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

March 2021

Prepared for:
Department of Veterans Affairs
Veterans Health Administration
Health Services Research & Development Service
Washington, DC 20420

Prepared by:
Evidence Synthesis Program (ESP) Center
Minneapolis VA Health Care System
Minneapolis, MN
Timothy J. Wilt, MD, MPH, Director
Wei Duan-Porter, MD, PhD, Associate Director

Authors:
Shahnaz Sultan, MD, MHSC
Eric Linskens, BS
Allison Gustavson, DP, PhD
Nina Sayer, PhD
Maureen Murdoch, MD, MPH
Roderick MacDonald, MS
Lauren McKenzie, MPH
Kristen Ullman, MPH
Noah Venables, PhD
Timothy J. Wilt, MD, MPH

VA | U.S. Department of Veterans Affairs
Veterans Health Administration
Health Services Research & Development Service

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.

Recommended citation: Sultan S, Linskens E, Gustavson A, Sayer N, Murdoch M, MacDonald R, McKenzie L, Ullman K, Venables N, Wilt T. Population and community-based interventions to prevent suicide: a systematic review. Washington, DC: Evidence Synthesis Program, Health Services Research and Development Service, Office of Research and Development, Department of Veterans Affairs. VA ESP Project #09-009; 2021. Available at: https://www.hsrd.research.va.gov/publications/esp/reports.cfm.

This report is based on research conducted by the Evidence Synthesis Program (ESP) Center located at the Minneapolis VA Medical Center, Minneapolis, MN funded by the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development. The findings and conclusions in this document are those of the authors who are responsible for its contents; the findings and conclusions do not necessarily represent the views of the Department of Veterans Affairs or the United States government. Therefore, no statement in this article should be construed as an official position of the Department of Veterans Affairs. No investigators have any affiliations or financial involvement (*eg*, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties) that conflict with material presented in the report.

ACKNOWLEDGMENTS

This topic was developed in response to a nomination by the VA Health Services Research & Development (HSR&D) Office for an evidence review on community- and systems-level interventions and approaches for suicide prevention that could be adapted for use among US Veterans. The scope was further developed with input from the topic nominators (*ie*, Operational Partners), the ESP Coordinating Center, the review team, and the technical expert panel (TEP).

In designing the study questions and methodology at the outset of this report, the ESP consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

The authors gratefully acknowledge the following individuals for their contributions to this project:

Operational Partners

Operational partners are system-level stakeholders who have requested the report to inform decision-making. They recommend Technical Expert Panel (TEP) participants; assure VA relevance; help develop and approve final project scope and timeframe for completion; provide feedback on draft report; and provide consultation on strategies for dissemination of the report to field and relevant groups.

Robert O'Brien, PhD
Scientific Program Manager
VA HSR&D

Lauren Denneson, PhD
Representative of SPRINT, Core Investigator and Associate Professor
VA HSR&D and Oregon Health & Science University

Technical Expert Panel (TEP)

To ensure robust, scientifically relevant work, the TEP guides topic refinement; provides input on key questions and eligibility criteria, advising on substantive issues or possibly overlooked areas of research; assures VA relevance; and provides feedback on work in progress. TEP members are listed below:

Elizabeth Karras-Pilato, PhD
Co-Research Director and Clinical Senior Instructor
VA VISN 2 Center of Excellence for Suicide Prevention and University of Rochester

Alan Teo, MD
Physician Investigator and Associate Professor
VA HSR&D and Oregon Health & Science University

Lindsey Monteith, PhD
Clinical Research Psychologist
VA Rocky Mountain MIRECC

Julie Cerel, PhD
Clinical Psychologist and Professor
University of Kentucky

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.

TABLE OF CONTENTS

TABLES

EXECUTIVE SUMMARY

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] Veterans are 1.5 times more likely to die by suicide than the general population, after adjusting for age and sex.[2] In 2018, Veterans represented 8% of the US adult population but accounted for 13.8% of suicide deaths.[2] Thus the Department of Veterans Affairs (VA) has made suicide prevention a top priority. Many VA initiatives focus on identifying and treating Veterans determined to be at elevated risk for suicidal behaviors. These initiatives include maintaining a Veterans Crisis line as well as preventions programs through the Veterans Health Administration (VHA), such as the Recovery Engagement and Coordination for Health – Veterans Enhanced Treatment (REACHVET) program, Caring Contacts to Veterans, yearly screenings for suicide risk, and hiring Suicide Prevention Coordinators at each Medical Center.[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, two-thirds of Veterans do not use the VA for health care. Community-based approaches to suicide prevention outside of VA health care settings may provide opportunities to reach Veterans. 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* and the President's Roadmap to Empower Veterans and End a National Tragedy of Suicide (PREVENTS) Executive Order all call for a public health approach to suicide prevention.[6,7] Population-based approaches targeting individuals across the spectrum of suicide risk may serve as adjunctive or complementary strategies to clinical interventions to help address this public health problem.

The purpose of this review was to examine the published literature on the effectiveness and harms of community-based or population-level strategies aimed at preventing suicide. We limited our review to studies conducted in non-health care settings and excluded studies that focused on pharmacologic treatments or psychotherapy. We addressed the following key questions: 1) What are the effects of population and community-based prevention interventions on suicide attempts and suicide deaths? 1a) What are the key/common components of the most effective interventions? 1b) What strategies have been used to deliver, sustain, and improve the quality of the most effective interventions? 1c) How do the effects vary by differences in community/setting and characteristics of individuals targeted? 2) What are the potential unintended consequences of population and community-based prevention interventions?

METHODS

Data Sources and Searches

We searched MEDLINE, Embase, PsycINFO, Sociological Abstracts, and the Cochrane Database of Systematic Reviews from January 2010 to the end of November 2020 for references published in English-language. We used Medical Subject Headings (MeSH) and title/abstract terms indicative of suicide outcomes and community-based interventions. We reviewed reference lists of relevant 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, specifically suicide-related stigma or caregiver burden and switching means of suicide, when applicable. For interventions aimed at reducing access to lethal means, we included studies reporting on switching means or location of suicide as an unintended consequence. We included studies conducted in the general community, workplace, schools, military organizations, prisons, or suicide hotspots. We included randomized controlled trials (RCTs), observational studies with concurrent controls, or pre- post-intervention studies conducted in countries with a Very High Human Developmental Index. Studies were screened in DistillerSR (Evidence Partners Inc, Ottawa, Canada).

Data Abstraction and Quality Assessment

We used the Cochrane Risk of Bias 1.0 instrument to assess the quality of RCTs.[8] Cluster RCTs were assessed with several additional domains. Observational studies were assessed for quality using a modified version of the Joanna Briggs Institute Critical Appraisal Tool for Quasi-Experimental Studies.[9] The overall risk of bias (ROB) of each RCT and observational study was classified as high, moderate, or low.

We abstracted information on study characteristics, participants, setting, intervention, control, and outcomes for eligible studies rated low or moderate ROB. Data from studies rated as high ROB were not further abstracted as they are unlikely to provide reliable information. We abstracted data on the following outcomes: suicide attempts, suicide deaths, caregiver burden, suicide-related stigma, switching suicide means, and cost. From the studies that found an intervention to be effective, we abstracted strategies to deliver, sustain, and improve the intervention. For this purpose, effectiveness was defined as reducing suicide deaths or attempts based on at least low certainty of evidence.

For each intervention and setting, we used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework to rate the certainty of evidence (COE) 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 for the outcome of switching suicide methods. We used a non-contextualized approach to make judgements about imprecision and reported if interventions led to a decrease (or increase) in suicides based on the point estimate. We did not derive thresholds or make judgments on magnitude of effect to determine clinical importance. When our overall COE across studies was deemed to be very low, we concluded that the effects were uncertain.

Data Synthesis and Analysis

We used the Center for Disease Control and Prevention's (CDC) guidebook *Preventing Suicide: A Technical Package of Policy, Programs, and Practices* to group interventions into suicide prevention approaches modifications as outlined in Table 1 below.[11] Findings were narratively summarized across studies due to the heterogeneity in populations, interventions, settings, and outcomes. Data were analyzed in Comprehensive Meta-Analysis version 3 (Biostat).

RESULTS

Results of Literature Search

Our literature search yielded 4,499 citations after removing duplicates. We excluded 3,844 citations when reviewing titles and abstracts. From hand-searching, we added 37 articles, leaving 692 for full-text review. We excluded 623 articles for the following reasons: no eligible outcomes (N=271); ineligible intervention (N=180); ineligible study design (N=119); ineligible population (N=39); ineligible setting (N=11); and not published in English (N=3). Sixty-nine articles met eligibility criteria and 13 were rated as high ROB studies. Ultimately, we included 56 publications that described 47 unique studies.

Summary of Results by Key Questions

What are the effects of population and community-based prevention interventions on suicide attempts and suicide deaths? (KQ1) How do the effects vary by differences in community/setting and characteristics of individuals targeted? (KQ1c)

Housing stabilization programs

Among Veterans, housing stabilization programs had unclear effects on suicide deaths and attempts. Our conclusions are based on observational study with concurrent control (rated as medium ROB) that evaluated the VHA Homeless Program, consisting of in-depth assessment for homeless services, emergency housing services, rapid rehousing and homelessness prevention, and permanent supportive housing, and transitional housing.[12] Overall COE was very low.

Reducing access to lethal means

Based on studies from Asia, restricting access to purchasing charcoal at retail stores may reduce suicides by self-immolation without any substitution effects (*ie*, increased suicides by other means). There was no data on suicide attempts. At bridges and railway stations, installing barriers may reduce suicide deaths and attempts at those locations. It is uncertain whether installing blue lights at railway platforms reduces suicide deaths and there was no data on attempts. Our conclusions are based on 11 observational studies (8 medium ROB, 3 low ROB) of reducing access to lethal means: 3 studies to reduce access to charcoal,[13-15] 7 studies of barrier installation at suicide hot spots,[16-23] and 1 study of blue light installation on a railway platform.[24-26] Overall COE was low to very low.

Organizational policies and culture

In police workplace settings, suicide prevention programs focused on organizational policies and culture may reduce suicide deaths. There was no data on suicide attempts. In construction workplace settings and military workplace settings (US Air Force and Israeli Defense Forces), the effects of organizational policies and workplace culture on suicide deaths are uncertain. There was no data on suicide attempts. Our conclusions are based on 4 observational studies (rated as medium ROB).[27-30] The intervention implemented in the police workplace setting in Montreal was referred to as “Together for Life” and in the construction workplace setting (Australia) was called “Mates in Construction.” The COE was low to very low.

Social-emotional learning programs

Social-emotional learning programs probably reduce suicide attempts in high school students over a follow up period of 3-12 months, but it is uncertain what effect they have on suicide deaths. Our conclusion is based on 2 RCTs (medium ROB) in high school settings that tested the following interventions: Youth Aware of Mental Health Programme (Europe) and Signs of Suicide (US).[31,32] The COE was moderate for suicide attempts and very low for suicide deaths. In addition, an RCT (medium ROB) evaluated the Contact+Connect program in construction workers in Australia.[33] However, the authors measured suicide attempts using a Likert Scale in response to the question "Have you tried to kill yourself in the past months?" (strongly agree to strongly disagree), and thus the data were not usable for our analysis.

Gatekeeper training

In high school students, the effect of gatekeeper training on suicide deaths is uncertain but gatekeeper training may reduce suicide attempts. In youths and young adults, the effect of the Garrett Lee Smith (GLS) program on suicide deaths (at 4 years) or suicide attempts (at 2 years) is uncertain. In an indigenous community, the effect of gatekeeper training on suicide deaths and attempts is uncertain. These conclusions were based on 1 RCT targeting high school adolescents (Europe), 1 RCT in an indigenous Canadian community which tested the Applied Suicide Intervention Skills Training (ASIST) program, and 1 observational study targeting youths and young adults evaluating the GLS program in the US.[32,34-37] Both RCTs were rated as medium ROB. The observational study was low ROB. The COE was low for suicide attempts and very low for suicide deaths in the study in high school students. The COE was very low for suicide deaths and attempts in both the study of indigenous Canadians and the GLS Program.

Crisis intervention

On non-pedestrian bridges, the effect of installing crisis phones (connecting individuals to suicide prevention specialists) on suicides is uncertain and there was no data on suicide attempts. This intervention was only informed by 1 pre-post observational study (US) with no concurrent control (medium ROB).[38] The COE was very low.

Public awareness and education campaign

The effect of a public awareness and education campaign on suicides is uncertain and there was no data on suicide attempts. Two observational studies (rated medium and low ROB) evaluated the effect of public awareness and education campaigns in Austria and Japan, respectively.[39,40] The interventions consisted of billboards with positive messages and crisis hotline numbers or pamphlets encouraging help-seeking behavior and telephone numbers for consultations. The COE was very low.

Screening for at-risk individuals (in a non-health care setting)

Community-based screening interventions for depression may reduce suicide deaths. There was no data on suicide attempts. In high school students, the effect of a suicide screening intervention is uncertain as no suicide deaths occurred during the 1-year study period. However, screening may reduce suicide attempts among high school students. In prisoners, the effect of a suicide screening intervention is uncertain and there was no data on suicide attempts. These conclusions are based on 4 studies (medium ROB) evaluating individuals at-risk for suicide in non-clinical

settings: 1 cluster RCT conducted in Europe targeted adolescent students,[32] 2 community-based observational studies conducted in Japan,[41,42] and 1 observational study of a German detention center with men.[43] The COE ranged from low to very low.

We found no studies that evaluated the following suicide prevention strategies listed in the CDC's technical package as stand-alone interventions: household financial security, community-based policies to reduce alcohol use, peer norm programs, community engagement activities, and parenting skills and family relationship approaches.[11] We note below the results from multi-strategy suicide prevention programs and their specific components.

Multi-strategy suicide prevention interventions

Fifteen studies, organized by the country in which they were tested, evaluated multi-strategy suicide prevention interventions.[44-60]

In Europe, community-based, multi-strategy suicide prevention programs may reduce suicide deaths. The effect on suicide attempts is uncertain. Conclusions were based on 4 observational studies (3 medium ROB and 1 low ROB) evaluating the intervention referred to as the European Alliance Against Depression.[45-48] Components of the European Alliance Against Depression included cooperation with primary care physicians, public relations campaigns, community facilitators, support for high risk groups, and reducing access to lethal means. The COE was low for suicide deaths and very low for suicide attempts.

In Asia, the effect of community-based, multi-strategy suicide prevention programs on suicide deaths or suicide attempts is uncertain. This conclusion was based on based on 8 observational studies (5 medium ROB and 3 low ROB) conducted in Hong Kong, South Korea, Taiwan, or Japan.[49-55,58,59] Studies targeted both rural areas and highly populated areas and evaluated activities developed by national centers and programs for suicide prevention. The COE across these studies was very low.

In New Zealand, 1 cluster RCT (Multi-level Intervention for Suicide Prevention in New Zealand [MISP-NZ]) found that a multi-strategy prevention program may increase suicide deaths.[44] There was no data on suicide attempts. Intervention components included gatekeeper training for lay persons and professionals to recognize suicide risk factors, media reporting on suicide using best practices, distribution of print material and information on web-based resources, workshops on mental health topics, and community events. The overall COE was low.

In Australia, the effect of a locally targeted, community-based, multi-strategy suicide prevention program on suicides was uncertain. This was based on 1 observational study with concurrent control (rated medium ROB).[60] The intervention components included: community and professional education activities; crisis intervention, treatment and referral support; counseling and personal development initiatives; and health promotion initiatives. The COE was very low.

In Australia (at a suicide hotspot), the effect of a multi-strategy intervention on suicide deaths is uncertain and there was no data on suicide attempts. This was based on 1 pre-post study (medium ROB) evaluating a comprehensive intervention at Gap Park in Sydney,[56,57] a recognized location for suicides. The intervention components included building a 130 cm fence 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 COE was very low.

What are the key/common components of the most effective interventions? (KQ1a)

Most multi-strategy interventions failed to show a benefit or were found to have insufficient evidence. For multi-strategy interventions with evidence of effectiveness, we were unable to determine the key or common components because authors often provided limited information on the individual components or provided insufficient information to assess specific contributions of components.

What strategies have been used to deliver, sustain, and improve the quality of the most effective interventions? (KQ1b)

The following interventions had the strongest evidence of effectiveness in reducing suicide deaths: reducing access to lethal means, implementing programs that influence organizational policies and culture in police workplace settings, screening for depression in the community, and the multi-strategy intervention called the European Alliance Against Depression. Additionally, in high school settings, social-emotional learning programs, suicide screening, and gatekeeper training may be effective strategies for reducing suicide attempts. Across these studies, the strategies to delivering effective interventions included using peer support to deliver the intervention, providing in-person training, and distributing a procedure manual on how to implement the program. To sustain effective suicide prevention programs, a key strategy included engaging stakeholders to determine potential challenges to implementation and other factors (*eg*, costs, community acceptance, resource allocation, number of people that can be reached with the program). Strategies to improve the quality of the program were not evaluated.

What are the potential unintended consequences of population and community-based prevention interventions? (KQ2)

Possible unintended consequences included increased suicide, suicide-related stigma, caregiver burden, and switching suicide means, when applicable. Based on 3 medium ROB studies (2 RCTs in young adults and 1 observational study at an addiction center), social-emotional learning programs may reduce stigma towards suicide at 1 month in individuals targeted for these interventions.[61-63] For gatekeeper training, 1 RCT in social work students and 1 pre-post observational study in rural Australian communities found no differences on attitudes and stigma between those who received gatekeeper training versus control.[64,65] No studies reported on caregiver burden. In studies that evaluated switching suicide means, restricting access to charcoal may not result in switching to other means of suicide and is uncertain for installation of barriers at bridges or blue lights at railway stations. One RCT evaluating a community-based, multi-strategy suicide prevention program in New Zealand demonstrated an increase in suicides.[44]

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. 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 US 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 them among Veterans or in other settings. 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.

Table 1. 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).

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

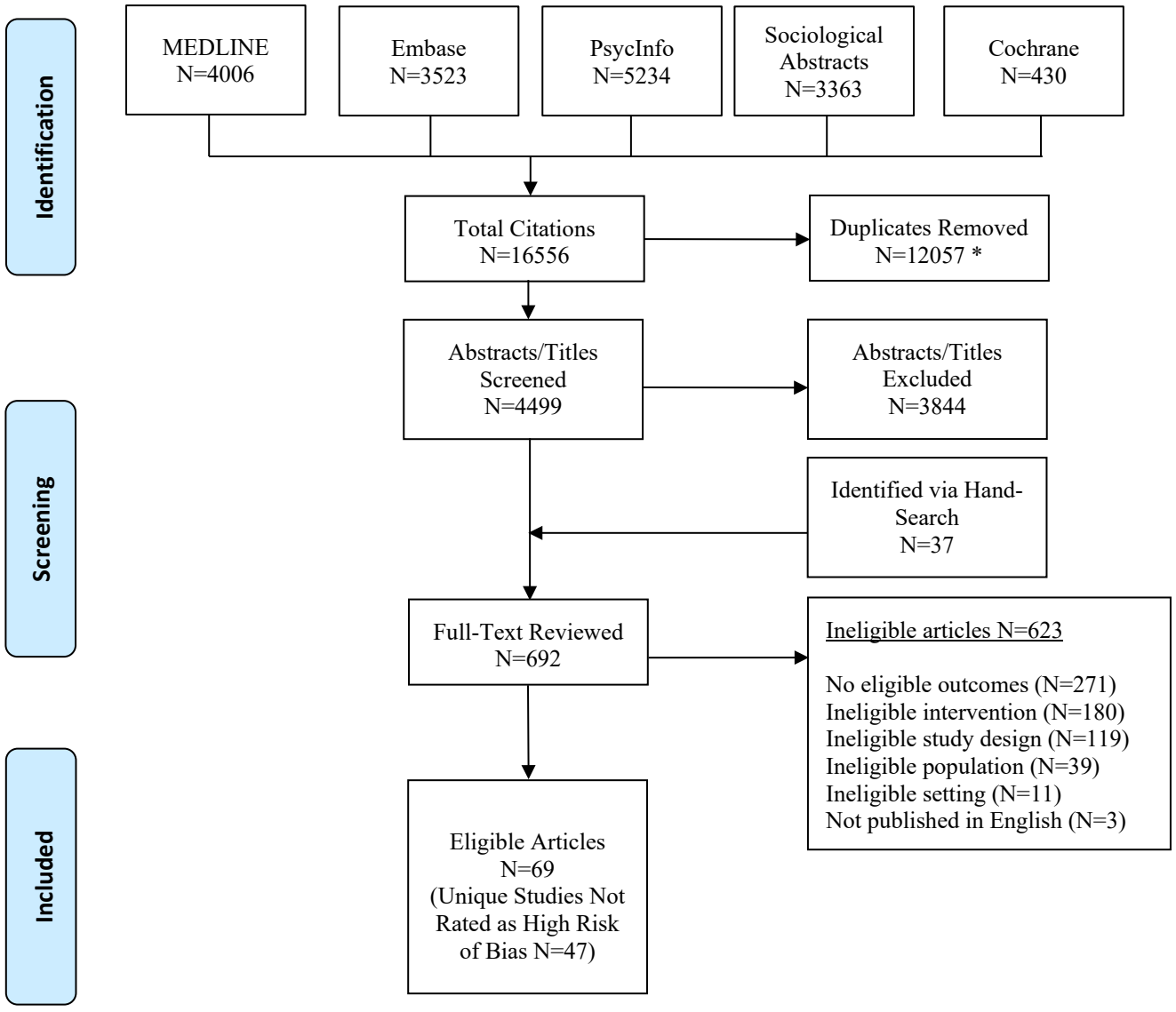
A draft version of this report was reviewed by technical experts as well as clinical leadership. Their comments and our responses are presented in Appendix 6.

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:
  - 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)
  - 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)
  - 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:
  - 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)
  - In construction workplaces, the effect of organizational policies and culture on suicide deaths is unclear; very low certainty (no data on attempts, suicide stigma)
  - 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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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 Intervention	Control	Difference (95% CI)	Certainty of Evidence:	What happens
	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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
(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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
	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.

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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
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]

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			Certainty of Evidence:	What happens
			Intervention	Control	Difference (95% CI)		
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 Intervention	Control	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 Intervention	 Control	 Difference (95% CI)	Certainty of Evidence:	What happens
	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.

REFERENCES

1. Centers for Disease Control and Prevention; National Center for Health Statistics. Leading Causes of Death. https://www.cdc.gov/nchs/fastats/leading-causes-of-death.htm. Accessed 11/20/20.
2. Office of Mental Health and Suicide Prevention. *National Veteran Suicide Prevention Annual Report.* US Department of Veterans Affairs;2020. https://www.mentalhealth.va.gov/docs/data-sheets/2020/2020-National-Veteran-Suicide-Prevention-Annual-Report-11-2020-508.pdf.
3. U.S. Department of Veterans Affairs, QUERI Partnered Evaluation Initiative. Evaluation of a Caring Letters Suicide Prevention Campaign. https://www.queri.research.va.gov/about/factsheets/suicide-prevention-PEI.pdf. Published 2019. Accessed 9/24/20.
4. Kessler RC, Hwang I, Hoffmire CA, et al. Developing a practical suicide risk prediction model for targeting high-risk patients in the Veterans health Administration. *Int J Methods Psychiatr Res.* 2017;26(3):e1575.
5. U.S. Department of Veterans Affairs. *VA National Suicide Data Report 2005–2016.* 2018. file:///Users/shahnazsultan/Dropbox/www.mentalhealth.va.gov/docs/data-sheets/OMHSP_National_Suicide_Data_Report_2005-2016_508.pdf.
6. U.S. Department of Veterans Affairs. *National Strategy for Preventing Veteran Suicide 2018–2028.* https://www.mentalhealth.va.gov/suicide_prevention/docs/Office-of-Mental-Health-and-Suicide-Prevention-National-Strategy-for-Preventing-Veterans-Suicide.pdf.
7. U.S. Department of Veterans Affairs. *PREVENTS. The Presidents' Roadmap to Empower Veterans and End a National Tragedy of Suicide.* 2020. https://www.va.gov/PREVENTS/docs/PRE-007-The-PREVENTS-Roadmap-1-2_508.pdf.
8. Higgins JP, Altman DG, Gotzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *Bmj.* 2011;343:d5928.
9. Tufanaru C MZ, Aromataris E, Campbell J, Hopp L. Chapter 3: Systematic reviews of effectiveness. In: Aromataris E MZ, ed.: The Joanna Briggs Institute; 2017: https://reviewersmanual.joannabriggs.org/.
10. Guyatt GH, Oxman AD, Kunz R, Vist GE, Falck-Ytter Y, Schünemann HJ. What is "quality of evidence" and why is it important to clinicians? *Bmj.* 2008;336(7651):995-998.
11. Stone DM, Holland, K.M., Bartholow, B., Crosby, A.E., Davis, S., and Wilkins, N. *Preventing Suicide: A Technical Package of Policies, Programs, and Practices.* Atlanta, GA National Center for Injury Prevention and Control, Centers for Disease Control and Prevention;2017.
12. Montgomery AE, Dichter M, Byrne T, Blosnich J. Intervention to address homelessness and all-cause and suicide mortality among unstably housed US Veterans, 2012-2016. *J Epidemiol Community Health.* 2020.
13. Yip PS, Law CK, Fu KW, Law YW, Wong PW, Xu Y. Restricting the means of suicide by charcoal burning. *Br J Psychiatry.* 2010;196(3):241-242.
14. Chen YY, Chen F, Chang SS, Wong J, Yip PS. Assessing the Efficacy of Restricting Access to Barbecue Charcoal for Suicide Prevention in Taiwan: A Community-Based Intervention Trial. *PLoS One.* 2015;10(8):e0133809.

