ARD), and standardized mean differences (SMD) with 95 percent confidence intervals for results from individual studies. Data were analyzed in Comprehensive Meta-Analysis version 3 (Biostat).

RATING THE BODY OF EVIDENCE

Based on the studies published 2010-2020 and for each intervention and setting, we used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach to rate the certainty of evidence as high, moderate, low, or very low for the outcomes of suicide deaths, suicide attempts, and suicide-related stigma.[10] For the studies that evaluated reducing access to lethal means, we rated the certainty of evidence for the outcome of switching suicide methods. Using the GRADE approach, data from observational studies start at low certainty while RCTs start at high. The certainty is adjusted based on factors such as study limitations, inconsistency, indirectness, imprecision, and other considerations. We relied on statistical significance to make judgements about imprecision. Certainty was determined by consensus.

PEER REVIEW

A draft version of this report was reviewed by technical experts as well as clinical leadership. Their comments and our responses are presented in Appendix 6.

RESULTS

LITERATURE FLOW

Our search identified 4,499 unique references after removing duplicates (Figure 1). After full-text screening, 69 articles met inclusion criteria. Thirteen studies were rated as high risk of bias. Thus, 56 articles that described 47 unique studies were used for analyses. We organized results according to the CDC framework of summary of strategies and approaches to prevent suicide. An overview of the number of studies by intervention, setting, study design, and outcome is provided in Table 3. A list of the eligible references is in Appendix 4.

Figure 1: Literature Flow Chart
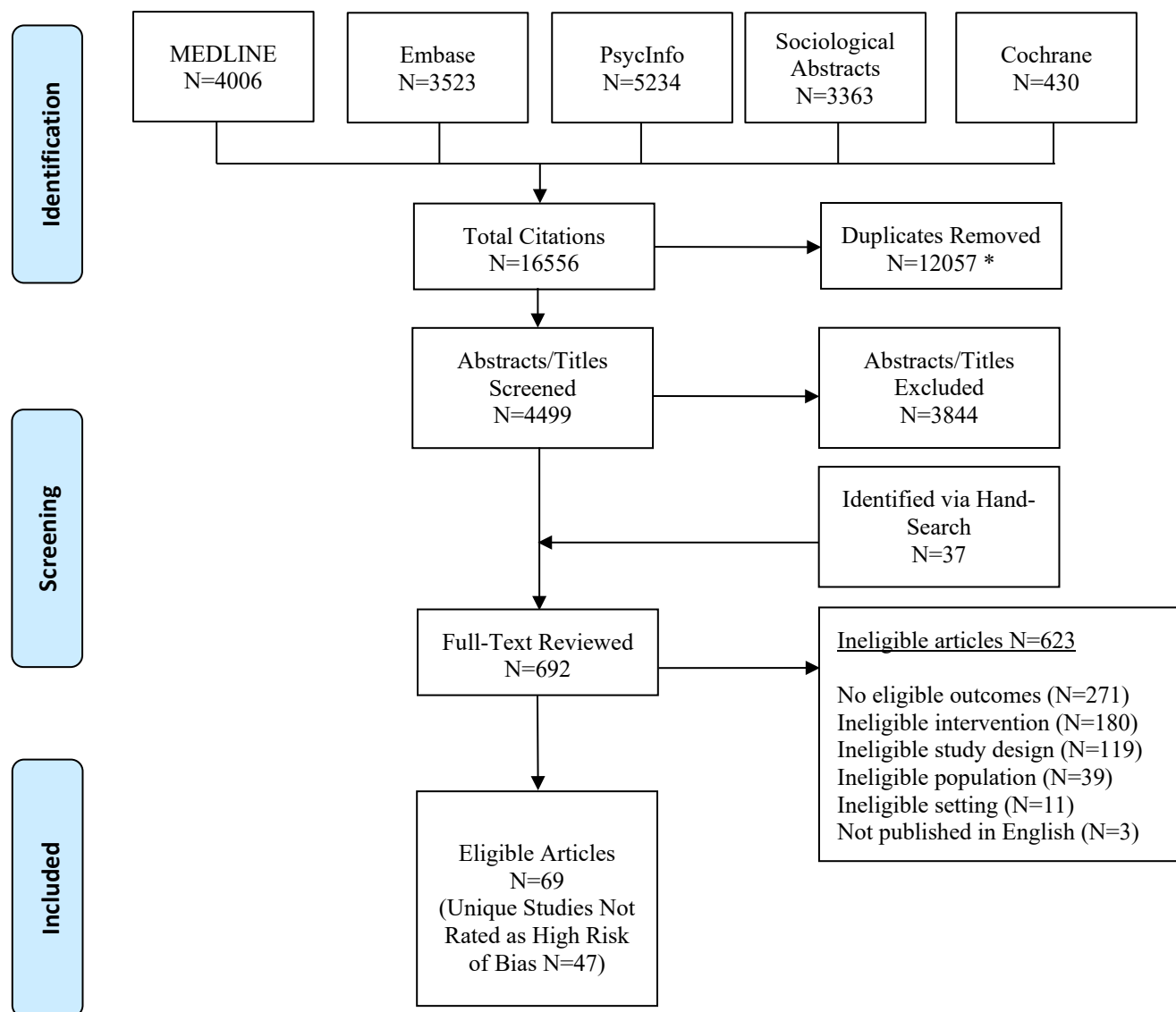
* The duplicates were from both a) duplicates between bibliographic databases and b) duplicates between the original search and the updated search

Table 3. Overview of Study Outcomes by CDC Strategy and Approach *

Primary CDC Strategy	Approach	Settings and Outcomes													
		Hot spots		General Community		Workplace		High School		Military or Veteran		Indigenous Community		Prison	
		SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA
Strengthen economic supports	*Household financial security*														
	Housing stabilization									□	□				
Strengthen access and delivery of suicide care	*Coverage of mental health conditions in health insurance policies*	Excluded from the current review. This strategy takes place within health care settings.													
	Reduce provider shortages in underserviced areas														
	Safer suicide care through systems change														
Create protective environments	*Reduce access to lethal means*	□□□ □□□ ○○	□□	□□ ○											
	Organizational policies and culture					□ ○				○○					
	Community-based policies to reduce alcohol use														
Promote connectedness	*Peer norm programs*														

Primary CDC Strategy	Approach	Settings and Outcomes													
		Hot spots		General Community		Workplace		High School		Military or Veteran		Indigenous Community		Prison	
		SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA
	Community engagement activities														
Teach coping and problem-solving skills	*Social-emotional learning programs*						◊	◊	◊◊						
	Parenting skills and family relationship approaches														
Identify and support people at risk	*Gatekeeper training*			□	□			◊	◊			◊	◊		
	Crisis intervention	○													
	Public awareness and education campaigns			□ ○											
	Screening for at-risk (not in clinic setting)			□□				◊	◊					□	
	Treatment for people at risk of suicide	Excluded from the current review. These approaches relate to clinical interventions.													
	Treatment to prevent re-attempts														
Lessen harms and prevent future risk	*Postvention*	Excluded from the current review. These approaches relate to interventions delivered after a suicide has occurred.													
	Safe reporting and message about suicide														

Primary CDC Strategy	Approach	Settings and Outcomes													
		Hot spots		General Community		Workplace		High School		Military or Veteran		Indigenous Community		Prison	
		SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA
Multiple Strategies	Varied	○		◊ □□□ □□□ □ ○○○ ○○○	□□□										

CDC=Centers for Disease Control and Prevention; SD=Suicide Deaths; SA=Suicide Attempts

◊=randomized controlled trial
□=observational study with concurrent control
○=observational study with pre-post study design and no concurrent control
_=study reported both suicide deaths and suicide attempts

*This framework was modified to remove the following CDC suicide prevention approaches: coverage of mental health conditions in health insurance policies, reduce provider shortages in underserved areas, safer suicide care through systems change, treatment of people at risk of suicide treatment to prevent re-attempts, postvention, and safe reporting and message about suicide. The following 2 interventions were added to the framework: public awareness and education campaigns and screening for at-risk (not in clinic setting).

CDC STRATEGY: STRENGTHEN ECONOMIC SUPPORTS

Key Messages

- Housing stabilization programs had unclear effects on suicide deaths and attempts; very low certainty (no data on suicide stigma)

Housing Stabilization (k=1)

Overview of Included Studies

One observational retrospective cohort study with a concurrent control evaluated the impact of a housing stabilization program to prevent suicide among unstably housed US Veterans.[12] The Veterans Health Administration (VHA) Homeless Program included 6 services: an in-depth assessment for homeless services, emergency housing services, rapid rehousing and homelessness prevention, permanent supportive housing, and transitional housing. This study compared suicide rates among Veterans who utilized at least 1 of the 6 VHA Homeless Program services (n=93,135) to VHA users who also experienced housing instability but received no homeless services (n=76,086). The study period was from October 2012 through September 2016. Compared with Veterans who received no services, Veterans who received services were more likely to be younger (mean age 50 years vs 52 years), female (11% vs 10%), black/African American (35% vs 23%), and have non-Hispanic ethnicity. Veterans who received homeless services also had fewer severe comorbidities, had more frequent documentation of military sexual trauma (9% vs 7%), and were more eligible for Medicaid and a VA pension (46% vs 35%). The study was rated as medium risk of bias. Quality assessments, population characteristics, intervention details, and outcomes data are in Appendix 5.

Suicide Attempts and Suicide Deaths

The effect of the VHA Housing stabilization program on suicide deaths was uncertain (very low certainty). Although "any VHA Homeless Program use" was associated with a 21% reduction in risk of a suicidal death compared with "no use" of homeless services, this finding was not statistically significant (adjusted HR 0.79 [95% CI 0.62 to 1.01]). Overall, suicide deaths were rare, approximately 0.2% in each group. The authors also found that Veterans who accessed "3 or more VHA homeless services" had reduced hazards of dying by suicide compared to those who did not access any VHA homeless services but did not provide any details about which of the 6 specific interventions were actually accessed (adjusted HR 0.62 [95% CI 0.40 to 0.96]).

The effect of the VHA Housing stabilization program on suicide attempts is uncertain (very low certainty). Veterans who used VHA homeless services had significantly higher rates of suicide attempts compared with Veterans who did not use VHA homeless services, 6% versus 2% ($P<.05$). However, because the authors did not provide temporal data, it was not clear whether the suicide attempt preceded the Veterans use of homeless program services.

Suicide-Related Stigma and Caregiver Burden

The study did not report on suicide-related stigma or caregiver burden.

Table 4. Certainty of Evidence: Strengthen Economic Supports

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Housing Stabilization Observational Study with Concurrent Control (k=1)[12]	**Suicide Deaths** Veterans US 169,221 Follow up 4 years	aHR* 0.79 (95% CI 0.62 to 1.01)	0.2% (157/93,135)	0.2% (140/76,086)	0% (Calculated CI ** -0.06 to 0.02)	⊕◯◯◯ VERY LOW [a]	The effect of housing stabilization programs on reducing suicide deaths in US Veterans is unclear.
	Suicide Attempts Veterans US 169,221 Follow up 4 years		6.0% (5628/93,135)	2.1% (1594/76,086)	Calculated RD ** 4% (95% CI 3.8 to 4.1)	⊕◯◯◯ VERY LOW [a]	The effect of housing stabilization programs on reducing suicide attempts in US Veterans is unclear.
	Stigma Towards Suicide - NR						

aHR=adjusted hazard ratio; CI=confidence interval; ESP=Evidence Synthesis Program; MST=military sexual trauma; VA=Department of Veterans Affairs; VHA=Veterans Health Administration

* Adjusted for age, sex, race, Hispanic ethnicity, MST, history of suicide ideation, history of suicide attempt, ever diagnosed with depression, weighted Elixhauser medical comorbidity, Enrolment Priority Group and whether the Veteran had any VHA Homeless Program use
** Calculated by Minneapolis VA ESP project team.

