Risk and Protective Factors Across Socioecological Levels of Risk for Suicide: An Evidence Map

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted healthcare topics of importance to clinicians, managers, and policymakers as they work to improve the health and healthcare 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. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, and interface with stakeholders. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee composed of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

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

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This topic was developed in response to a nomination by VA Health Services Research & Development (HSR&D) Office for an evidence review on the risk and protective factors for suicide across socioecological (SE) levels of risk. 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 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.

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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:

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Peer Reviewers

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

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EXECUTIVE SUMMARY

INTRODUCTION

Suicide remains a critical public health concern, with suicide rates increasing by 33% in the United States (US) between 1999 and 2019. Suicide rates vary by sex, race, age, and occupation, including military service, which is associated with increased risk for suicide. The suicide rate among US Veterans is 1.5 times that of the general population, when adjusted for age and sex.[1] Similar to the general population, male sex, non-Hispanic white race, mental health diagnoses, and age (55-74), are suicide risk factors in Veterans. Suicide prevention is the highest priority for the US Department of Veterans Affairs (VA).[2]

The Centers for Disease Control and Prevention (CDC) suggests that prevention efforts for any health or disease issue require an understanding of the underlying influencing factors. The CDC's Social-Ecological Model (SEM) is a 4-tiered framework for organizing risk and protective factors, which can then inform prevention strategies.[3] The framework considers the complex interaction between factors included in the 4 strata: societal, community, relationship, and individual. Evaluating risk factors through the lens of the Social-Ecological Model can provide additional context for the development of suicide prevention policies and practices.

Prior work has examined risk and protective factors among individuals known to be at high suicide risk based on age, sex, and mental health diagnoses. However, little information is available on suicide risk factors in the general population and understanding such factors may be helpful in developing public health and primary care prevention strategies. We conducted a systematic review of research published since 2011 and prepared an evidence map to identify risk and protective factors associated with suicide or suicide attempts in the general Veteran or active military personnel populations. The topic was nominated by VA Health Services Research and Development to develop research priorities and identify areas for future funding on suicide prevention in VA. In collaboration with VA leadership and members of a Technical Expert Panel (TEP) the following Key Question was developed: *What are the risk and protective factors for suicidal behaviors (attempts or death by suicide) across socioecological levels of risk?*

METHODS

Data Sources and Searches

We searched MEDLINE, Embase, PsycINFO, and Sociological Abstracts from January 2011 to January 2021. We used Medical Subject Headings (MeSH) and title/abstract terms indicative of suicide outcomes and risk or protective factors. We supplemented these results with additional searches of bibliographies from recent systematic reviews, and references from our TEP.

Study Selection

Eligible citations were screened independently by 2 reviewers using Distiller SR (Distiller SR, Evidence Partners, Ottawa, Canada) with prespecified criteria. Citations moved to full-text review if either reviewer considered the citation eligible. At full-text review, agreement of 2 reviewers was needed for study inclusion or exclusion; disputes were resolved by discussion with input from a third reviewer, if needed.

We included observational studies in the English-language that evaluated "modifiable" risk or protective factors for suicides or suicide attempts (*ie,* not sex, race, or age) in samples drawn from general populations of US Veterans and active military personnel. Studies must have reported suicide deaths or suicide attempts as outcomes; studies which included only composite outcomes (*eg*, suicide deaths plus attempts as 1 outcome) were excluded. Studies that did not capture the risk or protective factor(s) prior to the outcome of suicide or suicide attempts were excluded. We also excluded studies of special populations (*eg*, those known to be high risk due to mental health diagnoses or past suicide attempts) unless results were reported separately for individuals not considered at increased risk. However, we included studies of a general population of Veterans or active Service members that described their study sample's mental health diagnoses or past suicide attempts as risk factors.

Data Abstraction and Quality Assessment

Risk of bias (ROB) was assessed using the Quality In Prognosis Studies (QUIPS) tool.[4] Studies judged to have high risk of bias in 2 or more of the 6 domains were considered high overall ROB. Studies with low ROB in all 6 domains were considered low overall ROB. Studies not meeting either of these conditions were considered moderate ROB overall.

We abstracted data from eligible studies on study and population characteristics and reported prognostic factors and outcomes. For studies rated low or moderate ROB, we extracted the association between the risk or protective factor and the outcome, described the direction of the association and determined whether a factor was prognostic based statistical significance. ROB assessments and data abstraction were conducted by 1 trained reviewer and verified or modified by a second reviewer.

Data Synthesis and Analysis

Using the SEM,[3] we categorized reported risk and protective factors into 1 of 4 nested domains: Individual, Relational, Community, or Societal. We prepared an evidence map summarizing studies within this framework for those assessed as low or moderate ROB. We then included separate sections to summarize findings from studies with the strongest design or methodological quality – first, prospective cohort studies and second, any study design with low ROB. We did not conduct a quantitative evidence synthesis or detailed study level analyses due to study heterogeneity and the number and variation in risk and protective factor reporting. We did not rate certainty of evidence for the same reason. We describe the included individual studies in supplemental tables.

RESULTS

Results of Literature Search

After removing duplicates, we identified 1,351 citations for title and abstract triage. We reviewed the full text of 295 articles and identified 63 which met our inclusion criteria.

Summary of Results

Individual Level

The Individual domain of the Social-Ecological Model consists of factors pertaining to personal characteristics, such as demographics and health conditions.[5] We identified 57 studies, with 50 meeting low or moderate ROB criteria (6 prospective cohort studies[6-11]). Of the 50 studies identified, 25 had a study sample size ≥ 100,000, thirty evaluated samples drawn from the Veteran population, 25 made use of VHA data sources, and 29 made use of Department of Defense (DoD) data sources. Among these 50 studies, 19 also reported relational risk or protective factors, and 4 evaluated community-level risk or protective factors.

Of the 6 prospective cohort studies that identified individual risk factors, 4 reported on suicides and 3 reported on attempts. Two of the 6 were rated low ROB and evaluated ≥ 100,000 individuals and reported on suicides; neither of these 2 reported attempts. One study focused on Veterans and used VHA medical records while the other involved active duty military from Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) and used a variety of DoD data sources. All 4 moderate ROB studies evaluated active duty military personnel.

Posttraumatic Stress Disorder (PTSD), other mental health disorders, alcohol, tobacco, and/or drug use, and homelessness/housing instability, as well as prior suicide attempts or ideation, were commonly reported as risk factors. The evidence identifying these variables as risk factors for both suicides and attempts was primarily from retrospective and case-control studies, but the direction and statistical significance was generally consistent and found in both low and moderate risk of bias studies.

The evidence regarding other risk/protective factors, such as pain, healthcare service use, criminal or legal history, or financial or life stressors was more sparse and less consistent in direction and statistical significance across studies. Among the risk or protective factors related to military history, deployment status was most frequently reported, in 14 studies in total. However, the diverse categorization of deployment status (*ie,* currently vs previously deployed; ever vs never; or total number of deployments) made comparison between studies difficult. Military service variables, such as less time in service and separation from service, were also associated with both suicide deaths and attempts. Increased body mass index (BMI) was found to be a protective factor in 2 moderate ROB studies.

Relational Level

The Relational domain of the Social-Ecological Model contains direct person-to-person interactions, such as interpersonal relationships, social support, and family.[5] We identified 22 studies that reported on such factors; 18 were rated moderate ROB[6,8,9,12-26] and 4 were rated low ROB.[11,27,28] Studies reported a variety of risk and protective factors, including marital status, relationship problems, sexual violence, history of family violence, adverse childhood experiences, bullying within military unit, social isolation, perceived burdensomeness (*eg,* "feeling others would be better off if I were dead"), thwarted belongingness (*ie,* social isolation), and death of a loved one or pet.

Twelve studies reported on marital status. Most reported no significant effect for suicidal behaviors (k=8[9,11,13,15,17,18,23,24]), but some (k=4[19,25,27,29]) reported that being unmarried (single,

widowed, divorced, separated, or never married) were at increased risk for both suicides and attempts. Seven studies reported on relationship problems, including recently failed intimate relationships, and recent divorce or counseling. Five of these studies (including 2 low ROB) reported these factors increase risk for suicides and attempts,[11,16,17,22,28] while 2 reported no significant differences.[6,13]

Four studies reported on sexual violence; 1 of these studies was rated low ROB. Two reported that military sexual trauma increased risk of suicides for both men and women,[20,30] the third reported that any sexual assault increased risk for suicide attempts,[21] and the fourth study found no significant effects between sexual or physical abuse history and suicide attempts.[14]

Two moderate ROB studies reported no significant increase in suicide risk for those reporting perceived burdensomeness,[8] thwarted belongingness,[8] or social isolation.[13] However, 1 low ROB study reported decreased social support increased risk of suicide.[11]

Two moderate ROB studies reported a history of family violence increased risk for suicide attempts.[23,26] One low ROB study reported that an Adverse Childhood Experiences (ACE) score of ≥ 4 increased risk for suicide as an adult.[11] One moderate ROB study reported that being bullied within your military unit increased risk of suicide attempts.[6] One moderate ROB study reported no significant increase in risk of suicide behavior for those suffering from grief or loss of a loved one or pet.[13]

Community Level

The Community domain of the Social-Ecological Model contains factors which are bounded to a certain region, setting, or area, such as neighborhoods, schools, or workplaces.[5] We identified 3 studies which reported on factors in this domain; all were rated moderate ROB.[31-33] All 3 articles focused on military-related factors: monthly frequency of improvised explosive device (IED) incidents, unit suicides, and exposure to nerve gas.

One study that used data from the Study to Assess Risk and Resilience in Servicemembers (STARRS) reported that the monthly frequency of IED incidents (as measured by the Joint IED Defeat Organization) was associated with increased risk for suicide attempts (moderate ROB).[32] Another study found that, as the number of suicide attempts in a military unit increased, so too did individual risks for suicide attempt (moderate ROB).[33] One moderate ROB study found no significant effects of nerve gas exposure on risk of suicide deaths.[31]

Societal Level

We did not identify any studies that reported societal level factors.

Summary of Findings from Prospective Cohort Studies

The 6 prospective cohort studies may provide more reliable information on whether assessed factors were predictive of suicide rather than merely associated with suicide.

Four studies reported on suicide and 3 reported on suicide attempts. One of these studies reported on both suicides and attempts.[10] Two were considered low ROB and both reported on suicides (1 in Veterans and 1 in active military).[7,11] Of the 4 reports evaluating suicide death, only 2 assessed

more than a single predictive factor.[9,11] Three reports were from the STARRS database and were considered moderate ROB,[6,8,10] though only 1 study assessed suicide,[10] while the other 2 reported suicide attempts.