15. Jo SJ, Yun MI, Lee MS. Effects of a province-based strategy to prevent suicide using charcoal burning: A preliminary time series analysis. *Psychiatry Investigation.* 2019;16(8):621-624.
16. Sinyor M, Schaffer A, Redelmeier DA, et al. Did the suicide barrier work after all? Revisiting the Bloor Viaduct natural experiment and its impact on suicide rates in Toronto. *BMJ Open.* 2017;7(5):e015299.
17. Sinyor M, Levitt AJ. Effect of a barrier at Bloor Street Viaduct on suicide rates in Toronto: natural experiment. *Bmj.* 2010;341:c2884.
18. Perron S, Burrows S, Fournier M, Perron PA, Ouellet F. Installation of a bridge barrier as a suicide prevention strategy in Montreal, Quebec, Canada. *Am J Public Health.* 2013;103(7):1235-1239.
19. Law CK, Sveticic J, De Leo D. Restricting access to a suicide hotspot does not shift the problem to another location. An experiment of two river bridges in Brisbane, Australia. *Aust N Z J Public Health.* 2014;38(2):134-138.
20. Hemmer A, Meier P, Reisch T. Comparing Different Suicide Prevention Measures at Bridges and Buildings: Lessons We Have Learned from a National Survey in Switzerland. *PLoS One.* 2017;12(1):e0169625.
21. Law CK, Yip PS. An economic evaluation of setting up physical barriers in railway stations for preventing railway injury: evidence from Hong Kong. *J Epidemiol Community Health.* 2011;65(10):915-920.
22. Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform screen doors for the prevention of subway suicides in South Korea. *J Affect Disord.* 2016;194:80-83.
23. Ueda M, Sawada Y, Matsubayashi T. The effectiveness of installing physical barriers for preventing railway suicides and accidents: evidence from Japan. *J Affect Disord.* 2015;178:1-4.
24. Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue lights on train platforms prevent suicide? A before-and-after observational study from Japan. *J Affect Disord.* 2013;147(1-3):385-388.
25. Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue Lights on train platforms shift suicide to another station?: Evidence from Japan. *J Affect Disord.* 2014;169:57-60.
26. Ichikawa M, Inada H, Kumeji M. Reconsidering the effects of blue-light installation for prevention of railway suicides. *J Affect Disord.* 2014;152-154:183-185.
27. Mishara BL, Martin N. Effects of a comprehensive police suicide prevention program. *Crisis.* 2012;33(3):162-168.
28. Knox KL, Pflanz S, Talcott GW, et al. The US Air Force suicide prevention program: implications for public health policy. *Am J Public Health.* 2010;100(12):2457-2463.
29. Shelef L, Tatsa-Laur L, Derazne E, Mann JJ, Fruchter E. An effective suicide prevention program in the Israeli Defense Forces: A cohort study. *Eur Psychiatry.* 2016;31:37-43.
30. Doran CM, Ling R, Gullestrup J, Swannell S, Milner A. The Impact of a Suicide Prevention Strategy on Reducing the Economic Cost of Suicide in the New South Wales Construction Industry. *Crisis.* 2016;37(2):121-129.
31. Schilling EA, Aseltine RH, Jr., James A. The SOS Suicide Prevention Program: Further Evidence of Efficacy and Effectiveness. *Prev Sci.* 2016;17(2):157-166.

32. Wasserman D, Hoven CW, Wasserman C, et al. School-based suicide prevention programmes: the SEYLE cluster-randomised, controlled trial. *Lancet.* 2015;385(9977):1536-1544.
33. Milner A, Aitken Z, Law PCF, et al. The relationship between an electronic mental health stigma campaign and suicidal thoughts and behaviours: a two-arm randomized controlled trial in the Australian construction industry. *Health promotion international.* 2019;12.
34. Sareen J, Isaak C, Bolton SL, et al. Gatekeeper training for suicide prevention in First Nations community members: a randomized controlled trial. *Depress Anxiety.* 2013;30(10):1021-1029.
35. Walrath C, Garraza LG, Reid H, Goldston DB, McKeon R. Impact of the Garrett Lee Smith youth suicide prevention program on suicide mortality. *Am J Public Health.* 2015;105(5):986-993.
36. Godoy Garraza L, Walrath C, Goldston DB, Reid H, McKeon R. Effect of the Garrett Lee Smith Memorial Suicide Prevention Program on Suicide Attempts Among Youths. *JAMA Psychiatry.* 2015;72(11):1143-1149.
37. Godoy Garraza L, Kuiper N, Goldston D, McKeon R, Walrath C. Long-term impact of the Garrett Lee Smith Youth Suicide Prevention Program on youth suicide mortality, 2006-2015. *J Child Psychol Psychiatry.* 2019;60(10):1142-1147.
38. Stack S. Crisis Phones - Suicide Prevention Versus Suggestion/Contagion Effects. *Crisis.* 2015;36(3):220-224.
39. Till B, Sonneck G, Baldauf G, Steiner E, Niederkrotenthaler T. Reasons to love life. Effects of a suicide-awareness campaign on the utilization of a telephone emergency line in Austria. *Crisis.* 2013;34(6):382-389.
40. Matsubayashi T, Ueda M, Sawada Y. The effect of public awareness campaigns on suicides: evidence from Nagoya, Japan. *J Affect Disord.* 2014;152-154:526-529.
41. Oyama H, Sakashita T. Long-Term Effects of a Screening Intervention for Depression on Suicide Rates among Japanese Community-Dwelling Older Adults. *Am J Geriatr Psychiatry.* 2016;24(4):287-296.
42. Oyama H, Sakashita T. Community-based screening intervention for depression affects suicide rates among middle-aged Japanese adults. *Psychol Med.* 2017;47(8):1500-1509.
43. Dezso D, Konrad N, Seewald K, Opitz-Welke A. Implementation of a Suicide Risk Screening Instrument in a Remand Prison Service in Berlin. *Front Psychiatry.* 2018;9:665.
44. Collings S, Jenkin G, Stanley J, McKenzie S, Hatcher S. Preventing suicidal behaviours with a multilevel intervention: a cluster randomised controlled trial. *BMC Public Health.* 2018;18(1):140.
45. Hegerl U, Maxwell M, Harris F, et al. Prevention of suicidal behaviour: Results of a controlled community-based intervention study in four European countries. *PLoS One.* 2019;14(11):e0224602.
46. Hegerl U, Mergl R, Havers I, et al. Sustainable effects on suicidality were found for the Nuremberg alliance against depression. *Eur Arch Psychiatry Clin Neurosci.* 2010;260(5):401-406.
47. Szekely A, Konkoly Thege B, Mergl R, et al. How to decrease suicide rates in both genders? An effectiveness study of a community-based intervention (EAAD). *PLoS One.* 2013;8(9):e75081.
48. Hubner-Liebermann B, Neuner T, Hegerl U, Hajak G, Spiessl H. Reducing suicides through an alliance against depression? *Gen Hosp Psychiatry.* 2010;32(5):514-518.

49. Ono Y, Sakai A, Otsuka K, et al. Effectiveness of a multimodal community intervention program to prevent suicide and suicide attempts: a quasi-experimental study. *PLoS One.* 2013;8(10):e74902.
50. Lai CCS, Law YW, Shum AKY, Ip FWL, Yip PSF. A Community-Based Response to a Suicide Cluster. *Crisis.* 2020;41(3):163-171.
51. Kato R, Okada M. Can Financial Support Reduce Suicide Mortality Rates? *Int J Environ Res Public Health.* 2019;16(23):29.
52. Lee SU, Park JI, Lee S, Oh IH, Choi JM, Oh CM. Changing trends in suicide rates in South Korea from 1993 to 2016: a descriptive study. *BMJ Open.* 2018;8(9):e023144.
53. Nakanishi M, Yamauchi T, Takeshima T. National strategy for suicide prevention in Japan: impact of a national fund on progress of developing systems for suicide prevention and implementing initiatives among local authorities. *Psychiatry Clin Neurosci.* 2015;69(1):55-64.
54. Law YW, Yeung TL, Ip FWL, Yip PSF. Evidence-Based Suicide Prevention: Collective Impact of Engagement with Community Stakeholders. *J Evid Based Soc Work (2019).* 2019;16(2):1-17.
55. Lung FW, Liao SC, Wu CY, Lee MB. The effectiveness of suicide prevention programmes: urban and gender disparity in age-specific suicide rates in a Taiwanese population. *Public Health.* 2017;147:136-143.
56. Ross V, Koo YW, Kolves K. A suicide prevention initiative at a jumping site: A mixed-methods evaluation. *EClinicalMedicine.* 2020;19 (no pagination).
57. Lockley A, Cheung YT, Cox G, et al. Preventing suicide at suicide hotspots: a case study from Australia. *Suicide Life Threat Behav.* 2014;44(4):392-407.
58. Nakanishi M, Endo K, Ando S, Nishida A. The Impact of Suicide Prevention Act (2006) on Suicides in Japan. *Crisis.* 2020;41(1):24-31.
59. Okada M, Hasegawa T, Kato R, Shiroyama T. Analysing regional unemployment rates, GDP per capita and financial support for regional suicide prevention programme on suicide mortality in Japan using governmental statistical data. *BMJ Open.* 2020;10(8):e037537.
60. Page A, Taylor R, Gunnell D, Carter G, Morrell S, Martin G. Effectiveness of Australian youth suicide prevention initiatives. *Br J Psychiatry.* 2011;199(5):423-429.
61. Taylor-Rodgers E, Batterham PJ. Evaluation of an online psychoeducation intervention to promote mental health help seeking attitudes and intentions among young adults: randomised controlled trial. *J Affect Disord.* 2014;168:65-71.
62. Rogers ML, Schneider ME, Gai AR, Gorday JY, Joiner TE. Evaluation of two web-based interventions in reducing the stigma of suicide. *Behav Res Ther.* 2018;109:49-55.
63. Voss WD, Kaufman E, O'Connor SS, Comtois KA, Conner KR, Ries RK. Preventing addiction related suicide: a pilot study. *J Subst Abuse Treat.* 2013;44(5):565-569.
64. Jacobson JM, Osteen PJ, Sharpe TL, Pastoor JB. Randomized Trial of Suicide Gatekeeper Training for Social Work Students. *Research on Social Work Practice.* 2012;22(3):270-281.
65. Perceval M, Reddy P, Ross V, Joiner T, Kolves K. Evaluation of the SCARF Well-Being and Suicide Prevention Program for Rural Australian Communities. *J Rural Health.* 2020;36(2):247-254.
66. Shekelle P, Bagley S, Munjas B. Strategies for suicide prevention in veterans. 2010.
67. Graetz N, Preston SH, Peele M, Elo IT. Ecological factors associated with suicide mortality among non-Hispanic whites. *BMC Public Health.* 2020;20(1):1339.

68. National Institute of Mental Health. Suicide. https://www.nimh.nih.gov/health/statistics/suicide.shtml. Accessed November 3, 2020.
69. Klonsky ED, May AM, Saffer BY. Suicide, Suicide Attempts, and Suicidal Ideation. *Annu Rev Clin Psychol.* 2016;12:307-330.
70. Paykel ES, Myers JK, Lindenthal JJ, Tanner J. Suicidal feelings in the general population: a prevalence study. *Br J Psychiatry.* 1974;124(0):460-469.
71. Harris FM, Maxwell M, O'Connor R, et al. Exploring synergistic interactions and catalysts in complex interventions: longitudinal, mixed methods case studies of an optimised multi-level suicide prevention intervention in four european countries (Ospi-Europe). *BMC Public Health.* 2016;16:268.
72. Godoy Garraza L, Peart Boyce S, Walrath C, Goldston DB, McKeon R. An Economic Evaluation of the Garrett Lee Smith Memorial Suicide Prevention Program. *Suicide Life Threat Behav.* 2018;48(1):3-11.
73. Saeheim A, Hestetun I, Mork E, Nrugham L, Mehlum L. A 12-year National Study of Suicide by Jumping From Bridges in Norway. *Arch Suicide Res.* 2017;21(4):568-576.
74. Finney EJ, Buser SJ, Schwartz J, Archibald L, Swanson R. Suicide prevention in fire service: The Houston Fire Department (HFD) model. *Aggression and Violent Behavior.* 2015;21:1-4.
75. Han J, Batterham PJ, Calear AL, Wu Y, Xue J, Spijker BAJv. Development and pilot evaluation of an online psychoeducational program for suicide prevention among university students: A randomised controlled trial. *Internet Interventions.* 2018;12:111-120.
76. Dueweke AR, Bridges AJ. The effects of brief, passive psychoeducation on suicide literacy, stigma, and attitudes toward help-seeking among Latino immigrants living in the United States. *Stigma and Health.* 2017;2(1):28-42.
77. Freedenthal S. Adolescent help-seeking and the Yellow Ribbon Suicide Prevention Program: an evaluation. *Suicide Life Threat Behav.* 2010;40(6):628-639.
78. Gravesteijn C, Diekstra R, Sklad M, de Winter M. The Effects of a Dutch School-Based Social and Emotional Learning Programme (SEL) on Suicidality in Adolescents. *International Journal of Mental Health Promotion.* 2011;13(4):4-16.
79. Kennedy AJ, Brumby SA, Versace VL, Brumby-Rendell T. The ripple effect: a digital intervention to reduce suicide stigma among farming men. *BMC Public Health.* 2020;20(1):813.
80. Smith-Osborne A, Maleku A, Morgan S. Impact of applied suicide intervention skills training on resilience and suicide risk in army reserve units. *Traumatology.* 2017;23(1):49-55.
81. Wang J, Hausermann M, Berrut S, Weiss MG. The impact of a depression awareness campaign on mental health literacy and mental morbidity among gay men. *J Affect Disord.* 2013;150(2):306-312.
82. King KA, Strunk CM, Sorter MT. Preliminary effectiveness of surviving the teens((R)) suicide prevention and depression awareness program on adolescents' suicidality and self-efficacy in performing help-seeking behaviors. *J Sch Health.* 2011;81(9):581-590.
83. Nakanishi M, Endo K. National Suicide Prevention, Local Mental Health Resources, and Suicide Rates in Japan. *Crisis.* 2017;38(6):384-392.
84. Pirruccello LM. Preventing adolescent suicide: a community takes action. *J Psychosoc Nurs Ment Health Serv.* 2010;48(5):34-41.

85. Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide rates in 21 OECD nations. *Soc Sci Med.* 2011;73(9):1395-1400.

APPENDIX 1. SEARCH STRATEGIES

Database: MEDLINE

1	exp Suicide, Completed/	41
2	exp *Suicide, Attempted/pc [Prevention & Control]	938
3	((suicid* or self harm* or self injur* or self hatred or self directed violence) adj2 (prevent* or control* or reduc* or manag*)).ti,ab.	9021
4	1 or 2 or 3	9657
5	(intervention* or program* or strateg* or polic* or resource* or promotion* or campaign* or modul* or activit* or project* or training or implement* or limit* or restrict* or initiative* or barrier* or helpline or hotspot*).ti,ab.	8257659
6	4 and 5	5729
7	limit 6 to (english language and humans and yr="2010 -Current")	2701
8	(child* or youth* or preteen* or pediatric* or paediatric*).ti,ab.	1560906
9	((elementary or primary or grammar or grade) adj1 school).ti,ab.	16877
10	8 or 9	1565248
11	7 not 10	2255
12	(hospital* or inpatient* or medic* ward* or emergency department*).ti,ab.	1346476
13	11 not 12	1826
14	limit 13 to (meta analysis or "systematic review")	111
15	limit 13 to (address or biography or case reports or comment or congress or consensus development conference or editorial or interactive tutorial or interview or legal case or legislation or letter or news or newspaper article or observational study, veterinary or personal narrative or portrait or video-audio media or webcast)	83
16	13 not 15	1743

Database: Embase

1	exp *suicide/pc [Prevention]	4725
2	exp *Suicide, Attempted/pc [Prevention & Control]	876
3	((suicid* or self harm* or self injur* or self hatred or self directed violence) adj2 (prevent* or control* or reduc* or manag*)).ti,ab.	10850
4	1 or 2 or 3	13816
5	(intervention* or program* or strateg* or polic* or resource* or promotion* or campaign* or modul* or activit* or project* or training or implement* or limit* or restrict* or initiative* or barrier* or helpline or hotspot*).ti,ab.	10747946
6	4 and 5	7279
7	limit 6 to (english language and humans and yr="2010 -Current")	4381
8	(child* or youth* or preteen or pediatric* or paediatric*).ti,ab.	2173177
9	((elementary or primary or grammar or grade) adj1 school).ti,ab.	22099
10	8 or 9	2179108
11	7 not 10	3556
12	(hospital* or inpatient* or medic* ward* or emergency department*).ti,ab.	2125475
13	11 not 12	2848
14	limit 13 to (books or chapter or conference abstract or conference paper or "conference review" or letter or note)	478
15	13 not 14	2370
16	limit 15 to (book or book series or conference proceeding)	7
17	15 not 16	2363
18	(case adj2 (report or descri*)).ti,ab.	636751
19	("reviews the book" or "comments on an article").ab.	103
20	18 or 19	636853
21	17 not 20	2354

Database: PsycINFO

1	*Suicide/ or *Attempted Suicide/	29386
2	(prevent* or control or reduc* or manag*).ti,ab.	1148355
3	1 and 2	10603
4	*Suicide Prevention/ or *Suicide Prevention Centers/	3919
5	((suicid* or self harm* or self injur* or self hatred or self directed violence) adj2 (prevent* or control* or reduc* or manag*)).ti,ab.	9335
6	3 or 4 or 5	15388
7	(intervention* or program* or strateg* or polic* or resource* or promotion* or campaign* or modul* or postvention* or activit* or project* or training or implement* or limit* or restrict* or initiative* or barrier* or helpline or hotspot*).ti,ab.	1988975
8	6 and 7	9156
9	(child* or youth* or preteen or pediatric* or paediatric*).ti,ab.	752753
10	((elementary or primary or grammar or grade) adj1 school).ti,ab.	33533
11	9 or 10	766815
12	8 not 11	7504
13	(hospital* or inpatient* or medic* ward* or emergency department*).ti,ab.	185108
14	12 not 13	6359
15	limit 14 to (human and english language and yr="2010-Current")	3285
16	(case adj2 (report or descri*)).ti,ab.	30537
17	15 not 16	3266
18	limit 17 to "0110 peer-reviewed journal"	2644
19	limit 18 to (chapter or "column/opinion" or dissertation or editorial or encyclopedia entry or interview or letter or obituary or poetry or publication information or reprint or review-book or review-media or review-software & other)	183
20	18 not 19	2461

Database: Sociological Abstracts
mainsubject.Exact("suicide, attempted" OR "suicide") AND ab(prevent* OR control OR reduc* OR manag*) OR ab(suicid* OR self harm* OR self injur* OR self hatred OR self directed violence) AND ab(prevent* OR control OR reduc* OR manag*) AND ab(intervention* OR program* OR strateg* OR polic* OR resource* OR promotion* OR campaign* OR modul* OR activit* OR project* OR training OR implement* OR limit* OR restrict* OR initiative* OR barrier* OR helpline OR hotspot*) NOT ab((child* OR youth* OR preteen OR pediatric* OR paediatric* OR ((elementary OR primary OR grammar OR grade) NEAR/1 school))) NOT ab(hospital* OR inpatient* OR medic* ward* OR emergency department)

Databases: Sociological Abstracts

Limited by:

Peer reviewed,

Date: From January 01 2010 to May 31 2020

Source type:

Scholarly Journals

Document type:

Article, Literature Review

Language:

English

Narrowed by:
Peer reviewed: Peer reviewed

APPENDIX 2. RISK OF BIAS TOOL FOR OBSERVATIONAL STUDIES

Appendix Table 2-1. *Modified* JBI Critical Appraisal Checklist for Quasi-Experimental Studies

Question	Yes	No	Unclear	NA
Did the study include all eligible participants or were the participants a representative sample from the population of interest? Guidance to answer the question: Population-based studies: Were all eligible members of the population included? Studies with a "sample" from the population: Is the representative sample similar to the population from which it is drawn?				
Were the participants included in any comparison similar? Guidance to answer the question: If baseline demographic data are provided, are there statistically significant differences between the groups (*eg* age, gender, risk factors)? In 1 group, pre-test/post-test studies where the participants are the same in any pre-post comparisons, the answer to this question should be 'yes'. NOTE: Selection bias is defined "as a nonrandom imbalance among treatment groups of the distribution of factors capable of influencing the end points." This definition is from the Handbook of Pharmacogenomics and Stratified Medicine 2014.				
Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest? Guidance to answer the question: Did 1 group get any additional suicide prevention information/intervention? For example, if a study is exploring the effect of means restriction, did the intervention group also receive any other exposure (*eg* awareness campaign)? It is acceptable for all participants to be receiving some type of intervention provided the "intervention" group is receiving an additional intervention. The intervention of interest is the additional intervention.				
Was the control group concurrent? Guidance to answer the question: Sampled and followed over the same period of time?				
For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/exposure? Guidance to answer the question: Example: the study was between 2010 and 2017 and the intervention was initiated in 2014. Were there multiple measurements prior to 2014 and then after the intervention (2010, 2011, etc. and then 2016, 2017, etc.)				
Was follow-up complete?				

Guidance to answer the question: For pre-post studies that are population-based: answer “not applicable”. For studies that have a separate comparison group and a defined cohort: was there complete information on a high percentage of participants? Make a judgement on a case-by-case basis (no set threshold).				
Were completeness of follow-up similar for study groups? Guidance to answer the question: For pre-post studies that are population-based: answer “not applicable”. For studies that have a separate comparison group and a defined cohort: Were there differences between groups with regards to loss to follow up (large loss in 1 group versus the other) or differences in length of follow-up (one group followed to study end, 1 not)?				
Were the outcomes of participants included in any comparisons measured in the same way? Guidance to answer the question: Same method (questionnaires, registries, death certificates, ICD-10 codes) used for both groups?				
Were suicide deaths and/or attempts measured in a reliable way? Guidance to answer the question: Were data collected in a way that could be repeated (*eg*, death registry vs reported in interview with neighbors)?				
Were other eligible outcomes measured in a reliable way? Guidance to answer the question: Were other outcomes assessed in the study groups (or pre/post) with the same instruments and by similar methods of assessment?				
Did the study adjust for confounding variables? Guidance to answer the question: Did the statistical methods adjust for baseline variables considered to be confounders (examples may include age, gender, race, SES, history of suicide attempt, mental health diagnoses)? If the study attempted to adjust for any confounders, then answer “yes”.				

NA=not applicable

APPENDIX 3. DEFINITIONS OF THE CDC STRATEGIES AND APPROACHES

Table 3-1. Definitions of the CDC Strategies and Approaches to Prevent Suicide Relevant for our Review *, **

Primary CDC Strategy	*Approach*	Definition from the CDC Technical Document
Strengthen economic supports	*Household financial security*	**Strengthening household financial security** can potentially buffer the risk of suicide by providing individuals with the financial means to lessen the stress and hardship associated with a job loss or other unanticipated financial problems. The provision of unemployment benefits and other forms of temporary assistance, livable wages, medical benefits, and retirement and disability insurance to help cover the cost of necessities or to offset costs in the event of disability, are examples of ways to strengthen household financial security.
	Housing stabilization	**Housing stabilization policies** aim to keep people in their homes and provide housing options for those in need during times of financial insecurity. This may occur through programs that provide affordable housing such as through government subsidies or through other options available to potential homebuyers such as loan modification programs, move-out planning, or financial counseling services that help minimize the risk or impact of foreclosures and eviction.
Create protective environments	*Reduce access to lethal means*	**Reduce access to lethal means** among persons at risk of suicide. Means of suicide such as firearms, hanging/ suffocation, or jumping from heights provide little opportunity for rescue and, as such, have high case fatality rates (*eg*, about 85% of people who use a firearm in a suicide attempt die from their injury). Research also indicates that: 1) the interval between deciding to act and attempting suicide can be as short as 5 or 10 minutes, and 2) people tend *not* to substitute a different method when a highly lethal method is unavailable or difficult to access. Therefore, increasing the time interval between deciding to act and the suicide attempt, for example, by making it more difficult to access lethal means, can be lifesaving. The following are examples of reducing access to lethal means: intervening at suicide hotspots and safe storage practices.
	Organizational policies and culture	**Organizational policies and culture** that promote protective environments may be implemented in places of employment, detention facilities, and other secured environments (*eg*, residential settings). Such policies and cultural values encourage leadership from the top down and may promote prosocial behavior (*eg*, asking for help), skill building, positive social norms, assessment, referral and access to helping services (*eg*, mental health, substance abuse treatment, financial counseling), and development of crisis response plans, postvention and other measures to foster a safe physical environment. Such policies and cultural shifts can positively impact organizational climate and morale and help prevent suicide and its related risk factors (*eg*, depression, social isolation).
	Community-based policies to reduce alcohol use	**Community-based policies to reduce excessive alcohol use**. Research studies in the United States have found that greater alcohol availability is positively associated with alcohol-involved suicides. Policies to reduce excessive alcohol use broadly include zoning to limit the location and density of alcohol outlets, taxes on alcohol, and bans on the sale of alcohol for individuals under the legal drinking age. These policies are important because acute alcohol use has been found to be associated with more than one-third of suicides and approximately 40% of suicide attempts.
Promote connectedness	*Peer norm programs*	**Peer norm programs** seek to normalize protective factors for suicide such as help-seeking, reaching out and talking to trusted adults, and promote peer connectedness. By leveraging the leadership qualities and social influence of peers, these approaches can be used to shift group-level beliefs and promote positive social and

Primary CDC Strategy	*Approach*	Definition from the CDC Technical Document
		behavioral change. These approaches typically target youth and are delivered in school settings but can also be implemented in community settings.
	Community engagement activities	**Community engagement activities**. Community engagement is an aspect of social capital. Community engagement approaches may involve residents participating in a range of activities, including religious activities, community clean-up and greening activities, and group physical exercise. These activities provide opportunities for residents to become more involved in the community and to connect with other community members, organizations, and resources, resulting in enhanced overall physical health, reduced stress, and decreased depressive symptoms, thereby reducing risk of suicide.
Teach coping and problem-solving skills	*Social-emotional learning programs*	**Social-emotional learning programs** focus on developing and strengthening communication and problem-solving skills, emotional regulation, conflict resolution, help seeking and coping skills. These approaches address a range of risk and protective factors for suicidal behavior. They provide children and youth with skills to resolve problems in relationships, school, and with peers, and help youth address other negative influences (*eg*, substance use) associated with suicide. These approaches are typically delivered to all students in a particular grade or school, although some programs also focus on groups of students considered to be at high risk for suicide. Opportunities to practice and reinforce skills are an important part of programs that work.
	Parenting skills and family relationship approaches	**Parenting skill and family relationship programs** provide caregivers with support and are designed to strengthen parenting skills, enhance positive parent-child interactions, and improve children's behavioral and emotional skills and abilities. Programs are typically designed for parents or caregivers with children in a specific age range and can be self-directed or delivered to individual families or groups of families. Some programs have sessions primarily with parents or caregivers while others include sessions for parents or caregivers, youth, and the family. Specific program content typically varies by the age of the child but often has consistent themes of child development, parent-child communication and relationships, and youth's interpersonal and problem-solving skills.
Identify and support people at risk	*Gatekeeper training*	**Gatekeeper training** is designed to train teachers, coaches, clergy, emergency responders, primary and urgent care providers, and others in the community to identify people who may be at risk of suicide and to respond effectively, including facilitating treatment seeking and support services. Gatekeeper training may be implemented in a variety of settings to identify and support people at risk.
	Crisis intervention	**Crisis intervention**. These approaches provide support and referral services, typically by connecting a person in crisis (or a friend or family member of someone at risk) to trained volunteers or professional staff via telephone hotline, online chat, text messaging, or in-person. Crisis intervention approaches are intended to impact key risk factors for suicide, including feelings of depression, hopelessness, and subsequent mental health care utilization. Similar to means reduction, crisis interventions can put space or time between an individual who may be considering suicide and harmful behavior.