Explanations
[a] Downgraded study limitations (imbalance in the demographics between the intervention and control groups)

CDC STRATEGY: CREATE PROTECTIVE ENVIRONMENTS

Key Messages

- Reducing access to lethal means:

    o Restrictions to purchasing charcoal may reduce suicide deaths by self-immolation in Asian countries and may not lead to suicide deaths by other means; low certainty (no data on attempts, suicide stigma)

    o Installing barriers at bridges and railway stations may reduce suicide deaths and attempts at those locations; low certainty. It is unclear what the impact of this intervention is on suicide deaths by other means; very low certainty (no data on suicide stigma)

    o On railway platform, the effect of installation of blue lights on suicide deaths is unclear; very low certainty (no data on attempts, switching means, suicide stigma)

- Organizational policies and culture:

    o In police workplaces, suicide prevention programs focused on organizational policies and culture may reduce suicide deaths; low certainty (no data on attempts and suicide stigma)

    o In construction workplaces, the effect of organizational policies and culture on suicide deaths is unclear; very low certainty (no data on attempts, suicide stigma)

    o Among military populations, the effects of organizational policies and culture on suicide deaths is unclear; very low certainty (no data on attempts, suicide stigma)

Reducing Access to Lethal Means (k=11)

Overview of Included Studies

Eleven observational studies evaluated reducing access to lethal means: 3 studies were designed to reduce access to purchasing charcoal, as charcoal burning has been used as a suicide method; 7 studies involved installation of barriers at suicide hot spots where individuals were jumping to their death; and 1 study involved installation of blue lights on a railway platform.[13-26] Eight were observational studies with a concurrent control and 3 were pre-post observational studies without a concurrent control. The studies either took place in the general community (k=3[13-15]), or at bridges or railway stations (k=8[16-26]). Eight studies were rated as medium risk of bias and 3 as low risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

Charcoal burning

Three studies evaluated the effects of reducing access to purchasing charcoal in parts of Asia where self-immolation has emerged as a suicide method.[13-15] The intervention included removal of charcoal from open shelves of retail stores to a locked container that could only be retrieved by a shop assistant or seller via customer request. Sellers could then inquire about the use of the charcoal which might discourage use of charcoal for suicide or result in a conversation in which help seeking could be encouraged. The first study conducted in Hong Kong compared the rates of suicides (12 months prior and 12 months after implementation) between intervention region

(Tuen Mun) and the control region (Yuen Long).[13] The total population in Tuen Men and Yuen Long combined was 1,036,000 people and approximately 8% were 65 years and older. The second study (Taiwan) compared the rates of suicides between the intervention city (New Taipei City) and 2 control cities (Taipei City and Kaohsiung City) with a 40-month pre- and 20-month post-implementation period.[14] The total population in the intervention and control cities was 9.3 million. Demographic characteristics of the eligible population were not reported. A third study conducted in the Gyeonggi Province in Korea, used a time-series design, and did not have a concurrent control group.[15] Total population in Gyeonggi Province was about 13 million. Demographic characteristics of the target population were not reported.

Barriers at jumping sites and railway stations

Three studies examined rates of suicide at bridges where barriers were installed to prevent suicide by jumping.[16-20] The studies included concurrent controls and were conducted in Toronto (Bloor Street Viaduct Bridge) and Quebec (Jacques-Cartier Bridge) in Canada and in Brisbane, Australia (Gateway Bridge).[16-19] The studies reported suicide rates before and after the intervention at the bridge where the barrier was installed, compared with suicide rates at other surrounding jump sites near the intervention site, as well as all suicides in the city where the bridge is located. An additional study evaluated the effects of physical barriers and safety nets at 15 jump sites in Switzerland and did not have a concurrent control.[20] Lastly, 3 studies were conducted at railway stations and measured the effects of installing platform screen doors.[21-23] These studies took place in Hong Kong, South Korea, and Japan, respectively. Demographic characteristics of eligible populations were not reported.

Installation of blue lights at railway stations

One study, conducted in Japan, evaluated the effects of installing blue light-emitting-diode (LED) lamps on railway platforms as a suicide prevention strategy due to the possibility that blue lights may have a calming effect on people.[24-26] The study reported the rates of suicide at the stations with blue lights, compared with the neighboring 5 stations without blue lights. Demographic characteristics were not reported.

Suicide Attempts and Suicide Deaths

Prevention programs intended to restrict access to purchasing charcoal at retail stores may reduce suicide deaths by self-immolation (low certainty). The study in Hong Kong found a reduction in suicides by charcoal-burning in the intervention region from 4.3 at baseline to 2.0 per 100,000 persons at follow-up compared with an increase from 3.0 at baseline to 4.3 per 100,000 at follow-up in the control region.[13] The authors calculated a -66.9% adjusted difference in percent change in charcoal-burning suicides between the intervention and control regions (P=.03). The adjusted difference between regions remained significant in men (-72.7%; P=.03), but not in women (-48.6%; P=.47). The study in Taiwan also found a reduction in suicides by charcoal-burning in the intervention city from 6.2 to 3.9 per 100,000 persons compared with 3.5 to 2.5 in 1 control city and 5.3 to 4.7 in the second control city.[14] Compared to 1 control city, the authors reported a decrease in suicides by charcoal-burning of 37% (95% CI, 17 to 50%) in the intervention region. Within the intervention region, there were numerical decreases in suicides by charcoal-burning in all age and sex subgroups, except in men aged 65 years and older. Lastly, the study in Korea that utilized a time-series analysis without a control group showed a

significant decrease in suicides by charcoal-burning after the intervention (multi-variate time series P=.029).[15] These 3 studies did not report suicide attempts.

Installing physical barriers at bridges and railway stations may reduce suicide deaths at those locations (low certainty). Among studies reporting the Incident Rate Ratios (IRR)(k=4), the IRR ranged from 0.009 to 0.30 when comparing the suicide rates at those locations during the post-intervention period to the pre-intervention period.[16,18,20,22] The other studies also showed a reduction in suicides at the bridge or railway station after installing a physical barrier. Specifically, the study in Brisbane, Australia found a reduction in suicides by 87.5% at the Gateway Bridge after installing the barrier.[19] The study in Hong Kong found a reduction in suicides with a 5-year average percent change of a 80.6% decrease.[21] Studies comparing the pre- and post- implementation periods consistently found no significant differences in suicide deaths at nearby bridges and railway stations without an intervention.[16,18,19,21] In addition, installing physical barriers at railway stations may reduce suicide attempts at those locations (low certainty). The study in Hong Kong found a reduction in non-fatal suicide falls at the railway stations where platform screen doors were installed, from 33 to 17 comparing the 5-year pre- and post-implementation periods.[21] During that time period, the number of attempts occurring at railway stations where platform screen doors were not installed remained relatively consistent, from 11 to 12 during the 5-year pre- and post-periods.

Installing blue lights at railway stations has an unclear effect on suicide deaths (very low certainty). The study in Japan found the rates of suicide per station-year decreased from 0.44 at baseline to 0.19 at follow-up at stations where blue lights were installed compared with "no major increase or decrease" at nearby stations without the blue light intervention.[25] During the post-installation period, there were 10 total suicides at stations with blue lights, with 9 taking place during the day when the blue lights would have been off. While the study reported an IRR of 0.26 (95% CI 0.13 to 0.52), it was difficult to know if the reported estimates of effect could be attributed to the blue lights, because a subsequent analysis by Ichikawa et al found that only 14% of suicide attempts at railway stations in Japan occur at a time of day and location where the blue lights can be seen.[26]

Switching Suicide Means, Suicide-Related Stigma, and Caregiver Burden

Restricting access to purchasing charcoal at retail stores may not result in switching means of suicide (low certainty). The study in Hong Kong found a reduction in suicides by non-charcoal burning methods in the intervention region from 13.6 at baseline to 10.2 per 100,000 at follow-up and the control region also showed a decrease in non-charcoal burning methods from 9.6 to 8.1 per 100,000.[13] The study in Taiwan found small reductions in non-charcoal burning methods in both the intervention city and in the control cities after the intervention relative to pre-intervention (intervention region: 12.3 to 11.9 per 100,000; control city 1: 10.8 to 10.6 per 100,000; control city 2: 14.9 to 14.8 per 100,000).[14] No studies examined suicide-related stigma or caregiver burden.

It is uncertain whether installation of physical barriers at bridges results in switching means of suicide (very low certainty). Based on 1 study in Toronto, the rates of suicides by methods other than jumping decreased after installing the barrier at the Bloor Street Viaduct Bridge relative to the pre-intervention period (IRR=0.84 [95% CI, 0.76 to 0.93]).[16] No studies at bridges or railway stations reported on suicide-related stigma or caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 5. Implementation Strategies for Restricting Access to Charcoal

Strategies to…	Restricting Access to Charcoal
deliver an effective intervention	auditing intervention stores or providing on-site visits to assess compliance with procedures to limit access to charcoal.[13,14]
sustain an effective intervention	not explicitly utilized in the included studies. However, authors state the need to consider unintended consequences of reduced charcoal sales that occurred with the program implementation, which may be a deterrent to widespread adoption and dissemination to other stores.[13,14] In addition, media influence and public awareness of means restriction of charcoal may impact the results of means restriction use in suicide prevention.[14]
improve the quality of an effective intervention	not directly evaluated but authors state that some stores and employees had increased education on, use of, and access to pamphlets with education on mental health and resources for distribution to customers.[14]

Table 6. Implementation Strategies for Barriers at Jump Sites and Railway Stations

Strategies to…	Barriers at Jump Sites and Railway Stations
deliver an effective intervention	not explicitly stated in the included articles. However, authors mention that the cost of barrier installation, in conjunction with consideration for the aesthetic and functional design of the structure (*eg*, railway station), influenced the type of installation (*eg*, full versus half platform screen doors) and the extent to which installments are made at all locations.[23]
sustain an effective intervention	a cost-effectiveness analysis that evaluated outcomes important to stakeholders (*ie*, lives saved, costs).[21] Authors indicate that cost of barrier or safety net installation remains a significant deterrent to widespread application because many railroad companies may have limited budgets to extend construction and installation of barriers/safety nets across all lines or stations.[21] Effective resource allocation through the availability of funds and acceptance by the community to use such funds for barrier installation are important factors in policy-makers' decisions that impact societal and economic outcomes.[19,21] Media influence was stated as a factor that could potentially help or hurt the success of barriers designed for suicide prevention.[16,21]
improve the quality of an effective intervention	not directly evaluated but were suggested as topics for future research. Authors suggest a need for future study on the effects of a comprehensive suicide prevention strategy that includes barriers, in addition to education, stigma reduction, adequate access to resources, and depression screening.[17,18]

Organizational Policies and Culture (k=4)

Overview of Included Studies

Four observational studies evaluated the effect of suicide prevention programs designed to influence organizational policies and culture.[27-30] The interventions were implemented in a police workplace setting (k=1[27]), construction workplace settings (k=1[30]), or in military populations (k=2[28,29]). One study had a concurrent control group[27] and 3 were pre-post studies without a

concurrent control.[28-30] All 4 studies were rated as medium risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

Police workplace

One study evaluated the effect of the "Together for Life" program on suicide rates in the Montreal Canadian police force compared with a control group of police officers in the rest of Quebec, Canada).[27] "Together for Life" consisted of suicide training and education; development of police-specific resources, including a telephone hotline; training on how to identify of at-risk individuals; and a publicity campaign. The study period spanned from 1986-2008 with intervention implementation in 1997 (11 years pre- and 12 years post-intervention). The Montreal police force (N=4,178) was predominantly male (78%) and between the ages of 20-39 (70%). Participant demographics were not reported in the control group, which consisted of police officers in the rest of Quebec, Canada (N=10,131).

Construction workplace

One pre-post study in Australian construction workers evaluated the impact of the "Mates in Construction" program on suicide deaths.[30] This program was designed to provide general awareness of suicide and connector training to facilitate connecting at-risk coworkers to field officers, case managers, or additionally skilled co-workers. Some workers received additional training to identify cues and respond during a crisis by taking additional steps to reach a contract or safe plan. The study period spanned 2003-2012 with intervention implementation in 2008 (5 years follow-up) in Queensland (N=708,950 pre and N=841,425 post). All participants were male. Other participant demographics were not reported.

Military populations

One pre-post study of a military workplace intervention consisted of suicide education, provision of preventative or mental health services, and a suicide surveillance system targeting multiple stakeholders (United States Air Force Suicide Prevention Program)[28]; the other study of a military workplace intervention consisted of reducing weapon availability, improving screening and identification of at-risk soldiers, reducing stigma, and developing a suicide review process (Israeli Defense Forces Suicide Prevention Program).[29] The study in the United States Air Force spanned from 1981-2008 with intervention implementation in 1997 (11 years follow-up). Participant demographics were not reported. The study conducted in the Israeli Defense Forces spanned from 1992-2012 with intervention implementation in 2006 (7 years follow-up). The demographics of active duty Israeli soldiers (N=1,171,359) were 53% male, the average age was 19 years old, and approximately half were of middle socio-economic status (53.8%) with 24% in the low and 22.2% high socio-economic status. Mental health diagnoses were present in 2.7% of the population.

Suicide Attempts and Suicide Deaths

Suicide prevention programs focused on organizational policies and culture in police workplace settings may reduce suicide deaths (low certainty). In the Montreal police force, a reduction in suicides from 30.5 suicides per 100,000 persons per year to 6.4 per 100,000 persons per year was reported.[27] In the control group (police in the rest of Quebec), a non-significant change in suicide rates from a rate of 26.0 suicides per 100,000 persons per year to 29.0 per 100,000 persons per

year was reported. In construction workers, a comparison of pre- versus post-intervention implementation of the intervention yielded a relative risk reduction of 9.6% (95% CI 9.1-10.0) to 0.904 (95% CI 0.900, 0.909).[30] Specifically, the suicide rate decreased from 29.20 suicides per 100,000 persons prior to the intervention to 26.38 suicides per 100,000 persons post-intervention. In the United States Air Force study, the suicide rate decreased from 3.033 per quarter per 100,000 persons to 2.387 per quarter per 100,000 persons, resulting in 0.646 reduction in suicides per quarter per 100,000 persons from pre to post intervention.[28] In the study of active duty Israeli soldiers, suicide rates prior to the intervention were reported at 24.6 per year (344 suicides) and, post-intervention, at 12.7 suicides per year (89 suicides).[29] Authors calculated an increase in survival among soldiers in the post-intervention period (Hazard Ratio [HR]=0.42 [95% CI, 0.33 to 0.54]). The significant increase in probability of survival in the post-intervention period was represented in separate analyses of males (HR=0.43 [95% CI, 0.33 to 0.55]) but not females (HR=0.90 [95% CI, 0.45 to 1.83) where survival rates were not significantly different between pre- and post-intervention groups. No study reported suicide attempts.