Two low ROB studies assessed the role of tobacco use on suicides and found an increased risk when controlling for other factors.[7,11] Bohnert et al[7] used Veteran's Health Administration (VHA) electronic medical record information and found that a diagnosis of tobacco use disorder was associated with suicides among Veterans when controlling for age group, sex, Charlson comorbidity scores, VHA service connection, substance use disorder, bipolar disorder, depression, other anxiety disorder, posttraumatic stress disorder, and schizophrenia. Philipps[11] and colleagues evaluated tobacco and other drug use in OEF/OIF active military individuals as part of the Recruit Assessment Program study. However, only alcohol use was reported in models adjusting for other factors (depression, PTSD, adjustment disorder, and deployment). One moderate ROB study, using data from the Millennium Cohort Study,[34] reported that alcohol use, defined as heavy/binge drinking or alcohol related problems identified on a screening question, was positively associated with suicides.[9]

One low ROB study conducted in active duty military[11] noted a number of risk factors predictive of suicide death, including: mental illness, history of traumatic brain injury (TBI), lack of high school education, the percentage of time deployed while in the military, and military occupation. OEF/OIF deployment was a protective factor against suicide, while a history of PTSD was not significantly associated with suicide (similarly reported in 1 other moderate ROB prospective cohort study[9]). In contrast, the number of deployments was positively associated with suicide attempts in a single moderate ROB study among active duty military.[6]

Summary of Findings from Low Risk of Bias Studies

We identified 12 retrospective studies rated low ROB in addition to the 2 prospective studies mentioned above (14 total). Twelve studies involved more than 100,000 individuals, 11 studies enrolled Veterans and 5 included active duty military. Individual factors were reported in 14 studies, and relational factors were reported in 4 studies. No studies reported on community or societal factors. All studies reported on suicides and 2 reported on attempts.

While 14 studies reported on *individual risk factors,* each unique risk factor was typically assessed in only 1 or 2 studies. The following risk factors were assessed in 3 or more low ROB studies: previous suicide ideation or attempts; mental illness (not including PTSD); PTSD; and alcohol, drug, or tobacco use. Suicide ideation or previous attempts were positively associated with suicide in 3 retrospective studies, 2 in Veterans and 1 in active military.[27,28,35] A history of mental illness was consistently associated with suicide in 4 studies (3 in Veterans and 1 in active military).[27,28,35,36] In 4 of 5 retrospective studies, substance use disorder was associated with increased suicides and in the 2 prospective studies tobacco use was also associated with increased suicide risk in both Veterans and active military. The effect of PTSD on suicides was inconsistent. Two retrospective studies found a positive association while 1 found a protective effect, and the single prospective study[11] found no significant relationship with PTSD and subsequent suicide among active duty military.

Of the 4 low ROB studies reporting on *relational factors*, 2 were retrospective cohort studies, 1 was cross-sectional, and 1 was a prospective cohort. One study in Veterans noted that Veterans

who were divorced, widowed, or never married had an increased suicide risk compared to married individuals.[27] Similarly, the report by Shen and colleagues[28] showed that being divorced was associated with an increased risk of suicide. Cusack et al reported that a history of military sexual trauma increased risk for suicide deaths.[30] Phillips,[11] a prospective cohort study in active duty military, found that adverse childhood experiences, relationship problems, and social isolation were each associated with increased suicide while marital status had no significant association.

DISCUSSION

Key Findings

Our systematic review and evidence maps evaluated risk and protective factors for suicide and suicide attempts among general populations of Veterans and active duty military across the 4 levels included in the CDC's social-ecological model. We identified 55 studies rated as either low or moderate ROB published since 2011. Six were prospective studies (2 low ROB) examining risk factors for suicide deaths. The greatest amount of information was related to individual risk factors and came from retrospective cohort studies, many of which were moderate ROB. Additionally, variation in risk factor definitions and categorization limited consistency in reporting and results interpretation. Nonetheless, we found that:

1) A history of prior suicide ideation or attempts, mental illness (not including PTSD), and substance, alcohol, or tobacco use were consistently predictive of, or associated with, suicide and attempts.

2) PTSD, unlike depression, anxiety, and the other common mental disorders studied, was not consistently associated with suicide.

3) From the relational domain, marital status was not consistently associated with suicide or attempts, while relationship difficulties were generally consistently found to be risk factors.

4) Community-level, relational-level, and other individual-level factors were reported in only 1 or 2 studies. These factors were sometimes associated with suicide and attempts, but the few studies limited confidence. Thus, further exploration of factors such as firearm status, marital status, and various forms of interpersonal violence is warranted.

5) No studies reported on societal-level risk or protective factors.

Our report updates, and expands on, previous reviews evaluating suicide predictors in Veterans and active duty military.[37,38] These reviews included literature published prior to 2011 and 2015 respectively, evaluated demographic and clinical factors, mainly targeted high risk individuals, focused primarily on "risk prediction tools" and their accuracy, and did not use the CDC Social-Ecological Model to evaluate or summarize findings.

We urge caution in interpretation of our findings. This report was intended as an evidence map in general populations of Veterans and active duty military individuals. Thus, it provides a broad overview of risk and protective factors identified since 2011 using the CDC's social-ecological model and identifies gaps in existing evidence. We excluded studies focused on individuals

known to be at high risk of suicide and limited studies to those evaluating Veterans or active duty military. Studies in populations not known to be at high risk and outside of Veterans and active duty military members could be informative and provide a richer understanding of risk and protective factors for suicide and suicide attempts. Studies included in this review differed widely in terms of the factors they assessed, the categories they used to define risk domains, and the definitions they used to evaluate putatively similar constructs. This limited our ability to synthesize the available evidence. Most studies did not report the era of service for its sample, but when reported, the most common era of service was OEF/OIF for both active duty and Veterans. The factors assessed, and categories used to assess risk domains, varied considerably in their definition. The models used to assess the independence of reported factors also varied, and there remains a high potential that unmeasured confounders were explanatory. Additionally, results could be dependent on thresholds or methods used to define the factor or the variables controlled. Reported results may either be due to chance or lack of power. Prospective studies have the advantage of eliminating temporal ambiguity between the putative risk factor and the associated outcome. However, even in prospective studies, most of the effect sizes we saw were small to modest. Given the risk for potential unmeasured confounding and for Type 1 or Type 2 error, results should be accepted only cautiously. Furthermore, because suicide is a rare event in the general population (including Veterans and active duty military) implementing these findings is likely to unnecessarily label many at increased risk or result in program development to mitigate risk in identified individuals that could be resource intensive, burdensome, and costly and result in harms from overdiagnosis and labeling of individuals who would never attempt or die by suicide.

Applicability

This report is applicable to general Veteran and active military duty populations, as all studies evaluated Veterans or active duty military. We excluded studies that evaluated known high-risk populations (*eg*, individuals with a history of mental health illness or prior suicide attempts). Additionally, most studies did not report the era of service for its sample, but when reported, the most common era of service was OEF/OIF for both active duty and Veterans. Therefore, results may not apply to Veterans from World War II, or the Korean or Vietnam Wars.

Research Gaps/Future Research

The currently available evidence is perhaps most notable for its limitations and gaps, emphasizing the need for future research on risk and protective factors for suicide across social-ecological domains. Because suicide is a rare event, assessing prognostic factors in those not known to be at elevated risk requires very large sample sizes and long follow-up. However, given the large individual and societal impact of suicides and attempts, research to determine risk and protective factors and develop strategies to mitigate these events is valuable. Additional creation of large cohorts to prospectively collect data specifically targeted to potential social-ecologic factors, both known and unknown, in general populations associated with increased risk would be useful. Utilization of large administrative/clinical data sets is helpful for efficiently collecting data on clinical diagnoses, healthcare service use, and other centrally collected health information. However, additional, more granular information related to community, relational, societal, and individual levels will likely require supplemental data, such as self-report information and natural language processing of medical charts. The current social-ecological model is useful for conceptualizing broad domains. Categorizing identified factors into

standardized domains and then subdomains is 1 possible strategy for exploring factors. Additional research is needed to better classify the factors related to suicide and suicide attempts and to standardize their definitions and classifications. There is also little research on the potential combination of factors in predicting suicide or suicide attempts. More refined analytic methods are needed to adjust for known and potential confounders, and to better understand whether results are due to exploratory analyses, chance, or limited statistical power.

Conclusions

This systematic review and accompanying evidence map highlights main areas of information as well as gaps in the evidence according to study design and potential prognostic factor across the Social-Ecological Model among general populations of Veterans and active duty military. Individual-level social-ecological domain factors, especially mental illnesses, alcohol, drug, or tobacco use, as well as prior suicide attempts or ideation, may be the best currently supported risk factors for suicide and attempts. Information on the risk of interpersonal relationship issues was mixed. Information on military traumas and sexual or family violence generally showed positive associations with suicide. There were no data on societal level factors. There was little information regarding factors protective against suicide. Risk factor definitions and analyses varied considerably across reports and many were derived from multiple publications involving similar population databases. Standardization of risk factor definitions and comprehensive adjustments for potential confounding variables would aid our understanding of the association between these factors and suicidality, both individually and in concert with other factors.

ABBREVIATIONS TABLE

ACE	Adverse Childhood Experiences
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
DoD	Department of Defense
ESP	Evidence Synthesis Program
HSR&D	Health Services Research & Development
IED	Improvised explosive device
KQ	Key Question
MeSH	Medical Subject Heading
OEF/OIF	Operation Enduring Freedom/Operation Iraqi Freedom
PTSD	Posttraumatic stress disorder
QUIPS	Quality in Prognosis Studies
ROB	Risk of bias
SEM	Social-ecological Model
STARRS	Study to Assess Risk and Resilience in Servicemembers
TBI	Traumatic brain injury
TEP	Technical Expert Panel
US	United States
VA	Veterans Affairs
VHA	Veterans Health Administration

EVIDENCE REPORT

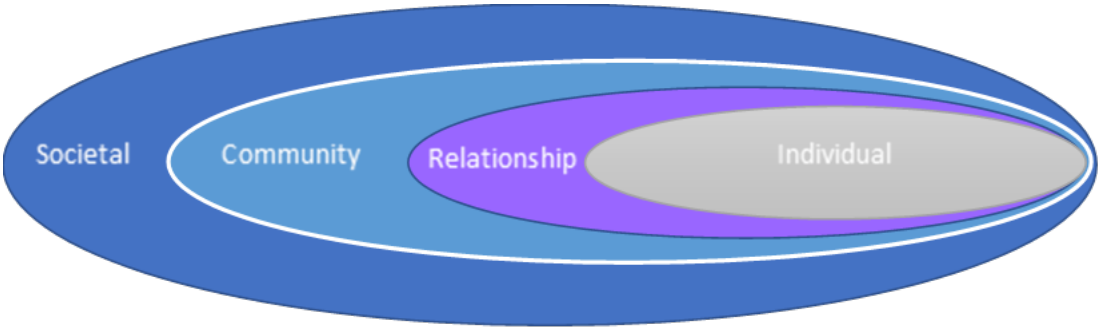
INTRODUCTION

Suicide remains a critical public health concern, with suicide rates increasing by 33% in the United States (US) between 1999 and 2019. Suicide rates vary by sex, race, age, and occupation, including military service, the latter of which is independently associated with increased risk for suicide. The suicide rate among US Veterans is 1.5 times that of the general population, when adjusted for age and sex.[1] While Veterans comprise only 8% of the US population, 13.8% (6,435) of all suicides in 2018 occurred in Veterans.[1] Similar to the general population, male sex, non-Hispanic white race, mental health diagnoses, and age (55-74), are risk factors in Veterans. Therefore, suicide prevention is the highest priority for the US Department of Veterans Affairs (VA).[2]

The National Strategy for Preventing Veteran Suicide 2018–2028[2] has outlined several goals, including increased surveillance and research to identify at-risk individuals and evaluate additional potential risk and protective factors. As further outlined in the 2020 National Veteran Suicide Annual Report, Veterans and active military "do not live, work, and serve in isolation….",[1] recognizing that risk and protective factors are not confined solely to the individual. Therefore, evaluating these factors through the lens of a socioecological framework can provide context for developing suicide prevention policies and practices.