CDC=Centers for Disease Control and Prevention

*Definitions are from the CDC document tilted "Preventing Suicide: A Technical Package of Policies, Programs, and Practices" published in 2017. Definitions were taken verbatim from the document except in select cases for brevity. Full citation listed in the reference list.

**For the purposes of our review, we modified the CDC framework by 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) excluding the CDC strategies and approaches not relevant for our review.

APPENDIX 4. ELIGIBLE REFERENCES

Chen YY, Chen F, Chang SS, Wong J, Yip PS. Assessing the Efficacy of Restricting Access to Barbecue Charcoal for Suicide Prevention in Taiwan: A Community-Based Intervention Trial. *PLoS One.* 2015;10(8):e0133809.

Chung YW, Kang SJ, Matsubayashi T, Sawada Y, Ueda M. The effectiveness of platform screen doors for the prevention of subway suicides in South Korea. *J Affect Disord.* 2016;194:80-83.

Collings S, Jenkin G, Stanley J, McKenzie S, Hatcher S. Preventing suicidal behaviours with a multilevel intervention: a cluster randomised controlled trial. *BMC Public Health.* 2018;18(1):140.

Dezso D, Konrad N, Seewald K, Opitz-Welke A. Implementation of a Suicide Risk Screening Instrument in a Remand Prison Service in Berlin. *Front Psychiatry.* 2018;9:665.

Doran CM, Ling R, Gullestrup J, Swannell S, Milner A. The Impact of a Suicide Prevention Strategy on Reducing the Economic Cost of Suicide in the New South Wales Construction Industry. *Crisis.* 2016;37(2):121-129.

Dueweke AR, Bridges AJ. The effects of brief, passive psychoeducation on suicide literacy, stigma, and attitudes toward help-seeking among Latino immigrants living in the United States. *Stigma and Health.* 2017;2(1):28-42.

Finney EJ, Buser SJ, Schwartz J, Archibald L, Swanson R. Suicide prevention in fire service: The Houston Fire Department (HFD) model. *Aggression and Violent Behavior.* 2015;21:1-4.

Freedenthal S. Adolescent help-seeking and the Yellow Ribbon Suicide Prevention Program: an evaluation. *Suicide Life Threat Behav.* 2010;40(6):628-639.

Garraza L, Boyce S, Walrath C, Goldston DB, McKeon R. An economic evaluation of the Garrett Lee Smith memorial suicide prevention program. *Suicide and Life-Threatening Behavior*. 2018;48(1):3-11.

Garraza L, Kuiper N, Goldston D, McKeon R, Walrath C. Long-term impact of the Garrett Lee Smith Youth Suicide Prevention Program on youth suicide mortality, 2006–2015. *Journal of Child Psychology and Psychiatry.* 2019;60(10):1142-1147.

Garraza L, Walrath C, Goldston DB, Reid H, McKeon R. Effect of the Garrett Lee Smith memorial suicide prevention program on suicide attempts among youths. *JAMA psychiatry*. 2015;72(11):1143-9.

Gravesteijn C, Diekstra R, Sklad M, de Winter M. The Effects of a Dutch School-Based Social and Emotional Learning Programme (SEL) on Suicidality in Adolescents. *International Journal of Mental Health Promotion.* 2011;13(4):4-16.

Han J, Batterham PJ, Calear AL, Wu Y, Xue J, Spijker BAJv. Development and pilot evaluation

of an online psychoeducational program for suicide prevention among university students: A randomised controlled trial. *Internet Interventions.* 2018;12:111-120.

Harris F, Maxwell M, O'Connor R, et al. Exploring synergistic interactions and catalysts in complex interventions: longitudinal, mixed methods case studies of an optimised multi-level suicide prevention intervention in 4 European countries (Ospi-Europe). *BMC Public Health*. 2016; 16(1):268.

Hemmer A, Meier P, Reisch T. Comparing Different Suicide Prevention Measures at Bridges and Buildings: Lessons We Have Learned from a National Survey in Switzerland. *PLoS One.* 2017;12(1):e0169625.

Hegerl U, Maxwell M, Harris F, et al. Prevention of suicidal behaviour: Results of a controlled community-based intervention study in 4 European countries. *PLoS One.* 2019;14(11):e0224602.

Hegerl U, Mergl R, Havers I, et al. Sustainable effects on suicidality were found for the Nuremberg alliance against depression. *Eur Arch Psychiatry Clin Neurosci.* 2010;260(5):401-406.

Hubner-Liebermann B, Neuner T, Hegerl U, Hajak G, Spiessl H. Reducing suicides through an alliance against depression? *Gen Hosp Psychiatry.* 2010;32(5):514-518.

Ichikawa M, Inada H, Kumeji M. Reconsidering the effects of blue-light installation for prevention of railway suicides. *J Affect Disord.* 2014;152-154:183-185.

Jacobson JM, Osteen PJ, Sharpe TL, Pastoor JB. Randomized Trial of Suicide Gatekeeper Training for Social Work Students. *Research on Social Work Practice.* 2012;22(3):270-281.

Jo SJ, Yun MI, Lee MS. Effects of a province-based strategy to prevent suicide using charcoal burning: A preliminary time series analysis. *Psychiatry Investigation.* 2019;16(8):621-624.

Kato R, Okada M. Can Financial Support Reduce Suicide Mortality Rates? *Int J Environ Res Public Health.* 2019;16(23):29.

Kennedy AJ, Brumby SA, Versace VL, Brumby-Rendell T. The ripple effect: a digital intervention to reduce suicide stigma among farming men. *BMC public health.* 2020;20:1-2.

King KA, Strunk CM, Sorter MT. Preliminary effectiveness of surviving the teens((R)) suicide prevention and depression awareness program on adolescents' suicidality and self-efficacy in performing help-seeking behaviors. *J Sch Health.* 2011;81(9):581-590.

Knox KL, Pflanz S, Talcott GW, et al. The US Air Force suicide prevention program: implications for public health policy. *Am J Public Health.* 2010;100(12):2457-2463.

Lai CCS, Law YW, Shum AKY, Ip FWL, Yip PSF. A Community-Based Response to a Suicide Cluster. *Crisis.* 2020;41(3):163-171.

Law CK, Sveticic J, De Leo D. Restricting access to a suicide hotspot does not shift the problem to another location. An experiment of 2 river bridges in Brisbane, Australia. *Aust N Z J Public Health.* 2014;38(2):134-138.

Law YW, Yeung TL, Ip FWL, Yip PSF. Evidence-Based Suicide Prevention: Collective Impact of Engagement with Community Stakeholders. *J Evid Based Soc Work (2019).* 2019;16(2):1-17.

Law CK, Yip PS. An economic evaluation of setting up physical barriers in railway stations for preventing railway injury: evidence from Hong Kong. *J Epidemiol Community Health.* 2011;65(10):915-920.

Lee SU, Park JI, Lee S, Oh IH, Choi JM, Oh CM. Changing trends in suicide rates in South Korea from 1993 to 2016: a descriptive study. *BMJ Open.* 2018;8(9):e023144.

Lockley A, Cheung YT, Cox G, et al. Preventing suicide at suicide hotspots: a case study from Australia. *Suicide Life Threat Behav.* 2014;44(4):392-407.

Lung FW, Liao SC, Wu CY, Lee MB. The effectiveness of suicide prevention programmes: urban and gender disparity in age-specific suicide rates in a Taiwanese population. *Public Health.* 2017;147:136-143.

Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue lights on train platforms prevent suicide? A before-and-after observational study from Japan. *J Affect Disord.* 2013;147(1-3):385-388.

Matsubayashi T, Sawada Y, Ueda M. Does the installation of blue Lights on train platforms shift suicide to another station?: Evidence from Japan. *J Affect Disord.* 2014;169:57-60.

Matsubayashi T, Ueda M. The effect of national suicide prevention programs on suicide rates in 21 OECD nations. *Soc Sci Med.* 2011;73(9):1395-1400.

Matsubayashi T, Ueda M, Sawada Y. The effect of public awareness campaigns on suicides: evidence from Nagoya, Japan. *J Affect Disord.* 2014;152-154:526-529.

Milner A, Aitken Z, Law PCF, et al. The relationship between an electronic mental health stigma campaign and suicidal thoughts and behaviours: a two-arm randomized controlled trial in the Australian construction industry. *Health promotion international.* 2019;12.

Mishara BL, Martin N. Effects of a comprehensive police suicide prevention program. *Crisis.* 2012;33(3):162-168.

Montgomery AE, Dichter M, Byrne T, Blosnich J. Intervention to address homelessness and all-cause and suicide mortality among unstably housed US Veterans, 2012–2016. *J Epidemiol Community Health.* 2020.

Nakanishi M, Endo K. National Suicide Prevention, Local Mental Health Resources, and Suicide

Rates in Japan. *Crisis.* 2017;38(6):384-392.

Nakanishi M, Endo K, Ando S, Nishida A. The Impact of Suicide Prevention Act (2006) on Suicides in Japan: An interruped time-series analysis. *Crisis: The Journal of Crisis Intervention and Suicide Prevention.* 2020;41(1):24-31.

Nakanishi M, Yamauchi T, Takeshima T. National strategy for suicide prevention in Japan: impact of a national fund on progress of developing systems for suicide prevention and implementing initiatives among local authorities. *Psychiatry Clin Neurosci.* 2015;69(1):55-64.

Okada M, Hasegawa T, Kato R, Shiroyama T. Analysing regional unemployment rates, GDP per capita and financial support for regional suicide prevention programme on suicide mortality in Japan using governmental statistical data. *BMJ open.* 2020;10(8):e037537.

Ono Y, Sakai A, Otsuka K, et al. Effectiveness of a multimodal community intervention program to prevent suicide and suicide attempts: a quasi-experimental study. *PLoS One.* 2013;8(10):e74902.

Oyama H, Sakashita T. Long-Term Effects of a Screening Intervention for Depression on Suicide Rates among Japanese Community-Dwelling Older Adults. *Am J Geriatr Psychiatry.* 2016;24(4):287-296.

Oyama H, Sakashita T. Community-based screening intervention for depression affects suicide rates among middle-aged Japanese adults. *Psychol Med.* 2017;47(8):1500-1509.

Page A, Taylor R, Gunnell D, Carter G, Morrell S, Martin G. Effectiveness of Australian youth suicide prevention initiatives. *The British Journal of Psychiatry.* 2011;199(5):423-9.

Perceval M, Reddy P, Ross V, Joiner T, Kolves K. Evaluation of the SCARF Well-being and suicide prevention program for rural Australian communities. *The Journal of Rural Health.* 2020;36(2):247-54.

Perron S, Burrows S, Fournier M, Perron PA, Ouellet F. Installation of a bridge barrier as a suicide prevention strategy in Montreal, Quebec, Canada. *Am J Public Health.* 2013;103(7):1235-1239.

Pirruccello LM. Preventing adolescent suicide: a community takes action. *J Psychosoc Nurs Ment Health Serv.* 2010;48(5):34-41.

Rogers ML, Schneider ME, Gai AR, Gorday JY, Joiner TE. Evaluation of 2 web-based interventions in reducing the stigma of suicide. *Behav Res Ther.* 2018;109:49-55.

Ross V, Koo YW, Kolves K. A suicide prevention initiative at a jumping site: A mixed-methods evaluation. *EClinicalMedicine.* 2020;19 (no pagination).

Saeheim A, Hestetun I, Mork E, Nrugham L, Mehlum L. A 12-year National Study of Suicide by Jumping From Bridges in Norway. *Arch Suicide Res.* 2017;21(4):568-576.

Sareen J, Isaak C, Bolton SL, et al. Gatekeeper training for suicide prevention in First Nations community members: a randomized controlled trial. *Depression and anxiety.* 2013;30(10):1021-1029.

Schilling EA, Aseltine RH, Jr., James A. The SOS Suicide Prevention Program: Further Evidence of Efficacy and Effectiveness. *Prev Sci.* 2016;17(2):157-166.

Shelef L, Tatsa-Laur L, Derazne E, Mann JJ, Fruchter E. An effective suicide prevention program in the Israeli Defense Forces: A cohort study. *Eur Psychiatry.* 2016;31:37-43.

Sinyor M, Levitt AJ. Effect of a barrier at Bloor Street Viaduct on suicide rates in Toronto: natural experiment. *Bmj.* 2010;341:c2884.

Sinyor M, Schaffer A, Redelmeier DA, et al. Did the suicide barrier work after all? Revisiting the Bloor Viaduct natural experiment and its impact on suicide rates in Toronto. *BMJ Open.* 2017;7(5):e015299.

Smith-Osborne A, Maleku A, Morgan S. Impact of applied suicide intervention skills training on resilience and suicide risk in army reserve units. *Traumatology.* 2017;23(1):49-55.

Stack S. Crisis Phones - Suicide Prevention Versus Suggestion/Contagion Effects. *Crisis.* 2015;36(3):220-224.

Szekely A, Konkoly Thege B, Mergl R, et al. How to decrease suicide rates in both genders? An effectiveness study of a community-based intervention (EAAD). *PLoS One.* 2013;8(9):e75081.

Taylor-Rodgers E, Batterham PJ. Evaluation of an online psychoeducation intervention to promote mental health help seeking attitudes and intentions among young adults: randomised controlled trial. *J Affect Disord.* 2014;168:65-71.

Till B, Sonneck G, Baldauf G, Steiner E, Niederkrotenthaler T. Reasons to love life. Effects of a suicide-awareness campaign on the utilization of a telephone emergency line in Austria. *Crisis.* 2013;34(6):382-389.

Ueda M, Sawada Y, Matsubayashi T. The effectiveness of installing physical barriers for preventing railway suicides and accidents: evidence from Japan. *J Affect Disord.* 2015;178:1-4.

Voss WD, Kaufman E, O'Connor SS, Comtois KA, Conner KR, Ries RK. Preventing addiction related suicide: a pilot study. *J Subst Abuse Treat.* 2013;44(5):565-569.

Walrath C, Garraza LG, Reid H, Goldston DB, McKeon R. Impact of the Garrett Lee Smith youth suicide prevention program on suicide mortality. *American Journal of Public Health*. 2015;105(5):986-93.

Wang J, Hausermann M, Berrut S, Weiss MG. The impact of a depression awareness campaign on mental health literacy and mental morbidity among gay men. *J Affect Disord.*

2013;150(2):306-312.

Wasserman D, Hoven CW, Wasserman C, et al. School-based suicide prevention programmes: the SEYLE cluster-randomised, controlled trial. *Lancet.* 2015;385(9977):1536-1544.

Yip PS, Law CK, Fu KW, Law YW, Wong PW, Xu Y. Restricting the means of suicide by charcoal burning. *Br J Psychiatry.* 2010;196(3):241-242.

APPENDIX 5. DATA ABSTRACTION TABLES AND RISK OF BIAS ASSESSMENTS

Appendix Table 5-1. Housing Stabilization: Study Characteristics

Author, Year **Country** **Study Design** **Intervention Type** **Setting** **Funding** **Risk of Bias**	**Inclusion/Exclusion Criteria**	**Intervention** **Comparator** **Study Period** **Length of Follow-up**	**Demographics**
Montgomery 2020[12] Country: US Study Design: Observational with concurrent control Intervention Type: Housing stabilization Setting: Military Funding: US government Risk of Bias: Medium	Inclusion: Veterans screened positive for current or imminent risk of housing instability at least once using the VHA's 2-question Homelessness Screening Clinical Reminder (HSC), defined as responded negatively to the question, 'In the past 2 months, have you been living in stable housing that you own, rent, or stay in as part of a household?' or positively to the question, 'Are you worried or concerned that in the next 2 months you may NOT have stable housing that you own, rent, or stay in as part of a household?' Exclusion: NR	Intervention: Received ≥1 VHA Homeless Program services (n=93,135) Specific programs included: (1) completing an in-depth assessment for VHA Homeless Programs; (2) Domiciliary Care for Homeless Veterans and Compensated Work Therapy with transitional housing; (3) emergency housing services through the healthcare for Homeless Veterans and Safe Haven programs; (4) rapid rehousing and homelessness prevention through Supportive Services for Veteran Families; (5) permanent supportive housing through US Department of Housing and Urban Development-VA Supportive Housing; and (6) transitional housing through the Grant and Per Diem program. Comparator: Received no VHA Homeless Program services (n=76,086) Study period: October 1, 2012 and September 30, 2016 Length of follow-up: 4 years	N= 169,221 Age (years, mean): Int. 50.3 vs Com. 52.8; P<.05 Gender (% male): Int. 89.2 vs Com.90; P<.05 Race (%): White: Int. 55.7 vs, Com. 65.9; P<.05 Black: Int. 34.7 vs, Com. 23.1; P<.05 Military status:100% veterans Housing status: 100% "housing instability" Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

Com=Comparator; Int=intervention; VHA=Veterans Health Administration

Appendix Table 5-2. Housing Stabilization: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Montgomery 2020[12]	Yes	No	Unclear	Yes	NA	Yes	Yes	Yes	Yes	NA	Yes	Medium

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-3. Housing Stabilization: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths					Suicide Attempts				
	Intervention Group		Control Group		Intervention vs Control	Intervention Group		Control Group		Pre vs Post Intervention vs Control
	Pre	Post	Pre	Post		Pre	Post	Pre	Post	
Montgomery 2020[12] Observational with concurrent control		0.2% (157/ 93,135)		0.2% (140/ 76,086)	P=.45 Any VHA Homeless Program Use aHR * 0.79 (95% CI 0.62 to 1.01) With each additional VHA Homeless Program accessed aHR **		6.0% (5628/ 93,135)		2.1% (1594/ 76,086)	P<.05 Calculated RD 4% (95% CI 3.8 to 4.1)

					0.81 (95% CI 0.73 to 0.89) Accessed 1 VHA Homeless Program aHR † 0.98 (95% CI 0.74 to 1.29) Accessed 2 VHA Homeless Programs aHR † 0.91 (95% CI 0.65 to 1.28) Accessed 3 VHA Homeless Programs aHR † 0.62 (95% CI 0.40 to 0.96) Accessed ≥4 VHA Homeless Programs aHR † 0.22 (95% CI 0.11 to 0.46)					

aHR=adjusted hazard ratio; CI=confidence interval; RD=risk difference; VHA=Veterans Health Administration
* Model 1 - includes 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
** Model 2 - includes 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 the number of VHA Homeless Program used as a continuous variable
† Model 3 includes 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 a categorical measure for whether the Veteran used 0, 1, 2, 3, or 4+ VHA Homeless Programs.

Appendix Table 5-4. Housing Stabilization: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Montgomery 2020[12] Observational with concurrent control	NR	NR	NR	NR

NR=not reported

Appendix Table 5-5. Means Restriction: Study Characteristics

Author, Year **Country** **Study Design** **Intervention Type** **Setting** **Funding** **Risk of Bias**	**Inclusion/Exclusion Criteria**	**Intervention** **Comparator** **Study Period** **Length of Follow-up**	**Demographics**
Yip 2010[13] Country: Hong Kong Study Design: Observational with concurrent control Intervention Type: Means restriction (charcoal restriction) Setting: General community Funding: Government Risk of Bias: Low	Inclusion: Two geographically adjacent districts in Hong Kong with similar demographic and socioeconomic characteristics. Tuen Mun was the intervention region and Yuen Long was the control region. Exclusion: None	Intervention: Access to charcoal was limited by removing all barbecue charcoal packs from the open shelves of major retail chains. Customers were required to ask a shop assistant for a pack, which the assistant would then retrieve from a locked container Comparator: Charcoal packs were displayed as usual Study period: July 2005 to June 2007 Length of follow-up: 1 year pre- and post-intervention periods	<u>Intervention</u> N= 502,000 people in Tuen Mun Age (years, mean): 8.8% 65+ years Gender (% male): NR Race (%): NR Military status: NR Housing status (% in public rental housing): 34.9% Socioeconomic status (median household income in Hong Kong $): 15,000 Mental health diagnoses: NR Prior suicide behavior: NR <u>Control</u> N= 534,000 people in Yuen Long Age (years, mean): 8.3% 65+ years Gender (% male): NR Race (%): NR Military status: NR Housing status (% in public rental housing): 35.1% Socioeconomic status (median household income in Hong Kong $): 14,810 Mental health diagnoses: NR Prior suicide behavior: NR

Chen 2015[14] Country: Taiwan Study Design: Observational with concurrent control Intervention Type: Means restriction (charcoal restriction) Setting: General community Funding: Government and University Risk of Bias: Medium	Inclusion: Three metropolitan cities in Taiwan that are comparable in terms of level of urbanization and access to retail stores. New Taipei City was the intervention site and Taipei City and Kaohsiung City were control sites. Exclusion: None	Intervention: New Taipei City required that all charcoal be removed from open shelves of retail stores. Customers purchasing charcoal must ask a shop assistant, who would then retrieve charcoal from a locked container. Comparator: No intervention in Taipei City and Kaohsiung City Study period: January 1, 2009 to December 31, 2013 Length of follow-up: 40-months pre- and 20-months post-intervention	<u>Intervention</u> N= 3.9 million people in New Taipei City Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR <u>Control</u> N= 2.7 million people in Taipei City; 2.7 million people in Kaohsiung City Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR
Jo 2019[15] Country: South Korea Study Design: Pre-post observational with no concurrent control Intervention Type: Means restriction (charcoal restriction) Setting: General community Funding: Government Risk of Bias: Medium	Inclusion: Data on suicides and suicides by charcoal burning in Gyeonggi Province from 2000 to 2016, released by the National Statistical Office. Exclusion: None	Intervention: Shops participating in the program changed the way they sold charcoal: they were kept out of sight, not on display, and they are taken out only when customers request them. The campaign allows sellers to ask about the use of charcoal. Comparator: Pre-intervention Study period: 2000 to 2016. During this time, a nation-wide prevention campaign was also ongoing. Length of follow-up: 2 years. The program started in 2014. It expanded from 1 district in 2014 to	N=about 13 million people in Gyeonggi Province Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

		10 districts in 2015 and later to 28 in 2016.	
Sinyor 2017[16] (longer-term follow-up) Sinyor 2010[17] (shorter-term follow-up) Country: Canada Study Design: Observational with concurrent control Intervention Type: Means restriction (barrier at bridge) Setting: Suicide hotspot Funding: Foundation and University Risk of Bias: Low	Inclusion: Records at the chief coroner's office of Ontario covering all suicides in Ontario from January 1, 1993 to December 31, 2014. Exclusion: None	Intervention: Barrier was erected at Bloor Street Viaduct bridge in Toronto. The barrier is about 5 meters high and consists of thousands of thin steel rods spaced closely together and supported externally by an angled steel frame. Comparator: a) pre-intervention and b) compared with suicides at other bridges Study period: January 1, 1993 to December 31, 2014 Length of follow-up: 11 years pre- and post-intervention period.	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Law 2014[19] Country: Australia Study Design: Observational with concurrent control Intervention Type: Means restriction (barrier at bridge) Setting: Suicide hotspot Funding: Government Risk of Bias: Medium	Inclusion: The location of suicide being in the Greater Brisbane Region or Statistical Area Level 4:301-305 and cause of death by either jumping from high place or drowning. Exclusion: None	Intervention: Fencing barriers about 3.3 meters high along the sidewalk of the Gateway Bridge. After the new duplication bridge was built in 2010, the barrier was replaced with a similar 1 with a height of 3.6 meters on the original bridge. Comparator: a) pre-intervention at Gateway Bridge; b) concurrent control at Story Bridge with no physical barriers Study period: 1990 to 2012 Length of follow-up: 4-year pre- and 19-year post-intervention period	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