Suicide Related-Stigma and Caregiver Burden

No studies reported on suicide-related stigma or caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 7. Implementation Strategies for Effective Organizational Policies and Culture

Strategies to…	Organizational Policies and Culture
deliver an effective intervention	utilizing peers to deliver the program who share a "common language" ("Together for Life," Montreal Police Force).[27]
sustain an effective intervention	creating a culture within the Montreal police force ("Together for Life") that suicidal behavior was not an acceptable way to deal with a crisis may help the population's overall, sustained awareness of suicide prevention.
improve the quality of an effective intervention	stakeholders participating in the "Together for Life" program identified the need for improved and sustained training with annual refresher courses, follow-ups, or memory aids.[27]

Table 8. Certainty of Evidence: Create Protective Environments

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Restrictions to Charcoal Observational Studies with Concurrent Control (k=2) [13,14]	**Suicide Deaths** Study 1 Community Hong Kong Eligible population= 1,036,000 Pre-period 1 year Post-period 1 year		Study 1: Suicides rates by charcoal-burning in the intervention region decreased from 4.3 to 2.0 per 100,000. Suicide rates by charcoal-burning in the control region increased from 3.0 to 4.3 per 100,000.		Study 1 ARD = -3.3 charcoal suicides per 100,000	⊕⊕○○ LOW	Reducing access to purchasing charcoal may reduce suicide deaths by self-immolation
	Study 2 Community Taiwan Eligible population= 9,300,000 Pre-period 40 months Post-period 20 months		Study 2: Suicides rates by charcoal-burning in the intervention region decreased from 6.2 to 3.9 per 100,000. Suicide rates by charcoal-burning in the 2 control regions decreased from 3.5 to 2.5 per 100,000 and 5.3 to 4.7 per 100,000, respectively.		Study 2 ARD vs both control cities ranged from -1.3 to -1.7 charcoal suicides per 100,000		
	Suicide Attempts – NR						
	Switching Means Study 1 Community Hong Kong Eligible population= 1,036,000 Pre-period 1 year Post-period 1 year		Study 1: Suicides rates by other means in the intervention region decreased from 13.6 to 10.2 per 100,000. Suicide rates by charcoal-burning in the control region decreased from 9.6 to 8.1 per 100,000.		Study 1 ARD = -1.9 non-charcoal-burning suicides per 100,000	⊕⊕○○ LOW	Reducing access to purchasing charcoal may not lead to suicide deaths by other means
	Study 2 Community Taiwan Eligible population= 9,300,000 Pre-period 40 months Post-period 20 months		Study 1: Suicides rates by other means in the intervention region decreased from 12.3 to 11.9 per 100,000. Suicide rates by other means in the 2 control regions changed from 10.8 to 10.6 per 100,000 and 14.9 to 14.8 per 100,000, respectively.		Study 2 ARD vs both control cities ranged from -0.2 to -0.3 non-charcoal-burning suicides per 100,000		

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
	Stigma Towards Suicide – NR						
Pre-Post Observational Study with No Concurrent Control (k=1) [15]	**Suicide Deaths** Community South Korea Eligible population= ~13 million Follow-up 2 years		Suicides by charcoal-burning started decreasing after the intervention (multi-variate time series P=.03)			⊕○○○ VERY LOW [a]	See above
Barriers at Bridges and Railway Stations Observational Studies with Concurrent Control (k=4) [16,18,19,21]	**Suicide Deaths** * Studies 1-4 Bridges and railway stations Canada, Australia, Hong Kong Eligible population= NR Pre-period 4-14.5 years Post-period 5-19 years	IRRs at intervention sites ranged from 0.009 to 0.24	At the intervention sites, the range of suicides per year decreased from 5.5-10.0 during pre-period to 0.1- 2.6 during the post-period At the control sites, the range of suicides per year stayed constant from 2.6-26.1 during pre-period to 3.0-22.5 during the post-period		ARD across studies ranged from -3.8 to -9.3 suicides per year	⊕⊕○○ LOW	Installation of barriers at bridges and railway stations may reduce suicide deaths at those locations
	Suicide Attempts ** Study 1 Railway stations Hong Kong Eligible population= NR Pre-period 5 years Post-period 5 years		Study 1: Non-fatal suicide attempts at the intervention sites went from 33 to 17. Non-fatal suicide attempts at the control sites stayed constant from 11 to 12.		ARD = -3.4 non-fatal attempts per year	⊕⊕○○ LOW	Installation of barriers at railway stations may reduce suicide attempts at those locations
	Switching Means Study 1 Bridge Canada Eligible population=NR Pre-period 11 years Post-period 11 years	IRR for other methods = 0.84 (0.76 to 0.93)	Suicide rates by other means in Toronto decreased from 190.8 to 160.4 per year		Decrease in 30.4 suicides per year by other methods	⊕○○○ VERY LOW [a]	It is unclear what the effect of installing barriers at bridges is on suicide deaths by other means
	Stigma Towards Suicide – NR						

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Pre-Post Observational Studies with No Concurrent Control (k=2) [20,22]	**Suicide Deaths** Study 1 Jump sites Switzerland Eligible population=NR Pre-period 14.9 years Post-period 6.1 years	IRR = 0.30 (0.17 to 0.44)	Across the 15 jump sites, the suicides per year changed from 1.47 to 0.41		Decrease 1.06 suicides per year	⊕◯◯◯ VERY LOW [a]	See above
	Study 2 Railway stations South Korea Eligible population=NR Follow-up varied; screen doors installed over time	IRR = 0.11 (0.03 to 0.43)	During the pre-period, there were 132 total suicides over 8769 station-months. During the post-period, there were 3 total suicides over 5751 station-months				
Blue LED Lights at Railway Stations Observational Study with Concurrent Control (k=1) [40]	**Suicide Deaths** Railway stations Japan Eligible population=NR Follow-up varied; blue lights installed over time		At the 14 intervention sites, the rates of suicide per station-year decreased from 0.44 to 0.19 At the nearby control sites (57 stations), there was no meaningful change in suicide rates per year		ARD vs control sites ranged from -0.23 to -0.28 suicides per year	⊕◯◯◯ VERY LOW [a]	It is unclear what the effect of installation of blue lights on railway platforms is on suicide deaths
	Suicide Attempts – NR						
	Switching Means – NR						
	Stigma Towards Suicide – NR						
Organizational Policies and Culture in Police Workplaces Observational Study with Concurrent Control	**Suicide Deaths** Police workplace Canada N=14,309 Follow-up 12 years	NR	Suicide rates in the intervention group decreased from 30.5 to 6.4 suicides per 100,000 per year. Suicide rates in the control group increased from 26.0 to 29.0 suicides per 100,000 per year.		ARD= -27.1 per 100,000 per year	⊕⊕◯◯ LOW	In police workplace settings, suicide prevention programs focused on influencing organizational policies and culture may reduce suicide deaths
	Suicide Attempts – NR						
	Stigma Towards Suicide - NR						

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
(k=1) [27]							
Organizational Policies and Culture in Construction Workplaces Pre-Post Observational Study with No Concurrent Control (k=1) [30]	**Suicide Deaths** Construction workplace Australia N=841,425 Follow-up 5 years	RRR=0.90 (0.90 to 0.91)	Suicide rates decreased from 29.2 to 26.38 suicides per 100,000 per year		-2.82 suicides per 100,000	⊕◯◯◯ VERY LOW [a]	In construction workplace settings, it is unclear what the effect of suicide prevention programs focused on influencing organizational policies and culture is on suicide deaths
	Suicides Attempts – NR						
	Stigma Towards Suicide - NR						
Organizational Policies and Culture in Military Settings Pre-Post Observational Studies with No Concurrent Control (k=2) [28,29]	**Suicides Deaths** Study 1 Military settings United States N=NR Follow-up 11 years Study 2 Military settings Israel N=1,171,359 Follow-up 7 years	Study 1 NR Study 2 HR=0.42 (0.33 to 0.54)	Study 1 Suicide rates decreased from 3.03 to 2.39 suicides per quarter per 100,000 Study 2 Suicide rates decreased from 24.6 to 12.7 suicides per year		Study 1 -0.65 suicides per quarter per 100,000 Study 2 -11.9 suicides per year	⊕◯◯◯ VERY LOW [a]	Among military populations, it is unclear what the effect of suicide prevention programs focused on influencing organizational policies and culture is on suicide deaths
	Suicides Attempts - NR						
	Stigma Towards Suicide - NR						

ARD= absolute risk difference; CI = confidence intervals; HR=Hazard Ratio; IRR = incidence rate ratio; NR=not reported; RRR=relative risk ratio
Explanations
[a] Downrated for study limitations
*Two of 4 studies reported an IRR.[16,18] The third and fourth studies also found reductions in suicide rates at the locations where a physical barrier was installed.[19,21]
All 4 studies contributed to the ranges of suicides per year and ARDs. A 5th study not shown in the table only reported the composite outcome of fatal and non-fatal suicides and we could only determine the suicides data by back-calculating.[23]
**A 2nd study not shown in the table only reported the composite outcome of fatal and non-fatal suicides and we could only determine suicide attempts data by back-calculating.[23]

⏮   ◀   ▶

CDC STRATEGY: TEACH COPING AND PROBLEM-SOLVING SKILLS

Key Messages

- Social-emotional learning programs:
  - Among high school students, social-emotional learning programs probably reduce suicide attempts; moderate certainty. It is unclear what impact they have on suicide deaths; very low certainty
  - Social-emotional learning programs may reduce suicide-related stigma; low certainty

Social-Emotional Learning Programs (k=6)

Overview of Included Studies

Six studies evaluated social-emotional learning programs for suicide prevention.[31-33,61-63] These programs were aimed at raising awareness about mental health, including depression and suicide, improving attitudes towards intervening with peers who may be depressed or suicidal, enhancing skills needed to cope with stressful life events and suicidal behaviors, and encouraging help-seeking behaviors. The studies that reported suicide outcomes were RCTs and included 2 in high schools [31,32] and 1 in a construction workplace.[33]

In addition, 3 studies examined stigma towards suicide as an outcome of social-emotional learning programs.[61-63] In these studies, participants were provided with educational materials to increase understanding about suicide risk factors and how to seek help. These studies enrolled persons at an addiction treatment center (k=1[63]), young adults in a university setting (k=1[61]), and adults from university research pools and the surrounding community (k=1[62]). All 6 studies were rated as medium risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

High schools

The Saving and Empowering Young Lives in Europe (SEYLE) study randomized 168 schools to 3 interventions or a control group in 10 European countries.[32] One of the interventions was the Youth Aware of Mental Health Programme (YAM). In the YAM arm, adolescent students participated in 3-hour role-play sessions with interactive workshops, received educational booklets, listened to two 1-hour lectures about mental health, and were exposed to 6 educational posters in the classroom. The control group was only exposed to 6 educational posters in the classroom. Forty-five schools were randomized to the YAM arm (n=2721 students) and 40 schools to the control arm (n=2933 students). Mean age of the students was approximately 15 years and most were female (58%). Suicide attempts were measured at 3 and 12 months. The results for the other 2 interventions in the SEYLE trial, gatekeeper training and screening, can be found in their respective sections.

In a second RCT, 16 high schools in Connecticut were randomized to either the Signs of Suicide (SOS) program or to a wait-list control.[31] The SOS program targeted ninth-grade students who watched a video depicting the right and wrong ways to interact with a peer who is depressed and suicidal. Participating schools were also provided a discussion guide, an optional self-screening

assessment, and other educational and promotional materials. The study was conducted during the 2007-2008 and 2008-2009 school years. Most students were male (58%) and a majority were white (60%) or Hispanic (23%). Suicide attempts were measured at 3 months. A total of 1,046 students provided data at follow-up.

Construction

An RCT randomized males in the Australian construction industry to Contact+Connect or wait-list control.[33] The program was an example of a brief contact intervention and it provided participants with 1 text message per week for 6 weeks that contained resources providing information about stigma, mental health, and information on help-seeking and sources of help. The program also encouraged participants to establish and maintain long-term contact with others. The trial randomized 682 participants. All participants were male, and most were between 30-59 years old. Less than 2% had previously attempted suicide. The study reported suicide attempts after 6 weeks.