The Centers for Disease Control and Prevention (CDC) suggests that prevention efforts for any health or disease issue require an understanding of the underlying factors that influence the issue. The CDC's Social-Ecological Model (SEM) (Figure 1) is a 4-tiered framework for organizing risk and protective factors, which may then inform prevention strategies.[3] The 4 strata, from macro to micro level are: Societal (factors concerning large-scale issues such as social and cultural norms, and guiding rules such as policies or laws); Community (factors limited to a certain region like a neighborhood, school, or workplace); Relational (factors involved with direct person-to-person interaction); Individual (person characteristics such as demographics, health, and beliefs). The overlapping rings of the SEM illustrate how factors at each level (individual, relationship, community, and society) impact factors at other levels; as do the various risk and protective factors associated with suicide. Table 1 provides a list of examples as to how different factors could be categorized within the model. Depending on how they are operationalized, some factors could conceptually fit into multiple categories.

Figure 1. Social-Ecological Model*



*https://www.cdc.gov/violenceprevention/publichealthissue/social-ecologicalmodel.html

Table 1. Examples of Risk Factors for Each Domain within the Social-Ecological Model[a]

Individual	Relationship
• Previous suicide attempt • Mental illness, such as depression • Gender • Criminal problems • Financial strain • Impulsive or aggressive tendencies • Job problems/unemployment • Legal problems • Serious illness • Substance use disorder	• Adverse childhood experiences such as child abuse and neglect • Bullying • Family history of suicide • Relationship problems such as a break-up, violence, or loss • Sexual violence
Community	**Societal**
• Barriers to health care • Cultural and religious beliefs, such as a belief that suicide is a noble resolution of a personal problem • Suicide cluster in a community	• Economic downturn/depression • Seasonal variation • Stigma associated with mental illness or help-seeking • Easy access to lethal means, such as firearms or medications • Unsafe media portrayals of suicide

[a]Examples were derived from the CDC[3] and a systematic review done by Cramer et al[5]

This is the second of a 2-part review nominated by VA Health Services Research and Development (HSR&D). The first review focused on community-based interventions for suicide prevention.[39] This second review focuses on research conducted since 2011 that reported risk and protective factors related to suicide or suicide attempt in Veteran or active duty military populations. The topic was nominated by VA HSR&D to further develop research priorities and identify areas for future funding on suicide prevention in VA. In collaboration with VA leadership and members of a Technical Expert Panel (TEP) the following Key Question was developed: *What are the risk and protective factors for suicidal behaviors (attempts or death by suicide) across social-ecological levels of risk?*

To answer this question, we provide an evidence map of identified risk and protective factors for suicidal behaviors in populations not known to be at high risk (*eg*, populations limited to those with mental health disorders or known prior suicide attempts). Evidence maps involve a systematic search of a broad field to identify gaps in knowledge and/or future research needs and presents results in a user-friendly format, often a visual figure or graph, or a searchable database.[40] Evidence maps are useful when there is both abundance and diversity of research. Their main utility is for displaying areas where research is concentrated and gaps that need to be addressed. Using the CDC Social-Ecological Model,[3] we categorized the reported risk and protective factors into 1 of 4 domains: Individual, Relational, Community, or Societal. We summarize studies by categories within this framework without commenting on the results or findings of individual studies.

METHODS

TOPIC DEVELOPMENT

The topic was nominated by VA Health Services Research and Development to further develop research priorities and identify areas for future funding on suicide prevention in VA. We worked with the Operational Partners and a Technical Expert Panel to refine the scope, key questions, and inclusion/exclusion criteria. We developed a protocol with input from our partners and registered in PROSPERO (CRD4202123641). The following Key Question was developed: *What are the risk and protective factors for suicidal behaviors (attempts or death by suicide) across social-ecological levels of risk?*

SEARCH STRATEGY

We searched MEDLINE, Embase, PsycINFO, and Sociological Abstracts (Appendix A) from January 2011 to January 2021. We limited our search from 2011 to avoid duplication with a 2012 VA ESP review that used inclusion criteria similar to the present review.[37] We used Medical Subject Headings (MeSH) and title/abstract terms indicative of suicide outcomes and risk or protective factors. We supplemented these results with additional hand searches of bibliographies from recent systematic reviews and with references from our technical expert panel.

STUDY SELECTION

Eligible citations were screened independently by 2 reviewers using Distiller SR (Distiller SR, Evidence Partners, Ottawa, Canada) with prespecified criteria. Citations moved to full-text review if either reviewer considered the citation eligible. At full-text review, agreement of 2 reviewers was needed for study inclusion or exclusion; disputes were resolved by discussion with input from a third reviewer, if needed.

We included observational studies in the English-language that evaluated "modifiable" risk or protective factors for suicides or suicide attempts (*ie,* not sex, race, or age) in samples drawn from general populations of US Veterans and active military personnel. Studies must have reported suicide deaths or suicide attempts as outcomes; studies which included only composite outcomes (*eg*, suicide deaths plus attempts as 1 outcome) were excluded. Studies that did not capture the risk or protective factor(s) prior to the outcome of suicide or suicide attempts were excluded. We also excluded studies of special populations (*eg*, those known to be high risk due to mental health diagnoses or past suicide attempts) unless results were reported separately for individuals not considered at increased risk. However, we included studies of a general population of Veterans or active Service members that described their study sample's mental health diagnoses or past suicide attempts as risk factors.

Table 2. Inclusion and Exclusion Criteria

	Inclusion Criteria	Exclusion Criteria
Population	Community-dwelling US Veteran or active military population (18 years of age or older)	Studies including >50% participants with increased risk of suicide due to prior suicide attempters or with specific mental or physical health conditions known to increase suicide risk: depression; psychoses, PTSD, recent cancer diagnosis, or terminal illness (unless results are stratified) Studies looking explicitly at genetic factors associated with suicide risk
Intervention	NA	NA
Comparator	NA	NA
Outcomes	Suicide attempts, suicide deaths	Composite outcome of suicide deaths plus attempts
Timing	Risk factors must precede the suicide/suicide attempt	Studies that do not capture the outcome of suicide/suicide attempt prior to the risk factor(s) of interest in the study
Setting	United States	Any
Study Design	Observational population-based studies published January 2011 – January 2021 that examine risk factors for suicide deaths and/or suicide attempts. Studies will capture risk factors/variables of interest, prior to (preceding) the outcomes of interest (suicide, suicide attempt).	Systematic reviews, narrative reviews, case reports, editorials, commentary, conference abstracts, interventions, and non-English language publications
Prognostic or Risk Factors	Any	Studies looking at physiological, laboratory, or imaging studies will be excluded (must have a clinical history or risen to the level of diagnosis; *ie,* we would include diabetes as a risk, but not A1C levels as measured by laboratory tests)

QUALITY ASSESSMENT AND DATA ABSTRACTION

Risk of bias (ROB) was assessed using the Quality In Prognosis Studies (QUIPS) tool.[4] The QUIPS tool uses 6 domains to critically appraise studies of prognostic factors (participation, attrition, prognostic factor measurement, outcome measurement, study confounding, and statistical analysis and reporting). Any study which was rated high in 2 or more domains was considered high ROB overall. Any study which was rated low ROB in all 6 domains was considered low ROB overall. Studies which did not meet either of those conditions were considered moderate ROB overall. Ratings for all eligible studies can be found in Appendix B.

We abstracted data from eligible studies on study and population characteristics, number of participants, data source, prognostic factors reported, and outcomes reported. We also reviewed and reported the analytic models and variables used to assess for possible independent effects. For studies rated low or moderate ROB, we abstracted the direction of the association between

the risk or protective factor and the outcome, based on statistical significance. ROB assessments and data abstraction were conducted by 1 trained reviewer and verified or modified by a second reviewer.

DATA SYNTHESIS

Due to the heterogeneity of identified studies, the large number of identified risk and protective factors, and variation in reporting of risk and protective factors, we prepared an evidence map rather than a quantitative synthesis of results or detailed analyses of individual studies. Evidence maps involve a systematic search of a broad field to identify gaps in knowledge and/or future research needs and present results in a user-friendly format, often a visual figure or graph, or a searchable database.[40] Evidence maps are useful when there is an abundance and a diversity of research as a first step to a systematic review on all or a portion of the topic or to identify gaps in a topic area. They display where research is concentrated and gaps that need to be addressed. Using the CDC Social-Ecological Model,[3] we categorized the reported risk and protective factors into 1 of 4 domains: Individual, Relational, Community, or Societal. We summarize studies by categories within this framework without commenting on the results or findings of individual studies.

We also summarize findings from studies with the strongest methodological study design, prospective cohort studies. In addition to reporting of prospective cohort studies, we summarize findings from any low risk of bias study regardless of study design (prospective, retrospective cohort, case-control, cross-sectional) as other methodologic criteria are used to assess the credibility of findings for a given outcome, including attrition, analytic methods, and the measurement of prognostic factors, outcomes, and confounders.

RATING THE BODY OF EVIDENCE

A formal certainty of evidence rating was not conducted as part of this review.

PEER REVIEW

A draft version of this report was reviewed by content experts and VA operational partners. Their comments and our responses are presented in Appendix C and the report was modified as needed.

RESULTS

OVERVIEW OF ALL ELIGIBLE STUDIES

After removing duplicates, we identified 1,351 citations for title and abstract triage. We reviewed the full text of 295 articles and identified 63 which met our inclusion criteria (Figure 2).

The majority (k=36) of studies were from large database s with sample sizes ≥ 100,000. Few studies (k=8) had sample sizes < 1,000. Most studies did not report the era of service for their samples, but when reported, the most common era of service was Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) for both active duty and Veterans. Most studies were retrospective cohorts by design (k=41) and few studies (k=7) were prospective cohort studies (Table 3).

Seventeen studies used data from the Study to Assess Risk and Resilience in Service members (STARRS) (Table 3). Most studies (k=52) combined 1 or more large databases, typically Veteran's Health Administration (VHA) or Department of Defense (DoD) with other databases such as the National Death Index (NDI). The remaining 11 studies used only 1 data source, either VHA or DoD data. It is likely that many studies evaluated overlapping groups of individuals and predictive variables though it was not possible to determine.

No eligible studies reported on risk or prognostic factors in the societal domain of the Social-Ecological Model; few studies (k=3) reported on factors within the community domain. Almost all studies (k=57) reported on factors within the individual domain, and approximately one-third (k=24) reported on relational factors. Of the 24 studies which reported a relational factor, the most common factor was marital status or problem with an intimate relationship (k=17).

Of the 63 eligible articles, 14 were rated as low ROB,[7,11,27,28,30,36,41-48] 41 rated as moderate ROB,[6,8-10,12-26,31-33,35,49-66] and the remaining 8 were rated as high ROB[67-74] and not analyzed further. For all low and moderate ROB studies, detailed evidence tables containing study characteristics, risk or protective factors reported, variables used for adjustment in models to control for potential confounding effects and assess potential independent roles for the reported factors, and direction of identified effects can be found in Appendix Table D1.