Perron 2013[18] Country: Canada Study Design: Observational with concurrent control Intervention Type: Means restriction (barrier at bridge) Setting: Suicide hotspots Funding: NR Risk of Bias: Medium	Inclusion: Suicide deaths among Quebec residents from the data banks of the chief coroner's office. Exclusion: Suicides (n=593) occurring during July to December 2004 when the barrier was under construction.	Intervention: Barrier on Jacques-Cartier Bridge in Québec, Canada Comparator: a) pre-intervention; b) other jump sites nearby excluding Jacques-Cartier Bridge Study period: Data collected from 1990 to December 31, 2009 Length of follow-up: 14.5 year pre- and 5-year post-intervention period	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Hemmer 2017[20] Country: Switzerland Study Design: Pre-post observational with no concurrent control Intervention Type: Means restriction (barriers or safety nets at jump sites) Setting: Suicide hotspots Funding: Government and a Psychiatric Hospital Risk of Bias: Medium	Inclusion: All jump sites in Switzerland with at least 0.5 suicides on average per year during any period of 10 years within the whole study period. From the 31 identified hotspots, 15 jump locations were included in the analysis. Exclusion: Jump sites with poor-quality data and not being within the study time period.	Intervention: Structural interventions at jumping sites. Eleven jump sites were secured by barriers and 4 by safety nets. Of the 15 jump sites, 9 sites also had a help sign. Comparator: a) pre-intervention and b) barriers vs safety nets Study period: 1990-2013 Length of follow-up: pre-intervention mean duration of 178.6 months and post-intervention of 73.4 months	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Law 2011[21] Country: Hong Kong Study Design: Observational with concurrent control	Inclusion: Information related to falls onto railway tracks from the Safety Office of the Mass Transit Railway Corporation Limited through the Transport and Housing Bureau of the Hong Kong Special Administration Region government.	Intervention: Platform screen doors at railway stations operated by Mass Transit Railway Corporation Limited - intended to restrict passengers' access to railway tracks	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR

Intervention Type: Means restriction (platform screen doors at railway stations) Setting: Suicide hotspot Funding: NR Risk of Bias: Medium	The patronage figures, the cost and the schedule of the platform screen door installation were made available from the same agency. Information on per capita gross domestic product was made available from the Census and Statistics Department of Hong Kong. Exclusion: None	Comparator: railway stations without platform screen doors at stations operated by Kowloon-Canton Railway Corporation Study period: 1997 to 2007 Length of follow-up: ~5 years. Most of the platforms were sealed in 2002 and the whole project done in 2005	Mental health diagnoses: NR Prior suicide behavior: NR
Chung 2016[22] Country: South Korea Study Design: Pre-post observational with no concurrent control Intervention Type: Means restriction (platform screen doors at railway stations) Setting: Suicide hotspots Funding: Government and Foundation Risk of Bias: Medium	Inclusion: Data on individual suicide cases that occurred between 2003 and 2012 at subway stations operated by Seoul Metro (121 total stations), which operates 50% of the subway stations in Seoul. Exclusion: None	Intervention: Platform screen doors installed at subway stations. 119 stations had full-height platform screen doors that extended completely or almost completely to the ceiling. Two stations had half-height platform screen doors (measured at 1.65 meters). Comparator: Subway stations prior to installing platform screen doors Study period: 2003 to 2012 Length of follow-up: 3 to 7 years. Screen doors started to be installed in 2005 and completed in 2009.	N= NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Ueda 2015[23] Country: Japan Study Design: Observational with concurrent control Intervention Type: Means restriction (platform screen doors at railway stations)	Inclusion: Data on suicide and accidents obtained from a major railway company in the Tokyo metropolitan area. Only incidents that occurred at stations were included in the analysis. Exclusion: Railway stations that started operating in 2008 (8.7% of all stations) because their accident	Intervention: Platform screen doors at train stations. When the study started, 19 stations had platform screen doors. They were installed at 71 stations by end of study. Among them, 73.24% were half-height platform screen doors. Comparator: Rail stations without platform screen doors and prior to	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

Setting: Suicide hotspots Funding: Government, Foundation, and life insurance company Risk of Bias: Low	and suicide records were available only for a subset of years.	them being installed. At the end of study, 97 stations did not have platform screen doors. Study period: Data collected from April 2004 to March 2014 Length of follow-up: Varied; platform screen doors were gradually installed during study period	
Matsubayashi 2013[24] Matsubayashi 2014[25] Ichikawa 2014[26] *The* 3 *articles used datasets that overlapped. To avoid double-counting, we mapped them to the same study.* Country: Japan Study Design: Observational with concurrent control Intervention Type: Means restriction (blue lights at railway platforms) Setting: Suicide hotspots Funding: Government, Foundation Risk of Bias: Medium	Inclusion: *Matsubayashi 2013 and 2014:* Data from 71 rail stations provided by a rail company. *Ichikawa 2014:* Data compiled by the Japanese Ministry of Land, Infrastructure, Transport and Tourism Exclusion: *Matsubayashi 2013 and 2014:* NR *Ichikawa 2014:* Suicide attempts within the train or by jumping out of the train	Intervention: Installation of blue light- emitting-diode lamps on railway platforms and at railway crossings as a method of deterring suicides Comparator: Railway stations without blue lights installed Study period: *Matsubayashi 2013:* 2000-2010 *Matsubayashi 2014:* 2000-2013 *Ichikawa 2014:* 2002-2012 Length of follow-up: *Matsubayashi 2013:* 1-3 years from installation to end of data collection *Matsubayashi 2014:* 1-6 years from installation to end of data collection Note: follow-up varied by platform as blue lights were installed over time. They started to be installed in 2008.	N=NR Age (years, mean):NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

NR=not reported

Appendix Table 5-6. Means Restriction: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Yip 2010[13]	Yes	Yes	Unclear	Yes	NA	NA	NA	Yes	Yes	NA	Yes	Low
Chen 2015[14]	Yes	Yes	Unclear	Yes	No	NA	NA	Yes	Yes	NA	No	Medium
Jo 2019[15]	Yes	Yes	Unclear	No	Yes	NA	NA	Yes	Yes	NA	No	Medium
Sinyor 2017[16] Sinyor 2010[17]	Yes	Unclear	Unclear	Yes	Yes	NA	NA	Yes	Yes	NA	Yes (Sinyor 2017) No (Sinyor 2010)	Low
Law 2014[19]	Yes	Unclear	Unclear	Yes	No	NA	NA	Yes	Yes	Unclear (cost)	Unclear	Medium
Perron 2013[18]	Yes	Unclear	Unclear	Yes	No	NA	NA	Yes	Yes	NA	No	Medium
Hemmer 2017[20]	Yes	Unclear	Unclear	No	No	NA	NA	Unclear	Yes	NA	No	Medium
Saeheim 2017[73]	Yes	Unclear	Unclear	No	No	NA	NA	Yes	Yes	NA	No	High
Law 2011[21]	Yes	Unclear	Unclear	Yes	No	NA	NA	Yes	Yes	Yes (cost)	Yes	Medium
Chung 2016[22]	Yes	Unclear	Unclear	No	Yes	NA	NA	Unclear	Unclear	Unclear (cost)	Yes	Medium
Ueda, 2015[23]	Yes	Unclear	Unclear	Yes	Yes	NA	NA	Yes	Yes	NA	Yes	Low

Matsubayashi 2013[24] Matsubayashi 2014[25] Ichikawa 2014[26]	Yes	Unclear	Unclear	Yes	Yes	No	NA	NA	Yes	NA	NA	Medium

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-7. Means Restriction: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design Intervention Details	**Suicide Deaths**						**Suicide Attempts**					
	Intervention Group		**Control Group**		**Pre** vs **Post**	**Intervention** vs **Control**	**Intervention Group**		**Control Group**		**Pre** vs **Post**	**Intervention** vs **Control**
	Pre	**Post**	**Pre**	**Post**			**Pre**	**Post**	**Pre**	**Post**		
Yip 2010[13] Observational with concurrent control Charcoal restriction	**charcoal suicides** 1 year: 21 suicides 4.3 per 100,000 *Men* 1 year: 16 suicides 6.6 per 100,000 *Women* 1 year: 5 suicides	**charcoal suicides** 1 year: 10 suicides 2.0 per 100,000 *Men* 1 year: 7 suicides 2.9 per 100,000 *Women* 1 year: 3 suicides	**charcoal suicides** 1 year: 16 suicides 3.0 per 100,000 *Men* 1 year: 10 suicides 3.9 per 100,000 *Women* 1 year: 6 suicides	**charcoal suicides** 1 year: 23 suicides 4.3 per 100,000 *Men* 1 year: 16 suicides 6.2 per 100,000 *Women* 1 year: 7 suicides	Intervention **Charcoal suicides** P<.05 pre vs post	**charcoal suicides** -66.9% adjusted difference on percentage change; P=.03 *Men* -72.7% adjusted difference on percent change; P=.03 *Women* -48.6% adjusted difference on percent	NR	NR	NR	NR	NR	NR

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
	2.0 per 100,000	1.2 per 100,000	2.2 per 100,000	2.6 per 100,000		change; P=.47						
Chen 2015[14] Observational with concurrent control Charcoal restriction	**charcoal suicides** N=808 6.2 per 100,000	**charcoal suicides** N=256 3.9 per 100,000	**charcoal suicides (Taipei City)** N=305 3.5 per 100,000 **charcoal suicides (Kao-hsiung City)** N=490 5.3 per 100,000	**charcoal suicides (Taipei City)** N=111 2.5 per 100,000 **charcoal suicides (Kao-hsiung City)** N=219 4.7 per 100,000	**Charcoal suicides** <u>New Taipei City</u> decrease of 37% (95% CI 17% to 50%) pre vs post Decrease of 30% (95% CI 14% to 44%) relative to Kaohsiung City Time series regression P=.001 <u>Taipei City</u> Time series regression P=.10 <u>Kaohsiung City</u> Time series regression P=.85 *Subgroups* Numerical decreases in charcoal suicides in New Taipei City were found in all age and sex groups, except men 65+ years old		NR	NR	NR	NR	NR	NR
Sinyor 2017[16] Sinyor 2010[17]	**Bloor Street Viaduct**	**Bloor Street Viaduct**	**Other bridges:**	**Other bridges:**	<u>Intervention</u>	NR	NR	NR	NR	NR	NR	NR

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Observational with concurrent control Barrier at bridge	1993-2003: 9.5 suicides observed per year	2004-2014: 0.1 suicides observed per year 2003-2007: 0 suicides observed per year	1993-2003: 10.1 suicides observed per year	2004-2014: 11.0 suicides observed per year 2003-2007: 15.3 suicides observed per year	**Bloor Street Viaduct** 2004-2014: IRR= 0.009 (95% CI, 0.0005 to 0.19) 2003-2007: IRR= 0.05 (95% CI, 0.01 to 0.31) <u>Control</u> **Other bridges** 2004-2014: IRR= 1.03 (95% CI, 0.76 to 1.40) 2003-2007: IRR= 1.64 (95% CI, 1.13 to 2.39)							

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		**Pre** vs **Post**	**Intervention** vs **Control**	Intervention Group		Control Group		**Pre** vs **Post**	**Intervention** vs **Control**
	Pre	**Post**	**Pre**	**Post**			**Pre**	**Post**	**Pre**	**Post**		
Law 2014[19] Observational with concurrent control Barrier at bridge	**Gateway Bridge** 1990-1993: 22 suicides 0.673 suicides per 100,000 persons	**Gateway Bridge** 1994-2012: 16 suicides 0.084 suicides per 100,000 persons 1994-1997: 11 suicides 0.316 suicides per 100,000 persons	**Story Bridge** 1990-1993: 15 suicides 0.459 suicides per 100,000 persons	**Story Bridge** 1994-2012: 73 suicides 0.382 suicides per 100,000 persons 1994-1997: 17 suicides 0.489 suicides per 100,000 persons	<u>Intervention</u> **Gateway Bridge** 1994-2012 vs pre: -87.5% change P=.000 1994-1997 vs pre: -53.0% change P=.041 <u>Control</u> **Story Bridge** 1994-2012 vs pre: -16.7% change P=.520 1994-1997 vs pre:	NR	NR	NR	NR	NR	NR	NR

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		**Pre** vs **Post**	**Intervention** vs **Control**	Intervention Group		Control Group		**Pre** vs **Post**	**Intervention** vs **Control**
	Pre	**Post**	**Pre**	**Post**			**Pre**	**Post**	**Pre**	**Post**		
					6.6% change P=.857							
Perron 2013[18] Observational with concurrent control Barrier at bridge	**Jacques-Cartier** 1990-2004: 0.324 suicides per 100,000 persons 10.0 annual suicides	**Jacques-Cartier** 2005-2009: 0.079 suicides per 100,000 persons 2.6 annual suicides	**Other jumping sites** 1990-2004: 0.844 suicides per 100,000 persons 26.1 annual suicides	**Other jumping sites** 2005-2009: 0.687 suicides per 100,000 persons 22.5 annual suicides	Intervention **Jacques-Cartier** IRR= 0.24 (95% CI, 0.13 to 0.43) Control **Other jumping sites** IRR= 0.82 (95% CI, 0.66 to 1.01)	NR	NR	NR	NR	NR	NR	NR
Law 2011[21] Observational with concurrent control Platform screen door at railway stations	**Mass Transit** 1997-2001: 38 suicides	**Mass Transit** 2003-2007: 8 suicides	**Kowloon-Canton** 1997-2001: 13 suicides	**Kowloon-Canton** 2003-2007: 15 suicides	Intervention **Mass Transit** -80.6% 5-year average percent change; P<.0001 vs pre Control	NR	**Mass Transit** 1997-2001: 33 non-fatal suicide falls	**Mass Transit** 2003-2007: 17 non-fatal suicide falls	**Kowloon-Canton** 1997-2001: 11 non-fatal suicide falls	**Kowloon-Canton** 2003-2007: 12 non-fatal suicide falls	Intervention **Mass Transit** -52.6% 5-year average percent change; P=.0126 Control	NR

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
					Kowloon-Canton 8.8% 5-year average percent change; P=.824 vs pre						**Kowloon-Canton** 1.5% 5-year average percent change; P=.9713	
Ueda 2015[23] Observational with concurrent control Platform screen door at railway stations	The study reported the composite outcome fatal and non-fatal suicides. Based on the reported data, we calculated that 2 suicide deaths occurred at stations with platform screen doors over 5417 station-months and 57 suicide deaths occurred at stations without platform screen doors over 14743 station-months. We did not prioritize this study in the write-up due to the difficulty of interpreting this result. This study is included in the counts in Table 2.						The study reported the composite outcome fatal and non-fatal suicides. Based on the reported data, we calculated 5 non-fatal suicide attempts at stations with platform screen doors over 5417 station-months and 80 non-fatal suicide attempts at stations without platform screen doors over 14743 station-months. We did not prioritize this study in the write-up due to the difficulty of interpreting this result. This study is included in the counts in Table 2.					
Matsubayashi 2013[24] Matsubayashi 2014[25] Ichikawa, 2014[26] Observational with concurrent control	*2014 paper:* 0.44 suicides/year	*2014 paper:* 0.19 suicides/year	*2014 paper:* Suicides/year ranged from 0.23-0.28 at nearby stations (1 to 5 stations away)	*2014 paper:* Suicides/year ranged from 0.25-0.28 at nearby stations (1 to 5 stations away)	*2014 paper:* Intervention IRR= 0.26 (95% CI, 0.13 to 0.52) *2013 paper:* Intervention	NR	*Ichikawa 2014* The authors analyzed the location and time of day when suicide attempts occurred at railway stations. This gives an estimate of how many suicide attempts are potentially preventable by blue lights (meaning the proportion of attempts that occurred at a time and place where the blue lights could be seen). This analysis does not report the effects of blue lights on attempts. Among suicide attempts at railways stations: 43% occurred within stations premises, 43% were at night, and 14% fell in both categories					

Author, Year Study Design Intervention Details	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Blue lights at railway stations					IRR= 0.17 (95% CI, 0.03 to 0.87)							

CI=confidence interval; IRR=incident rate ratio; NR=not reported; RCT=randomized controlled trial

Appendix Table 5-8. Means Restriction: Suicides Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design Intervention Details	Suicide Deaths			Suicide Attempts		
	Pre-Intervention	Post-Intervention	Pre vs Post Comparison	Pre-Intervention	Post-Intervention	Pre vs Post Comparison
Jo 2019[15] Pre-post observational with no concurrent control Charcoal restriction	**charcoal suicides** 2012: 294 suicides 2013: 286 suicides 2014: 536 suicides	**charcoal suicides** 2015: 514 suicides 2016: 433 suicides	**charcoal suicides** Multivariate time series P=.029	NR	NR	NR
Hemmer 2017[20] Pre-post observational with no concurrent control Barrier and safety nets at bridges	**all 15 jump sites** 1.47 suicides/year **structural barriers** 1.61 suicides/year **safety nets** 1.01 suicides/year	**all 15 jump sites** 0.41 suicides/year **structural barriers** 0.51 suicides/year **safety nets** 0.23 suicides/year	**all 15 jump sites** RR=0.30 (95% CI 0.17 to 0.44) 71.7% prevention **structural barriers** RR=0.34 (95% CI 0.18 to 0.64) 68.7% prevention **safety nets** RR=0.21 (95% CI 0.07 to 0.62) 77.1% prevention	NR	NR	NR

	completed safety measures 1.62 suicides/year	**completed safety measures** 0.57 suicides/year	No significant difference for safety nets vs barriers **completed safety measures** RR=0.18 (95% CI 0.10 to 0.44) 82.0% prevention			
Chung 2016[22] Pre-post observational with no concurrent control Platform screen doors at railway stations	**suicides at subway stations** 132 suicides over 8769 station-months	**suicides at subway stations** 3 total suicides over 5751 station-months All 3 suicides were at stations with half-height platform screen doors (not full-height screen doors) For 3 years with complete installation (2010-2012), there was 1 suicide	**suicides at subway stations** IRR=0.11 (95% CI 0.03 to 0.43)	NR	NR	NR

CI=confidence interval; IRR=incident rate ratio; NR=not reported; RCT=randomized controlled trial; RR=rate ratio

Appendix Table 5-9. Means Restriction: Secondary Outcomes

Author, Year Study Design Intervention Details	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Yip 2010[13] Observational with concurrent control Charcoal restriction	NR	NR	NR	**Intervention region: other methods** Pre-intervention: 67 suicides 13.6 per 100,000 1-year follow-up: 50 suicides 10.2 per 100,000

				Men only- Pre-intervention: 35 suicides 14.5 per 100,000 1-year follow-up: 26 suicides 10.8 per 100,000 *Women only-* Pre-intervention: 32 suicides 12.8 per 100,000 1-year follow-up: 24 suicides 9.6 per 100,000 **Control region: other methods** Pre-intervention: 51 suicides 9.6 per 100,000 1-year follow-up: 43 suicides 8.1 per 100,000 *Men only-* Pre-intervention: 28 suicides 10.8 per 100,000 1-year follow-up: 23 suicides 8.9 per 100,000 *Women only-* Pre-intervention: 23 suicides 8.5 per 100,000

				1-year follow-up: 20 suicides 7.4 per 100,000
Chen 2015[14] Observational with concurrent control Charcoal restriction	NR	NR	NR	**Intervention region: other methods** Pre-intervention: N=1598 12.3 per 100,000 Follow-up: N=783 11.9 per 100,000 Time series regression P=.68 **Control region (Taipei City): other methods** Pre-intervention: N=945 10.8 per 100,000 Follow-up: N=471 10.6 per 100,000 Time series regression P=.85 **Control region (Kaohsiung City): other methods** Pre-intervention: N=1381 14.9 per 100,000 Follow-up: N=684 14.8 per 100,000 Time series regression P=.25
Jo 2019[15]	NR	NR	NR	Besides charcoal burning, the only other suicide method that fell more

Pre-post observational with no concurrent control Charcoal restriction				than 0.5% from 2014 was hanging (53.4% to 52.4%)
Sinyor 2017[16] Sinyor 2010[17] Observational with concurrent control Barrier at bridge	NR	NR	NR	**Pre-intervention: other methods** 197.7 suicides observed per year **Post-intervention: other methods** From 2004-2014: 177.5 suicides observed per year IRR=0.84 (95% CI 0.76 to 0.93) From 2003-2007: 180.8 suicides observed per year IRR=0.86 (95% CI 0.74 to 0.99)
Law 2014[19] Observational with concurrent control Barrier at bridge	NR	NR	**Installation costs** new barriers at the Gateway Bridge in 2010 incurred a direct cost of $2.2 million	NR
Perron 2013[18] Observational with concurrent control Barrier at bridge	NR	NR	NR	NR
Hemmer 2017[20] Pre-post observational with no concurrent control Barrier and safety nets at jump sites	NR	NR	NR	NR
Law 2011[21] Observational with concurrent control	NR	NR	**Installation costs** $256.4 million USD according to railway corporation	NR

Platform screen doors at railway stations			Estimated $237,748,900 after adjustment of price and discounting **Net costs** Traditional approach: $237,748,900 USD Modified approach: $229,851,700 USD after accounting for $7,897,200 saved from loss fare revenue **Incremental cost-effectiveness ratios** Traditional approach: 77,874 USD per person-year Modified approach: 65,354 USD per person-year **Minimal useful life-years to be cost-effective** Traditional approach: 27 years Modified approach: 21 years	
Chung 2016[22] Pre-post observational with no concurrent control Platform screen doors at railway stations	NR	NR	**Installation costs** 194.06 million USD across 121 stations	NR
Ueda 2015[23] Observational with concurrent control Platform screen doors at railway stations	NR	NR	NR	NR
Matsubayashi 2013[24] Matsubayashi 2014[25] Ichikawa 2014[26]	NR	NR	NR	NR

Observational with concurrent control Blue lights at railway stations				

CI=confidence interval; IRR=incident rate ratio; NR=not reported; USD=United States Dollar

Appendix Table 5-10. Means Restriction: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design Intervention Details	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Yip 2010[13] Observational with concurrent control Charcoal restriction	Two on-site quality checks for compliance (fidelity) over the 1-year intervention period	Need to consider unintended consequences of reduced charcoal sales which may be a deterrent to widespread adoption and dissemination	NR
Chen 2015[14] Observational with concurrent control Charcoal restriction	Chain supermarkets were regularly audited for compliance (fidelity)	Authors state future studies will need to engage multiple stakeholder groups (store administrators, store employees and managers, the public) to support this initiative given its inconvenience Media influence and public awareness may influence results	While not directly linked to the intervention being tested in the study, the authors state that stores also increased use and access to pamphlets/leaflets with education and resources. In addition, store clerks were advised to monitor behaviors of people buying charcoal and provide pamphlets as needed.
Sinyor 2017[16] Sinyor 2010[17] Observational with concurrent control Barrier at bridge	NR	Media influence can potentially help or hurt immediate success of a bridge barrier designed as a suicide prevention strategy	Future study is needed to evaluate the effect of a comprehensive suicide prevention strategy that includes the barrier in addition to education, reduced stigma, and adequate resources for help.
Law 2014[19]	NR	Authors state more research is needed to evaluate cost-effectiveness to assist	NR

Observational with concurrent control Barrier at bridge		policy makers in decisions regarding the installation of barriers	
Perron 2013[18] Observational with concurrent control Barrier at bridge	NR	NR	Future study is needed to evaluate the effect of a comprehensive suicide prevention strategy that includes the barrier in addition to depression screening and access to treatment
Law 2011[21] Observational with concurrent control Platform screen doors at railway stations	NR	The studies evaluated the societal and economic outcomes of barrier placement, which was overall considered cost-effective and relevant to stakeholders Cost remains a huge barrier when asking railroad companies to extend construction across all lines/stations Effective resource allocation is an important factor in policy-makers' decisions; community acceptance (increased fares and wait times), availability of funds, and media influence need to be considered in future studies	NR
Ueda 2015[23] Observational with concurrent control Platform screen doors at railway stations	Need to consider station design and costs when deciding to install full versus half height platform screen doors	NR	NR

NR=not reported

* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

Appendix Table 5-11. Organizational Policies and Culture: Study Characteristics

Author, Year **Country** **Study Design** **Intervention Type** **Setting** **Funding** **Risk of Bias**	**Inclusion/Exclusion Criteria**	**Intervention** **Comparator** **Study Period** **Length of Follow-up**	**Demographics**
Mishara 2012[27] Country: Canada Study Design: Observational with concurrent control Intervention Type: Organizational Policies and Culture Setting: workplace (police) Funding: Government Risk of Bias: Medium	Inclusion: Program was provided to all members of the Montreal police. Data was compared with other police suicides in the Province of Quebec. Exclusion: None reported	Intervention: *Together for Life* program for Montreal police 1) Training for all units (suicide education) 2) Police resources (telephone helpline) 3) Training of supervisors and union representatives (identification of officers at risk; how to provide help) 4) Publicity campaign ("Together for Life", brochures, posters, internal news articles) Comparator: 1) Pre-intervention in Montreal police 2) Police in the rest of Quebec Study period: 1986-2008 Length of follow-up: 12 years after program and data for 11 years before program	<u>Intervention Sites</u> N=4178 (Montreal police force as of December 31, 2000) Age (years): 20-29: 27% 30-39: 43% 40-49: 21% 50-59: 8% 60+: <1% Gender (% male): 78 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: 30.5 suicides per 100,000 per year (pre-intervention Montreal police) <u>Control Sites</u> N=10,131 (police rest of Quebec as of 1986-1996) Age (years): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: 26.0 suicides per 100,000 per year (pre-intervention police rest of Quebec)