Other Studies

The remaining 3 studies informed the outcome of stigma towards suicide.[61-63] One RCT enrolled young adults in Australia. Participants were randomized to online psychoeducation material or control.[61] The psychoeducation material focused on depression, anxiety, and suicide. The trial randomized 67 participants. Average age was 22 years, 25% were male, and 78% were white. Another RCT was conducted in the US. Participants were randomized to an online psychoeducation group, interpersonal exposure, or control.[62] Participants in the psychoeducation group reviewed the National Suicide Prevention Lifeline website. Those in the interpersonal exposure group reviewed the Live Through This project website. A total of 266 participants were randomized. Average age was 26 years, 35% are male, and 67% were white. Lastly, a pre-post observational study took place at an addiction treatment center.[63] That study evaluated the impact of providing participants with educational materials about suicide and how to seek help. Seventy-eight participants were enrolled at baseline. Average age was 35 years and 64% were male. The participants were 44% Caucasian, 26% African American, 8% Asian, 5% American Indian/Alaskan Native, and 6% >1 race; 8% did not report race (8%).

Suicide Attempts and Suicide Deaths

It is unclear what the impact is on suicide deaths of social emotional learning programs targeting high school students at 12 months (very low certainty). In the European SEYLE trial, no suicide deaths occurred over the follow-up period in the intervention and control groups.[32] However, social-emotional learning programs probably reduce suicide attempts in high school students at 3-12 months (moderate certainty). In the SEYLE trial that enrolled European adolescents, there were 14 suicide attempts (0.70%) in the YAM treatment group compared with 34 attempts (1.5%) in the control arm (ARD comparing incident suicide attempts = -0.80% [95% CI -1.43% to -0.18%]).[32] There was no effect modification by sex and age. The second trial in adolescent students in the US also showed a benefit on suicide attempts with social-emotional learning program group compared with control.[31] In participants who received the SOS program, the rate of suicide attempts in the 3 months before baseline was 1.8% and the rate was 1.7% in the 3 months post-intervention, while participants in the wait-list control arm showed an increase from 2.5% in the 3 months before baseline to 5.0% in the 3 months after baseline (ARD comparing

percent change between intervention and control = -2.6%). The study authors found that results were significant after controlling for the differences in suicides attempts at baseline between groups (P<.05).

In male construction workers, 1 trial found no difference in suicide attempts at 6 weeks as measured with a Likert scale between the Contact+Connect group and wait-list control (mean difference [MD] = 0.01 [95% CI -0.16, 0.19]).[33] Event rates were not reported.

Suicide-Related Stigma and Caregiver Burden

Based on 2 RCTs in mostly young adults and 1 observational study at an addiction center, social-emotional learning programs may reduce stigma towards suicide at 1 month (low certainty).[61-63] In 1 RCT, both intervention groups showed reduced scores on the Stigma of Suicide scale after 1 month (psychoeducation vs control: SMD= -0.33 [95% CI, -0.64 to -0.02]; interpersonal exposure vs control: SMD=-0.36 [95% CI, -0.67 to -0.05]).[62] However, another RCT found no difference on the Stigma of Suicide scale after 1 month between the online psychoeducation group and control (P=.619).[61] Lastly, from a pre-post observational study in an addiction treatment center, scores on an author-create scale measured stigma and bias toward suicide acts or persons changed from 19.3 points prior to the intervention to 17.3 at follow-up (P=.0001).[63] No studies reported caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 9. Implementation Strategies for Social Emotional Learning Programs in High Schools

Strategies to…	Social Emotional Learning Programs in High Schools
deliver an effective intervention	providing training on the program delivery and providing a procedure manual[31,32] that included potential solutions to address anticipated barriers to program delivery.[31]
sustain an effective intervention	embedding the respective program into routine activities such as classroom curriculum.[31,32]
improve the quality of an effective intervention	not explicitly reported but authors stated that future research is needed to determine the potentially additive effectiveness of integrating adjunct elements into the program that address risk factors (*eg*, alcohol abuse, violence reduction).[31] Finally, researchers indicated that suicide prevention programs could potentially be improved and sustained with the addition of "booster" activities at intervals beyond the end of the initial, comprehensive program.[31,32]

Table 10. Certainty of Evidence: Teach Coping and Problem-Solving Skills

Intervention Study Design	Outcome Setting Country № of participants Follow Up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Social-Emotional Learning Programs RCT (k=4) * 31,32,61,62	**Suicide Deaths** Study 1 High School 10 European countries N=4243 adolescents; 85 schools Follow up 12 months		0% (0/1987)	0% (0/2256)	ARD = 0%	⊕◯◯◯ VERY LOW a, b	In high school students, the effect of social-emotional learning programs on suicide deaths is unclear as no suicides occurred over the following 12 months
	Suicide Attempts Study 1 High School 10 European countries N=4243 adolescents; 85 schools Follow up 12 months	Study 1 RR=0.47 (0.25 to 0.87)	Study 1 0.70% (14/1987)	Study 1 1.51% (34/2256)	Study 1 ARD = -0.80% (-1.43% to -0.18%)	⊕⊕⊕◯ MODERATE a	In high school students, social-emotional learning programs probably reduce suicide attempts
	Study 2 High School United States N=1046 adolescents; 16 schools Follow up 3 months		Study 2 Suicide attempt rates in the intervention group went from 1.8% (13/719) to 1.7% (11/650). Rates in the in the control group increased from 2.5% (14/553) to 5.0% (20/396).		Study 2 ARD = -2.6%		
	Stigma Towards Suicide Study 1 University research pools and surrounding community United States N=238 Follow up 1 month		Study 1 Scales score measuring stigma towards suicide in the psychoeducation group decreased from 61.99 to 60.34 and in the interpersonal exposure group from 65.58 to 63.28. Control group increased from 61.45 to 67.69.		Study 1 SMD psychoeducation vs control: -0.33 (-0.64 to -0.02) SMD interpersonal exposure vs control: -0.36 (-0.67 to -0.05)	⊕⊕◯◯ LOW a, c	Social-emotional learning programs may reduce stigma towards suicide

Intervention Study Design	Outcome Setting Country № of participants Follow Up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
	Study 2 Young adults recruited in University settings Australia N=56 Follow up 1 month		Study 2 Scale score measuring stigma towards suicide showed no difference between psychoeducation and control.				
Social-Emotional Learning Programs Pre-Post Observational Study with No Concurrent Control (k=1) [63]	**Suicide Deaths** – NR						
	Suicide Attempts – NR						
	Stigma Towards Suicide Addiction treatment center United States N=64 Follow up 1 month		Scale score measuring stigma and bias toward suicide acts or persons changed from 19.3 points (SE 0.4) prior to the intervention to 17.3 (SE 0.6) at follow-up		2.0-point improvement in scale score	⊕○○○ VERY LOW [a]	In persons at an addiction treatment center, the effect of social-emotional learning programs on stigma towards suicide is unclear

ARD=absolute risk difference; CI=confidence interval; RCT=randomized controlled trial; RR=risk ratio; SE=standard error; SMD=standardized mean difference

Explanations

[a] Downgraded 1 level for study limitations

[b] Downgraded 2 levels for imprecision (unknown precision due to no events)

[c] Downgraded 1 level for inconsistency

*A 5th RCT in a construction workplace reported attempts.[33] The outcome was measured with a 5-point Likert scale and not shown in the table.

CDC STRATEGY: IDENTIFY AND SUPPORT PEOPLE AT-RISK

Key Messages

- Gatekeeper training:
    - In high school students, the effect of gatekeeper training on suicide deaths is unclear; very low certainty. Gatekeeper training may reduce suicide attempts; low certainty (no data on suicide stigma)
    - In youths and young adults, the effect of the Garrett Lee Smith program on suicide deaths at 4 years is unclear; very low certainty. The effect on suicide attempts at 2 years is unclear; very low certainty (no data on suicide stigma)
    - In an indigenous community in Canada, the effect of gatekeeper training on suicide deaths and attempts is unclear; very low certainty (no data on suicide stigma)

- Crisis intervention:
    - The effect of installing crisis phones on non-pedestrian bridges on suicide deaths is unclear; very low certainty (no data on attempts and suicide stigma)

- Public awareness and education campaigns:
    - The effect of public awareness and education campaigns on suicide deaths is unclear; very low certainty (no data on attempts and suicide stigma)

- Screening for at-risk individuals:
    - In high school students, the effect of a school-based intervention of screening for suicide is unclear; very low certainty. Screening may reduce suicide attempts; low certainty (no data on suicide stigma)
    - Community-based screening interventions for depression may reduce suicide deaths; low certainty (no data on attempts and suicide stigma)
    - In prison settings, the effect of screening for suicide on suicide deaths is unclear; very low certainty (no data on attempts and suicide stigma)

Gatekeeper Training (k=5)

Overview of Included Studies

Five studies evaluated gatekeeper training for suicide prevention.[32,34-37,64,65] The gatekeeper training programs were aimed at training community members to identify the warning signs for suicide, learn how to ask about suicidality, and refer and connect persons to mental health providers and crisis services. The studies that reported suicide outcomes included an RCT in high schools (SEYLE), an RCT in an indigenous Canadian community (ASIST), and an observational study in youths and young adults (Garrett Lee Smith program).[32,34-37]

In addition, 2 studies examined stigma towards suicide as an outcome among the participants who were trained as gatekeepers. These studies enrolled social work students (k=1) and rural

community members in Australia (k=1).[64,65] Quality assessments, population characteristics, and outcomes data are in Appendix 5.

High schools

The SEYLE study, a cluster RCT, randomized 168 schools in 10 European countries to 3 interventions compared to a control group.[32] One of the interventions consisted of a gatekeeper training module, Question, Persuade and Refer (QPR), to train teachers and school workers to identify students at-risk for suicide and to enhance student communication skills to encourage at-risk students to seek professional help. The control group was exposed to 6 educational posters in the classrooms and encouraged the students to could contact health care providers if they self-recognized a need for help. Suicidal behavior was assessed by the Paykel Hierarchical Suicidal Ladder.[70] Forty schools were randomized to QPR (n=2692 students) and 40 schools to control (n=2933 students) and followed up for 12 months. Mean age of the students was approximately 15 years and most were female (59%). Suicide attempts were measured at 3 and 12 months. The results for the other 2 interventions in the SEYLE trial, a social-emotional learning program and screening, can be found in their respective sections. The risk of bias was medium.

Youths and young adults in the community

One observational study with a concurrent control group evaluated the effect of the Garrett Lee Smith program in the US targeting youths and young adults. The program was evaluated in multiple articles that reported different follow-up periods.[35-37] The primary aim of the Garrett Lee Smith program was gatekeeper training. However, the program also includes outreach and awareness, screening programs, early intervention and linkages to community providers and treatment, care transitions, culturally based prevention activities, and means restriction. The study compared 481 counties in the US that had implemented this program with 851 counties that had not.[37] A total of 80,300 youths and young adults (10-24 years), mostly white (85%) were included. Median household income was around $39,000, unemployment rate was 5%, and the poverty rate was 14%. The risk of bias was low.

Indigenous community

Another RCT evaluated a gatekeeping training program, Applied Suicide Intervention Skills Training (ASIST), within a First Nations Cree tribal community in Manitoba, Canada.[34] The ASIST program, a 2-day intensive, interactive workshop, trained members of the community, volunteers, and professionals to recognize and intervene to prevent suicide. The control group was involved in a 2-day resilience retreat that included cultural teachings, small group discussions, and storytelling. In the ASIST group, 48 were recruited to participate and 31 received the intervention. In the control group, 24 of the 48 recruited participants attended the resilience retreat. Most of the 55 participants were youth between 16 and 21 years (44%) followed by those aged 22 to 44 years (33%). The majority were female (60%). Participants were asked if they attempted suicide during the 6 months after the ASIST program. The risk of bias was medium.

Other studies

The remaining 2 studies informed the outcome of stigma towards suicide among persons trained as gatekeepers. One RCT enrolled master of social work students at the University of Maryland,

Baltimore School of Social Work.[64] Participants were randomized to QPR gatekeeper training (n=35) or control (n=38). Most participants were female (≥90% in both groups), a majority were Caucasian (≥ 63% in both groups), and average age was 30 years old. Lastly, a pre-post observational study took place in rural communities in Australia.[65] Participants attended an educational workshop called SCARF (Suspect, Connect, Ask, Refer, Follow-Up). A total of 255 participants attended and agreed to participate in the research. The average age was 44 years, 40% were male, and most worked in farming/agriculture of business/finance.

Suicide Attempts and Suicide Deaths

High schools

It is unclear what the impact is on suicide deaths of gatekeeper training in high school students at 12 months (very low certainty). In the European SEYLE trial, no suicide deaths occurred over the follow-up period in the intervention and control groups.[32] However, gatekeeper training may reduce suicide attempts in high school students (low certainty).[32] At 12 months, there were 22 suicide attempts (1.1%) in the gatekeeper arm versus 34 attempts (1.5%) in the control arm (ARD = -0.4% [95% CI -1.1 to 0.3]).