Figure 2. Literature Flow

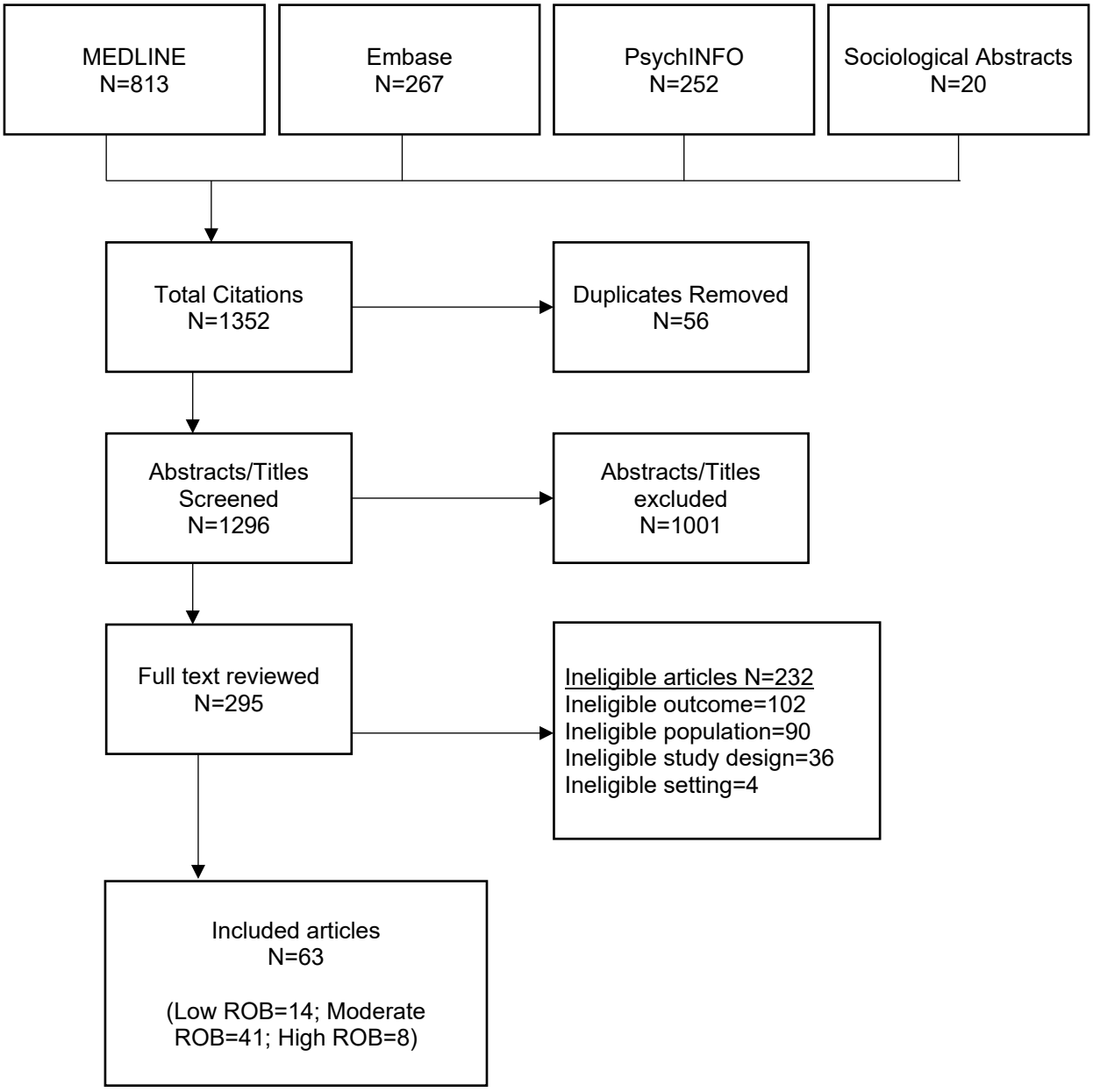


Table 3. Study Characteristics of All Eligible Studies

Study Characteristics	Risk of Bias			
	Low (k=14)	**Moderate** (k=41)	**High** (k=8)	**Total** (k=63)
Sample Size				
<1,000	0	3	5	8
1,000-9,999	1	5	1	7
10,000-99,999	1	11	0	12
≥100,000	12	22	2	36
Population				
Veteran	11	22	2	35
Active Military	5	20	6	31
Era of Service: Vietnam	1	1	0	2
Era of Service: OEF/OIF	6	8	2	16
Era of Service: Gulf War	0	2	0	2
Social-Ecologic Domains				
Individual	14	36	7	57
Relational	4	18	2	24
Community	0	3	0	4
Societal	0	0	0	0
Data Source				
VHA (administrative data)	10	18	0	28
DoD (administrative data)	7	21	4	32
VA/DoD SDR	1	4	0	5
STARRS	1	14	2	17
Survey/Self-Report	1	3	4	8
National Death Index	9	15	1	25
Claims Data (CMS/Tricare)	2	0	0	2
Other Military Data	4	6	0	10
National Violent Death Reporting System	0	1	1	2
Other Data Sources	0	2	0	2
Study Design				
Case-Control	0	7	3	10
Cross-Sectional	1	2	2	5
Prospective Cohort	2	4	1	7
Retrospective Cohort	11	28	2	41

CMS=Centers for Medicare/Medicaid Services; DoD=Department of Defense; OEF/OIF=Operation Enduring Freedom/Operation Iraqi Freedom; SDR=Suicide Data Repository; STARRS=Study to Assess Risk and Resilience in Servicemembers; VHA=Veterans Health Administration

OVERVIEW OF STUDIES RATED LOW OR MODERATE RISK OF BIAS

Key Messages

- The quality and quantity of information in Veterans and active duty military is limited, in part due to study design, multiplicity of reporting using similar data sources, variation in outcome reporting, inadequate adjustment for confounding factors, and possibly post-hoc analyses.
- The greatest amount of information is related to individual risk factors and comes from retrospective cohort studies, many of which have moderate risk of bias. No studies reported on societal level factors.
- Information from prospective cohort and low risk of bias studies among Veterans and active duty military suggests that individual level factors, such as a history of prior suicide ideation or attempts, mental illness (other than posttraumatic stress disorder), and substance, alcohol, or tobacco use are consistently predictive of, or associated with, suicide and attempts.
- Posttraumatic stress disorder, another individual level factor, was not consistently associated with suicide.
- Community level, relational level, and other individual level factors were reported in only 1 or 2 studies. These factors were sometimes associated with suicide and attempts, but the few studies limited confidence. Thus, further exploration of factors such as firearm status, marital status, and various forms of interpersonal violence is warranted.

Summary of Findings

Of the 55 studies rated low or moderate ROB, 50 reported on individual level factors, 22 reported on relational level factors, 3 reported on community level factors, and zero reported on societal level factors. Table 4 summarizes the number of studies which reported on risk or protective factors organized by the SEM. For many factors, results were informed by few studies with moderate ROB as details about factors used to control for potential confounding and determining the independent effect of the identified factors on deaths and attempts in the models, were difficult to adequately assess. Furthermore, there was little information regarding the selection of variables or thresholds used in the various models and whether the analyses were conceived a priori. Thus, assessing reported findings validity/reproducibility was problematic. Additional information on individual studies is included in Appendix B (ROB assessments) and Appendix D (evidence tables).

The most commonly reported factors at the individual level, in addition to demographic factors (age, race, sex, *etc*) and education were posttraumatic stress disorder (PTSD), other mental illnesses (*ie,* depression or anxiety), and alcohol, drug, or tobacco use (Table 4). Healthcare service use, criminal or legal problems, as well as military and deployment status, were also frequently noted. Firearm ownership and storage was only reported in 1 study despite firearms identified as a leading cause of suicide in Veterans. Ten studies explored the association of previous suicide attempt or ideation with future attempts or suicide.

At the relational level, marital status and relationship problems were most frequently reported.

Figure 3 further refines the identified risk/protective factors in a heat map stratified by study design. Individual risk factors were most frequently reported and consistently described across study design. The heat map also illustrates the limited amount of evidence from many of the reported factors even when looking across study design. Furthermore, as we describe the sections for the risk factor domains, many of the risk factors that we grouped in a single broad category (*eg*, alcohol, drug, or tobacco use) often used varying definitions or specific components of the category to assess the factor. Thus, the heat map provides an upper limit of the frequency and consistency of reporting across broad categories.

Table 5 provides the direction of the effect for each study which reported a risk or protective factor based on statistical significance as reported by study authors. Risk factors (*ie,* increased risk for suicide or attempt) are indicated as an upward arrow; protective factors (*ie,* decreased risk) are indicated as a downward arrow; and no association is indicated as horizontal double pointed arrowed. Individual results from each low risk of bias study are shown with blue arrows, moderate risk of bias in orange. Forty studies reported on suicides (4 prospective and 28 retrospective cohort studies) and 19 reported on attempts (3 prospective cohort, 13 retrospective cohort, and 3 case-control studies). While most studies reporting on a factor identified that factor as a risk rather than a protective factor, the findings were often from only 1 or 2 studies (and frequently using varying definitions of the factor. The figure illustrates the large identified gaps in evidence and the finding that most results were from moderate (rather than low) ROB studies. Results from each study that found "no effect" are shown with horizontal arrows without a discussion of the direction of the point estimate or the uncertainty that might be seen in the reported confidence intervals.

Table 4. Risk/Protective Factors Identified in Studies Rated Low/Moderate Risk of Bias (k=54)

Risk Factors	Number of Studies (k)
Individual Level	
Previous suicide attempt/suicidal ideation	10
Posttraumatic stress disorder	12
Other mental illness (*eg*, depression, anxiety, psychiatric conditions)	22
Emotions, such as anger, numbness, or hopelessness	4
Alcohol, tobacco, and/or drug use	17
Physical illness or pain	8
Sleep disorders	4
Cognitive or physical decline in functioning	3
Body mass index	2
Healthcare services use	10
Criminal or legal problems	7
Financial problems	2
Job problems or loss	5
Homelessness or housing instability	4
Life stressors (non-specific)	8
Firearm ownership/use/storage/accessibility	1

Demographics (*eg*, age, sex, race, education)	22
Sexual minority status	1
Transition from incarceration to civilian life	1
Military occupation	7
Military rank	9
Service connected (service-related disability)	2
Deployment status	14
Service branch	5
Service component	5
Time spent in service	9
Time deployed	3
Time since military separation	4
Military part-time vs full-time	1
Military former vs current service member	2
Relational Level	
Adverse childhood experiences	1
Bullying	1
Relationship problems (*eg*, break-up, violence, or loss)	9
Sexual violence	4
Marital status	12
Social isolation/perceived burdensomeness/thwarted belongingness	3
Death of a loved one or pet	1
Community Level	
Access to mental health care	0
Monthly IED rates	1
Military unit suicides	1
Military-related chemical exposures	1

Figure 3. Risk and Protective Factors for Suicide Deaths and Attempts, Stratified by Study Design