Doran 2016[30] Country: Australia Study Design: Pre-post observational with no concurrent control Intervention Type: Organizational Policies and Culture Setting: Workplace (construction) Funding: NR Risk of Bias: Medium	Inclusion: Males construction industry workers in New South Wales and Queensland Exclusion: Women, due to the small numbers of women in the construction industry and consequent confidentiality issues with reporting small sample sizes	Intervention: *Mates in Construction* program for Australian construction workers 1) General awareness training – 1 hour training session provided by accredited trainers to construction workers on site; aims are increasing awareness of suicide as a work place health and safety issue, improving knowledge of warning signs, and encouraging workers to seek support 2) Connector training – 4 hour training session; role of connector is to keep coworkers safe while connecting them to help 3) Applied suicide intervention skills training – 2-day training course to enable these individuals to identify cases and respond appropriately to calls for help Sites also receive promotional materials and access to other programs including 24/7 helpline Comparator: Pre-intervention Study period: *Queensland:* 2003-2012 *New South Wales*: 2008-2017 Length of follow-up: *Queensland:* 5 years *New South Wales:* the post data was estimated, not originally collected	N: *Queensland pre*: 708,950 *Queensland post*: 841,425 *New South Wales pre*: 1,068,500 Age (years, mean): NR Gender (% male): 100 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Knox 2010[28] Country: United States Study Design: Pre-post observational with no concurrent control	Inclusion: Quarterly suicide rates for active duty air force population from 1981 through 2007 and forecasted for 2008. Exclusion: None reported	Intervention: US Air Force Suicide Prevention Program Leadership involvement Addressing suicide prevention through professional military education Guidelines for commanders on use of mental health services Community preventive services Community education and training	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

Intervention Type: Organizational Policies and Culture Setting: Military setting Funding: Government Risk of Bias: Medium		Investigative intervention policy Trauma stress response Integrated Delivery System and Community Action Information Board Limited Privilege Suicide Prevention Program Integrated Delivery System Consultation Assessment Tool Suicide Event Surveillance System Comparator: Pre-intervention Study period: 1981-2008 Length of follow-up: 11 years after program. Data for 16 years before	
Shelef 2016[29] Country: Israel Study Design: Pre-post observational with no concurrent control Intervention Type: Organizational policies and culture Setting: Military settings Funding: NR Risk of Bias: Medium	Inclusion: Active duty mandatory service Israeli Defense Forces soldiers that served during the years 1992 to 2012. Exclusion: Subsection of the population (n=176,287) that does not represent the regular mandatory service Israeli Defense Forces soldiers.	Intervention: Israeli Defense Forces Suicide Prevention Program Reduce weapon availability Improve screening and management of suicidal soldiers Identify specific populations profiled for intervention by employing 2 indices: a) service timeline; b) subgroups with increased risk and gatekeeper groups Reduce stigma through education and integrating Mental Health Officers in army units and increasing availability of Mental Health Officers through the Human Resources Division Develop a suicide review process Comparator: Pre-intervention Study period: 1992-2012 Length of follow-up: 7 years after program. Data for 14 years before	N=1,171,359 active duty mandatory service soldiers Age (years, mean): 19 Gender (% male): 53.4% Race (%): NR Military status: All active duty. 16.9% combat duty Housing status: NR Socioeconomic status: 24.0% low, 53.8% average, 22.2% high Mental health diagnoses: 2.7% Prior suicide behavior: NR

NR=not reported

Appendix Table 5-12. Organizational Policies and Culture: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Mishara 2012[27]	Yes	Unclear	Unclear	Yes	Yes	Unclear	Unclear	Yes	Yes	NA	No	Medium
Doran 2016 [30]	Yes	Unclear	Unclear	NA	Yes	Yes	Yes	Yes	Unclear	Yes (cost)	No	Medium
Finney 2015[74]	Yes	Unclear	Unclear	No	Yes	NA	NA	Unclear	Unclear	NA	No	High
Knox 2010[28]	Yes	Unclear	Yes	NA	Yes	NA	NA	Yes	Yes	NA	No	Medium
Shelef 2016[29]	Yes	No	NA	NA	Yes	NA	NA	Yes	Yes	NA	Yes	Medium

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-13. Organizational Policies and Culture: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		

Mishara 2012[27] Observational with concurrent control	**Montreal police** 11 years before: 30.5 per 100,000 per year 14 suicides/ 4178 people	**Montreal police** 12 years after: 6.4 per 100,000 4 suicides/ 5189 people	**Rest of Quebec Police** 11 years before: 26.0 per 100,000 per year 29 suicides/ 10131 people	**Rest of Quebec Police** 12 years after: 29.0 per 100,000 32 suicides/ 9197 people	**Montreal police** Change -78.9% (95% CI -93.3 to -33.4) **Rest of Quebec Police** Change 11.4% (95% CI -33.3 to 86.2)	Pre: P=.63 Montreal vs rest of Quebec Post: P=.007 Montreal vs rest of Quebec	NR	NR	NR	NR	NR	NR

CI=confidence interval; NR=not reported; RCT=randomized controlled trial

Appendix Table 5-14. Organizational Policies and Culture: Suicides Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design	**Suicide Deaths**			**Suicide Attempts**		
	Pre-Intervention	**Post-Intervention**	**Pre** vs **Post Comparison**	**Pre-Intervention**	**Post-Intervention**	**Pre** vs **Post Comparison**
Doran 2016[30] Pre-post observational with no concurrent control	**Queensland** Rate: 29.20 per 100,000 207 suicides/ 708,950 people New South Wales was not extracted for suicide deaths because the post-intervention data was estimated	**Queensland** Rate: 26.38 per 100,000 222 suicides/ 841,425 people	**Queensland** RRR (post/pre rate)= 0.904 (95% CI 0.900 to 0.909) -9.6% change (95% CI -10.0% to -9.1%)	NR	NR	NR
Knox 2010[28]	1981-1997: 3.033 suicides per quarter per 100,000 persons	1997-2008: 2.387 suicides per quarter per 100,000 persons	-0.646 suicides per quarter per 100,000; P<.01	NR	NR	NR

Pre-post observational with no concurrent control						
Shelef 2016[29] Pre-post observational with no concurrent control	1992-2005: 24.6 suicides/year 344 total suicides *Females* 4.3 per 100,000 person-year 24 suicides/364,810 people *Males* 35.6 per 100,000 person-year 320 suicides/401,297 people	2006-2012: 12.7 suicides/year 89 total suicides *Females* 3.5 per 100,000 person-year 12 suicides/181,458 people *Males* 16.0 per 100,000 person-year 77 suicides/223,794 people	HR adjusted=0.42 (95% CI 0.33 to 0.54) *Females* HR unadjusted=0.90 (95% CI 0.45 to 1.83) *Males* HR adjusted=0.43 (95% CI 0.33-0.55)	NR	NR	NR

CI=confidence interval; HR=hazard ratio; NR=not reported; RCT=randomized controlled trial; RRR=relative risk ratio

Appendix Table 5-15. Organizational Policies and Culture: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Mishara 2012[27] Observational with concurrent control	NR	NR	NR	NR
Doran 2016[30] Pre-post observational with no concurrent control	NR	NR	**Cost of Intervention** NR; the model used $800,000 each year (Australian dollars) as cost of the program **Total Cost Savings** Impact of implementing the program in New South Wales	NR

			was estimated to save $3.66 million (Australian dollars) each year The benefit-cost ratio was estimated to be 4.6:1	
Knox 2010[28] Pre-post observational with no concurrent control	NR	NR	NR	NR
Shelef 2016[29] Pre-post observational with no concurrent control	NR	NR	NR	NR

NR=not reported

Appendix Table 5-16. Organizational Policies and Culture: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Mishara 2012[27] Observational with concurrent control	Utilizing peers to deliver the program who share a “common language”	Creating a culture that suicidal behavior is not an acceptable way to deal with a crisis	Stakeholders indicated that the training could be improved and sustained with annual refresher courses, follow-up, or memory aids

* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

Appendix Table 5-17. Social-Emotional Learning Programs: Study Characteristics

Author, Year Country Study Design Intervention Type Setting Funding Risk of Bias	Inclusion/Exclusion Criteria	Intervention Comparator Study Period Length of Follow-up	Demographics
Schilling 2016[31] Country: United States Study Design: Cluster RCT Intervention Type: Social-Emotional Learning Program Setting: High school Funding: Foundation Risk of Bias: Medium	Inclusion: 9th grade students at 16 technical high schools in Connecticut Exclusion: NR	Intervention: High schools assigned to the Signs of Suicide program. Schools received a kit of materials containing the DVD, discussion guide, screening forms, and other educational and promotional items. The goals of the program were to increase an understanding of depression and suicide, improve attitudes towards intervening with peers, and encourage youth who are contemplating suicide to seek help. Comparator: Schools assigned to wait-list control Study period: 2007-2008 and 2008-2009 school years Length of follow-up: 3 months	N=1,302 Age (years, mean): in 9th grade Gender (% male): 58 Race (%): White 60%, Hispanic 23%, Black 6% Military status: NR Housing status: NR Socioeconomic status: almost 1/3 qualified for free/reduced lunches Mental health diagnoses: NR Prior suicide behavior: 8% treated for depression/suicidal ideation, 8% ideation in past 3 months, 7% suicide plan in past 3 months, 2% attempt in past 3 months, 8% lifetime attempt
Wasserman 2015[32] (SEYLE trial) Country: Austria, Estonia, France, Germany, Hungary, Ireland, Italy, Romania, Slovenia, Spain Study Design: Cluster RCT Intervention Type: Social-Emotional Learning Program Setting: High School	Inclusion: Public schools containing at least 40 pupils aged 15 years, had more than 2 teachers for pupils aged 15 years, and had no more than 60% of pupils of the same sex. Within the schools, all classes with pupils aged mainly 15 years were approached for participant recruitment. To avoid discrimination, all pupils in the participating classrooms, including those aged 14 to 16 years, were also approached for recruitment.	Intervention: Schools were assigned to 1 of 3 interventions. Questions, Persuade, and Refer was a gatekeeper training module targeting teachers and other school personnel to recognize the risk of suicidal behavior and motivate and help pupils seek help The Youth Aware of Mental Health Program targeted pupils and including interactive workshops,	N=5,654 adolescents (85 schools) randomized to Youth Aware of Mental Health or control group Age (years, mean): 15 Gender (% male): 42 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: 10% pupils' parents lost employment in prior year Mental health diagnoses: NR

Funding: Government Risk of Bias: Low	Exclusion: All pupils who reported suicide attempts ever, or severe ideation in the past 2 weeks before the baseline assessment, and those with missing data regarding these 2 variables were not included in the final analysis.	educational posters, and lectures about mental health At-risk pupils were referred for professional screening based on responses to the baseline questionnaire Comparator: Control group was exposed to educational posters displayed in their classrooms Study period: November 1, 2009-December 14, 2010 Length of follow-up: 12 months	Prior suicide behavior: Pupils with prior suicide attempt or severe suicide ideation were excluded from analysis
Milner 2019[33] Country: Australia Study Design: RCT Intervention Type: Social-Emotional Learning Program Setting: Workplace (construction) Funding: Foundation Risk of Bias: Medium	Inclusion: Adult men workers in the construction industry consecutively accessing services from Incolink (social welfare trustee company that provides support to unemployed members of the construction industry) between 30 May 2016 and 4 April 2017 who owned a smartphone with Internet connectivity and adequate data download capacity Exclusion: <18 years of age with inadequate English	Intervention: Contact+Connect; an electronic intervention designed to reduce stigma against mental health problems delivered to participants' smart phones. One text message was delivered per week for 6 weeks, containing links to resources. Comparator: Wait-list (received the intervention materials in full at the conclusion of the intervention period) Study period: NR (around 2016-2017) Length of follow-up: 6 weeks	N=682 randomized Age (years, mean): Aged 18-29 11% Aged 30-39 23% Aged 40-49 32.5% Aged 50-59 24% Aged 60+ 9% Gender (% male): 100% Race (%): NR Military status: NR Housing status: NR Socioeconomic status: Unemployed 77% Mental health diagnoses: NR Prior suicide behavior: Attempted suicide 1.4% Communicated suicide 1.7%
Rogers 2018[62] Country: United States Study Design: RCT Intervention Type: Social-Emotional Learning Program	Inclusion: aged 18 to 69, recruited from undergraduate psychology student research pools (n= 114) and the surrounding community (n= 152). Exclusion: NR	Intervention: Psychoeducation; Participants browsed the National Suicide Prevention Lifeline. This website provides information about suicide statistics, risk factors, and resources related to prevention.	N=266 randomized Age (years, mean): 26 Gender (% male): 35 Race (%): 67% White, 20% Black, 14% Hispanic, 6% Asian, 4% Native American, 2% other Military status: NR Housing status: NR

Setting: University research pools and surrounding community Funding: Government, foundation Risk of Bias: Medium		Intervention: Interpersonal exposure; Participants browsed the Live Through This project website. This website contains photographed portraits of suicide attempters and detailed firsthand accounts, personal stories, and interviews about their lives and suicidal history. Comparator: Participants browsed the National Diabetes Education site Study period: NR Length of follow-up: 1 month	Socioeconomic status: 11% income <$10,000, 18% income $10,000 to <$25,000, 15% income $25,000 to <$40,000, 17% income $40,000 to <$75,000, 15% income $75,000 to <$100,000, 12% income $100,000 to <$150,000, 11% income ≥$150,000 Mental health diagnoses: NR Prior suicide behavior: 38% lifetime suicide ideation, 12% lifetime suicide plan, 9% lifetime suicide attempt
Taylor-Rodgers 2014[61] Country: Australia Study Design: RCT Intervention Type: Social-Emotional Learning Program Setting: Recruited on University campus and social media Funding: Government Risk of Bias: Medium	Inclusion: Age 18-25 years. Exclusion: NR	Intervention: Online psychoeducation on depression, anxiety, and suicide with vignettes of young people experiencing mental health problems. Program lasted 3 weeks. Comparator: Online attention-matched control information (emailed links to webpages on dental hygiene, common household medications and nutrition facts). Study period: NR Length of follow-up: 4 weeks	N=67 randomized Age (years, mean): 22 Gender (% male): 25 Race (%): 78% White, 16% Asian, 6% other Military status: NR Housing status: NR Socioeconomic status: NR; 9% no university, 82% bachelor's degree, 9% post-graduate education Mental health diagnoses: NR Prior suicide behavior: NR
Voss 2013[63] Country: United States Study Design: Pre-post observational with no concurrent control Intervention Type: Social-Emotional Learning Program	Inclusion: attendance at a publicly funded addiction treatment agency in Washington State Exclusion: 1) imminently suicidal patients or those who planned or attempted suicide within the past 3 months 2) patients with cognitive or language barriers judged severe enough to impede participation	Intervention: *Preventing Addiction Related Suicide* is a group-based program implemented by counselors in the intensive outpatient program for addiction treatment. The session took place over a single 2-3 hour session consisting of didactive material and discussion. The program provides participants with an overview of factors related to suicide risk and	N=78 Age (years, mean): 35 Gender (% male): 64 Race (%): Caucasian (44%), African American (26%), Asian (8%), American Indian/Alaskan Native (5%), >1 race (6%), did not report race (8%) Military status: NR Housing status: NR

Setting: Intensive outpatient program for addiction treatment Funding: Government (National Institute on Drug Abuse) Risk of Bias: Medium		steps 1 can take to address current suicide risk in oneself or others. Comparator: Pre-intervention Study period: months and years of data collection were not reported Length of follow-up: immediately after the program and 1 month later	Socioeconomic status: NR Mental health diagnoses: all participants were part of an addiction treatment program Prior suicide behavior: several participants reported prior suicide attempts

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe trial

Appendix Table 5-18. Social-Emotional Learning Programs: Risk of bias – Cluster RCTs

Author, Year	Sequence Generation	Allocation Concealment	Recruitment Bias	Baseline Imbalance	Blinded Outcome Assessment	Incomplete Cluster Data	Incomplete Outcome Data	Selective Outcome Reporting	Overall Risk of Bias
Schilling 2016[31]	Unclear (NR)	Unclear (NR)	Low (students participating prior to being randomized)	High (race/ ethnicity and gender)	Unclear (NR)	Low	High (28% in the control arm and 10% in the intervention arm not available for post-test)	Low	Medium
Wasserman 2015[32] (SEYLE)	Low (random number generator)	Unclear (NR)	Low (recruitment prior to being randomized)	Low	Unclear (NR)	Low	Moderate (19% not available at the 12-month follow-up)	Low	Medium

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe trial

Appendix Table 5-19. Social-Emotional Learning Programs: Risk of Bias – RCTs

Author, Year	Random sequence generation	Allocation concealment	Blinding of participants, personnel, and outcome assessors	Incomplete outcome data	Selective outcome reporting	Other sources of bias	Overall Risk of Bias
Milner 2019[33]	Low (Adequate)	Low	Low	Medium	Low	-	Medium
Rogers 2018[62]	Unclear	Unclear	High	Low	Low	Low	Medium
Taylor-Rodgers 2014[61]	Low	Unclear	Low	Medium (16% lost to follow-up. All subjects were analyzed.)	Unclear	Low	Medium
Han 2018[75]	Low	Low	Low	High	Low	Low	High
Dueweke 2017[76]	Low	High	Unclear	Low	Low	Low	High

RCT=randomized controlled trial

Appendix Table 5-20. Social-Emotional Learning Programs: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Voss 2013[63]	Yes	Yes	NA	NA	Yes	Yes	NA	Yes	NA	Yes	No	Medium
Freedenthal 2010[77]	Yes	No	Unclear	Yes	NA	No	Yes	Yes	No	NA	No	High
Gravesteinj 2011[78]	Yes	No	Yes	Yes	No	NA	NA	Yes	No	No	Unclear	High
Kennedy 2020[79]	Unclear	Yes	Yes	No	No	No	NA	Yes	NA	Yes	No	High

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-21. Social-Emotional Learning Programs: Suicide Deaths and Attempts from RCTs

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Schilling 2016[31] Cluster RCT	NR	NR	NR	NR	NR	NR	Past 3 months: 1.8% (13/719) Lifetime: 7.7% (56/719)	Past 3 months: 1.7% (11/650) Lifetime: 8.3% (54/650)	Past 3 months: 2.5% (14/553) Lifetime: 9.4% (52/553)	Past 3 months: 5.0% (20/396) Lifetime: 14.9% (59/396)	NR	Past 3 months: P<.05 Lifetime: P<.05
Wasserman 2015[32] (SEYLE) Cluster RCT	No completed suicides were reported for any study participants				NR	NR	NA (only looked at incident suicide behavior)	3 months: 0.88% (19/ 2166) 12 months: 0.70% (14/ 1987)	NA (only looked at incident suicide behavior)	3 months: 1.14% (27/ 2366) 12 months: 1.51% (34/ 2256)	NR	3 months: OR=0.78 (95% CI 0.42 to 1.44) 12 months: OR=0.45 (95% CI 0.24 to 0.85) No effect modification by sex (interaction test P=.27) and age (interaction test P=.89)

Milner 2019[33] RCT	NR	NR	NR	NR	NR	NR	Suicide attempts was measured using a Likert-scale from strongly agree to strongly disagree to the question "Have you tried to kill yourself in the past 6 months?" (asked at baseline) and "…since joining the project?" (asked at post-intervention). <u>Intervention over time</u> MD from baseline unadjusted = 0.04 (95% CI -0.10 to 0.18) MD from baseline adjusted = 0.06 (95% CI -0.09 to 0.20) <u>Control over time</u> MD from baseline unadjusted = 0.03 (95% CI -0.08 to 0.14) MD from baseline adjusted = 0.02 (95% CI -0.10 to 0.14) <u>Intervention vs control</u> MD intervention vs control unadjusted = 0.01 (95% CI -0.16 to 0.19) MD intervention vs control adjusted = 0.04 (95% CI -0.15 to 0.22)					
Rogers 2018[62] RCT	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Taylor-Rodgers 2014[61] RCT	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

CI=confidence interval; MD=mean difference; NA=not applicable; NR=not reported; OR=odds ratio; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe trial

Appendix Table 5-22. Social-Emotional Learning Programs: Suicides Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design	Suicide Deaths			Suicide Attempts		
	Pre-Intervention	Post-Intervention	Pre vs Post Comparison	Pre-Intervention	Post-Intervention	Pre vs Post Comparison
Voss 2013[63] Pre-post observational with no concurrent control	NR	NR	NR	NR	NR	NR

NR=not reported; RCT=randomized controlled trial

Appendix Table 5-23. Social-Emotional Learning Programs: Secondary Outcomes

Author, Year Study Design Intervention Type	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Schilling 2016[31] Cluster RCT	NR	NR	NR	NR
Wasserman 2015[32] (SEYLE) Cluster RCT	NR	NR	NR	NR
Milner 2019[33] RCT	NR	NR	NR	NR
Rogers 2018[62] RCT	**Stigma of Suicide Scale Score (SD), n** *Psychoeducation arm* Pre: 62.0 (22.0), n=90 Post: 57.5 (22.8), n=90 1 month: 60.3 (22.6), n=80 *Exposure arm* Pre: 65.6 (23.7), n=86 Post: 60.6 (23.5), n=86 1 month: 63.3 (22.9), n=76	NR	NR	NR

	Control arm Pre: 61.5 (23.0), n=90 Post: 60.2 (25.1), n=90 1 month: 67.7 (25.6), n=82 The 2 interventions resulted in a significantly greater decrease in stigma of suicide compared with the control at all timepoints (T1-T3 P<.001)			
Taylor-Rodgers 2014[61] RCT	**Stigma of Suicide Scale** **Score (SD), n** *Psychoeducation* Pre: 2.8 (0.4), n=34 *Control* Pre: 2.8 (0.3), n=33 Difference between psycho-intervention and control at post-test was non-statistically significant (P=.619). N= 56 participants with post-test survey data	NR	NR	NR
Voss 2013[63] Pre-post observational with no concurrent control	**Stigma and Bias Towards Suicides Acts or Persons** **Score (SE)** Pre: 19.29 (0.44) Post: 15.57 (0.57) 1-month: 17.26 (0.60) N=64 participants with follow-up Better attitudes towards suicidal acts or persons immediately following the session (P=.000) and 1-month post (P=.0001) compared to prior to the session	NR	NR	NR

NR=not reported; RCT=randomized controlled trial; SD=standard deviation; SE=standard error; SEYLE=Saving and Empowering Young Lives in Europe trial

Appendix Table 5-24. Social-Emotional Learning Programs: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Schilling 2016[31] Cluster RCT	School counselors and social work staff completed a 1-day training prior to administering the program.	Program was implemented as part of routine health	Recommended “booster” programs for longer-term follow-up.

	Schools received a kit of materials containing the DVD (dramatizations of reactions to a young person who is depressed and suicidal, along with real world interviews and experiences), discussion guide, screening forms and other educational/promotional items. They also received a procedure manual for program implementation and potential solutions to anticipated barriers.	class curriculum received by all students.	Recommended integrating adjunct elements into the program that address risk factors such as alcohol abuse, anger recognition & management, and violence reduction.
Wasserman 2015[32] (SEYLE) Cluster RCT	Local teams were trained in the study methods and a steering group monitored adherence (process assessments and quality control—though limited detail given). The program required students to be active participants (role play). Procedure manual was provided to all sites.	Embedded into classroom-based curriculum (5 hours in 4 weeks).	Recommended evaluation of booster activities and combination of different interventions.

RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe trial
* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

Appendix Table 5-25. Gatekeeper Training: Study Characteristics

Author, Year **Country** **Study Design** **Intervention Type** **Setting** **Funding** **Risk of Bias**	**Inclusion/Exclusion Criteria**	**Intervention** **Comparator** **Study Period** **Length of Follow-up**	**Demographics**
Wasserman 2015[32] (SEYLE trial) Country: Austria, Estonia, France, Germany, Hungary, Ireland, Italy, Romania, Slovenia, Spain Study Design: Cluster RCT	Inclusion: Public schools containing at least 40 pupils aged 15 years, had more than 2 teachers for pupils aged 15 years, and had no more than 60% of pupils of the same sex. Within the schools, all classes with pupils aged mainly 15 years were approached for participant recruitment. To avoid discrimination, all pupils in the participating classrooms, including those aged 14 to 16 years, were also approached for recruitment.	Intervention: Schools were assigned to 1 of 3 interventions. Questions, Persuade, and Refer was a gatekeeper training module targeting teachers and other school personnel to recognize the risk of suicidal behavior and motivate and help pupils seek help The Youth Aware of Mental Health Program targeted pupils and including interactive	N=5,625 adolescents (80 schools) randomized to gatekeeper or control Age (years, median): 15 Gender (% male):41 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: 10% pupils had parents that lost employment in previous year Mental health diagnoses: NR Prior suicide behavior: Pupils with prior suicide attempt or severe suicide ideation were excluded

Intervention Type: Gatekeeper training Setting: School Funding: Government Risk of Bias: Low	Exclusion: All pupils who reported suicide attempts ever, or severe ideation in the past 2 weeks before the baseline assessment, and those with missing data regarding these 2 variables were not included in the final analysis.	workshops, educational posters, and lectures about mental health At-risk pupils were referred for professional screening based on responses to the baseline questionnaire Comparator: Control group was exposed to educational posters displayed in their classrooms Study period: November 1, 2009-December 14, 2010 Length of follow-up: 12 months	
Sareen 2013[34] Country: Canada Study Design: RCT Intervention Type: Gatekeeper training Setting: Community (First nations) Funding: Government Risk of Bias: Medium	Inclusion: Members of the Swampy Cree tribal communities who were currently residing on the reserves Exclusion: <16 years of age, prior training in SafeTALK (a briefer version of suicide awareness training) or Applied Suicide Intervention Skills Training, being an elected official in a First Nations community, living off reserve, and an inability to read or write English.	Intervention: Applied Suicide Intervention Skills Training, A 2-day intensive, interactive and practice-dominated workshop aimed at enabling people to recognize risk and learn how to intervene immediately to prevent suicide. Comparator: Resilience Retreat, a 2-day retreat that was divided into cultural teachings and activities, sharing circles, small group discussions, and storytelling. Study period: years NR (sample recruited from 2010-2011) Length of follow-up: 6 months	N=55 Age (years, mean): NR Aged 16-21 44% Aged 22-44 33% Aged 45+ 22% Gender (% male): 40% Race (%): First nations (Cree) 100% Military status: NR Housing status: NR Socioeconomic status: Working full or part time 25% Unemployed/social assistance 45% Educational attainment grade 9 or lower: 40% Mental health diagnoses: NR Prior suicide behavior: NR
Garraza 2019[37] (long-term suicides) Walrath 2015[35] (short-term suicides)	Inclusion: Counties exposed to the suicide prevention efforts of the Garrett Lee Smith program at some point between 2006 and 2009 (intervention counties) and counties that shared key characteristics but were	Intervention: *Garrett Lee Smith Suicide Prevention Program*-gatekeeper training is a core part of the program. Intervention group was defined as a county	<u>Baseline Characteristics After Matching as Reported in Garraza 2019</u> N=80,300 youths; 231,200 adults N=481 exposed countries; 851 unexposed counties

Garraza 2015[36] (suicide attempts) Garraza 2018[72] (cost-benefit) Country: United States Study Design: Observational with concurrent control Intervention Type: Gatekeeper training Setting: General community (activities took place in multiple settings) Funding: Government Risk of Bias: Low *Note: All 4 articles evaluated the Garrett Lee Smith program. They used overlapping datasets and time periods. We considered them to be the same single study to avoid double-counting data. We used Garraza 2019 to extract long-term suicide deaths, Garraza 2015 for suicide attempts, and Garraza 2018 for cost-benefit analysis.*	not exposed to these suicide prevention efforts (control counties). For suicide mortality, the authors explicitly stated that counties had to have more than 3,000 youths (aged 10-24) to be included as smaller counties had large variability of youth suicide mortality rates. Exclusion: Nothing additional	conducting a Garrett Lee Smith-funded gatekeeper training event targeting youths/young adults. Though, the program is usually implemented in concert with other prevention strategies. Comparator: 1) Counties that did not implement the Garrett Lee Smith Program 2) Adult populations who were not the target of the program Study period: Initially exposed to the program between 2006 and 2009 Length of follow-up: 4 years for suicide deaths outcome; ≥2 years for attempts	Age (years, mean): NR Gender (% male): only reported in the initial analysis in Walrath 2015, 49% male Race (%): 85% White; 10% Black/African American; 6% Hispanic; 2% American Indian/Alaskan Native Military status: NR Housing status: NR Socioeconomic status: 5% unemployment rate; 14% poverty rate; ~$39,000 median household income; 17% uninsured rate Mental health diagnoses: NR Prior suicide behavior: youth suicide rate 8.5 per 100,000; adult rate 17.6/100,00 <u>Baseline Characteristics After Matching as Reported in Garraza 2015</u> N=141,000 persons N=466 intervention counties; 1161 control Age (years, mean): 12% 12-17 years; 15% 18-25 years; 73% ≥26 years Gender (% male): 48% Race (%): 81% Non-Hispanic White; 9% Non-Hispanic African American; 2% Non-Hispanic American Indian or Alaskan Native; <1% Non-Hispanic Native Hawaiian and other Pacific Islander; 1% Non-Hispanic Asian; 1% Non-Hispanic multiracial/multiethnic; 5% Hispanic Military status: NR Housing status: NR Socioeconomic status: 23% family income <20000; 38% between 20,000 and 49,999; 18% between 50,000 and 74,999; 21% 75,000 or more 50% employed full-time; 14% employed part-time; 4% unemployed; 32% other (*eg*, not in labor force) 85% have health insurance

			Mental health diagnoses: 15% lifetime major depressive episode; 8% past year major depressive episode Prior suicide behavior: ~10 attempts per 1000 youths aged 16-23 years; ~6 attempts per 1000 adults aged ≥24 years

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-26. Gatekeeper Training: Risk of bias – Cluster RCTs

Author, Year	Sequence Generation	Allocation Concealment	Recruitment Bias	Baseline Imbalance	Blinded Outcome Assessment	Incomplete Cluster Data	Incomplete Outcome Data	Selective Outcome Reporting	Overall Risk of Bias
Wasserman 2015[32] (SEYLE)	Low (random number generator)	Unclear (NR)	Low (recruitment prior to randomization	Low	Unclear (NR)	Low	Moderate (19% not available at the 12-month follow-up period)	Low	Medium

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-27. Gatekeeper Training: Risk of Bias – RCTs

Author, Year	Random sequence generation	Allocation concealment	Blinding of participants, personnel, and outcome assessors	Incomplete outcome data	Selective outcome reporting	Other sources of bias	Overall Risk of Bias
Sareen 2013[34]	Low (Adequate)	Unclear	Unclear	Low	Low	-	Medium

RCT=randomized controlled trial

Appendix Table 5-28. Gatekeeper Training: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Garraza 2019[37] Walrath 2015[35] Garraza 2015[36] Garraza 2018[72]	Yes	Yes	Unclear	Yes	NA	NA	NA	Yes	Yes (deaths) Unclear (attempts)	Yes (cost)	Yes	Low
Smith Osborne 2017[80]	Unclear	No	No	NA	No	NA	NA	Unclear	Unclear	Yes	Yes	High

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=Not applicable; RCT=randomized controlled trial

Appendix Table 5-29. Gatekeeper Training: Suicide Deaths and Suicide Attempts Outcomes from RCTs

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Wasserman 2015[32] (SEYLE) Cluster RCT	No completed suicides were reported for any study participants				NR	NR	NA; only looked at incident suicide attempt	3 months: 0.68% (15/ 2209) 12 months: 1.11% (22/ 1978)	NA; only looked at incident suicide attempt	3 months: 1.14% (27/ 2366) 12 months: 1.51% (34/ 2256)	NR	3 months: OR=0.62 (95% CI 0.32 to 1.18) 12 months: OR=0.70 (95% CI 0.39 to 1.25)

												No effect modification by sex (interaction test P=.27) and age (interaction test P=.89)
Sareen 2013[34] RCT	NR	6 months: 0% (0/31)	NR	6 months: 0% (0/24)	NR	P=1.0	lifetime attempt: 19% (6/31)	6 months: 0% (0/28)	lifetime attempt: 25% (6/24)	6 months: 0% (0/22)	NR	P=1.0

CI=confidence interval; NA=not applicable; NR=not reported; OR=odds ratio; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-30. Gatekeeper Training: Suicide Deaths and Suicide Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Garraza 2019[37] Walrath 2015[35] Garraza 2015[36] Garraza 2018[72] Observational with concurrent control	**Suicides among youths 10-24 years old as reported in Garraza 2019** *Reported as difference per 100,000 between intervention and control* At 1 year: -0.893 (SE=0.408; P=.029) At 2 years: -1.095 (SE=0.422; P=.010) At 3 years: -0.431 (SE=0.481; P=.370) At 4 years: -0.324 (SE=0.477; P=.498) **Suicides among youths in rural counties as reported in Garraza 2019** *Reported as difference per 100,000 between intervention and control* At 1 year: -0.803 (SE=0.768; P=.296) At 2 years: -2.936 (SE=0.807; P<.001) At 3 years: -0.671 (SE=0.836; P=0.422) At 4 years: -1.016 (SE=0.791; P=.199)						**Attempts among youths 16-23 years old as reported in Garraza 2015** *Reported as difference per 1,000 between intervention and control* At 1 year: -4.91 (SE=1.57; P=.003) At ≥2 years: -1.19 (SE=1.87; P=.53) **Attempts among youths 16-19 years old as reported in Garraza 2015** *Reported as difference per 1,000 between intervention and control* At 1 year: -4.46 (SE=2.14; P=.042) At ≥2 years: -2.70 (SE=2.98; P=.369) **Attempts among youths 20-23 years old as reported in Garraza 2015** *Reported as difference per 1,000 between intervention and control* At 1 year: -5.68 (SE=2.46; P=.025) At ≥2 years: 3.09 (SE=3.63; P=.399)					

SE=standard error; RCT=randomized controlled trial

Appendix Table 5-31. Gatekeeper Training: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Wasserman 2015[32] (SEYLE) Cluster RCT	NR	NR	NR	NR
Sareen 2013[34] RCT	NR	NR	NR	NR
Garraza 2019[37] Walrath 2015[35] Garraza 2015[36] Garraza 2018[72] Observational with concurrent control	NR	NR	**As reported in Garraza 2018** Cost savings from averted hospitalizations $187.8 million (95% CI, 67.1 to 308.5) Cost savings from averted emergency department visits $34.1 million (95% CI, 8.7 to 59.9) Total medical cost savings $222.1 million (95% CI, 78.7 to 365.4) Total Garrett Lee Smith program costs $49.4 million Benefit-cost ratio $4.5 (95% CI, 1.6 to 7.4)	NR

CI=confidence interval; NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-32. Gatekeeper Training: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Wasserman 2015[32] (SEYLE) Cluster RCT	Local teams were trained in the study methods and a steering group monitored adherence (process assessments and quality control—though limited detail given). Power point presentations and booklet were distributed to all trainees.	Embedded into school setting.	Recommended evaluation of booster activities and combination of different interventions.

RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe
* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

Appendix Table 5-33. Crisis Intervention: Study Characteristics

Author, Year Country Study Design Intervention Type Setting Funding Risk of Bias	Inclusion/Exclusion Criteria	Intervention Comparator Study Period Length of Follow-up	Demographics
Stacks 2015[38] Country: United States Study Design: Pre-post observational with no concurrent control Intervention Type: Crisis intervention Setting: Suicide hotspot Funding: NR Risk of Bias: Medium	Inclusion: Yearly suicide counts at Skyway Bridge from the period 1954 (the year the bridge opened) through 2012. Exclusion: Year 1999 was omitted from the analysis because the phones were installed in 1999.	Intervention: Phones were installed on the Skyway Bridge in St. Petersburg, Florida – with direct links to a crisis center counselor Comparator: Pre-intervention Study period: 1954-2013 Length of follow-up: ~13 years. Crisis phones were installed in July, 1999	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

NR=not reported

Appendix Table 5-34. Crisis Intervention: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Stacks 2015[38]	Yes	Unclear	Unclear	No	Yes	NA	NA	Unclear	Yes	NA	Unclear	Medium

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-35. Crisis Intervention: Suicide Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design	Suicide Deaths			Suicide Attempts		
	Pre-Intervention	Post-Intervention	Pre vs Post Comparison	Pre-Intervention	Post-Intervention	Pre vs Post Comparison
Stacks 2015[38] Pre-post observational with no concurrent control	1986-1998: 48 suicides	2000-2012: 106 suicides	2000-2012: +4.46 suicides/year vs 1986-1998; P<.001 +2.73 suicides/year vs 1986-1998 when adjusting for Florida suicide rate; P<.05 2000-2001: -5.0 suicides/year vs 1997-1998; not statistically significant	NR	NR	NR

NR=not reported; RCT=randomized controlled trial

Appendix Table 5-36. Crisis Intervention: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Stacks 2015[38] Pre-post observational with no concurrent control	NR	NR	NR	NR

NR=not reported

Appendix Table 5-37. Public Awareness and Education Campaigns: Study Characteristics

Author, Year Country Study Design Intervention Type Setting Funding Risk of Bias	Inclusion/Exclusion Criteria	Intervention Comparator Study Period Length of Follow-up	Demographics
Matsubayashi 2014[40] Country: Japan	Inclusion: Resident of Nagoya Japan. Exclusion: NR	Intervention: Public awareness campaign as part of a city-wide suicide prevention program in the city of Nagoya Japan. Promotional materials that were aimed to stimulate public awareness	N=2.3 million (population of Nagoya) Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR

Study Design: Pre-post observational with no concurrent control Intervention Type: Public awareness and education campaign Setting: Community Funding: Foundation Risk of Bias: Low		of depression and promote care- seeking behavior were distributed to residents during 2010-2012. Materials were handed out to pedestrians on city streets and commuters in train stations. Comparator: None Study period: 2010-2012; intervention effects measured at 5 months	Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: 448 people died by suicide in 2010, rate of 20.3. per 100,000
Till 2013[39] Country: Austria Study Design: Observational with concurrent control Intervention Type: Public awareness and education campaign Setting: Community Funding: NR Risk of Bias: Medium	Inclusion: Resident of the Styria region of Austria Exclusion: NR	Intervention: Suicide awareness campaign in the Austrian federal state of Styria to increase help-seeking behavior in the population via a telephone counseling service providing support 24/7 for all people in all kinds of crises, including individuals at risk for suicide. Comparator: Federal state of Upper Austria with its own telephone crisis service was used as the control region Study period: January to June 2011 Length of follow-up: 3 months pre-intervention and 3 months post	N=2.6 million in both study and control areas in 2011 Age (years, mean): 20% age 0-18, 58% age 19-60, 22% age 61+ Gender (% male): 49% Race (%): NR Military status: NR Housing status: NR Socioeconomic status: Unemployment rates 4-6.3% Mental health diagnoses: NR Prior suicide behavior: 17.5 suicides per 100,000 in study area; 15.1 suicides per 100,000 in control area

NR=not reported

Appendix Table 5-38. Public Awareness and Education Campaigns: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Till 2013[39]	Yes	Yes	Unclear	Yes	NA	Yes	Yes	NA	Unclear	NA	No	Medium
Matsubayashi 2014[40]	Yes	Yes	Yes	NA	Yes	NA	NA	Yes	Yes	NA	Unclear	Low

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=Not applicable; RCT=randomized controlled trial

Appendix Table 5-39. Public Awareness and Education Campaigns: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Till 2013[39] Observational with concurrent control	3 months before campaign: 52	3 months after campaign: 69	3 months before campaign: 67	3 months after campaign: 68	Intervention +32.6% Control +1.4%	P=.28	NR	NR	NR	NR	NR	NR

NR=not reported; RCT=randomized controlled trial

Appendix Table 5-40. Public Awareness and Education Campaigns: Suicide Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design Intervention Type	Suicide Deaths			Suicide Attempts		
	Pre-Intervention	Post-Intervention	Pre vs Post Comparison	Pre-Intervention	Post-Intervention	Pre vs Post Comparison
Matsubayashi 2014[40] Pre-post observational with no concurrent control	Reference = months with no campaign activity	Notes: Men: The effect of the campaign lasts for 4 months, but not more than 5 months Women: The only statistically significant reduction in the number of suicides was observed in the second month during the post-distribution period.	Ward with a campaign 0 months earlier 0 month: IRR= ~1.005 (95% CI 0.99 to 1.02) *Estimated from figure* Ward with a campaign 2 months earlier: IRR = 0.971 (95% CI 0.957 to 0.985) Ward with a campaign 5 months earlier: IRR = ~0.995 (95% CI 0.97 to 1.02) *Estimated from figure*	NR	NR	NR

CI=confidence interval; IRR=incident rate ratio; NR=not reported; RCT=randomized controlled trial

Appendix Table 5-41. Public Awareness and Education Campaigns: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Till 2013[39] Observational with concurrent control	NR	NR	NR	NR
Matsubayashi 2014[40] Pre-post observational with no concurrent control	NR	NR	NR	NR

NR=not reported

Appendix Table 5-42. Screening for At-Risk: Study Characteristics

Author, Year Country Study Design Intervention Type Setting Funding Risk of Bias	Inclusion/Exclusion Criteria	Intervention Comparator Study Period Length of Follow-up	Demographics
Wasserman 2015[32] (SEYLE trial) Country: Austria, Estonia, France, Germany, Hungary, Ireland, Italy, Romania, Slovenia, Spain Study Design: Cluster RCT Intervention Type: screening for at-risk (not in clinic setting) Setting: School Funding: Government Risk of Bias: Low	Inclusion: Public schools containing at least 40 pupils aged 15 years, had more than 2 teachers for pupils aged 15 years, and had no more than 60% of pupils of the same sex. Within the schools, all classes with pupils aged mainly 15 years were approached for participant recruitment. To avoid discrimination, all pupils in the participating classrooms, including those aged 14 to 16 years, were also approached for recruitment. Exclusion: All pupils who reported suicide attempts ever, or severe ideation in the past 2 weeks before the baseline assessment, and those with missing data regarding these 2 variables were not included in the final analysis.	Intervention: Schools were assigned to 1 of 3 interventions. Questions, Persuade, and Refer was a gatekeeper training module targeting teachers and other school personnel to recognize the risk of suicidal behavior and motivate and help pupils seek help. The Youth Aware of Mental Health Program targeted pupils and including interactive workshops, educational posters, and lectures about mental health. At-risk pupils were referred for professional screening based on responses to the baseline questionnaire Comparator: Control group was exposed to educational posters displayed in their classrooms Study period: November 1, 2009- December 14, 2010 Length of follow-up: 12 months	N=5,697 adolescents (83 schools) randomized to screening or control group Age (years, median): 15 Gender (% male): 43 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: 10% pupils had parents that lost employment in previous year Mental health diagnoses: NR Prior suicide behavior: Pupils with prior suicide attempt or severe suicide ideation were excluded
Dezso 2018[43] Country: Europe Study Design: Observational with concurrent control	Inclusion: All arrivals to Berlin remand prison between March and May 2016 Exclusion: transport prisoners, detainees admitted prior to the study period but who were temporarily transferred to the	Intervention: Suicide screening instrument administered to arriving prisoners. Comparator: Prisoners arriving pre-screening instrument Study period: Participants in the intervention group entered the detention facility from March-May 2016.	N=1,510 Age (years, mean): 35 Gender (% male): 100 Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR

Intervention Type: Screening for at-risk (not in clinic setting) Setting: Prison/detention facility Funding: NR Risk of Bias: Medium	prison hospital for health reasons.	Participants in the control group entered the facility December-February 2016. Length of follow-up: 6 months Note: the control group consisted of prisons who entered the detention facility in the 3 months prior to the screening intervention. We considered the study to have a "concurrent control" because the follow-up period overlapped between intervention and control.	Mental health diagnoses: NR Prior suicide behavior: NR
Oyama 2017[42] Country: Japan Study Design: Observational with concurrent control Intervention Type: Screening for at-risk (not in clinic setting) Setting: General community (rural areas/older adults) Funding: Government Risk of Bias: Medium	Inclusion: Residents of the Aomori Prefecture in northern Japan aged 40-64 years Exclusion: recently received a depression intervention	Intervention: Standardized work plan autonomously conducted by municipalities. Municipalities distributed public information leaflets and newsletters designed to publicize information about depression as a risk factor for suicide, explain about depression screening and treatment options, and reduce the stigma of mental illness. Depression screener mailed to all residents aged 36–64 years in districts with a history of high suicide rates. Anyone with a Self-Rating Depression Scale score of ≥48 was contacted in the second screening stage consisting of a telephone interview based on the major depressive episodes module. Interviewers summarized the results, and the psychiatrist treating the 5 municipalities rated these results for severity of depressive episode. Written feedback was mailed to all respondents, and those diagnosed with any depressive episode were contacted by health professionals and provided with a referral to a psychiatrist and support to help them continue treatment, including information about the importance of doing so. Comparator: Municipalities without intervention Study period: 2009-2012 Length of follow-up: 8 years	N=12,682 participants who were first stage screened in the intervention area Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Oyama 2016[41] Country: Japan	Inclusion: Japanese adult residents of the Aomori Prefecture in northern Japan, age ≥65 years and were	Intervention: Self-administered screening questionnaire administered to municipalities with high prevalence of depressive symptoms. Identified participants followed-up via telephone interview and referred for treatment.	N=24,312 Age (years, mean): NR Gender (% male): NR Race (%): NR

Study Design: Observational with concurrent control Intervention Type: Screening for at-risk (not in clinic setting) Setting: General community (rural areas/older adults) Funding: Government, foundation, university Risk of Bias: Medium	exposed to potential long-term effects of the initial 4-year intervention, ending in 2010. Exclusion: NR	Educational component provided information on depression symptoms treatment through workshops and newsletters at community centers. Comparator: Municipalities without intervention, usual care consisted of health check-ups Study period: 1999-2010 (intervention period 2005-2006) Length of follow-up: 4 years	Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-43. Screening for At-Risk: Risk of bias – Cluster RCTs

Author, Year	Sequence Generation	Allocation Concealment	Recruitment Bias	Baseline Imbalance	Blinded Outcome Assessment	Incomplete Cluster Data	Incomplete Outcome Data	Selective Outcome Reporting	Overall Risk of Bias
Wasserman 2015[32] (SEYLE)	Low (random number generator)	Unclear (NR)	Low (recruitment prior to randomization	Low	Unclear (NR)	Low	Moderate (19% not available at the follow-up period)	Low	Medium

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-44. Screening for At-Risk: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Dezso 2018[43]	Yes	Yes	Yes	No	NA	Yes	Yes	Yes	NA	Yes	No	Medium
Oyama 2017[42]	Yes	Unclear	Yes	Yes	No	Yes	Yes	Yes	Yes	NA	Yes	Medium
Oyama 2016[41]	Yes	Yes	Yes	No	NA	Yes	Yes	Yes	Yes	NA	Yes	Medium

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-45. Screening for At-Risk: Suicide Deaths and Attempts from RCTs

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Wasserman 2015[32] (SEYLE) Cluster RCT	No completed suicides were reported for any study participants				NR	NR	NA (only looked at incident suicide behavior)	3 months: 1.23% (27/ 2203) 12 months: 1.02% (20/ 1961)	NA (only looked at incident suicide behavior)	3 months: 1.14% (27/ 2366) 12 months: 1.51% (34/ 2256)	NR	3 months: OR=1.10 (95% CI 0.61 to 1.97) 12 months: OR=0.65 (95% CI 0.36 to 1.18) No effect modification by sex (interaction test

									P=.27) and age (interaction test P=.89)

CI=confidence interval; NA=not applicable; NR=not reported; OR=odds ratio; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-46. Screening for At-Risk: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Dezso 2018[43] Observational with concurrent control	No suicides were reported during the 6-month study period in either the intervention or control groups. Note: the control group consisted of prisons who entered the detention facility in the 3 months prior to the screening intervention. We considered the study to have a "concurrent control" because the follow-up period overlapped between intervention and control.						NR	NR	NR	NR	NR	NR
Oyama 2017[42] Observational with concurrent control	2005-2008: rate 64.9 per 100,000 105 suicides	2009-2012: Rate 37.0 per 100,000 59 suicides	**Control areas** 2005-2008: rate 57.9 per 100,000 114 suicides **Country** 2005-2008: rate 33.4 per 100,000 56,943 suicides	**Control areas** 2009-2012: rate 53.8 per 100,000 103 suicides **Country** 2009-2012: rate 30.2 per 100,000 51,759 suicides	Intervention IRR adj = 0.57 (95% CI 0.41 to 0.78) Control IRR adj = 0.93 (95% CI 0.70 to 1.23) Country IRR adj = 0.93 (95% CI 0.82 to 1.06)	Ratio of IRR adj = 1.63 (95% CI 1.06 to 2.48) in control with intervention as reference	NR	NR	NR	NR	NR	NR
Oyama 2016[41]	1999-2004:	2005-2010:	1999-2004:	2005-2010:	Intervention	Ratio of IRR adj = 1.83	NR	NR	NR	NR	NR	NR

Observational with concurrent control	range of rates 42.8 to 49.2 per 100,000 per year 63 suicides *Men* 32 suicides *Women* 31 suicides	range of rates 23.1 to 28.8 per 100,000 per year 37 suicides *Men* 26 suicides *Women* 11 suicides	range of rates: 39.9 to 41.9 per 100,000 per year 59 suicides *Men* 37 suicides *Women* 22 suicides	range of rates: 35.4 to 47.6 per 100,000 per year 65 suicides *Men* 40 suicides *Women* 25 suicides	IRR adj = 0.52 (95% CI 0.33 to 0.83) <u>Control</u> IRR adj = 0.93 (95% CI 0.69 to 1.26)	(95% CI 1.08 to 3.09) in control with intervention as reference *Men* Ratio of IRR adj = 1.29 (95% CI 0.76 to 2.19) *Women* Ratio of IRR adj = 3.10 (95% CI 1.10 to 8.73)						

CI=confidence interval; IRR=incident rate ratio; NR=not reported; RCT=randomized controlled trial

Appendix Table 5-47. Screening for At-Risk: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Wasserman 2015[32] (SEYLE) Cluster RCT	NR	NR	NR	NR
Dezso 2018[43] Observational with concurrent control	NR	NR	NR	NR
Oyama 2017[42] Observational with concurrent control	NR	NR	NR	NR
Oyama 2016[41] Observational with concurrent control	NR	NR	NR	NR