Youths and young adults in the community

The effect of the Garrett Lee Smith program on suicide deaths in youths and young adults at ≥4 years) is unclear (very low certainty). There was an estimated 0.3 fewer suicides per 100,000 in the intervention counties compared with control counties, though the results were not statistically significant (P=.5).[37] There was a statistically significant reductions of 0.9 and 1.1 suicides per 100,000 at 1 or 2 years follow-up, respectively. The effect of the Garrett Lee Smith program on suicide attempts at ≥2 years, the longest available follow-up, was unclear (very low certainty). At 2 years, there was at estimated 1.2 fewer suicide attempts per 1,000 among populations 16-23 years in the intervention counties compared with control, but the results were not statistically significant (P=0.5).[36]

Indigenous community

The ASIST trial conducted within a First Nations community in Canada reported a lifetime suicide attempt rate of 19% (6/31) in the intervention group compared with a rate of 25% (6/24) in the control group.[34] No completed suicides or suicide attempts occurred in either group over the 6-month follow-up period.

Suicide-Related Stigma and Caregiver Burden

In the RCT in social work students, there was no statistically significant difference in suicide-related stigma based on the Attitude to Suicide Prevention scale between the gatekeeper training group and control group after 6-month follow-up (P=.27).[64] Lastly, from a pre-post observational study in rural communities in Australia, participants of the SCARF gatekeeper training showed no statistically significant difference in total scores on the Stigma of Suicide scale at 3-month follow-up compared with before.[65] However, there was a significant decline on the specific stigma subscale, which is 1 of 3 subscales that makes of the total score (P<.001). Results were only reported graphically. No study reported on or caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 11. Implementation Strategies for Effective Gatekeeper Training in High Schools

Strategies to…	Gatekeeper Training in High Schools
deliver an effective intervention	providing training on program delivery.[32]
sustain an effective intervention	embedding the program into routine setting activities such as classroom curriculum.[32]
improve the quality of an effective intervention	not explicitly reported but authors recommended evaluation of booster activities and combinations of different interventions.[32]

Crisis Intervention (k=1)

Overview of Included Studies

One observational study with no concurrent control group evaluated the effect of crisis intervention on suicide prevention at a suicide hotspot.[38] The intervention consisted of the installation of 6 crisis phones (wired directly to suicide prevention specialists) on the Skyway Bridge in St. Petersburg, Florida, a non-pedestrian bridge with a high frequency of suicides. Number of suicide deaths were compared in the 13 years prior to installation (1986-1998) and in the 13 years post-installation (2000-2012). The year the phones were installed was excluded from analyses. The study was rated as medium risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

Suicide Attempts and Suicide Deaths

A total of 48 suicides were recorded in the 13 years prior to the intervention and 106 suicides in the 13 years post-intervention, equating to an average of 4.5 additional suicides per year (P<.001). However, only 27 suicidal persons actually used the crisis phones; of these 27 individuals, 1 died, suggesting that 26 suicidal individuals were potentially saved by the crisis phones. In that same period, there were 80 suicides by individuals on that bridge who did not use the crisis phones. Suicide attempts were not reported in this study.

Suicide-Related Stigma and Caregiver Burden

No studies reported on suicide-related stigma or caregiver burden.

Public Awareness and Education Campaigns (k=2)

Overview of Included Studies

Two observational studies evaluated the effect of public awareness and education campaigns.[39,40] One Austrian study examined the effect of a suicide awareness campaign and compared changes in suicide rates with a concurrent control.[39] That study was rated as medium risk of bias. A Japanese study evaluated the impact of a city-wide suicide awareness campaign and used a pre-post study design without a control.[40] That study was rated as low risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

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The Austrian study evaluated the impact of a suicide awareness campaign to increase help-seeking behavior in the state of Styria (total population of 1,211,506 in 2011).[39] In the intervention region, the campaign included billboards displaying images reminding people of reasons to live along a Telephone Emergency Service (crisis hotline) which connected individuals to volunteers trained in suicide prevention and crisis management. The control region was the state of Upper Austria (total population of 1,415,020 in 2011) and included access to the telephone crisis service. Mean ages were 42.5 and 40 in the intervention and control regions, respectively. Women comprised just slightly over half (51%) of the populations in both regions. Suicide rates were slightly higher in the intervention region (17.5 per 100,000) compared with the control area (15.1 per 100,000). The study period totaled 6 months: a 3-month period prior to the awareness campaign and a 3-month period from the onset of the campaign.

The Japanese study evaluated the impact of a city-wide suicide awareness campaign in 16 wards in the city of Nagoya (total population 2.3 million).[40] Promotional materials consisting of a pamphlet that detailed symptoms of depression, treatment options, and messages encouraging care-seeking behavior in addition to telephone numbers for consultations were distributed to commuters at major train stations and city streets over 4 months during the study period of 2010-2012. Middle-aged male residents, the highest risk group for suicide in Nagoya, were the primary target of the campaign but the materials were distributed without discrimination. The comparator was the period of months without suicide awareness campaign activity. No demographic information was provided. The suicide rate in 2010 was 20.3 per 100,000 (n=448 suicides). The study duration was 36 months.

Suicide Attempts and Suicide Deaths

The effect of community-based public awareness and education campaigns on suicide deaths is unclear. The overall certainty of evidence across these studies was very low due to study limitations. The Austria study reported that within the intervention region, 52 suicides occurred in the 3 months prior to the onset of the campaign and 69 suicides occurred during the 3-month follow-up period.[39] The control region reported 67 and 68 suicides for the respective 3-month intervals. Suicide attempts was not reported.

The Japanese study found a reduction in suicides for the wards that had awareness campaigns at 2 months.[40] The adjusted Poisson regression IRR at 2 months was 0.971 (95% CI 0.957 to 0.985) using the months with no campaign activity as the reference. This estimated effect was determined to be equivalent to reducing 1 suicide if the promotional materials were distributed over 15 weekdays per month. Results were similar at 4 months (IRR not reported, graphic display only). However, at 5 months follow-up, the awareness campaign had little to no effect on suicide deaths (graphic display only). An association between a higher frequency of distribution of promotional materials and reduction in suicides was noted. The campaign was shown to be effective for men, the higher risk group, with statistically significant reductions at months 2 through 4 but no effect at month 5. The effect in women only showed a significant reduction at month 2 but not at months 3 through 5. Suicide attempts was not reported.

Suicide-Related Stigma and Caregiver Burden

No study reported on suicide-related stigma or caregiver burden.

Screening for At-risk Individuals (k=4)

Overview of Included Studies

Four studies evaluated the effect of screening for individuals at-risk for suicide in non-clinical settings: 1 cluster RCT conducted in Europe targeting adolescent students, 2 community-based observational studies conducted in Japan, and 1 observational study focused on adult males at a detention center in Germany.[32,41-43] All 4 studies were rated as medium risk of bias. Quality assessments, population characteristics, and outcomes data are in Appendix 5.

High schools

The SEYLE study, a cluster RCT, randomized 168 schools in 10 European countries to 1 of 3 suicide prevention intervention arms versus a control group.[32] In schools randomized to the ProfScreen intervention arm, students scoring at or above pre-determined thresholds to a baseline questionnaire were invited to receive a mental health clinical assessment and, if needed, referred for clinical services. Forty-three schools were randomized to ProfScreen (n=2764 students) and 40 schools to control (n=2933 students). Students' mean age was approximately 15 years and 57% were female. Suicide attempts were measured at 3 and 12 months. The results for the other 2 interventions in the SEYLE trial, a social-emotional learning program and gatekeeper training, can be found in their respective sections.

Community

The 2 observational studies with concurrent controls evaluated the effect of screening interventions for depression in Japan.[41,42] One evaluated a community screening intervention in adults aged 40-65 years using a quasi-experimental, parallel-cluster design.[42] Individuals scoring at or above the pre-determined thresholds for depression on a self-administered depression scale were contacted and interviewed by telephone and provided a referral to a psychiatrist if needed. Five communities consisting of districts with high suicide rates (N= 40,000) were assigned the intervention and 6 communities (N= 90,000) assigned to controls; a total of 12,682 individuals in the intervention region received the screening. Changes in suicides from 4-year pre-and post-intervention periods were compared with the control group and the whole country. Overall mean age and gender were not reported.

The second Japanese study targeted adults aged ≥65 years and utilized a 2-step screening process consisting of first a self-administered depression questionnaire to identify individuals with depressive symptoms, who secondly underwent telephone interviews and subsequent referrals to health professionals/psychiatrists.[41] An educational component, consisting of workshops was also added to improve access and adherence to treatment. Three communities within the intervention region (n=11,710) were matched with 3 communities in the control region (n=12,602) Among adults in the intervention region, 4,918 at-risk individuals (58% women) were offered the screening component. Approximately 52% participated (n=2,552). Fifty 1 percent of the participants in the screening program were women. Changes in suicides from a 6-year baseline period, the 2-year intervention, and a 4-year follow-up period for the intervention region (n=11,700) were compared with matched controls and the entire prefecture that included the intervention and control communities.

Prisons

One controlled study evaluated a suicide risk screening instrument among male adult prisoners at a detention center in Germany.[43] Over a 3-month period, all new arriving prisoners (n=611) were administered a suicide risk screening instrument (German Scale for Initial Risk Assessment). Those reaching a pre-determined threshold were considered at higher risk for suicide and were presented to a psychologist or medical staff on that day. The 899 prisoners who entered the facility in the 3 months prior to implementing the screening intervention served as controls. Mean age of the prisoners was 35 years. Following the intervention phase, both groups were then followed up over the subsequent 6 months.

Suicide Attempts and Suicide Deaths

In adolescent students, the effect of a school-based intervention of screening on suicide deaths is uncertain (very low certainty). In the European SEYLE trial, no suicides deaths occurred in either the intervention or control groups during the 12-month follow up.[32] However, screening for suicide in adolescent students may reduce suicide attempts (low certainty). Fewer attempts occurred among adolescents randomized to the ProfScreen arm at 12 months compared to those in the control group (20 [1%] versus 34 [1.5%], ARD= -0.5% [95% CI = -1.2 to 2.0]).

Community-based screening interventions for depression may reduce suicide rates (low certainty). In the study of adults aged 40-65 years, suicide rates in the pre-intervention period were 64.9/100,000 in the intervention communities and 57.9/100,000 in the control communities.[42] Four years after screening, suicide rates were 37.0/100,000 in the intervention communities and 53.8/100,000 in the control communities (Incidence rate difference = -23.8 per 100,000). This resulted in an age- and gender-adjusted IRR of 1.63 (95% CI 1.06 to 2.48; P=.025), indicating a 63% higher post-intervention incidence rate of suicide in control communities relative to intervention communities. Using the whole of Japan as the control, the IRR was 1.64 (95% CI 1.16 to 2.34; P=.006), indicating a 64% higher post-intervention suicide rate country-wide relative to the intervention communities. Suicide attempts were not reported.

In the study of adults >65years, suicide rates in the intervention group ranged from 42.8 to 49.2/100,000 (pre-intervention) and decreased to 23.1 to 23.9/100,000 post-intervention.[41] In the control group, suicide rates ranged from 39.9 to 41.9/100,000 (pre-intervention) to 35.4 to 47.6/100,000 post-intervention. The adjusted (age and gender) ratio of IRR was 1.83 (95% CI 1.08 to 3.09; P=.026), indicating an 83% relatively higher risk of suicides in the control group compared with the intervention group (reference group). Additionally, findings were also compared with the entire prefecture; the adjusted ratio of IRR was 1.70 (95% CI 1.10 to 2.63; P=.002). Change in suicide rates did not differ among men in the intervention region compared with men in the control region (ratio of IRR 1.29 [95% CI 0.76 to 2.19]; P=0.336) or the entire prefecture. In contrast, suicide rates were reduced among women compared with both the control region (ratio of IRR 3.10 [95% CI 1.10 to 8.83]; P=.033) and the entire prefecture (ratio of IRR 2.76 [95% CI 1.56 to 4.90]; P=.002). Suicide attempts were not reported.

In the study of German prisoners, there were no suicides in either the pre-intervention or post-intervention groups after 6-months' follow-up.[43] Suicide attempts were not reported.