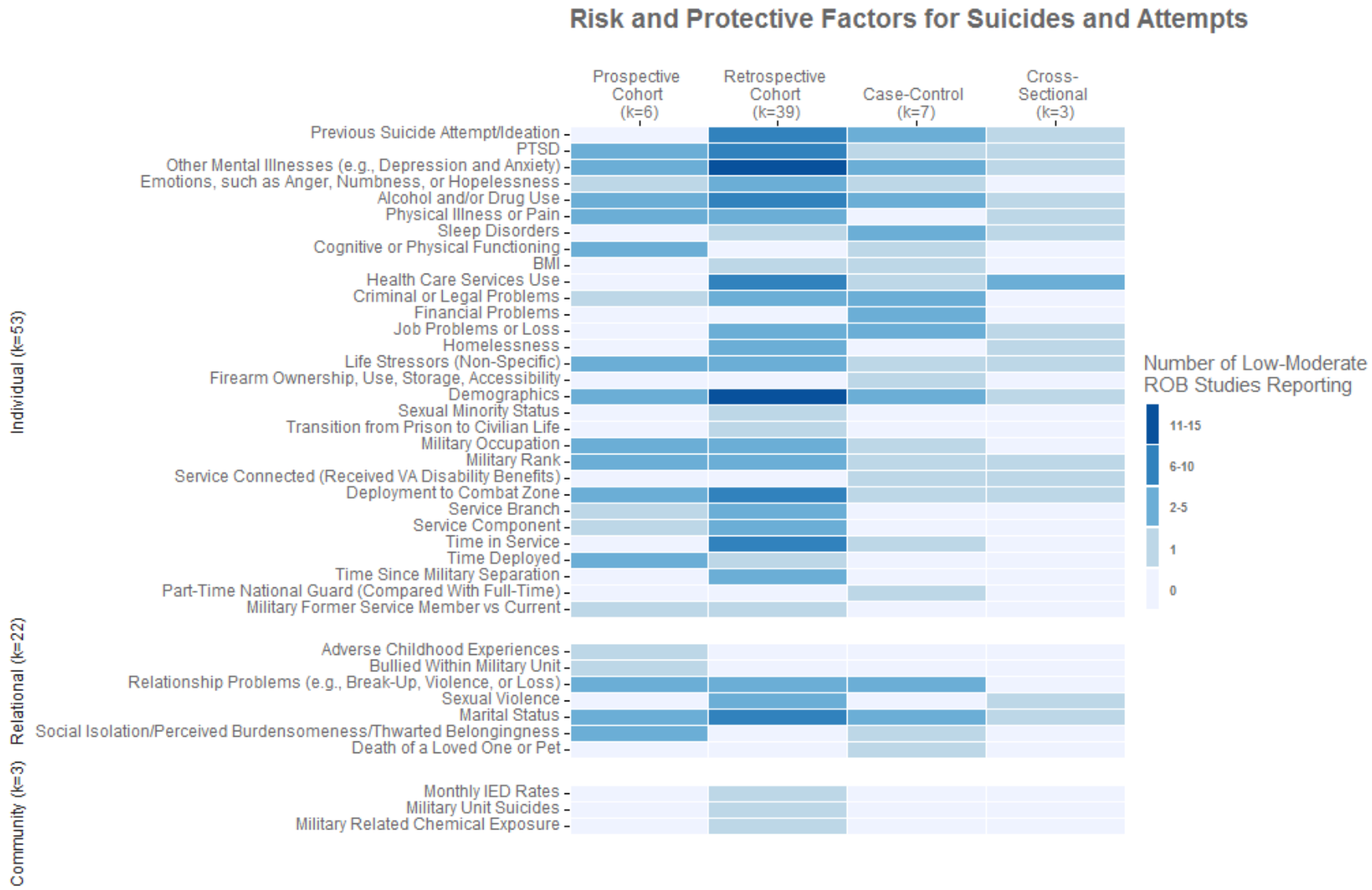


Table 5. Direction of Effect on Suicide Deaths and Attempts

Risk/Protective Factor		Prospective Cohort (k=6)		Retrospective Cohort (k=39)		Case-Control (k=7)		Cross-Sectional (k=3)	
		Deaths (k=4)	Attempts (k=3)	Deaths (k=28)	Attempts (k=13)	Deaths (k=6)	Attempts (k=3)	Deaths (k=3)	Attempts (k=0)
Individual (k=50)	Previous suicide attempt/ideation			↑↑↑↑	↑↑↑	↑ ↔↔	↑↑	↑	
	PTSD	↔↔		↑↑↑ ↓↓↓	↑↑↑		↑	↑	
	Other mental illnesses (*eg*, depression and anxiety)	↑↑	↔	↑↑↑↑↑↑ ↓	↑↑↑↑↑↑ ↔	↑↑↑↑	↑↑ ↔	↑	
	Emotions, such as anger, numbness, or hopelessness		↔	↑	↔	↔			
	Alcohol and/or drug use	↑↑↑		↑↑↑↑↑↑ ↔	↑↑ ↔	↑↑ ↔	↑↑↑	↑	
	Physical illness or pain	↑	↔	↑↑ ↓ ↔	↔			↑	
	Sleep disorders				↔	↔	↑	↑	
	Cognitive or physical decline in functioning	↑ ↔	↑			↑			
	BMI (overweight or obese)			↓			↓		

Risk/Protective Factor	Prospective Cohort (k=6)		Retrospective Cohort (k=39)		Case-Control (k=7)		Cross-Sectional (k=3)	
	Deaths (k=4)	Attempts (k=3)	Deaths (k=28)	Attempts (k=13)	Deaths (k=6)	Attempts (k=3)	Deaths (k=3)	Attempts (k=0)
Health care services use			↑↑↑ ↓ ↔	↑ ↔	↑		↑ ↓	
Criminal or legal problems		↑	↑ ↔	↑ ↔	↑ ↔↔	↔↔		
Financial problems					↔↔	↔		
Job problems or loss			↑	↑	↔↔	↔	↑	
Homelessness			↑↑ ↔	↑			↑	
Life stressors (non-specific)	↔	↔	↑↑	↑ ↔	↔		↑	
Firearm ownership, use, storage, accessibility					↑			
Sexual minority status			↑					
Transition from prison to civilian life			↔	↑				
Military rank (enlisted/lower rank)	↔	↔	↑↑ ↔	↑↑	↑		↑	
Service connected (received VA disability benefits)					↓		↑	

Risk/Protective Factor		Prospective Cohort (k=6)		Retrospective Cohort (k=39)		Case-Control (k=7)		Cross-Sectional (k=3)	
		Deaths (k=4)	Attempts (k=3)	Deaths (k=28)	Attempts (k=13)	Deaths (k=6)	Attempts (k=3)	Deaths (k=3)	Attempts (k=0)
	Service branch (Army/Marine)	↔		↑↑ ↔↔					
	Service component (active vs reserves)	↔		↑↑ ↔	↑				
	Less time in service			↑↑↑	↑↑↑↑↑	↑			
	Longer time or larger proportion of time deployed	↑ ↓			↑				
	Shorter time since military separation			↑↑↑ ↔					
	Part-time National Guard					↑			
	Military former service member vs current	↔		↑					
Relational (k=22)	Adverse childhood experiences	↑							
	Bullied within military unit		↑						
	Relationship problems (*eg*, break-up, violence, or loss)	↑	↔	↑	↑↑	↑↑↑ ↔	↑↑		
	Sexual violence			↑	↑ ↔			↑	

Risk/Protective Factor		Prospective Cohort (k=6)		Retrospective Cohort (k=39)		Case-Control (k=7)		Cross-Sectional (k=3)	
		Deaths (k=4)	Attempts (k=3)	Deaths (k=28)	Attempts (k=13)	Deaths (k=6)	Attempts (k=3)	Deaths (k=3)	Attempts (k=0)
	Marital status (unmarried)	↔↔		↑↑↑	↑↑ ↔↔↔	↔↔		↔	
	Social isolation/ perceived burdensomeness/ thwarted belongingness	↑	↔			↔			
	Death of a loved one or pet					↔			
Community (k=3)	Monthly IED rates				↑				
	Military unit suicides				↑				
	Military-related chemical exposure			↔					

BMI = Body mass index; IED= Improvised explosive devices; PTSD = Post traumatic stress disorder; VHA = Veterans Health Administration; VA = Department of Veterans Affairs

↑=increased risk
↓=decreased risk
↔=no difference or inconsistent
Blue=Low risk of bias study
Orange=Moderate risk of bias study

Notes: Each arrow represents results from a single study. Direction of effect based on reported p-values and confidence intervals. Across articles, there is overlap (to an unknown degree) in populations when the same administrative databases were used. Definitions of risk/protective factors across articles varied for several factors shown in table.
Demographics, military occupation, and deployment to combat zone are not shown in this table.

Individual Level

The Individual domain of the Social-Ecological Model consists of factors pertaining to personal characteristics, such as demographics, health, or attitudes.[5] We identified 50 studies that reported on individual risk factors. Of the 50 studies identified, 25 had a study population size ≥ 100,000, 30 captured the Veteran population, 25 made use of a VHA data source, and 29 made use of a DoD data source. Among the 50 studies that assessed individual risk or protective factors, 19 also assessed relational risk or protective factors and 3 evaluated community level risk or protective factors. These risk/protective factors were categorized into 26 subdomains which aligned with mental health conditions or health resource use, marital status, financial, legal or life/job stressors, or military service.

Among the identified 50 studies, 6 were of a prospective study design.[6-11] Of the 6 prospective cohort studies, 4 reported on suicides and 3 reported on attempts. Two of the 6 were rated low risk of bias, evaluated ≥ 100,000 individuals, and reported on suicides; neither reported attempts. One study focused on Veterans and used VHA medical records[7] while the other involved active duty military from Operation Enduring Freedom/Operation Iraqi Freedom (OEF/OIF) and used a variety of DoD data sources.[11]

All 4 moderate risk of bias studies evaluated active duty military personnel.

PTSD, other mental illnesses, and alcohol and/or drug use, as well as prior suicide attempts or ideation, were commonly reported as risk factors for both suicides and suicide attempts. The evidence identifying these variables as risk factors was generally consistent, primarily captured from retrospective or case-control studies, and found in both low and moderate risk of bias studies. PTSD was consistently shown to be a risk factor for suicide attempts, but results were inconsistent for suicide deaths.

Very few studies were prospective in nature with minimal overlap regarding the study risk factor of interest. Only the risk factors "other mental illness" and alcohol, tobacco, or drug use were evaluated by more than 1 prospective study and found to be a predictor of suicide. With little overlap of risk/protective factors between studies, there was less evidence to evaluate risk/protective factors on suicide attempts.

The evidence regarding other risk/protective factors, such as pain, healthcare service use, criminal or legal history, or financial or life stressors was sparse and less consistent across studies. Among the risk or protective factors related to the military, deployment status was captured by the largest number of studies, 14 in total. Military service variables such as less time in service and separation from service were also associated with both deaths and attempts. Increased body mass index (BMI) was determined to be a protective factor in 2 moderate risk of bias studies. Marital status (unmarried) was generally found to be a risk factor for suicide.