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe

Appendix Table 5-48. Screening for At-Risk: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Wasserman 2015[32] (SEYLE) Cluster RCT	Local teams were trained in the study methods and a steering group monitored adherence (process assessments and quality control—though limited detail given).	Embedded into school setting.	Recommended/suggested screening would be more acceptable to stakeholders if completed with concurrent activities to reduce stigma of mental health issues. Recommended evaluation of booster activities and combination of different interventions.
Oyama 2017[42] Observational with concurrent control	Each intervention cluster (municipality) was given a standardized work plan Dissemination of public information (leaflets and newsletter) on depression as a risk factor for suicide, depression screening, and treatment options. This was done to improve receptiveness to depression screening which was the main element of the intervention.	NR	Recommended exploring the long-term effect of personal contact alone without the screening procedure
Oyama 2016[41] Observational with concurrent control	Educational component was used first to enhance receptiveness to screening.	NR	NR

NR=not reported; RCT=randomized controlled trial; SEYLE=Saving and Empowering Young Lives in Europe
* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

Appendix Table 5-49. Multi-Strategy Programs: Study Characteristics

Author, Year Country Study Design Intervention Type Setting Funding Risk of Bias	Inclusion/Exclusion Criteria	Intervention Comparator Study Period Length of Follow-up	Demographics
Collings 2018[44] Country: New Zealand	Inclusion: The pool of 20 potential District Health Boards ranged	Intervention: Multi-level intervention in 4 District Health Boards	N=NR Age (years, median): NR Gender (% male): NR

Study Design: Cluster RCT Intervention Type: Multi-strategy Setting: General community Funding: Government Risk of Bias: Medium	from 31,000 to 481,00 people. Prior to randomization, District Health Boards were matched on a variety of demographic factors including age-standardized suicide rates, socioeconomic deprivation, population size, and number of full-time-equivalent general practitioners. Four pairs (8 total) were selected. Exclusion: NR	Adapted Question, Persuade, and Refer program module was accessible online. Provided training in recognition of suicide factors and how to encourage help Workshops on mental health issues were delivered and tailored to local needs. Workshops hosted by community health organizations Community based interventions involving advocacy and information. Included workshops to media on safe reporting Distribution of print material and information on web-based resources Comparator: Practice as usual Study period: June 1, 2010 to June 1, 2012. The preceding 6 months was used for baseline data Length of follow-up: 25 months	Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Hegerl 2019[45] (suicides and attempts) Harris 2016[71] (implementation) Country: Germany, Hungary, Portugal, Ireland Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: Community Funding: Government Risk of Bias: Medium *Both articles evaluated the European Alliance Against Depression that was implemented in Germany,*	Inclusion: Regions in 4 selected countries (Germany, Hungary, Portugal, Ireland) with at least 150,000 inhabitants, regional interest in hosting the intervention, and no previous suicide prevention or depression awareness program in the region Exclusion: NR	Intervention: Multi-level intervention based on the 4-level *European Alliance Against Depression* Primary care training Public awareness campaign Community facilitator training Support for self-help groups Plus, efforts to restrict access to lethal means by local identification and security inspection of areas where suicides occur Note: some variation in intervention between countries Comparator: No intervention (in regions matched on population) Study period: Unclear; reported baseline population data for 2008 Length of follow-up: 2 years	N= Populations in the intervention and control regions in 2008: Germany: 745,516 Hungary: 339,264 Ireland: 426,197 Portugal: 338,213 Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

Hungary, Portugal, and Ireland. We used the Hegerl 2019 article to extract baseline characteristics and suicide outcomes. We used the Harris 2016 article to extract additional information about implementation.			
Hegerl 2010[46] Country: Germany Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: Community Funding: Government Risk of Bias: Medium	Inclusion: Nuremberg and Wuerzburg regions of Germany Exclusion: NR	Intervention: 4-level *Nuremberg Alliance Against Depression* 1) training primary care physicians 2) media and public campaign 3) training of community facilitators 4) support for depressed persons, suicide attempters and their families (self-help groups, emergency cards) Note: Intensive intervention stopped at the end of the 2nd year (2002), with 'minor' interventions in follow-up year Comparator: No intervention in the control region (Wuerzburg) Study period: 2000-2003 Length of follow-up: 1 year	N= Populations in the intervention and control region in 2000: Nuremberg: 488,400 Wuerzburg: 287,000 Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status= unemployment rate in 2000: Nuremburg: 10.1% Wuerzburg: 5.6% Mental health diagnoses: NR Prior suicide behavior: NR
Hübner-Liebermann 2010[48] Country: Germany Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: Community Funding: NR	Inclusion: Populations of a) city of Regensburg, b) county district of Regensburg, c) county district of Neumarkt, and d) Germany Exclusion: NR	Intervention: 4-Level *Regensburg Alliance Against Depression* 1) General Practitioner cooperation 2) Education for general public 3) Training workshops for secondary teachers, lay helpers, carers for elderly, police personnel, and other professionals; media guide 4) Self-help groups and groups for relatives of those affected by depression; flyers with crisis service and hospital resources Comparator: No intervention in control regions (2 county districts)	N= Populations in the intervention and control region: City of Regensburg: 150,000 Country district Regensburg: 180,000 Country district Neumarkt: 130,000 Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR

Risk of Bias: Medium		Study period: 1998-2007 Length of follow-up: 4 years. Intervention started in 2003	Prior suicide behavior: 24 per 100,000 (2002, year before intervention)
Székely 2013[47] Country: Hungary Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: Community Funding: Government Risk of Bias: Low	Inclusion: Southern and eastern regions of Hungary (cities of Szolnok and Szeged) and all of Hungary Exclusion: None reported	Intervention: 4-Level *European alliance Against Depression* 1) Cooperation with general practitioners 2) Public relations campaign 3) Training community facilitators 4) Support high-risk groups/self-help (emergency cards with hotline number; educational materials to support telephone emergency services) Comparator: No intervention in a control city (Szeged) Study period: 2002-2007 Length of follow-up: 3 years (included 2 years during intervention phase)	N= Populations in the intervention and control region in 2004: Szolnok: 76,881 Szeged: 162,586 Age (years, mean): NR Gender (% male): Szolnok: 47% Szeged: 46% Race (%): NR Military status: NR Housing status: NR Socioeconomic status: unemployment rate in 2004: Szolnok: 5.9% Szeged: 4.7% Mental health diagnoses: NR Prior suicide behavior: NR
Ono 2013[49] Country: Japan Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: General community (rural and highly population areas) Funding: Local government and local health authorities Risk of Bias: Low	Inclusion: The entire population in 2 rural areas and 2 highly populated areas near metropolitan cities. Exclusion: NR	Intervention: Community-based multi-modal intervention, including Leadership involvement: a) publicizing messages from the mayor and officials b) establishment of regional committee to promote organization-wide awareness c) formalization of roles to promote pathways to build social support networks Education and Awareness to reduce stigma and improve recognition of suicide risk and facilitate help seeking a) public health events, posters, websites, placards, leaflets b) regional educational opportunities Gatekeeper training: community leaders, priests, telephone hotlines, social services, youth workers, geriatric care providers, policy, physicians, pharmacists, school employees	<u>Rural</u> N=Population in 2006: Intervention: 291,459 Control: 339,674 Age (years, mean): NR Intervention: 16% under 25, 55% 25-64, 29% 65 and over Control: 16% under 25, 53% 25-64, 31% 65 and over Gender (% male): Intervention: 47% Control: 47% Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR

		Supporting individuals at high risk a) home visits by regional public health nurses and psychiatrists b) regional social gatherings c) Screening to identify at-risk individuals d) support for self-help activities for high risk groups Comparator: Suicide prevention activities as usual Study period: 2003-2009 Length of follow-up: Pre- and post-intervention periods both 3.5 years	<u>Highly Populated</u> N=Population in 2006: Intervention: 615,586 Control: 704,341 Age (years, mean): NR Intervention: 17% under 25, 66% 25-64, 17% 65 and over Control: 17% under 25, 64% 25-64, 19% 65 and over Gender (% male): Intervention: 50% Control: 49% Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Kato 2019[51] (overall and subgroups by sex) Okada 2020[59] (subgroups by age) Country: Japan Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: Government Risk of Bias: Medium	Inclusion: Suicide rates obtained from the Ministry of Health, Labour, and Welfare and the Statistics Bureau of the Ministry of Internal Affairs and Communications of Japan Exclusion: NR	Intervention: *Emergency Fund to Enhance Community-Based Suicide Countermeasures*. Components included: personal consultation support, telephone consultation, development program for leaders/listeners, enlightenment program to enhance social support for high risk persons, and an intervention model program. Comparator: years prior to emergency funds Study period: 2009-2018, though the funding period was 2009 and 2014 Length of follow-up: 9 years	N= Mean population of 2.7 million across the 47 prefectures in Japan Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Lee 2018[52] Country: South Korea	Inclusion: Suicide deaths coded as X60-X84 according to the	Intervention: National Suicide Prevention Program (*eg*, high risk group-oriented monitoring	N=48,485,314 population of South Korea in 2004 Age (years): NR

Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: University Risk of Bias: Low	ICD-10 code from Statistic Korea Exclusion: NR	and prevention, general population mass media campaign) Comparator: pre-intervention Study period: 1993-2016 Length of follow-up: ~13 years after the 1st program. ~8 years for the 2nd program	Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Lai 2019[50] Country: Hong Kong Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: General community Funding: University, government Risk of Bias: Medium	Inclusion: Housing estate in North district intervention site Exclusion: NR	Intervention: A multi-strategy intervention in a high-risk housing estate in the North District universal programs: mental health events, mental health materials, limit access to suicide means; selective programs: training workshops for gatekeepers, training for volunteers; indicated programs: referral systems, psychosocial services, resource kits Comparator: Three other housing estates in the North District Study period: 2006-2015 Length of follow-up: ~4 years. The program started July 1st, 2011	N=NR Age (years, mean): NR Study site: 6% <15 years, 18% 15-24, 28% 25-44, 40% 45-64, 8% ≥65 Control site 1: 24% <15 years, 15% 15-24, 29% 25-44, 24% 45-64, 7% ≥65 Control site 2: 8% <15 years, 22% 15-24, 24% 25-44, 35% 45-64, 11% ≥65 Control site 3: 7% <15 years, 27% 15-24, 21% 25-44, 36% 45-64, 9% ≥65 Gender (% male): Study site: 49% Control site 1: 48% male Control site 2: 51% male Control site 3: 46% male Race (%): NR Military status: NR Housing status: NR Socioeconomic status: Median monthly income (US$): Study site: 2,421 Control site 1: 1,245 Control Site 2: 2,060 Control site 3: 1,792 Mental health diagnoses: NR Prior suicide behavior: NR

Nakanishi 2020[58] Country: Japan Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: Government Risk of Bias: Medium	Inclusion: Suicide data obtained from death certificates from the Ministry of Health, Labour, and Welfare Exclusion: NR	Intervention: *Suicide Prevention Act* 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 10. Access to health care and policies to reduce harmful use of alcohol Comparator: years before and after the Suicide Prevention Act Study period: Data from 1996-2016 (divided into intervals surrounding a recession, suicide prevention act, and an earthquake) Length of follow-up: Trend measured for the 5 years after the intervention	N=NR (only reported among completed suicides) Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Nakanishi 2015[53] Country: Japan Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: Government Risk of Bias: Medium	Inclusion: Japanese local authorities in their position as of April 30, 2013 Exclusion: NR	Intervention: Five components possible including 1) face to face counseling, 2) tele counseling, 3) training of community service providers, 4) public awareness campaigns, and 5) trauma informed policies and practices. Each local authority voluntarily determines the components of the suicide prevention program to be implemented in their prefecture; this national initiative and funding was launched in 2009. Comparator: time since 2009 Study period: 2009-2012 Length of follow-up: 3 years	N=range 24,320-175,157 (reported by intervention category) Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: annual per capita income range 1.1-1.2 million yen (reported by intervention type) Mental health diagnoses: NR Prior suicide behavior: NR

Law 2019[54] Country: Hong Kong Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: NR Risk of Bias: Medium	Inclusion: NR Exclusion: NR	Intervention: Centre for Suicide Research and Prevention applied a multi-component approach based after WHO recommendations including: 1) surveillance, 2) identifying risks and protective factors, 3) develop and evaluate interventions, and 4) implement. Comparator: before the Centre was established Study period: 1997-2016 Length of follow-up: ~14 years. The Centre was established in 2002	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Lung 2017[55] Country: Taiwan Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: General community Funding: None Risk of Bias: Low	Inclusion: 9 urban and 14 rural areas in Taiwan Exclusion: None reported	Intervention: Taiwan Suicide Prevention Center provides integrated platform for suicide prevention and control, assists county and city health bureaus and mental health network hospitals, and related suicide prevention instruments (prevention strategies, care materials, suicide risk assessment, gatekeeper training, standardizing reporting and aftercare delivery, organizing community support networks) Note: 1st phase: 2005-2008; 2nd phase: 2009-2013 Comparator: Pre-intervention Study period: 1991-2013 Length of follow-up: ~9 years after 1st phase. ~5 years after 2nd program	N=NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Page 2011[60] Country: Australia	Inclusion: Prevention programs/ activities clearly related to the immediate area in	Intervention: National Youth Suicide Prevention Strategy (139 local areas) 1) Community and professional education activities	N=Population catchment approximately 2.3 million Age (years, median): NR, people were aged 20-34 years Gender (% male): NR

Study Design: Observational with concurrent control Intervention Type: Multi-strategy Setting: General community Funding: NR Risk of Bias: Medium	which the organization was based. Exclusion: Prevention programs/activities that targeted a broader region or where it was unclear as to which geographic area the program related were not included in the primary analyses.	2) Crisis, early intervention, treatment and referral support 3) Counseling and personal development initiatives 4) Health promotion initiatives Note: exact prevention strategies may have varied by local area Comparator: Local areas with no prevention activity (774 local areas) Study period: Period implementation (1995-1998) and the period after implementation (1999-2002). Suicide data for 1992-1994 was used to establish suicide rate prior to implementation Length of follow-up: up to 8 years	Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR Mental health diagnoses: NR Prior suicide behavior: NR
Ross 2020[56] (longer-term follow-up) Lockley 2014[57] (shorter-term follow-up) Country: Australia Study Design: Pre-post observational with no concurrent control Intervention Type: Multi-strategy Setting: Suicide hotspot Funding: Government and local councils Risk of Bias: Medium	Inclusion: Data from the National Coronial Information System for closed cases by the coroner where a suicide occurred for 2000-2016 within postcode 2030. Also, data on cases that occurred within Gap Park Masterplan area. Exclusion: None	Intervention: Multi-strategy at Gap Park in Sydney, Australia. Means restriction: construction of 130-centimeter fencing along the cliff-tops. Encourage help-seeking: installation of 2 crisis telephones and 2 signs to encourage help-seeking. Increase likelihood of intervention by a third party: installation of cameras to record footage and assist in real-time and landscaping work to increase the probability that people would be present Comparator: Pre-intervention Study period: 2000-2016 Length of follow-up: 10-year pre-intervention, 2-year implementation period, 5-year post-intervention	N= NR Age (years, mean): NR Gender (% male): NR Race (%): NR Military status: NR Housing status: NR Socioeconomic status: NR (employment status only reported among completed suicides) Mental health diagnoses: NR Prior suicide behavior: NR

ICD-10 International Classification of Diseases; NR=not reported; RCT=randomized controlled trial; WHO=World Health Organization

Appendix Table 5-50. Multi-Strategy Programs: Risk of bias – Cluster RCTs

Author, Year	Sequence Generation	Allocation Concealment	Recruitment Bias	Baseline Imbalance	Blinded Outcome Assessment	Incomplete Cluster Data	Incomplete Outcome Data	Selective Outcome Reporting	Overall Risk of Bias
Collings 2018[44]	Low (computer-generated)	Low (independent statistician)	Low (recruitment prior to randomization)	Unclear (reported matching on a variety of demographic factors)	Low (suicide the only outcome, data obtained from coroner services)	Low	Unclear (no information)	Low	Low

RCT=randomized controlled trial

Appendix Table 5-51. Multi-Strategy Programs: Risk of Bias – Non-RCTs *

Author, Year	Did the study include all eligible participants or were the participants a representative sample from the population of interest?	Were the participants included in any comparison similar?	Were the participants included in any comparisons receiving similar treatment/ care, other than the exposure or intervention of interest?	Was the control group concurrent?	For pre-post studies, were there multiple measurements of the outcome both pre and post the intervention/ exposure?	Was follow-up complete?	Was completeness of follow-up similar for study groups?	Were the outcomes of participants included in any comparisons measured in the same way?	Were suicide deaths and/or attempts measured in a reliable way?	Were other eligible outcomes measured in a reliable way?	Did the study adjust for confounding variables?	Overall Risk of Bias
Hegerl 2019[45] Harris 2016[71]	Yes	Unclear	Unclear	Yes	NA	Yes	Yes	Yes	No (for attempts)	NA	Unclear	Medium
Hegerl 2010[46]	Yes	Unclear	Unclear	Yes	No	Yes	Yes	Yes	Unclear (attempts)	NA	No	Medium
Hübner-Liebermann 2010[48]	Yes	Unclear	Unclear	Yes	Yes	Unclear	Unclear	Unclear	Unclear	NA	No	Medium
Székely 2013[47]	Yes	Unclear	Unclear	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Low
Ono 2013[49]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Low

Kato 2019[51] Okada 2020[59]	Yes	Unclear	Unclear	No	Yes	Unclear	Unclear	Yes	Yes	NA	Yes	Medium
Lee 2018[52]	Yes	Yes	Unclear	NA	Yes	NA	Unclear	Yes	Yes	NA	Yes	Low
Lai 2019[50]	Yes	Yes	Yes	Yes	Yes	NA	Unclear	Yes	Yes	NA	No	Medium
Nakanishi 2020[58]	Yes	Yes	Unclear	No	Yes	NA	NA	Yes	Yes	NA	Yes	Medium
Nakanishi 2015[53]	Yes	Unclear	Unclear	Yes	NA	NA	NA	Yes	Yes	NA	Yes	Medium
Law 2019[54]	Yes	Unclear	Unclear	No	Yes	NA	NA	NA	Yes	NA	No	Medium
Lung 2017[55]	Yes	Unclear	Unclear	Yes	Yes	NA	NA	Yes	Yes	NA	Yes	Low
Page 2011[60]	Yes	Yes	Unclear	Yes	No	NA	NA	Yes	Yes	NA	Yes	Medium
Ross 2020[56] Lockley 2014[57]	Yes	Unclear	Unclear	No	Yes	NA	NA	Yes	Yes	Unclear (costs)	No	Medium
Wang 2013[81]	Unclear	No	Unclear	No	No	Yes	Yes	Yes	Unclear	NA	No	High
King 2011[82]	Unclear	Yes	NA	No	No	No	NA	Yes	Unclear	NA	No	High
Nakanishi 2017[83]	Yes	No	Unclear	Yes	NA	Unclear	Unclear	Yes	Yes	NA	Yes	High
Pirrucello 2010[84]	Unclear	Unclear	Unclear	NA	No	NA	Unclear	Yes	Unclear	No	No	High
Matsubayashi 2011[85]	Yes	No	Unclear	No	NA	NA	NA	Yes	Unclear	NA	No	High

*Modification of the Joanna Briggs Institute Critical Appraisal Checklist for Quasi-Experimental Studies
NA=not applicable; RCT=randomized controlled trial

Appendix Table 5-52. Multi-Strategy Programs: Suicide Deaths and Attempts from RCTs

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Collings 2018[44] Cluster RCT	**District A** Baseline: 13 deaths **District B** Baseline: 11 deaths **District C** Baseline: 10 deaths **District D** Baseline: 6 deaths	**District A** 25 months: 33 deaths **District B** 25 months: 53 deaths **District C** 25 months: 64 deaths **District D** 25 months: 46 deaths	**District A** Baseline: 13 deaths **District B** Baseline: 21 deaths **District C** Baseline: 11 deaths **District D** Baseline: 24 deaths	**District A** 25 months: 61 deaths **District B** 25 months: 68 deaths **District C** 25 months: 49 deaths **District D** 25 months: 111 deaths	Intervention Rate ratio = 1.17 (95% CI 0.84 to 1.65) Control Rate ratio = 1.01 (95% CI 0.77 to 1.31)	Intervention effect ratio = 1.18 (95% CI 0.51 to 2.70)	NR	NR	NR	NR	NR	NR

CI=confidence interval; NR=not reported; RCT=randomized controlled trial

Appendix Table 5-53. Multi-Strategy Programs: Suicide Deaths and Attempts from Non-RCTs with Concurrent Control

Author, Year Study Design	Suicide Deaths						Suicide Attempts					
	Intervention Group		Control Group		Pre vs Post	Intervention vs Control	Intervention Group		Control Group		Pre vs Post	Intervention vs Control
	Pre	Post	Pre	Post			Pre	Post	Pre	Post		
Hegerl 2019[45] Harris 2016[71] Observational with concurrent control	**All regions** 138 suicides	**All regions** 2 years: Mean (SD) 163 (13) suicides	**All regions** 88 suicides	**All regions** 2 years: Mean (SD) 112 (4) suicides	Intervention +18.1% from baseline Control +27.3% from baseline	OR= 0.93 (95% CI 0.65 to 1.33)	**All regions** 1,643 attempts	**All regions** 2-years: Mean (SD) 1,545 (178) attempts	**All regions** 1,195 attempts	**All regions** 2-years: Mean (SD) 1,128 (112) attempts	Intervention -6.0% from baseline Control -5.6% from baseline	OR= 1.00 (95% CI 0.90 to 1.11)
Hegerl 2010[46] Observational with concurrent control	**Nurem-berg** 100 suicides	**Nurem-berg** Follow-up year: 88 suicides	**Wuerz-burg** 58 suicides	**Wuerz-burg** Follow-up year: 42 suicides	NR	NR	**Nurem-berg** 520 attempts	**Nurem-berg** Follow-up year: 331 attempts	**Wuerz-burg** 125 attempts	**Wuerz-burg** Follow-up year: 131 attempts	Intervention baseline -36.2% from baseline Control +4.8% from baseline	P=.0005 vs control during same time period
Székely 2013[47] Observational with concurrent control	**Szolnok** 2002-2004: 30.0 per 100,000 *Men* 45.5 per 100,000 *Women* 16.3 per 100,000	**Szolnok** 2005-2007: 13.2 per 100,000 *Men* 18.0 per 100,000 *Women* 9.1 per 100,000	**Szeged** 2002-2004: 26.2 per 100,000 *Men* 41.3 per 100,000 *Women* 13.3 per 100,000	**Szeged** 2005-2007: 26.7 per 100,000 *Men* 43.5 per 100,000 *Women* 12.4 per 100,000	Intervention -55.9% mean change Cohen's d: 8.30 *Men* -60.5% Cohen's d: 5.53 *Women* -44.3%	NR	NR	NR	NR	NR	NR	NR

			All of Hungary 2002-2004: 27.6 per 100,000 *Men* 44.6 per 100,000 *Women* 12.2 per 100,000	**All of Hungary** 2005-2007: 24.9 per 100,000 *Men* 40.2 per 100,000 *Women* 11.1 per 100,000	Cohen's d: 3.19 <u>Control</u> **Szeged** +2% Cohen's d: 0.15 *Men* +5.4% Cohen's d: 0.31 *Women* -6.3% Cohen's d: 0.28 **All of Hungary** -9.6% Cohen's d: 3.72 *Men* -9.9% Cohen's d: 2.94 *Women* -8.7% Cohen's d: 4.78							
Hübner-Liebermann 2010[48] Observational with	**City of Regens-burg** 1998: 21 per 100,000	**City of Regens-burg** 2004: 7 per 100,000	**County of Regens-burg** 1998: 19 per 100,000	**County of Regens-burg** 2004: 9 per 100,000	**City of Regens-burg** *Males* Significant change in male	NR	NR	NR	NR	NR	NR	NR

concurrent control	2003: 13 per 100,000	2007: 14 per 100,000	2003: 13 per 100,000 **County of Neumarkt** 1998: 10 per 100,000 2003: 7 per 100,000 **Germany overall** 1998: 14 per 100,000 2003: 14 per 100,000	2007: 11 per 100,000 **County of Neumarkt** 2004: 9 per 100,000 2007: 13 per 100,000 **Germany overall** 2004: 13 per 100,000 2007: 11 per 100,000	suicide rate; P<=.001 *Females* No change in female suicide rate; P=.28							
Ono 2013[49] Observational with concurrent control	**Rural** 46.6 per 100,000 **Highly populate** 22.8 per 100,000 Note: rates calc by review team	**Rural** 38.2 per 100,000 **Highly populate** 23.2 per 100,000	**Rural** 40.6 per 100,000 **Highly populate** 26.0 per 100,000	**Rural** 38.8 per 100,000 **Highly populate** 24.8 per 100,000	NR	**Rural** 3.5 years RR 1.09 (95% CI 0.82 to 1.45) *Females* RR 1.44 (95% CI 0.85 to 2.43) RRs for other subgroups only in graph; not significantly different	**Rural** 24.8 per 100,000 **Highly populat e** 24.0 per 100,000 Note: rates calc by review team	**Rural** 18.8 per 100,000 **Highly populate** 29.0 per 100,000	**Rural** 26.0 per 100,000 **Highly populat e** 26.6per 100,000	**Rural** 23.8 per 100,000 **Highly populat e** 32.8 per 100,000	NR	**Rural** 3.5 years RR 0.86 (95% CI 0.55 to 1.36) *Females* RR 1.56 (95% CI 0.80 to 3.04) *Males* RR 0.39 (95% CI 0.22 to 0.68) *<25 years*