Suicide-Related Stigma and Caregiver Burden

No studies reported on suicide-related stigma or caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 12. Implementation Strategies for Effective Screening Interventions

Strategies to…	Screening for At-Risk Individuals
deliver an effective intervention	providing training on program delivery and providing a work plan to outline the delivery of the program.[32,42]
sustain an effective intervention	embedding the respective program into routine setting activities such as classroom curriculum.[32]
improve the quality of an effective intervention	not explicitly reported but authors recommended future research to determine the potentially additive effectiveness of the program if concurrently offered with other classroom- or school-based activities to reduce stigma of mental health issues.[32] Authors of another study recommended exploring the long-term effect of personal contact alone (*eg*, written letters), without the screening survey, to determine the impact on the population who did not respond to the survey for depression screening.[42]

Table 13. Certainty of Evidence: Identify and Support People At-Risk *

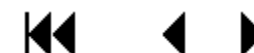| Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Gatekeeper Training in Schools Cluster RCT (k=1)[32]	**Suicide Deaths** High School 10 Europe Countries N=4234; 80 schools Follow up 12 months	NA	0% (0/1978)	0% (0/2256)	ARD = 0%	⊕○○○ VERY LOW [a, b]	In high school students, the effect of gatekeeper training on suicide deaths is unclear as no suicides occurred over the following 12 months
	Suicide Attempts High School 10 Europe Countries N=4234; 80 schools Follow up 12 months	RR = 0.74 (0.43 to 1.26)	1.08% (22/1978)	1.51% (34/2256)	ARD = -0.4 (-1.1 to 0.3)	⊕⊕○○ LOW [a, c]	In high school students, gatekeeper training may reduce suicide attempts
	Stigma Towards Suicide - NR						
Gatekeeper Training for Youths and Young Adults in the Community Observational Study with Concurrent Control (k=1) [35-37]	**Suicide Deaths** Community United States N=80,300 youth (10-24 years); 1,332 counties Follow up 4 years	NR	NR	NR	0.3 fewer suicides per 100,000 persons (SE=0.48; P=.5)	⊕○○○ VERY LOW [c]	In youth and young adult populations, the effect of Garrett Lee Smith-funded gatekeeper training on suicide deaths at ≥4 years is unclear
	Suicide Attempts Community United States N=total youth population (16-23 years) not clearly reported; 1,627 counties Follow up ≥2 years	NR	NR	NR	1.2 fewer suicide attempts per 1,000 persons (SE=1.87; P=.53)	⊕○○○ VERY LOW [c]	In youth populations and young adult populations, the effect of Garrett Lee Smith-funded gatekeeper training on suicide attempts at ≥2 years is unclear
	Stigma Towards Suicide – NR						

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Gatekeeper Training in Indigenous Community RCT (k=1)[34]	**Suicide Deaths** First Nations community Canada N=50 Follow up 6 months	NA	0% (0/28)	0% (0/22)	ARD = 0%	⊕○○○ VERY LOW [a, b]	In indigenous Canadians, the effect of gatekeeper training on suicide deaths is unclear as no suicides occurred over the following 6 months
	Suicide Attempts First Nations community Canada N=50 Follow up 6 months	NA	No suicide attempts occurred in the gatekeeper group or control group (0/28 vs 0/22). The lifetime suicide attempt was 19% (6/31) in the gatekeeper group and 25% (6/24) in the control group.		ARD = 0%	⊕○○○ VERY LOW [a, b]	In indigenous Canadians, the effect of gatekeeper training on suicide attempts is unclear as no suicide attempts occurred over the following 6 months
	Stigma Towards Suicide - NR						
Crisis Intervention Pre-Post Observational Study with No Concurrent Control (k=1)[38]	**Suicide Deaths** Non-pedestrian bridge United States N=NR Pre-period 13 years Post-period 13 years	NR	The total number of suicides increased from 48 to 106 after the installment of crisis phones		2.7 additional suicides per yr. (when adjusted for FL suicide rate)	⊕○○○ VERY LOW [a]	The effect of crisis phones on non-pedestrian bridges on suicide deaths is unclear
	Suicide Attempts – NR						
	Stigma Towards Suicide – NR						
Public Awareness and Education Campaign Observational Study with Concurrent Control (k=1)[39]	**Suicide Deaths** Community Austria N=2.6 million Follow up 3 months	NA	In the intervention region, the number of suicides increased from 52 to 69 during the campaign period. In the control region, suicides increased from 67 to 68.		NR	⊕○○○ VERY LOW [a]	The effect of a community-based suicide-awareness campaign promoting a crisis hotline on reducing suicide deaths is unclear
	Suicide Attempts - NR						
	Stigma Towards Suicide - NR						

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Public Awareness and Education Campaign Pre-Post Observational Study with No Concurrent Control (k=1)[40]	**Suicide Deaths** Community Japan N=2.3 million; 16 wards Follow up 5 months	IRR = 0.971 (0.957 to 0.985) for 2 months	There was a reduction in suicides for wards which had awareness campaigns 2- and 4-months follow-up (the reference was the months with no campaign activity, not further defined). There was little to no difference at 5 months follow-up (IRR only graphically reported).		NR	⊕◯◯◯ VERY LOW [a]	The effect of a community-based public awareness campaign that distributed material encouraging care-seeking behavior on reducing suicide deaths is unclear
	Suicide Attempts - NR						
	Stigma Towards Suicide - NR						
Screening in Schools Cluster RCT (k=1)[32]	**Suicide Deaths** High School 10 Europe Countries N=4217; 83 schools Follow up 12 months	NA	0% (0/1961)	0% (0/2256)	ARD = 0%	⊕◯◯◯ VERY LOW [a, b]	In high school students, the effect of a school-based intervention of screening on suicide deaths is unclear as no suicides occurred over the following 12 months
	Suicide Attempts High School 10 Europe Countries N=4217; 83 schools Follow up 12 months	RR = 0.68 (0.39 to 1.17)	1.02% (20/1961)	1.51% (34/2256)	ARD = -0.5 (-1.2 to 0.2)	⊕⊕◯◯ LOW [a, c]	In high school students, screening for suicide may reduce suicide attempts
	Stigma Towards Suicide – NR						

Intervention Study Design	Outcome Setting Country № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Screening in Community Observational Studies with Concurrent Control (k=2)[41,42]	**Suicide Deaths** Study 1 Community Japan Eligible population =90,000 Pre-period 4 years Post-period 4 years Study 2 Community Japan Eligible population=24,312 Pre-period 6 years Post-period 6 years	Study 1 IRR = 1.63 (1.06 to 2.48) Study 2 Ratio of IRR=1.83 (1.08 to 3.09)	Study 1: Suicide rates in the intervention group decreased from 64.9 to 37.0 per 100,000. Suicide rates in the control region decreased from 57.9 to 53.8 per 100,000 and rates in Japan as a whole 33.4 to 30.2 per 100,000. Study 2: Suicide rates in the pre-intervention group ranged from 42.8 to 49.2 per 100,000 and decreased to the following range: 23.1 to 28.8 per 100,000. Suicide rates in the control region pre-intervention ranged from 39.9 to 41.9 per 100,000 and post-intervention, ranged from 35.4 to 47.6 per 100,000.	ARD = -23.8 per 100,000	⊕⊕◯◯ LOW	Community-based screening interventions for depression may reduce suicide deaths
	Suicide Attempts – NR						
	Stigma Towards Suicide – NR						
Screening in Prisons Observational Study with Concurrent Control (k=1) [43]	**Suicide Deaths** Prison Germany N=1510 Follow up 6 months	NA	No suicides	No suicides	NA	⊕◯◯◯ VERY LOW [a]	Among prisoners, the effect of screening for suicide on suicide deaths is unclear as no suicides occurred over the 6 month follow up period
	Suicide Attempts – NR						
	Stigma Towards Suicide – NR						

ARD = absolute risk difference; CI = confidence intervals; IRR = incidence rate ratio; NA=not applicable; NR=not reported; RCT=randomized controlled trial; RR=relative risk; SE=standard error

Explanations

[a] Downgraded 1 level for study limitations

[b] Downgraded 2 levels for imprecision due to difficulty in interpreting results as no events occurred during follow up

[c] Downgraded 1 level for impression

*No study reported suicide-related stigma among individuals who are the targeted population to benefit from gatekeeper training. One study reported suicide-related stigma among individuals who were trained as gatekeepers and would deliver the intervention (social work graduate students).[64]

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CDC STRATEGY: MULTI-STRATEGY PREVENTION INTERVENTIONS

Key Messages

- In New Zealand, a multi-strategy suicide prevention program may increase suicide deaths; low certainty (no data on suicide attempts, suicide stigma)

- In Europe, a multi-strategy suicide prevention program may reduce suicide deaths; low certainty. It is unclear what the effect is for suicide attempts; very low certainty (no data on suicide stigma)

- In Asia, the effect of multi-strategy suicide prevention programs on suicide deaths or suicide attempts is unclear: very low certainty (no data on suicide stigma)

- In Australia, locally targeted, community-based multi-strategy programs had unclear effects on suicide deaths; very low certainty (no data on suicide attempts, suicide stigma)

- At a suicide hotspot in Australia, a multi-strategy intervention had unclear effects on suicide deaths; very low certainty (no data on suicide attempts, suicide stigma)

Multi-Strategy (k=15)

Overview of Included Studies

Fifteen studies evaluated suicide prevention interventions that included more than 1 CDC approach or strategy to prevent suicide. One was a cluster RCT, 7 were observational studies with a concurrent control, and 7 were observational studies with pre-post data.[44-57] We organized the studies by the region or country in which they were tested as some interventions, such as the European Alliance Against Depression, were developed and tested in specific settings. Most were city-wide, national, or multi-national suicide prevention programs. One study focused on a comprehensive intervention at a suicide hotspot, the Gap Park in Sydney, Australia.[56,57] Ten studies were rated as medium risk of bias and 5 as low risk of bias. Quality assessments, population characteristics, intervention details, and outcomes data are in Appendix 5.

New Zealand (k=1)

The Multi-level Intervention for Suicide Prevention in New Zealand (MISP-NZ), a cluster RCT, randomized 4 of 8 district health-boards to a multi-level intervention and 4 to usual practice after matching for baseline characteristics.[44] Intervention components included gatekeeper training for lay and professionals to recognize suicide risk factors, working with the media to report suicide using best practices, distribution of print material and information on web-based resources, workshops on mental health topics, and other community events. The intervention was implemented in 2010-2012 and follow-up was 25 months. Demographic characteristics of the eligible population was not reported.

Australia (k=2)

One pre-post study with a concurrent control evaluated the effectiveness of a locally targeted, community-based multi-strategy program (titled the National Youth Suicide Prevention Strategy) in Australia aimed at young adults aged 20-34 years.[60] The components included: community and professional education activities; crisis, early intervention, treatment and referral support; counseling and personal development initiatives; and health promotion initiatives. The suicide

prevention program occurred over a 4-year period of 1995-1998 and the subsequent follow-up period occurred over the 4-year period of 1999-2002. Demographic characteristics of the eligible population were not reported. Analyses were based on 139 local areas with suicide prevention activities compared with 774 local areas without suicide prevention activities. The population catchment was approximately 2.3 million people.

One pre-post study without a concurrent control evaluated a comprehensive intervention at Gap Park in Sydney, Australia, a recognized location for suicide by jumping to death.[56,57] Intervention components included building a fence (130cm) along the cliff tops, installing 2 crisis telephones, 2 signs to encourage help-seeking, cameras to monitor the area, and changing the landscaping to increase the probability that suicidal persons would be seen prior to jumping. The intervention was implemented in 2010-2011 and the follow-up period went to 2016. Eligible demographic characteristics of the eligible population was not reported.

Europe (k=4)

Four observational studies with concurrent controls evaluated the effect of a community-based multi-strategy intervention in Europe, referred to as the European Alliance Against Depression.[45-48] The multi-strategy program was initially implemented in Nuremberg, Germany but then expanded to other regions and countries: Regensburg, Germany and Hungary. Thereafter, it expanded to multiple countries in Europe where it was referred to as the European Alliance Against Depression. Broadly, the intervention components included educational workshops for primary care physicians (to improve detection and treatment of depression), public relations campaigns, training of community facilitators (policeman, pharmacists, nurses, teachers, and hotline workers), and support for high-risk groups. When it expanded to more countries, a component to restrict access to lethal means was added.[45] All 4 studies compared the rates of suicide deaths and/or suicide attempts in an intervention region(s) with a control region(s). The total sample size of the eligible populations were large (Nuremberg study: N=775,400; Regensburg study: N=460,000; Hungary study: N=239,467; study across Germany, Hungary, Ireland, and Portugal: N=1,849,190).[45-48] Follow-up ranged from 1 to 4 years. The demographic characteristics of the eligible populations were limited to employment status or gender. From the Nuremberg study, 10.1% of people in Nuremberg were unemployed and 5.6% in Wuerzburg (the control region) were unemployed.[46] From the Hungary study, slightly under half of people in Szolnok and Szeged (the control region) were male (46-47%) and the employment rate was 5.9% in Szolnok and 4.7% in Szeged, respectively.[47]

Asia (k= 8)

Eight observational studies evaluated multi-strategy suicide prevention programs in Asia: 2 had concurrent controls.[49-55] Among the studies with concurrent controls, 1 study was conducted in Japan, which targeted rural and highly populated areas.[49] Regions selected for control and intervention were matched by suicide rate and population size. Broadly, the intervention consisted of leadership involvement, (engagement with local government leaders to raise awareness and build social support), suicide education and community awareness programs (lectures, seminars), gatekeeper training, and supporting individuals at high risk (home visits, facilitating access to mental health). The follow-up period was 3.5 years. In the highly populated areas, the population was 1.3 million, about half were male, and 65% were between 25-64 years. In rural areas, the population was 631,133, 47% were male, and 54% were between 25-64 years.

Another study with concurrent controls took place in Hong Kong and targeted a housing estate in the North District where there had been a cluster of suicides.[50] Control sites were 3 other housing estates in the North District with similar demographic and geographic characteristics. The intervention consisted of events (booths, exhibitions, talks) and distribution of materials (leaflets, posters) to promote mental health and reduce stigma, limiting access to suicide means (by jumping to death from rooftops and windows), resource kits for families of suicide survivors and individuals with self-harm behaviors, training workshops for gatekeepers (medical doctors, social workers, police, security guards), and training for volunteers taskforces to help promote help-seeking and identify and refer individuals for psychosocial services. Follow up period was approximately 4 years. The total population was not reported. Across the sites, 46-51% were male, and median monthly household income ranged from 1,245 to 2,421 US$.