Housing instability (unstably housed and imminent risk for housing instability) was reported to increase risk of suicide death in 1 low ROB study.[30] Homelessness was found to increase risk of suicide deaths in 2 studies (both by the same author and rated moderate ROB),[63,64] while another low ROB study found no effect for suicide deaths, but an increase in suicide attempts.[27]

Two risk factors, military occupation and deployment status, were variably defined across the included studies. Seven studies describe an association between military occupation and suicide risk and 14 studies (low and moderate risk of bias) describe the association between deployment status and suicide risk (Appendix Table D2 and Appendix Table D3). Five of the studies investigating military occupation or job class used a version of combat occupation versus no-combat occupation; 2 of the 5 found no association and the remaining 3 found an increased risk of suicide[48] and increased risk of suicide attempt[23,33] for those with an occupational classification that included combat. The other 2 studies used very specific occupational titles; the first[47] found no association between job class and risk of death from suicide and the second[11] found a protective effect among those with a higher pay grade (E04-E07 vs E01-E03) and risk of death from suicide. Deployment status among the included studies referred to whether the individual had ever been deployed, was currently deployed, the number of deployments, whether the deployments had been to a combat region (OEF/OIF or Kosovo/Bosnia), or some combination of the previous categories. Three studies [23,24,32] investigated currently versus previously versus never deployed and suicide attempt risk. Never and previously deployed were found to be risk factors for suicide attempts but not currently deployed.

Relational Level

The Relational domain of the Social-Ecological Model contains direct person-to-person interaction, such as interpersonal relationships, social support, and family.[5] We identified 22 studies that reported on such factors; 18 were rated moderate ROB[6,8,9,12-26] and 4 were rated low ROB.[11,27,28,30] Studies reported a variety of factors at the relational level, including marital status, relationship problems, sexual violence, history of family violence, adverse childhood experiences, bullying within military unit, social isolation, perceived burdensomeness, thwarted belongingness, and death of a loved one or pet.

Several studies (k=12) reported on marital status, with most reporting no significant effect for suicidal behaviors (k=8[9,11,13,15,17,18,23,24]) and few (k=4[19,25,27,29]) reporting unmarried (single, widowed, divorced, separated, or never married) individuals were at increased risk for both suicides and attempts. Seven studies reported on relationship problems, including recently failed intimate relationships, and recent divorce or counseling. Five of these studies (including 2 low ROB) reported these factors increased risk for suicides and attempts,[11,16,17,22,28] while 2 reported no significant differences.[6,13]

Military sexual trauma was reported to increase risk for suicide death in 1 low ROB study.[30] Three moderate ROB studies also reported on sexual violence: 1 reporting military sexual trauma increased risk of suicides for both men and women,[20] the second reporting sexual assault victim status increased risk for suicide attempts,[21] and the third study found no significant effect of a history of sexual or physical abuse on suicide attempts.[14]

Two moderate ROB studies reported no significant increase in suicide risk for those reporting perceived burdensomeness,[8] thwarted belongingness,[8] or social isolation.[13] One low ROB study reported decreased social support increased risk of suicide.[11]

Two moderate ROB studies reported a history of family violence increased risk for suicide attempts.[23,26] One low ROB study reported an Adverse Childhood Experiences score of ≥ 4 increased risk for suicide as an adult.[11] One moderate ROB study reported that being bullied

within your military unit increased risk of suicide attempts.[6] One moderate ROB study reported no significant increase in risk of suicide behavior for those suffering from grief or loss of a loved one or pet.[13]

Community Level

The Community domain of the Social-Ecological Model contains factors which are bounded to a certain region or area, like neighborhoods, schools, or workplaces.[5] We identified 3 studies which reported on factors in this domain; all rated moderate ROB.[31-33] All 3 studies reported on military-related factors: monthly improvised explosive device rates, unit suicides, and exposure to nerve gas.

Two studies used data from STARRS, the first reported that an increase in the frequency of monthly improvised explosive device incidents (as measured by the Joint IED Defeat Organization) increased risk for suicide attempts (moderate ROB),[32] and the second reported as the number of suicide attempts in a military unit increased, so did individual risk for suicide attempt (moderate ROB).[33]

One moderate ROB study[31] found no significant effects of nerve gas exposure on risk of suicide deaths.

Societal Level

The Societal domain of the Social-Ecological Model contains large-scale issues such as social and cultural norms, policies, or other guiding rules and laws.[5] Our review did not identify any studies which met our inclusion criteria that reported on these factors.

Summary of Findings from Prospective Cohort Studies

We summarize findings from the 6 prospective cohort studies[6-11] because their prospective design generally provides more reliable information on whether assessed factors are predictive of suicide rather than merely associated with suicide (Table 6). Overall, 4 studies reported on suicide and 3 reported on suicide attempts. One of these studies reported on both suicides and attempts.[10] Two were considered low ROB and both reported on suicides (1 in Veterans[7] and 1 in active military[11]). Of the 4 reports evaluating suicide, only 2 assessed more than a single predictive factor.[9,11] The other 2, Bohnert[7] and Naifeh,[10] assessed the role of tobacco use in Veterans and cognitive decline in active military members, respectively. Three reports used data from the STARRS database and all were considered moderate ROB.[6,8,10] The only prospective cohort study that utilized STARRS data to assess suicides was by Naifeh et al.[10] No prospective cohort studies reported on either community or societal level factors.

Both low ROB studies with a prospective study design assessed the role of tobacco use on suicides and found an increased risk when controlling for other factors.[7,11] Bohnert[7] made use of VHA electronic medical record information and only assessed the predictive effect of tobacco use on suicide. They found that a diagnosis of tobacco use disorder was associated with suicides among Veterans when controlling for age group, sex, Charlson comorbidity score, VHA service connection, substance use disorder, bipolar disorder, depression, other anxiety disorder, posttraumatic stress disorder, and schizophrenia. Philipps[11] and colleagues evaluated tobacco and other drug use in OEF/OIF Active Military individuals as part of the Recruit Assessment

Program study. However, only alcohol use was reported in models that adjusted for other confounding factors (depression, PTSD, adjustment disorder, and deployment). One moderate ROB study using data from the Millennium Cohort Study[34] reported alcohol use, defined as heavy/binge drinking or alcohol-related problems identified on a screening question, was positively associated with suicides.[9]

The low ROB prospective study conducted in active duty military[11] noted a number of risk factors predictive of suicide including: mental illness, history of traumatic brain injury (TBI), lack of high school education, the percentage of time deployed while in the military, and military occupation. OEF/OIF deployment was a protective factor against suicide, while a history of PTSD was not significantly associated with suicide (similarly reported in 1 other moderate ROB prospective cohort study[9]). In contrast, the number of deployments was positively associated with suicide attempts in a single moderate risk of bias study among active duty military.[6]

Table 6. Findings from Prospective Cohort Studies [a, b]

Risk/ Protective Factor		Author, Publication Year, Population, Sample Size, Cohort Name											
		Bernecker 2019[6] Active Military N: 10,000-99,999 STARRS		**Bohnert 2014[7]** Veteran N: ≥ 100,000 VHA		**Chu 2020[8]** Active Military N: 1,000-9,999 STARRS		**LeardMann 2013[9]** Veteran and Active Military N: ≥ 100,000 Millennium Cohort Study		**Naifeh 2017[10]** Active Military N: 10,000-99,999 STARRS		**Phillips 2017[11]** Active Military N: ≥ 100,000 Recruit Assess Program	
		SD	SA	SD	SA	SD	SA	SD	SA	SD	SA	SD	SA
Individual	PTSD							↔				↔	
	Other mental illnesses (*eg*, anxiety, depression)		↔					↑				↑	
	Hopelessness						↔						
	Alcohol, tobacco, or other drug use			↑				↑				↑	
	Physical illness or pain		↔									↑	
	Cognitive or physical decline in functioning							↔		↑	↑		
	Criminal or legal problems		↑										
	Life stressors (non-specific)		↔					↔					
	Military rank (enlisted vs officer)		↔					↔					
	Service branch (Army/Marine)							↔					
	Service component (active vs reserves)							↔					
	Longer time or larger proportion of time deployed							↓				↑	
	Military former vs current service member							↔					
Relational	Adverse childhood experiences											↑	
	Bullied within military unit		↑										
	Relationship problems		↔									↑	
	Marital status [c]							↔				↔	
	Social isolation/ perceived burdensomeness/ thwarted belongingness						↔					↑	

SA = suicide attempts; SD = suicide deaths; STARRS = Army Study to Assess Risk and Resilience in Servicemembers

↑=increased risk
↓=decreased risk
↔=no difference or inconsistent
Low risk of bias study
Moderate risk of bias study

a Demographics, including education are not shown in this table.
b Military occupation and deployment status can be found in appendix tables.
c The 2 studies measuring marital status used different definitions. LeardMann et al evaluated not married relative to married. Phillips et al analyzed marital status during in-service and re-captured at later date. Phillips et al. also assessed whether individuals had received relationship counseling.

Summary of Findings from Low Risk of Bias Studies

We identified 12 retrospective studies in addition to the 2 prospective cohort studies that were rated low ROB (14 total) and thus provide additional information. As summarized in Table 3, 12 studies involved more than 100,000 individuals, 11 studies enrolled Veterans, and 5 included active duty military. Individual factors were reported in 14 studies, and relational factors were reported in 4 studies. No studies reported on community or societal factors. All studies reported on suicides and 2 reported on attempts.

While 14 studies reported on individual risk factors, each unique risk factor was typically assessed in only 1 or 2 studies. The following risk factors were assessed in 3 or more low ROB studies: previous suicide ideation or attempts, mental illness, PTSD, and alcohol, drug, or tobacco use. Suicide ideation or previous attempts were positively associated with suicide in 3 retrospective studies, 2 in Veterans and 1 in active military.[27,28,35] A history of mental illness was consistently associated with suicide in 4 studies (3 in Veterans and 1 in active military.[27,28,35,36] In 4 of 5 retrospective studies, substance use disorder was associated with increased suicides, and in the 2 prospective studies tobacco use was also associated with increased suicide risk in both Veterans and active military. The effect of PTSD on suicides was inconsistent. Two retrospective studies found a positive association while 1 found a protective effect, and the single prospective study[11] found no significant relationship with PTSD and subsequent suicide among active military.

Of the 4 low ROB studies reporting on relational factors, 2 were retrospective cohort studies, 1 cross-sectional, and 1 prospective cohort. One study in Veterans noted that Veterans who were divorced, widowed, or never married had an increased suicide risk compared to married individuals.[27] Similarly, the report by Shen and colleagues[28] also showed that being divorced was associated with an increased risk of suicide. Cusack et al reported that a history of military sexual trauma increased risk for suicide deaths.[30] As noted above, Phillips[11] was a prospective cohort study in active duty military. They found that adverse childhood experiences, relationship problems, and social isolation were associated with increased suicide while marital status had no significant association.

SUMMARY AND DISCUSSION

We conducted a systematic review and prepared a corresponding evidence map on the social-ecological risk and protective factors for suicide and suicide attempts among Veterans and active military.

We identified 55 studies rated as either low or moderate risk of bias published since 2011. Six were prospective studies with 4 (2 low risk of bias) examining risk factors for suicide deaths. Based on the available evidence we found that: 1) the quality and quantity of information was limited due in part to study design, multiplicity of reporting using similar data sources, variation in outcome reporting, potential lack of adequate adjustment for confounding factors, and possibly results-driven reporting; 2) the greatest amount of information was related to individual risk factors and came from retrospective cohort studies, many of which had moderate risk of bias; 3) information from prospective cohort and low risk of bias studies suggested that a history of prior suicide ideation or attempts, mental illness (not including PTSD), and substance, alcohol, or tobacco use are consistently predictive of, or associated with, suicide and attempts; 4) PTSD, unlike depression, anxiety, and other common mental disorders studied, was not consistently associated with suicide; 5) from the relational domain, marital status was not consistently associated with suicide or attempts, while relationship difficulties were generally found to be risk factors; 6) community level, relational level, and other individual level factors were reported in only 1 or 2 studies. These factors were sometimes associated with suicide and attempts, but the few studies limited confidence. Thus, further exploration of factors such as firearm status, marital status, and various forms of interpersonal violence is warranted; and 7) no studies reported on societal level factors.