						Highly populate RRs only in graph. Not significantly different except decrease in females						RR 0.74 (95% CI 0.24 to 2.31) *25-65 years* RR only in graph. Not significantly different *>65 years* RR 0.35 (95% CI 0.17 to 0.71) **Highly Populate** RRs only in graph. Not significantly different except decrease in males and increase in females
Lai 2019[50] Observational with concurrent control	**Intervention Site** 2006-2010: 16 suicides	**Intervention Site** 2012-2015: 11 suicides Note: program started in July 2011	**Control Site 1** 2006-2010: 3 suicides **Control Site 2** 2006-2010: 5 suicides **Control Site 3**	**Control Site 1** 2012-2015: 6 suicides **Control Site 2** 2012-2015: 6 suicides **Control Site 3**	**Intervention Site** Trend from 2010-2015: P>.001 **Control Site 1** Trend from 2010-2015: P=.172 **Control Site 2**	NR	NR	NR	NR	NR	NR	NR

			2006-2010: 3 suicides	2012-2015: 3 suicides	Trend from 2010-2015: P=1 **Control Site 3** Trend from 2010-2015: P=.325							
Page 2011[60] Observational with concurrent control	Baseline 1992-1994: *Men* 32.7 per 100,000 *Women* 4.4 per 100,000 Period of activity 1995-1998: *Men* 37.4 per 100,000 *Women* 7.7 per 100,000	1999-2002: *Men* 33.7 per 100,000 *Women* 8.1 per 100,000 <u>Change in rates over 1999-2002</u> *Men* 12.5% (95% CI, -22.5 to -1.3) *Women* 8.1% (95% CI, -14.3 to 36.4)	Baseline 1992-1994: *Men* 33.3 per 100,000 *Women* 6.0 per 100,000 Period of activity 1995-1998: *Men* 39.4 per 100,000 *Women* 6.4 per 100,000	1999-2002: *Men* 35.2 per 100,000 *Women* 7.2 per 100,000 <u>Change in rates over 1999-2002</u> *Men* -7.9% (95% CI, -15.9 to 0.7) *Women* 11.5% (95% CI, -9.3 to 37.1)	1995-1998: *Men* RR adjusted 0.95 (95% CI, 0.85 to 1.06) 1999-2002: RR adjusted 0.96 (95% CI, 0.86 to 1.07) 1995-1998: *Women* RR adjusted 1.20 (95% CI, 0.94 to 1.52) 1999-2002: RR adjusted 1.12 (95% CI, 0.90 to 1.40)	<u>Difference in change in rates 1999-2002:</u> *Men* P=.541 *Women* P=.770	NR	NR	NR	NR	NR	NR

CI=confidence interval; NR=not reported; OR=odds ratio; RCT=randomized controlled trial; RR=rate ratios (for Ono 2013 study) and relative risk (for Page 2011 study); SD=standard deviation

Appendix Table 5-54. Multi-Strategy Programs: Suicide Deaths and Attempts from Non-RCTs with No Concurrent Control

Author, Year Study Design	Suicide Deaths			Suicide Attempts		
	Pre-Intervention	**Post-Intervention**	**Pre** vs **Post Comparison**	**Pre-Intervention**	**Post-Intervention**	**Pre** vs **Post Comparison**
Kato 2019[51] Okada 2020[59] Pre-post observational with no concurrent control	2009: 25.7 suicides per 100,000	2018: 16.5 suicides per 100,000	**As reported in the Kato 2019 article** Time dependent reduction trends on all persons (mean ±SD): -1.15 ±0.26 Change from 2009 to 2018: P<.05 for all prefectures Decreases associated with enlightenment program and development of leader and listener *Males* Time dependent reduction trends (mean ±SD): -1.74 ±0.43 Change from 2009 to 2018: P<.05 for all prefectures Decreases associated with enlightenment program and intervention model. Increase associated with personal consultation program *Females* Time dependent reduction trends (mean ±SD): -0.61 ±0.18 Change from 2009 to 2018: P<.05 in all but 2 prefectures	NR	NR	NR

			Decrease associated with development of leader and listener **As reported in the Okada 2020 article** *Age 20-29* Decrease with telephone consultation support and enlightenment program. Increase with development program of leaders and listeners *Age 30-39* Decrease with intervention model program and enlightenment program *Age 40-49* No differences *Age 50-59* Decrease with enlightenment program. Increase with personal consultation program *Age 60-69* Decrease with intervention model program and enlightenment program. Increase with personal consultation program *Age 70-79* Decrease with enlightenment program and telephone consultation *Age 80+* Decrease with personal consultation program,			

			enlightenment program, and intervention model program			
Lee 2018[52] Pre-post observational with no concurrent control	1993-2003 14.9 per 100,000 (calculated by investigators) *Males* 1993-2010: +5.0% annually (95% CI, 3.6 to 6.4%) *Females* 1993-2009: +7.5% annually (95% CI, 6.3 to 8.7%)	2004-2016 27.2 per 100,000 (calculated by investigators) **1st strategy** 2004-2008 24.2 per 100,000 (calculated by investigators) **2nd Strategy** 2009-2016 28.8 per 100,000 (calculated by investigators) *Males* 2011-2016: -4.3% annually (95% CI, -9.8, 1.6%) *Females* 2010-2016: -6.1% annually (95% CI, -9.1 to -3.0%)	**1st strategy** Suicide rate from 1993-2010 increased by 5.6% annually (95% CI, 4.4 to 6.9%) **2nd strategy** Suicide rate from 2010 to 2016 decreased by 5.5% annually (95% CI, -10.3 to -0.5%)	NR	NR	NR
Nakanishi 2020[58] Pre-post observational with no concurrent control	1998-2006 (economic recession) Trend -0.0007 (95% CI, -0.002 to 0.0008) *Male*	2006-2011 (Post Suicide Prevention Act) Trend -0.001 (95% CI, -0.003 to 0.001) *Male*	Trend Difference (Suicide Prevention Act) -0.0004 (95% CI, -0.003 to 0.002) *Male* -0.001 (95% CI, -0.005 to 0.004)	NR	NR	NR

	Trend -0.0007 (95% CI, -0.003 to 0.001) *Female* Trend -0.001 (95% CI, -0.002 to 0.000) *Age ≤19 years* Trend -0.0003 (95% CI, -0.001 to 0.0002) *Age 20-39 years* Trend 0.002 (95% CI, 0.001 to 0.004) *Age 40-59 years* Trend -0.001 (95% CI, -0.004 to 0.001) *Age ≤60 years* Trend -0.002 (95% CI, -0.003 to -0.002)	Trend -0.002 (95% CI, -0.006 to 0.002) *Female* Trend -0.001 (95%CI -0.002 to -0.000) *Age ≤19 years* Trend -0.0004 (95% CI, -0.001 to -0.0001) *Age 20-39 years* Trend 0.001 (95% CI, -0.002 to 0.004) *Age 40-59 years* Trend -0.004 (95% CI, -0.008 to 0.001) *Age ≤60 years* Trend -0.002 (95% CI, -0.002 to -0.001)	*Female* 0.00008 (95%CI -0.001 to 0.001) *Age ≤19 years* -0.0001 (95% CI, -0.001 to 0.001) *Age 20-39 years* -0.001 (95% CI, -0.005 to 0.002) *Age 40-59 years* -0.091 (95% CI, -0.268 to 0.085) *Age ≤60 years* 0.001 (95% CI, -0.0001 to 0.002)			
Nakanishi 2015[53] Pre-post observational with no	The number of suicide cases was not significantly different between the categories of implementation of suicide-prevention programs			NR	NR	NR

concurrent control						
Law 2019[54] Pre-post observational with no concurrent control	1997: 10.2 per 100,000 persons 2002: 13.4 per 100,000 persons Notes: rates were age-standardized	2003: 14.7 per 100,000 persons 2009 (6-year follow-up): 10.3 per 100,000 persons 2016 (13-year follow-up): 8.9 per 100,000 persons	NR	NR	NR	NR
Lung 2017[55] Pre-post observational with no concurrent control	*Age 15-25 years* 2004: 6 per 100,000 persons *Age 24-44 years* 2004: 18 per 100,000 persons *Age 45-64 years* 2004: 22 per 100,000 persons	*Age 15-24 years* 2008: 6 per 100,000 persons 2013: 5 per 100,000 persons *Age 24-44 years* 2008: 21.5 per 100,000 persons 2013: 15 per 100,000 persons *Age 45-64 years* 2008: 24 per 100,000 persons 2013: 19.5 per 100,000 persons *Age 65+ years* 2008:	NR	NR	NR	NR

	Age 65+ years 2004: 36.5 per 100,000 persons Note: data estimated from plots	36.5 per 100,000 persons 2013: 32 per 100,000 persons				
Ross 2020[56] Lockley 2014[57] Pre-post observational with no concurrent control	**At Gap Park** 2000-2009: 41 suicides *Males* 22 suicides *Females* 19 suicides	**At Gap Park** 2012-2016 post-intervention: 24 suicides *Males* 16 suicides *Females* 8 suicides 2010-2011 during implementation: 21 suicides *Males* 10 suicides *Females* 11 suicides	**At Gap Park** 2000-2016: APC = 5.41% (95% CI, -0.38 to 11.53) *Males* 2000-2016: APC = 6.23% (95% CI, -0.41 to 13.30) *Females* 2000-2010: APC = 16.64% (95% CI, 8.18 to 25.76) 2010-2016: APC = -21.27% (95% CI, -33.14 to -7.30)	NR	NR	NR

APC=annual percentage change; CI=confidence interval; NR=not reported; RCT=randomized controlled trial; SD=standard deviation

Appendix Table 5-55. Multi-Strategy Programs: Secondary Outcomes

Author, Year Study Design	Stigma Towards Suicide	Caregiver Burden	Cost	Substitution (Alternative Method)
Collings 2018[44] Cluster RCT	NR	NR	NR	NR
Hegerl 2019[45] Harris 2016[71]	NR	NR	NR	NR

Observational with concurrent control				
Hegerl 2010[46] Observational with concurrent control	NR	NR	NR	NR
Hübner-Liebermann 2010[48] Observational with concurrent control	NR	NR	NR	NR
Székely 2013[47] Observational with concurrent control	NR	NR	NR	NR
Ono 2013[49] Observational with concurrent control	NR	NR	NR	NR
Kato 2019[51] Okada 2020[59] Pre-post observational with no concurrent control	NR	NR	NR	NR
Lee 2018[52] Pre-post observational with no concurrent control	NR	NR	NR	NR
Lai 2019[50] Observational with concurrent control	NR	NR	NR	NR
Nakanishi 2020[58]	NR	NR	NR	NR

Pre-post observational with no concurrent control				
Nakanishi 2015[53] Pre-post observational with no concurrent control	NR	NR	NR	NR
Law 2019[54] Pre-post observational with no concurrent control	NR	NR	NR	NR
Lung 2017[55] Pre-post observational with no concurrent control	NR	NR	NR	NR
Page 2011[60] Observational with concurrent control	NR	NR	$76 million in Australian dollars total funds for prevention programs and activities . *Effect of level of funding on suicide rates noted*	NR
Ross 2020[56] Lockley 2014[57] Pre-post observational with no concurrent control	NR	NR	Woollahra Council contributed $700,000 of its own funds. <u>Timeline of funding</u> January 2009: Woollahra Council received $248,000 which is allocated to camera installation December 2009: $91,000 allocated under Round 2 of an infrastructure program July 2010: $277 million pledged to initiatives to prevent suicide including at the Gap in Sydney August 2010: If elected, Liberal-National Coalition will provide $2.1 to complete the Gap Masterplan	NR

			September 2010: Labor Government will provide $1.1 million to Woollahra Municipal Council for infrastructure November 2010: $91,000 allocated under Round 3 of an infrastructure program June 2012: Successful application for $477,869 for Phase 3 of Masterplan	

NR=not reported; RCT=randomized controlled trial

Appendix Table 5-56. Multi-Strategy Programs: Strategies to Deliver, Sustain, and Improve the Quality of Intervention *

Author, Year Study Design	Strategies to Deliver the Intervention	Strategies to Sustain the Intervention	Strategies to Improve the Quality of the Intervention
Hegerl 2019[45] Harris 2016[71] Observational with concurrent control	**As reported in Hegerl 2019** Employ a multi-strategy approach Engage a broad range of stakeholders Conduct qualitative interviews/focus groups with stakeholders throughout the implementation process to identify barriers and facilitators to implementation and contextual factors influencing implementation Conduct workshops to optimize implementation approach (fidelity) Tailor strategies for engagement and implementation to specific region context/needs Engage local champions for healthcare provider adoption **As reported in Harris 2016** Employ a multi-strategy approach Invite media to public launch event to engage early in the process for subsequent coverage	**As reported in Hegerl 2019** Provide stakeholder workshops at the end of the intervention period to reflect on sustainability and explore lessons learned Provide training for healthcare providers that is accredited for Continuing Medical Education credits Employ the train the trainer model for community facilitators Develop local collaborative networks with individuals or organizational with a shared goal of reducing suicidal behavior **As reported in Harris 2016** Support community volunteers (initial members of self-help groups) in taking ownership of public campaigns (provide materials for distribution, give	**As reported in Hegerl 2019** Simultaneous implementation with a public mental health awareness campaign **As reported in Harris 2016** Explore the value of external activities that are stimulated by association with the suicide prevention program (*eg*, broad

	Engage volunteers to support the implementation capacity and dissemination	opportunities to speak at public events, listen to their ideas for dissemination) Use the program activities to create an impetus and environment for different stakeholder groups to communicate and work towards a common goal of reducing suicides	training may prompt systems or facilities to start their own training programs on suicide prevention due to greater awareness)
Hegerl 2010[46] Observational with concurrent control	NR	Follow-up year to the 2-year resource intensive intervention consisted of low-resource interventions including a depression day to increase awareness, self-help activities, and lectures about depressive disorders	NR
Hübner-Liebermann 2010[48] Observational with concurrent control	Employ a multi-strategy approach Engage and collaborate with local media Conduct training workshops for community facilitators Distribute educational materials in multiple formats/medias to the public	Provide training for healthcare providers that is accredited for Continuing Medical Education credits	NR
Székely 2013[47] Observational with concurrent control	Provide interactive educational packages included panel/roundtable discussions and an online information center were provided to general practitioners Distribute educational materials in multiple formats/medias to the public Engage and collaborate with local media Conduct training workshops for community facilitators Create of a local information data network to facilitate fast communication regarding high-risk persons	NR	Future research should assess health behavior (*eg*, alcohol and psychoactive agent use)

NR=not reported

* We abstracted this information from studies that found an intervention to be effective (defined as yielding at least low certainty evidence on reducing suicide deaths or attempts).

APPENDIX 6. PEER REVIEW COMMENTS/AUTHOR RESPONSES

Appendix Table 6-1. Peer Reviewer Comments and Author Responses

Question Text	Reviewer Number	Comment	Author Response
Are the objectives, scope, and methods for this review clearly described?	1	Yes	Thank you.
	3	Yes	
	4	Yes	
	5	Yes	
	6	Yes	
	7	Yes	
	8	Yes	
	9	Yes	
Is there any indication of bias in our synthesis of the evidence?	1	No	Thank you.
	3	No	
	4	No	
	5	No	
	6	No	
	7	No	
	8	No	
	9	No	
Are there any published or unpublished studies that we may have overlooked?	1	Yes - 2020 National Veteran Suicide Prevention Annual Report - i think this was just disseminated	We revised the introduction to use the 2020 National Veteran Suicide Prevention Annual Report when citing statistics.
	3	No	Thank you.
	4	No	Thank you.
	5	Yes - Garraza, L. G., Kuiper, N., Goldston, D., McKeon, R., & Walrath, C. (2019). Long-term impact of the Garrett Lee Smith Youth Suicide Prevention Program on youth suicide mortality, 2006–2015. Journal of Child	We incorporated the articles about the Garrett Lee Smith program (specifically Garraza 2019 for long-term suicide deaths, Walrath 2015 for short-term suicide deaths, Garraza 2015 for suicide attempts, and Garraza 2018 for cost-benefit analysis).

		Psychology and Psychiatry, 60(10), 1142–1147. https://doi.org/10.1111/jcpp.13058	
	6	No	Thank you.
	7	No	Thank you.
	8	Yes - The review seems to miss most of the Garrett Lee Smith manuscripts. Several are listed in the document to be included. Others are: Godoy Garraza, L., Kuiper, N., Goldston, D., McKeon, R., & Walrath, C. (2019). Long-term impact of the Garrett Lee Smith Youth Suicide Prevention Program on youth suicide mortality, 2006–2015. Journal of child psychology and psychiatry, 60(10), 1142-1147. Godoy Garraza, L., Peart Boyce, S., Walrath, C., Goldston, D. B., & McKeon, R. (2018). An economic evaluation of the Garrett Lee Smith memorial suicide prevention program. Suicide and Life-Threatening Behavior, 48(1), 3-11. Other areas that are missing that surprise me are school based programs including Sources of Strength and SOS. A community approach that is not mentioned is Zero Suicide. In terms of means, it is surprising nothing on blister packaging versus bulk packaging of psychiatric/other medications was not in the search.	We incorporated the articles about the Garrett Lee Smith program (specifically Garraza 2019 for long-term suicide deaths, Walrath 2015 for short-term suicide deaths, Garraza 2015 for suicide attempts, and Garraza 2018 for cost-benefit analysis). Regarding school-based programs, we included the Signs of Suicide (SOS) program. It was categorized as a social-emotional learning program. We also included the SEYLE trial in Europe which had 3 arms and were categorized as a social-emotional learning program, gatekeeper training, and screening, respectively. We identified additional school-based programs that we rated as high risk of bias and thus not included in the analysis. Examples of these were the Yellow Ribbon program (categorized as a social-emotional learning program), the Skills for Life program (categorized as a social-emotional learning program), and the Surviving the Teens program (categorized as multi-strategy). Our search did not identify any studies for Sources of Strength. We excluded Zero Suicide because this intervention takes place in a healthcare system. Our search did not identify any eligible studies on blister packaging versus bulk packaging.
	9	No	Thank you.
Additional suggestions or comments can be provided below. If applicable,	1	Misc but in the Intro line 23 there is a sentence saying... "use of suicide prevention coordinators" which might be revised to something like installing and supporting; the word "use" seemed somehow less than accurate. in terms of references, i mention above the newly released 2020 report.	We revised the wording on line 23. We revised the introduction to use the 2020 National Veteran Suicide Prevention Annual Report when citing statistics.

please indicate the page and line numbers from the draft report.		p 2 line 53, "reduce" might read better to revise to "reduction of..." Assessment of bias and grading system are highly appreciated. Notes about Mates in Construction cost vs savings - is the huge payoff true? that seems immense IF i am reading it correctly. I am quite taken with the conclusion of what seems not to be working: public awareness campaigns, crisis hotlines, and gatekeeper - makes 1 pause about	We revised the wording on line 53. For Mates in Construction, the $4.60 benefit-cost ratio is true, as reported. We added information about the assumptions used in the model.
	3		
	4	Very minor comment: page 9, line 36-37 may be missing a word or phrase?	We revised the wording on line 36-37.
	5	Very useful and important study. page 2, line 16. Missing a period.	We added a period on line 16.
	6	The statistics in the introduction regarding the proportion of veterans in the general population and their contribution to US suicide deaths is wrong (line 17). I looked at your citation - the VA suicide data report which cites different statistics … please check again and revise.	We revised the statistics on line 17. We also updated them with the data in the 2020 National Veteran Suicide Prevention Annual Report.
	7	This review conveys a wealth of information regarding the effectiveness of community-based and public health strategies to prevent suicide. This review appears to have been well-executed, with sound methods. The content is comprehensive, and the conclusions both succinct and nuanced. One question concerned the categorization of interventions under specific strategies vs as multi-component interventions. The interventions listed under “Organizational Policies and Culture” (p. 26-27) appear to be somewhat similar to the multi-component interventions in that they involve multiple components (*eg*, telephone hotline, gatekeeper training, education, screening, lethal means reduction), but are distinct in that the setting of the intervention is the workplace and/or the population is more circumscribed. Although	We added rationale about categorizing interventions as Organizational Policies and Culture. Per the CDC framework, comprehensive suicide prevention programs targeting “closed communities” such as a workplace or military were categorized under Organizational Policies and Culture, acknowledging that these programs often were multi-component. Thus, the setting influenced how we categorized them. The SEYLE trial in European high schools had 4 different arms (3 intervention arms and 1 control arm). This allowed us to analyze the specific effects of each intervention. We revised the introduction to use the 2020 National Veteran Suicide Prevention Annual Report when citing statistics.

		this is indeed discussed later (p. 57-58), it would be helpful to understand the decision process by which interventions were categorized into a specific strategy/approach (creating protective environments), as opposed to “multiple strategies” (with workplace as the setting). On a somewhat related note, the SEYLE study was included under 3 different intervention strategies. Did SEYLE parse out the different intervention strategies (social-emotional learning, gatekeeper training, and screening) and evaluate them separately? If not, this seems like it would be more appropriately classified as a multi-component intervention, particularly given the findings and conclusions about the multi-component interventions. P. 1 (executive summary, introduction): The authors may wish to update this section to reflect the latest VA Suicide Data Report (reference 2), which was released in late 2020. P. 1, lines 26-27 discusses the potential import of community-based approaches for reducing suicide among non-VHA Veterans, which appears to have been an important factor for the current undertaking. Briefly revisiting this in the Conclusion section may thus be useful. P. 3, lines 11-12: Suggest stating the rationale for excluding studies on safe reporting and messaging about suicide (since this can be community-based or population-based). P. 16: I agree with the decision to focus on suicide attempts and deaths, but readers might be interested in understanding why suicidal ideation was not an outcome of interest for KQ1. P. 27, line 16: Minor point - does “contract” here refer to	We re-visited the idea that community approaches are potentially important for reducing suicide among non-VHA Veterans in the discussion. We added rationale why we excluded safe reporting and messaging about suicide. That intervention is a part of the CDC strategy of “Lessen harms and prevent future risk.” These interventions take place after a suicide has occurred. This was not the focus of our review. We added rationale for excluding suicide ideation. A 2016 publication by Klonsky et al. in Annual Review of Clinical Psychology stipulates that “the progression from ideation to suicide attempts are distinct phenomena with distinct explanations and predictors.” The point about a “no suicide contract” is well-acknowledged. However, the primary study does not further specify what they mean by “contract.” We added to the discussion that since suicides are rare, it is important for future studies to have adequate follow-up and sample sizes.

		a “no suicide contract”? If so, it would be worth specifying that, as these have actually been shown to be ineffective and potentially harmful. The current findings regarding multi-component interventions are particularly important given recent community-based initiatives in the U.S., such as the Mayor’s and Governor’s Challenges. It may be worth noting some of the inherent challenges to studying the effectiveness of community-based interventions for suicide, such as low base rates of suicide and ethical considerations.	
	8	The authors do not make it clear why stigma related to suicide 1 of the outcome measures. I would suggest the addition of some introductory material on why this is important. Given the timeframe of the review, earlier studies of strategies like the Columbia Suicide Screening Scale might be missed, A brief review of findings from studies before 2010 might be useful for the reader. p. 22- SA, SD not included as abbreviations p. 41- Garrett Lee Smith papers are most likely gatekeeper training and not coping and problem solving	Stigma associated with suicide can have negative effects. As expressed by a Centre for Suicide Prevention in Canada, “Many victims suffer from very real psychological scars inflicted by the hurt and shame of attempting suicide or knowing someone who has died by suicide” (accessed at: https://www.suicideinfo.ca /resource/suicideandstigma/ on February 1st, 2021). We posited that an unintended consequence of any suicide prevention intervention could be an increase in suicide-related stigma. After reviewing the literature, we did not find evidence of that. We summarized findings from a prior ESP Report about suicide prevention that was published in 2009. This helps inform readers about findings before our search date. Abbreviations for SD and SA are placed as footnotes under Table 1 and 3. We categorized the Garrett Lee Smith program as gatekeeper training.
	9	This represents a lot of work and an excellent compilation and synthesis. Four comments presented in order of priority:	Tables 1 and 3 are the same. The executive summary is a stand-alone feature of the report.

		Tables 1 and 3 look identical. In the Discussion, you bring up that "the methodological quality on the effectiveness of suicide prevention strategies is limited." It would be helpful to discuss why that might be the case. What would it take to actually have a community-based intervention that would be of high methodological quality? For things like a public awareness campaign, it may be very hard to think of a feasible and fundable way design a study that would meet such criteria. Similarly, the Future Research section suggests "using RCT trial designs" but for many community-based intervention strategies, I'm not sure that a RCT design can (or even should) be used. No "peer norm" interventions were found. I wanted to confirm if you checked that the socio-emotional interventions did not include a "peer norm" component. In particular, the Signs of Suicide (US) intervention involves discussion of peer interaction so I'm wondering if this was part of it. Fine to mention the caveat that the Australian intervention costs were likely in Australian dollars, but can you report the costs in USD based on that assumption?	We revised the "Future Research" section to provide realistic suggestions. RCTs may not be feasible for all community or population-based interventions. However, RCTs in organizational workplaces, schools, or other closed communities could be conducted (example: SEYLE trial in European high schools). In the absence of RCTs, observational studies with concurrent control groups, adequate adjustment for confounding, large sample sizes, and adequate follow-up should be conducted. We categorized the interventions according to their primary approach. The Signs of Suicide program consisted of a video and guided discussion. The aim was to increase knowledge and improve attitudes, encourage help-seeking, reduce stigma, engage parents and school staff as partners in prevention, and encourage schools to develop partnerships to support mental health. We categorized this as a social-emotional learning program. We left the cost in question in Australian dollars as this was the context of the study.

CDC=Centers for Disease Control and Prevention; ESP=Evidence Synthesis Program; KQ=Key Question; RCT=Randomized Controlled Trial; SEYLE=Saving and Empowering Young Lives in Europe; SOS=Signs of Suicide; US=United States; USD=United States dollar; VA=Department of Veterans Affairs; VHA=Veterans Health Administration