The remaining studies used a pre-post design without concurrent controls. One study in South Korea evaluated 2 national suicide prevention programs (implemented in 2004 and 2009) and evaluated the effectiveness through 2016.[52] The intervention included mass media campaign, limiting access to pesticide, welfare support, basic living subsidies, suicidal behavior management in the ED, establishment of autopsy center, and collaborations between government and religious organizations. Total population in South Korea was 48,485,314 in 2004.

Another study in Taiwan assessed the effects of establishing a Suicide Prevention Center in 2005 as well as the suicide prevention programs implemented thereafter.[55] This Center promoted 2 phases of suicide prevention from 2005-2008 and from 2009-2013 and oversaw efforts of county level programs focused on promoting comprehensive, selective suicide prevention strategies, including risk assessment and gatekeeper training. The follow up period went through 2013. No information on population characteristics.

A study in Hong Kong evaluated the programs implemented by the Centre for Suicide Research and Prevention, established in 2002.[54] The interventions included mental health policies, restricting access to means, raising awareness, responsible media reporting, strategies targeting vulnerable patients, gatekeeper training, and follow up on self-harm and community support. The follow up went through 2016. No information on population characteristics.

The remaining studies took place in Japan.[51,53,59,58] Two publications reported on the Emergency Fund to Enhance Community-based Counter Measures (2009-2014) Initiative.[51,59] This multi-strategy approach included 5 independent components: 1) personal consultations with lawyers, social workers, other professionals (to help individuals with unemployment, bankruptcy, debt) and consultation for health issues; 2) 24-hour telephone support for counseling; 3) workshops for human resources training for consultation training for persons at high risk (individuals with previous suicide attempts, bereaved family members); 4) efforts to enhance public and social support awareness through television, radio, pamphlets, and lectures; and 5) survey and support programs for high-risk persons. The follow-up period was from 2009-2018. The study analyzed data from all 47 prefectures in Japan. The mean population of the prefectures was 2.7 million.[59] No information on population characteristics was provided.

Another study in Japan evaluated various combinations of suicide prevention strategies implemented in different municipalities.[53] These initiatives were 1 or more of the following strategies: face to face counseling, training of community service providers, public awareness

campaigns, installation of screen doors at platforms, and patrols at hotspots. The study duration was from 2009-2012. No information on population characteristics was provided.

The last study in Japan evaluated suicide data before and after 3 time points which included the economic recession (1996-2006), the implementation of the Suicide Prevention Act (2006-2011), and the great earthquake (2011–2016).[58] The Suicide Act included the following strategies: 1) research on prevalence, risk, and protective factors for suicide; 2) assessment and management of suicidal behaviors; 3) assessment and management of mental and substance use disorders; 4) follow-up and community support; 5) crisis hotlines; 6) gatekeeper training; 7) intervention for vulnerable groups; 8) restriction to suicide means; 9) increased public awareness and responsible media reporting; and 10) access to health care and policies to reduce harmful use of alcohol. The study duration was from 1996 to 2016, with the national Suicide Prevention Act implemented in 2006. No information on population characteristics was provided.

Suicide Attempts and Suicide Deaths

New Zealand (k=1)

In New Zealand, a community-based, multi-strategy interventions implemented at a district level may increase suicide deaths (low certainty). Results from the MISP-NZ cluster RCT demonstrated an increase in suicide deaths at 25 months.[44] In the 4 district health boards randomized to the intervention, rates of suicide deaths were compared before and after the intervention and a small increase in suicide deaths was reported (rate ratio=1.17 [95% CI 0.84 to 1.65]). The suicides rates in the 4 control district health-boards remained constant after the intervention compared with before (rate ratio=1.01 [95% CI 0.77 to 1.31]). Rate ratios were compared between the intervention and control groups, intervention effect ratio was 1.18 (95% CI 0.51 to 2.70) demonstrating an increase in suicide deaths. The MISP-NZ cluster RCT did not report suicide attempts.

Australia (k=2)

In Australia, the effect of a locally targeted, community-based, multi-strategy suicide prevention program on suicides was unclear (very low certainty). Over the follow-up period of 1999-2002, suicide rates for men aged 20-34 declined 13% (95% CI -23 to -1) in the intervention group versus 8% (95% CI -16 to 1) in the non-intervention group, based on models adjusted for sociodemographic variables.[60] The between-group difference in the changes in rates was not significant. In women, the change in suicide rates increased 8% (95% CI -14 to 36) in the intervention group and 12% (95% CI -9 to 37) in the non-intervention group, based on models adjusted for sociodemographic variables. The between-group difference in the changes in rates was also not significant in women. The study authors did not speculate why suicide rates increased in women. Of note, the suicide rates among women were substantially lower in the implementation and follow-up periods compared with the men. Over the follow-up period, adjusted rates were 7-8 per 100,000 for women compared to 34-35 per 100,000 for men. The impact of this intervention on suicide attempts was not reported.

At a suicide hotspot in Australia, it is unclear if multi-strategy interventions reduced suicide deaths (very low certainty). The intervention consisted of installation of a 130cm fence, cameras, signs with help numbers, and increased opportunities to see suicidal persons.[56] In this pre-post study at Gap Park in Sydney, Australia, 41 suicides deaths prior to the implementation of the

intervention from 2000-2009 were reported. The intervention was implemented from 2010-2011 (during which time 21 suicides were reported). Post-intervention from 2012-2016, 24 suicide deaths were reported. The authors reported an annual percentage change (APC) of 5.41% (95% CI -0.38 to 11.53). The analysis in males showed a similar result, while findings in females showed a downward trend from 2010-2016 (APC=-21.27% [95% CI -33.14 to -7.30]).

Europe (k=4)

In Europe, the multi-strategy European Alliance Against Depression intervention may reduce suicide deaths (low certainty). It is unclear what the effect is for suicide attempts (very low certainty). The largest study tested this intervention in 4 countries (Germany, Hungary, Portugal, Ireland) and demonstrated a 9% relative decrease in suicide deaths in the intervention regions compared with control regions after 2 years (OR 0.93 [95% 0.65 to 1.33]).[45] Suicide attempts were the same between the intervention and control regions after 2 years (odds ratio [OR] 1.00 [95% CI, 0.90 to 1.11]).[45] One study tested the intervention in a region in Hungary (Szolnok) and reported that suicide death rates decreased from 30.0 to 13.2 suicides per 100,000 in the intervention region when comparing the pre- and post-intervention periods.[47] The rates in the control region (Szeged) remained similar from 26.2 to 26.7 suicides per 100,000. In the German study, the total number of suicide deaths in the intervention region (Nuremberg) decreased from 100 at baseline to 88 during the follow-up year and in the control region (Wuerzburg), suicide deaths decreased from 58 to 42.[46] Suicide attempts decreased in Nuremberg from 520 at baseline to 331 but there was a small increase in attempts from 125 to 131 in Wuerzburg. In a second German study (Regensburg), the rates of suicide in the 3 years (2000-2002) before implementation were between 19 to 30 suicides per 100,000.[48] After the intervention started in 2003, the rates of suicide ranged from 13 to 16 per 100,000. Reported rate of suicides in 2004 was significantly lower than the average 10-year rate. In the control areas, the authors reported no significant "deviations" in suicide deaths during the post-intervention time period.

Asia (k=8)

In Asia, community-based, multi-strategy suicide prevention programs had unclear effects on suicide deaths and suicide attempts (very low certainty). Results were informed by 8 non-randomized studies and findings were inconsistent. Among studies with concurrent controls, a study in Japan targeting rural and highly populated areas found no significant differences in suicide deaths and attempts after 3.5 years between the intervention and control regions.[49] In the rural areas, the rate ratio for suicide deaths after 3.5 years was 1.09 (95% CI, 0.82 and 1.45) and suicide attempts was 0.86 (95% CI, 0.55 to 1.36). In the highly populated areas, suicide deaths and attempts were only reported graphically and estimated to be close to the line of no difference. A study in Hong Kong targeting housing estates found that suicide deaths decreased significantly at the intervention housing estate when comparing 2010-2015 with 2006-2012 (P>.001).[50] At the 3 control housing estates, there was no significant differences in suicide deaths when comparing 2010-2015 with 2006-2012 (P≥.172).

Among the pre-post studies without concurrent controls, a study in South Korea evaluating their national suicide prevention program found that suicide rates increased annually by 5.6% (95% CI, 4.4 to 6.9) from 1993-2010 without break, despite the first national strategy going into effect in 2004.[52] However, after a second strategy was implemented in 2009, suicide rates decreased annually by 5.5 (95% CI, -10.3 to -0.5) from 2010 to 2016. The Taiwanese study evaluating

services provided by the Taiwan Suicide Prevention Center were reported graphically only.[55] The authors found that secular trends in suicides rates had been increasing up to establishment of the Prevention Center and then started to decline after, particularly in people 25 years and older. A study in Hong Kong described the services provided by the Centre for Suicide Research and Prevention, which was established in 2002.[54] In this study, suicide rates generally increased from 1997-2003, decreased from 2004-2011, and then remained constant through 2016. A Japanese study evaluated the effect of government funding from 2009 to 2014 for regional suicide prevention programs. Results showed that suicide rates significantly decreased from 2009 to 2018.[51] An additional study in Japan found no significant differences in suicide cases between categories of suicide prevention programs across municipalities.[53] A third study in Japan found the difference in suicide trends before and after the implementation of the Suicide Prevention Act in 2006 were not significant for the population overall and any age and sex subgroups.[58]

Suicide-Related Stigma and Caregiver Burden

No studies reported on suicide-related stigma or caregiver burden.

Strategies to Deliver, Sustain, and Improve Effective Interventions

Table 14. Implementation Strategies for the European Alliance Against Depression

Strategies to…	European Alliance Against Depression
deliver an effective intervention	• employing a multi-strategy approach[45,47,48,71] • engaging a broad range of stakeholders including members of the healthcare system, community leaders (*eg*, teachers, police officers, clergyman), and the local media[45,47,48,71] • engaging and recruiting volunteers to support implementation capacity and dissemination[71] • conducting a process evaluation through qualitative inquiry with stakeholders to identify barriers and facilitators that emerged during the implementation[45] • conducting workshops to optimize fidelity of the implementation[45] • providing training workshops for community facilitators[45,47,48,71] • engaging local champions for healthcare provider adoption[45] • tailoring strategies for engagement and implementation to the specific region's context and needs[45] • distributing educational materials in multiple formats/medias to the public[47,48] • creating a local information data network to facilitate fast communication regarding high-risk persons[47]
sustain an effective intervention	• developing local collaborative networks with individuals or organizations with a shared goal to reduce suicidal behavior[45,71] • supporting community volunteers who participated in aspects of the program in taking ownership of the public campaign (*eg*, provide materials for distribution, give opportunities to speak at events, listen to their ideas)[71] • providing stakeholder workshops at the end of the intervention period to reflect on sustainability and explore lessons learned[45]

	• providing training for healthcare providers that is accredited for Continuing Medical Education credits[45,48]
	• embedding the train the trainer model into the implementation of training programs for community facilitators[45]
	• following up the resource intensive initiative with low-resource interventions to promote sustainability[46]
improve the quality of an effective intervention	• not explicitly reported but were generalized by indicating the simultaneous implementation with a public mental health awareness campaign may have synergistic effects with the suicide prevention program[45]
	• exploration is needed to determine the value of external activities stimulated by the program (*ie*, local healthcare system or facility internal trainings prompted by the larger suicide prevention effort and visibility)[71]
	• future research is needed to assess the impact of health behavior (*eg*, alcohol and psychoactive agent use) on suicide prevention programs.[47]

Table 15. Certainty of Evidence: Multi-Strategy Prevention Interventions

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Absolute effects		Difference (95% CI)	Certainty of Evidence:	What happens
			Intervention	Control			
New Zealand Cluster RCT (k=1) [44]	**Suicide Deaths** General Community Eligible population=8 District Health Boards ranged from 31,000 to 481,000 people in each Follow up 25 months	Intervention effect ratio=1.18 (0.51 to 2.70)	In the intervention regions, there were 40 suicides in the 6 months before baseline and 196 suicides in 25-month follow-up In the control regions, there were 69 suicides in the 6 months before baseline and 289 suicides in 25-month follow-up			⊕⊕◯◯ LOW [a, b]	A multi-strategy suicide prevention program tested in New Zealand may increase suicide deaths
	Suicide Attempts - NR						
	Stigma Towards Suicide - NR						
Australia Observational Study with Concurrent Control (k=1)[60]	**Suicide Deaths** General Community (Population catchment ~2.3 million) Follow up 4 years	NR	Based on adjusted models, suicide rates for men aged 20-34 declined by 13% (95% CI -23 to -1) in the intervention group versus 8% (95% CI -16 to 1) in the non-intervention group. The changes in rates were not significant between the groups (P=0.541). Based on adjusted models, suicide rates for women aged 20-34 increased by 8% (95% CI -14 to 36) in the intervention group versus 12% (95% CI -9 to 37) in the non-intervention group. The changes in rates were not significant between the groups (P=0.77).		*Men* ARD= -5% (95% CI NR) *Women* ARD= -4% (95% CI NR)	⊕◯◯◯ VERY LOW [b]	The effect of a locally targeted multi-strategy suicide prevention intervention tested in Australia on suicide deaths is unclear
	Suicide Attempts - NR						
	Stigma Towards Suicide - NR						