Our report updates and expands on previous reviews evaluating suicide predictors in Veterans and active duty military.[37,38] These reviews included literature published prior to 2011 and 2015 respectively, evaluated demographic and clinical factors, mainly included studies of individuals at known high risk, primarily described “risk prediction tools” used and their accuracy in these populations, and did not use the CDC Social-Ecological Model to evaluate studies and summarize results.

We urge caution in the interpretation and application of our findings. This report was intended as an evidence map of risk and protective factors using the Social-Ecological Model, which has utility for learning where research is concentrated and gaps that need to be addressed. We limited studies to those evaluating general populations of Veterans or active duty military not at otherwise known increased risk for suicide. Studies in other populations may also be informative, including general community populations and high-risk clinical samples. The factors assessed and categories used to assess risk domains often varied considerably in their definition. Findings were infrequently reported in more than 1 study, and when reported by multiple studies, factors were often defined differently. Consensus around which risk factors to include and their measurement has the potential to increase comparability of findings across studies and advance the field. The models used to assess the independence of reported factors also varied and there remains a high potential that unmeasured confounders are explanatory. Additionally, results could be dependent on thresholds or methods used to define the factor or the variables controlled. Reported results may either be due to chance or lack of power. There is a limited body of research examining multiple factors and their potential additive or non-additive

influence of suicide and attempts. Positive associations from studies other than prospective designs may be merely associations rather than prognostic risk or protective factors. Furthermore, for most identified risk factors the defined risk estimates were relatively modest. Suicide is a rare event in the general population (even among Veterans and active duty military). Therefore, implementing these findings in individuals may unnecessarily label many at increased risk or result in program development to mitigate risk in identified individuals that could be resource-intensive, burdensome, and costly, and result in harms from overdiagnosis and labeling of individuals who would never attempt or die by suicide.

LIMITATIONS

Due to the heterogeneity of identified studies and the large number and variation in reporting of risk and protective factors, we prepared a systematic review and evidence map rather than a quantitative synthesis of results or detailed analyses of individual studies. We did, however, provide information on directionality of effect and reported on study design, risk of bias, and analytic methods, thus enriching the information available typically shown in evidence maps.

Evidence maps identify gaps in knowledge and/or future research needs and present results, often in figures or graphs, or as a searchable database.[40] Evidence maps may serve as a first step to a systematic review to identify gaps in a topic area. We identified many gaps in the quantity and quality of evidence that limits our ability to draw conclusions and provide immediate policy/practice considerations.

There were only 2 low risk of bias prospective studies specifically designed to address the key questions or risk factors. Inclusion of low risk of bias retrospective studies provides additional information but prognostic effects of evaluated factors cannot be inferred from retrospective data. Even when including lower methodologic quality studies, individual risk/protective factor results were informed by few studies. The details regarding variable inclusion in analytic models to control for potential confounding and determine the independent effect of reported factors on deaths and attempts varied and were difficult to adequately assess. There was little information regarding the conceptual frameworks used to select variables or thresholds used in the various models and whether the analyses were conceived of *a priori*. Many studies were derived from the same databases and thus are unlikely to be truly independent regarding their findings. We based our assessment of whether a factor was a risk or protective factor solely on the author-defined statistical significance of their findings. It is possible that some statistically significant results were due to chance or data-driven analyses or were very small in magnitude while some statistically nonsignificant results were due to poor statistical power and accompanying wide confidence intervals that could miss potentially clinically important findings.

Finally, available information generally infers associations rather than prognosis of factors with suicide or attempts. Consensus was reached in consultation with our partners and technical expert panel members on how to broadly categorize various factors and their domains. Authors used varying definitions of risk and protective factors. We attempted to discuss the specific factors used in each of the domains, especially when describing prospective cohort and low risk of bias studies, as results may vary due to variations in the factors or definition of given factor included in the specific domain. It is possible that different interpretations or categorizations may result in differing perspectives on our evidence map. In summary, our ability to reliably assess reported findings/validity/reproducibility was problematic.

Study Quality

In general, the methodological quality of included studies was limited. Only 13 studies were assessed to be low risk of bias and only 6 were designed prospectively. Multiple reports used the same or similar databases for their analyses and thus findings are likely limited in their independent assessment or reproducibility. Furthermore, authors did not fully describe the models used to assess the independent risk or protective effect. There are no well-established analytic models or confounding factors of interest to control for in analytic models. Additionally, it is not clear why certain thresholds or variables were used or whether results were data rather than hypotheses driven. It is not known whether authors adequately adjusted for confounders, if analyses were post-hoc/data driven, or whether negative results were not consistently reported.

Heterogeneity

We created an evidence map to summarize findings across study design, methodological quality and outcomes reported. We also summarize the populations assessed including Veteran versus active duty military and time in service. Rather than pooling results we describe results across study design and risk of bias. We described results separately for prospective cohort studies and for any study rated as low risk of bias. Therefore, readers can focus on the results presentation of this report that are most useful for them: *eg*, according to study population (Veteran or active duty); risk factor domain (individual, relational, community); study design (prospective, retrospective…); risk of bias (low vs low plus moderate). However, the results are already limited and additional attempts to determine whether findings were consistent or varied across other subgroups was not methodologically useful.

Applicability of Findings to the VA Population

Our findings are highly applicable to the VA population. We targeted inclusion to studies of US Veterans or active duty military. We excluded studies only reporting individuals known to be at increased suicidal risk, typically due to mental health concerns or prior suicide attempts.

RESEARCH GAPS/FUTURE RESEARCH

The currently available evidence is perhaps most notable for its limitations, gaps, and difficulty and thus emphasizes the need for future research in the areas of social-ecological factors for suicide. Because suicide is fortunately a rare event, assessing prognostic factors in those not known to be at markedly elevated risk requires very large sample sizes and long follow-up. Additionally, interventions known to reduce suicide risk or alter known risk factors may differentially affect suicide and attempts, thus making study of unknown factors difficult. However, given the large individual and societal impact of suicides and attempts research to determine risk and protective factors and develop strategies to mitigate these events is valuable. Additional creation of large cohorts to prospectively collect data specifically targeted to potential social-ecologic factors in general populations or those not to be at known marked increased risk based on sociodemographic, race/ethnicity, age, or sex would be useful. Utilization of large administrative/clinical data sets is helpful for efficiently collecting data on clinical diagnoses, healthcare service use, and other centrally collected health information. However, additional, more granular information related to community, relational, societal, and individual levels will likely require innovative survey methods. The current social-ecological model is useful for conceptualizing broad domains. Our attempt at categorizing identified factors into these domains

and then subdomains is 1 possible strategy for exploring factors. Additional research is needed to better identify factor classification and definitions used to categorize and standardize factor reporting. More refined analytic methods to adjust for known and potential confounders is important and would lead to a better understanding of whether results are due to exploratory analyses, chance, or limited statistical power. Additional work is needed to validate and harmonize how factors and confounders are operationalized, measured, and reported, as well as the analytic models used.

CONCLUSIONS

This systematic review and accompanying evidence map highlights main areas of information as well as gaps in the evidence according to study design and potential prognostic factors across the Social-Ecological Model among general populations of Veterans and active duty military. What information does exist is mainly from moderate risk of bias retrospective studies and describes risk factors within the social-ecological individual domain. Individual level social-ecological domain factors, especially mental illnesses and alcohol, drug, or tobacco use, as well as prior suicide attempts or ideation, may be the best currently supported risk factors for suicide and attempts. Information on military traumas and sexual or family violence generally showed positive associations with suicide. There were no data on societal level factors. There was little information regarding factors protective against suicide. Risk factor definitions and analyses varied considerably across reports and many were derived from multiple publications involving similar population databases. Standardization of risk factor definitions and comprehensive adjustments for potential confounding variables would aid our understanding of the association between these factors and suicidality, both individually and in concert with other factors.

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73. Thomsen CJ, Stander VA, McWhorter SK, Rabenhorst MM, Milner JS. Effects of combat deployment on risky and self-destructive behavior among active duty military personnel. *J Psychiatr Res.* 2011;45(10):1321-1331.
74. Zuromski KL, Dempsey CL, Ng THH, et al. Utilization of and barriers to treatment among suicide decedents: Results from the Army Study to Assess Risk and Resilience Among Servicemembers (Army STARRS). *J Consult Clin Psychol.* 2019;87(8):671-683.

APPENDIX A. SEARCH STRATEGIES

OVID MEDLINE, EMBASE AND PSYCINFO

1	Suicide/ or Suicide, Attempted/ or suicide.mp.
2	(suicide$1 or suicidal or suicidality).ti, ab.
3	(suicide$1 adj (prevent or prevention or preventing or prevents)).ti,ab.
4	Or/1-3
5	Risk Factors/
6	Risk.mp.
7	5 or 6
8	Veterans/ or Military Personnel/
9	Veteran$1 or (military adj person*)).ti,ab.
10	8 or 9
11	4 and 7 and 10
12	Limit 11 to English language
13	Limit 12 to yr=”2011-current”
14	Limit 13 to (case reports or clinical conference of comment or editorial or letter or news or newspaper article)
15	13 not 14
16	(child8 or adolescen*).ti,ab.
17	15 not 16
18	Limit 17 to humans
19	Remove duplicates from 18

SOCIOLOGICAL ABSTRACTS

((mainsubject.Exact("veterans" OR "veteran/veterans" OR "military" OR "military personnel")) or (ab(veteran OR military) OR ti(veteran OR military))) and (mainsubject.Exact("suicides & suicide attempts" OR "suicide, attempted" OR "suicide" OR "suicide/suicides/suicidal") OR ab(suicide OR suicidality OR suicidal) OR ti(suicide OR suicidality OR suicidal)) and (mainsubject.Exact("risk factors") OR ab(RISK FACTOR) OR ti(RISK FACTOR))