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Absolute effects		Certainty of Evidence:	What happens
			Intervention	**Control**	**Difference (95% CI)**		

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Intervention / Control (Absolute effects)	Difference (95% CI)	Certainty of Evidence:	What happens
Australia Pre-Post Observational Study with No Concurrent Control (k=1) [56,57]	**Suicide Deaths** Suicide hotspot Eligible population=NR Follow-up 5 years		At Gap Park, there were 41 suicide deaths during the pre-intervention period (2000-2009), 21 deaths during the implementation period (2010-2011), and 24 deaths during the post-intervention period (2012-2016)	APC= 5.41% (-0.38 to 11.53) from 2000-2016	⊕◯◯◯ VERY LOW [a]	The effect of a multi-strategy intervention at a suicide hotspot tested in Australia on suicide deaths is unclear
	Suicide Attempts - NR					
	Stigma Towards Suicide - NR					
Europe Observational Studies with Concurrent Control (k=4) [45-48]	**Suicide Deaths** Study 1 General Community Eligible population across 4 countries =1,849,190 Follow-up 2 years	OR=0.93 (0.65 to 1.33)	In the intervention regions, there were 138 suicides at baseline and 163 during follow-up. In the control regions, there were 88 suicides at baseline and 112 during follow-up		⊕⊕◯◯ LOW	A multi-strategy suicide prevention program tested in Europe may reduce suicide deaths
	Study 2 General Community Eligible population =775,400 Follow-up 1 year		In the intervention region, there were 100 suicides at baseline and 88 after 1 year. In the control region, there were 58 suicides at baseline and 42 after 1 year.			
	Study 3 General Community Eligible population =239,467 Follow-up 3 years		In the intervention region, the suicide rate decreased from 30 to 13.2 per 100,000. In the control region, the suicide rate went from 26.2 to 26.7 per 100,000	ARD= -17.3 per 100,000		

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Absolute effects		Difference (95% CI)	Certainty of Evidence:	What happens
			Intervention	Control			
	Study 4 General Community Eligible population= 460,000 Follow-up 4 years		During the post-intervention period, the authors calculated that only in the intervention region (City of Regensburg) was there a significant decrease in suicide rates relative to the 10-year average. The authors found no significant deviations in the control regions.				
	Suicide Attempts Study 1 General Community Eligible population across 4 countries =1,849,190 Follow-up 2 years Study 2 General Community Eligible population =775,400 Follow-up 1 year	OR=1.00 (0.90 to 1.11)	In the intervention regions, there were 1,643 suicide attempts at baseline and 1,545 during follow-up. In the control regions, there were 1,195 attempts at baseline and 1,128 during follow-up In the intervention region, there were 520 suicide attempts at baseline and 331 after 1 year. In the control region, there were 125 suicide attempts at baseline and 131 after 1 year.			⊕◯◯◯ VERY LOW b, c	The effect of a multi-strategy suicide prevention program tested in Europe on suicide attempts is unclear
	Stigma Towards Suicide - NR						
Asia Observational Studies with Concurrent Control (k=2)[49,50]	**Suicide Deaths** Study 1 General Community Eligible population in rural=631,133 and in highly populated= 1,319,927 Follow-up 3.5 years	Rural: RR= 1.09 (0.82 to 1.45) Highly populated: RR not significant (only reported graphically)	Rural: In the intervention regions, the suicide rate went from 46.6 to 38.2 per 100,000. In the control regions, suicide rate went from 40.6 to 38.8 per 100,000 Highly populated: In the intervention regions, the suicide rate went from 22.8 to 23.2. In the control regions, suicide rate went from 26.0 to 24.8 per 100,000			⊕◯◯◯ VERY LOW b, c	The effect of multi-strategy suicide prevention programs tested in Asia on suicide deaths is unclear

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
	Study 2 General Community Eligible population=NR Follow-up ~4 yrs		In the intervention site, there were 16 suicides pre-intervention (2006 to 2010) and 11 post-intervention (2012 to 2015). In control site 1, there were 3 suicides pre- and 6 post. In control site 2, there were 5 suicides pre- and 6 post. In control site 3, there were 3 suicides pre- and 3 post. Intervention started in 2011.				
	Suicide Attempts General Community Eligible population in rural=631,133 and in highly populated= 1,319,927 Follow-up 3.5 years	Rural: RR= 0.86 (0.55, 1.36) Highly populated: RR not significant (only reported graphically)	Rural: In the intervention regions, the suicide attempt rate went from 24.8 to 18.8 per 100,000. In the control regions, suicide attempt rate went from 26.0 to 23.8 per 100,000. Highly populated: In the intervention regions, the suicide attempt rate went from 24.0 to 29.0 per 100,000. In the control regions, suicide attempt rate went from 26.6 to 32.8 per 100,000			⊕○○○ VERY LOW [b]	The effect of multi-strategy suicide prevention programs tested in Asia on suicide attempts is unclear
	Stigma Towards Suicide - NR						

Region Study Design	Outcome Setting № of participants Follow-up	Relative effect (95% CI)	Absolute effects			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
Asia Pre-Post Observational Studies with No Concurrent Control (k=5) * 51,52,54,55	**Suicide Deaths** Study 1-4 General Community Total eligible population only reported in 2 studies Follow-up: range 5 to ~14 years		A study in South Korea found an increase in suicide rates from 1993-2010 despite the first national strategy going into effect in 2004.[52] Rates decreased from 2010 to 2016 after a second strategy was implemented in 2009. A study in Hong Kong showed that suicide rates appeared to decrease from 2004-2011 after establishing the Centre for Suicide Research and Prevention in 2002.[54] A study in Japan found a decrease in suicide rates from 2009 to 2018 after government funding was used for regional suicide prevention programs.[51] A study in Japan found no difference in suicide trends before and after the implementation of the Suicide Prevention Act in 2006.[58] A study in Taiwan showed that suicide rates in persons 25 and older appeared to start to decline after establishing the Taiwan Suicide Prevention Center (results reported graphically).[55]			⊕○○○ VERY LOW a	See above

APC=annual percentage change; ARD=Absolute risk difference; CI=confidence interval; OR=odds ratio; RR=rate ratio
Explanations
[a] Downgraded for study limitations
[b] Downgraded for imprecision
[c] Downgraded for inconsistency
* A 6th pre-post study in Asia[53] reported suicide deaths, but they did not report rates or raw numbers, so it is not shown in the table. They found that various combinations of suicide prevention programs implemented in different municipalities were not significantly different on suicide deaths.

COST DATA

Policy decisions often weigh the intervention costs against the potential benefit. Cost data are limited. Select studies of physical barriers at bridges and railway stations reported the installation costs. The Gateway Bridge barrier in Brisbane cost $2.2 million Australian dollars to install.[19] Installation costs for fences, crisis phones, signs, and cameras at Gap Park in Sydney was approximately $2 million Australian dollars.[57] Installation costs for platform screen doors at railway stations in South Korea was $194 million US dollars[22] and in Hong Kong cost $256.4 million US dollars.[21] A Hong Kong study found that platform screen doors were cost-effective only when the analysis considered loss of fare revenue, passenger waiting time, and disability-adjusted life years.[21] Among the other interventions, a cost-effectiveness analysis of the "Mates in Construction" program targeting Australian construction workers estimated a cost saving of $3.7 million Australian dollars each year and that each dollar invested in the program would result in $4.60 (Australian dollars) in savings.[30] This analysis assumed that the potential cost of a suicide was $2.14 million (based on the economic impact of productive employment and life years lost). A cost-benefit analysis of the Garrett Lee Smith program estimated that the program cost $49.4 million to implement but saved $222.1 million in medical costs from the prevented hospitalizations and emergency department visits.[72] This corresponds to a return of $4.50 in medical cost savings for each dollar invested in implementation.

SUMMARY AND DISCUSSION

Using the CDC framework of community-based approaches to suicide prevention, we found that reducing access to lethal means, implementing programs that influence organizational policies and culture in police workplace settings, and screening for depression in the community may reduce suicide deaths. However, we found uncertain or no evidence for reducing suicide deaths for other interventions as standalone interventions, including public awareness and education campaigns, crisis hotlines, and gatekeeper training. In high school students, social-emotional learning programs, gatekeeper training, and screening may reduce suicide attempts but had uncertain effects on suicide deaths. Additionally, we found inconsistent results for comprehensive, multi-strategy interventions. We found an increase in suicides after implementation of a multi-strategy intervention in New Zealand but found a decrease in suicides associated with the European Alliance Against Depression Program.

Our report builds on a 2009 VA-ESP report.[66] These authors focused on suicide prevention strategies among Veterans or military personnel and evaluated: educational awareness programs, screening for high-risk individuals, pharmacotherapy, psychotherapy, restriction of means, media reporting, and multi-component interventions (*eg* the U.S. Air Force). They summarized evidence from 1966-2008 and concluded that multi-component interventions in military personnel may reduce suicide risk. They also concluded that restriction of access to lethal means may reduce cause-specific suicides, although its effect on total suicides was less clear. The authors found insufficient data about community-based suicide prevention interventions and no studies assessing hotlines, outreach programs, peer counseling, treatment coordination programs, and new counseling programs.

Our inability to determine effective components of multi-strategy interventions limits the ability to adapt or implement the effective interventions among Veterans or other settings. While some standalone strategies may reduce suicide deaths or attempts; it is unclear why interventions that combine multiple strategies into comprehensive programs showed inconsistent results. One possible explanation is that it is important to target specific populations or settings and use tailored interventions. For example, the "Together for Life" program targeting the police workplace and the Signs of Suicide or Youth Awareness of Mental Health program targeting high school students, were associated with reductions in suicide deaths or attempts.[27,31,32] Another possible explanation is that multi-strategy programs are arguably more complex and the fidelity of the individual strategies was not clear.

LIMITATIONS AND FUTURE RESEARCH

An important limitation of the evidence is the methodological quality of the eligible studies. Drawing conclusions from these studies was challenging due to lack of adequate adjustment for temporal trends in suicide rates or differences between intervention and comparison communities in terms of socioeconomic characteristics and access to lethal means, both of which have been associated with suicide risk.[67] Additional limitations included the scarcity of evidence for some interventions, lack of detail on the specific elements of each intervention, and limited data on implementation, resource use, or cost. Additionally, we did not find studies that examined the applicability or adaptability of an intervention from 1 setting to another. Few studies examined implementation-related outcomes and thus it is not possible to determine if wider implementation of the included interventions would result in positive outcomes. Higher-quality studies using

RCT trial designs may not be feasible for all community- or population-based intervention but could be conducted in organizational workplaces, schools, or other communities. In the absence of RCTs, observational studies with concurrent control groups and adequate adjustment for confounding would provide useful information. Because suicide is rare, having adequate follow-up and sample size is important. Evidence quality would be enhanced by using standardized descriptions of the interventions. More complete intervention descriptions would facilitate replication or evaluation of effective programs. For multi-strategy interventions, a clearer framework to justify and describe the components is needed, as well as an attempt to evaluate individual components. More evidence is needed to see if the success of suicide interventions is population-specific and if specific combinations of interventions are more successful than others. Finally, studies examining interventions' acceptability, feasibility, effectiveness, and sustainability in US Veterans are needed, particularly those targeting suicide means relevant to Veterans, such as firearms, poisoning, and suffocation.

APPLICABILITY TO VETERANS

Only 1 study targeted Veterans.[12] It provided unclear evidence regarding the effect of housing stabilization programs. Studies of interventions influencing organizational policies were conducted in the US Air Force and the Israeli Defense Forces[28,29] but these may not be directly applicable to Veterans. In addition, while community-based programs to restrict the purchase of charcoal at retail stores may reduce self-immolation, this is not a common method of suicide in the US, where the top 3 suicide methods in 2018 were firearms, suffocation, and poisoning.[68] Utilizing peers with shared experiences may be an effective strategy to deliver a suicide prevention program for Veterans.

CONCLUSIONS

Community-based interventions that may reduce suicide deaths include reducing access to lethal means, implementing organizational policies in workplace settings, and screening for depression. It is uncertain if housing stabilization programs, public awareness and education campaigns, crisis hotlines, and gatekeeper training prevent suicide. Evidence was inconsistent for community-based, multi-strategy interventions. The most promising multi-strategy intervention was the European Alliance Against Depression. In high school populations, social-emotional learning programs, gatekeeper training, and screening for at-risk may reduce suicide attempts; however, it is unclear if these interventions reduce suicides. Future studies using randomized designs or observational studies with concurrent controls and appropriate adjustment are needed. Studies are needed to determine which interventions and combinations would be most effective and feasible for US Veterans. Until then community-based approaches to suicide prevention outside of VA health care settings may provide additional opportunities to prevent suicide among Veterans.

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