APPENDIX B. QUALITY ASSESSMENT FOR ELIGIBLE PUBLICATIONS

Study, Year	Study Participation	Study Attrition	Prognostic Factor Measurement	Outcome Measurement	Study Confounding	Statistical Analysis and Reporting	Overall Risk of Bias
Alexander, 2014[67]	High	Moderate	Low	Low	High	Low	High
Barry, 2018[41]	Low	NA	Low	Low	Low	Low	Low
Barth, 2016[31]	Low	NA	Moderate	Low	Moderate	Low	Moderate
Bernecker, 2019[6]	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate
Bishop, 2020[49]	Low	NA	Moderate	Moderate	Low	Low	Moderate
Black, 2011[68]	Moderate	NA	High	Low	Moderate	Moderate	High
Blow, 2012[50]	Low	NA	Low	Low	Moderate	Low	Moderate
Bohnert, 2014[7]	Low	Low	Low	Low	Low	Low	Low
Bohnert, 2017[42]	Low	NA	Low	Low	Low	Low	Low
Bullman, 2018[12]	Low	NA	Low	Low	Moderate	Low	Moderate
Bullman, 2019[51]	Low	NA	Low	Low	Moderate	Low	Moderate
Chu, 2020[8]	Moderate	Moderate	Moderate	Moderate	Low	Low	Moderate
Conner, 2013[52]	Low	NA	Low	Low	Moderate	Low	Moderate
Cooper, 2020[43]	Low	NA	Low	Low	Low	Low	Low
Cusack, 2020[30]	Low	NA	Low	Low	Low	Low	Low
Dempsey, 2019[53]	Low	Moderate	Low	Low	Low	Low	Moderate
Dobscha, 2014[13]	Low	NA	Moderate	Moderate	Low	Low	Moderate
Doran, 2016[14]	Low	NA	Low	Low	High	Moderate	Moderate
Finley, 2015[15]	Low	NA	Low	Low	Moderate	Moderate	Moderate
Goodin, 2019[16]	Low	NA	Low	Low	Moderate	Low	Moderate
Gradus, 2013[69]	Low	High	Low	Moderate	High	Low	High
Griffith, 2017[17]	Low	NA	Low	Low	Moderate	Low	Moderate
Hoffmire, 2015[54]	Moderate	NA	Low	Low	High	Moderate	Moderate
Hostetter, 2019[55]	Low	NA	Low	Low	Moderate	Low	Moderate
Hyman, 2012[18]	Low	Low	Low	Low	Moderate	High	Moderate
Ilgen, 2012[36]	Low	NA	Low	Low	Low	Low	Low
Ilgen, 2013[56]	Low	NA	Low	Low	Moderate	Low	Moderate
Kang, 2015[19]	Low	NA	Low	Low	Moderate	Low	Moderate

Study, Year	Study Participation	Study Attrition	Prognostic Factor Measurement	Outcome Measurement	Study Confounding	Statistical Analysis and Reporting	Overall Risk of Bias
Katz, 2012[57]	Moderate	NA	Low	Moderate	High	Moderate	Moderate
Kimerling, 2016[20]	Low	NA	Low	Low	Moderate	Low	Moderate
LeardMann, 2013[9]	Moderate	Low	Low	Low	Low	Low	Moderate
Louzon, 2016[35]	Low	NA	Low	Low	Low	Low	Low
Lynch, 2020[44]	Low	NA	Moderate	Low	Moderate	Low	Moderate
Martz, 2018[58]	Low	NA	Low	Low	Moderate	Low	Moderate
McCarthy, 2014[59]	Moderate	NA	Low	Low	Moderate	Low	Moderate
McCarthy, 2019[70]	Low	NA	High	Low	High	Low	High
Naifeh, 2017[10]	Low	Moderate	Low	Low	Moderate	Low	Moderate
Nock, 2017[71]	Moderate	Moderate	High	Low	High	Low	High
Palframan, 2020[27]	Low	NA	Low	Low	Low	Low	Low
Phillips, 2017[11]	Low	Low	Low	Low	Low	Low	Low
Ravindran, 2020[60]	Low	NA	Low	Low	Moderate	Low	Moderate
Reger, 2015[45]	Low	NA	Low	Low	Low	Low	Low
Reger, 2017[72]	Moderate	NA	Moderate	Low	High	Moderate	High
Riberiro, 2017[61]	Low	NA	Low	Low	Moderate	Moderate	Moderate
Rosellini, 2017[21]	Moderate	NA	Low	Low	Low	Low	Moderate
Ryan, 2020[62]	Low	NA	Low	Low	Moderate	Low	Moderate
Schinka, 2016[63]	Moderate	NA	Moderate	Low	High	Low	Moderate
Schinka, 2018[64]	Moderate	NA	Moderate	Low	High	Moderate	Moderate
Shen, 2016[28]	Low	NA	Low	Low	Low	Low	Low
Shiner, 2020[46]	Low	NA	Low	Low	Low	Low	Low
Skopp, 2016[22]	Low	NA	Moderate	Low	High	Moderate	Moderate
Thomsen, 2011[73]	Moderate	Moderate	High	High	Low	Low	High
Trofimovich, 2013[47]	Low	NA	Low	Low	Low	Low	Low
Ursano, 2015[65]	Low	NA	Low	Moderate	Low	Low	Moderate
Ursano, 2016[66]	Low	NA	Low	Moderate	Low	Low	Moderate
Ursano, 2017a[48]	Low	NA	Low	Low	Low	Low	Low
Ursano, 2017b[33]	Low	NA	Low	Moderate	Low	Low	Moderate
Ursano, 2017c[32]	Low	NA	Moderate	Moderate	Low	Low	Moderate

Study, Year	Study Participation	Study Attrition	Prognostic Factor Measurement	Outcome Measurement	Study Confounding	Statistical Analysis and Reporting	Overall Risk of Bias
Ursano, 2018a[23]	Low	NA	Low	Moderate	Low	Low	Moderate
Ursano, 2018b[25]	Low	NA	Low	Moderate	High	Low	Moderate
Ursano, 2018c[24]	Low	NA	Low	Moderate	Low	Low	Moderate
Ursano, 2018d[26]	Low	NA	Moderate	Moderate	Low	Low	Moderate
Zuromski, 2019[74]	Moderate	Moderate	High	Low	Low	Moderate	High

APPENDIX C. PEER REVIEW COMMENTS/AUTHOR RESPONSES

Question Text	Reviewer Number	Comment	Author Response
Are the objectives, scope, and methods for this review clearly described?	1	Yes	Thank you.
	2	Yes	
	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.
	2	No	
	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	No	Thank you.
	2	No	
	3	No	
	4	No	
	5	Yes - Two articles available here: https://onlinelibrary.wiley.com/doi/abs/10.1111/sltb.12511 and https://www.sciencedirect.com/science/article/abs/pii/S0165032718327757?via%3Dihub	Monteith et al. was excluded from this review as it was conducted in a sub-population; included studies had to investigate risk factors within a general Veteran/armed forces population. Barnes et at. was excluded at abstract level as developing predictive models was outside of the scope of this review.
	6	No	Thank you.
	7	No	

	8	No	
	9	Yes - Montgomery, A. E., Dichter, M. E., Byrne, T. H., & Blosnich, J. R. (2021). Intervention to address homelessness and all-cause and suicide mortality among unstably housed U.S. Veterans, 2012–2016. Journal of Epidemiology and Community Health, 75, 380–386. doi:10.1136/jech-2020-214664 Montgomery, A. E., Dichter, M. E., & Blosnich, J. R. (2021). Gender differences in the predictors of suicide-related morbidity among Veterans reporting current housing instability. Medical Care, 59, S36–S41. doi:10.1097/MLR.0000000000001422 Cusack, M. C., Montgomery, A. E., Cashy, J., Dichter, M. E., Byrne, T. H., & Blosnich, J. R. Examining Veteran housing instability and mortality by homicide, suicide, and unintentional injury. (2020). Journal of Social Distress and Homelessness, online ahead of print. doi:10.1080/10530789.2020.1801020	Montgomery et al. was excluded as intervention studies were explicitly excluded from this review. Montgomery et al. was excluded from this review as it was conducted in a sub-population; included studies had to investigate risk factors within a general Veteran/armed forces population. Thank you, the Cusack et at. was not identified by our search and we have included this article and updated our report to reflect this.
Additional suggestions or comments can be provided below. If applicable, please indicate the page and line numbers from the draft report.	1	Under the individual section a rich data resource from VA is described. - this is an important note to consider how much information is available APA shows Posttraumatic stress disorder (PTSD) as the way it is presented (no hyphen, not 2 words) p4, line 36-37, mentioned diverse categorization of deployment status - since this seems foundational information, is it a PI generated issue in what information was collected or another issue in terms of not having common data elements, etc.? At the individual level a description of the	Thank you. We have updated all instances of this throughout the report to remove the hyphen. Many authors defined their deployment variables differently, ie, some used currently vs. previously deployed, while others used ever vs. never and some broke this down further by number of deployments. We have added information into the report for clarity.

		studies were presented but not for the other levels. this could be a bolstered description to help from level to level, e.g., retrospective data analysis based upon VHA records, vs original prospective data collection, etc.	We've reorganized our report slightly to include these more detailed descriptions in the corresponding sections (ie, low risk of bias or prospective studies).
		???what is it we can conclude about PTSD and suicide???	The following sentence was added to the report: Post-traumatic stress disorder (PTSD) was consistently shown to be a risk factor for suicide attempts but results were inconsistent for suicide.
		I am unsure the order of presentation of tables and figures - not alphabetical and not by frequency - mentioning it for considering the best way to present the list of factors on the Y axes.	We thank the author for the suggestion, we grouped factors by socioecological model domains, and within those domains we tried to group like factors near each other. We initially thought we might subcategorize, but there was no foundational framework to do so.
	2	page line 40 - change to "...than 100,000 individuals, 10 studies enrolled Veterans...."	Thank you, this has been corrected.
		on page 13, line 50; I feel the description of ROB needs more; is there a way to provide any kind of examples in the text (and some in the Executive Summary, too)? It is not clear to me how all of these prognostic factors might indicate bias in a study of suicide prevention. What kind of bias was found within the research that was screened? Knowing that may help inform investigators and improve our new research studies moving forward. page 18, line 27: this sentence was hard to read, could some commas be added? "Other factors at the individual, community or relational level while sometimes found to be associated with suicide and attempts were reported in only 1 or 2 studies thus limiting conclusions."	The prognostic factors themselves do not create bias, it's the methodological decisions made by the authors that may introduce bias into a study. We discuss limitations of study quality in the Limitations section. We also have discussed the issues of risk of bias in our future research needs section: "More refined analytic methods to adjust for known and potential confounders is important and a better understanding of whether results are due to exploratory analyses, chance, or limited statistical power. Additional work is needed to validate and harmonize how factors and confounders are operationalized, measured, and reported as well as the analytic models used." This sentence has been edited to for clarity. "Community-level, relational-level, and other individual-level factors were reported in only 1 or 2 studies. These factors were sometimes associated with suicide and attempts, but the few studies limited confidence. Thus, further exploration of factors such as firearm status, marital status, and various forms of interpersonal violence is warranted."

3	Page 2 says studies of “nontraditional” risk or protective factors were included, which doesn’t align with Table 2 of inclusion/exclusion criteria. These should be aligned, and if the inclusion criteria of “studies of ‘nontraditional’ risk or protective factors” is retained, it should be clarified/specified.	We’ve changed the term “nontraditional” to “modifiable”. Due to the large amounts of research available on sex, race and age as risk factors for suicidal behaviors, we focused our report on other factors that have the potential to be modified, to align with VAs mission to reduce suicidal behaviors.
	Homelessness is not a community level factor. Individual experience of homelessness (i.e., being homeless) is an individual-level factor. If the studies included were indeed evaluating the degree of homelessness in the community as an exposure variable, then this should be specified as such. If they were assessing the association between being homeless and suicide risk, then these studies should be re-categorized into the individual level group.	We agree with the reviewer and have moved homelessness to the individual domain.
	It seems overly simplistic to state that the converse of a risk factor could be interpreted as a protective factor (page 8). Protective factors should ideally operate as a buffer – reducing risk despite/in the context of harmful experiences. Recommend removing this statement.	We agree and have removed this statement.
	When the data source is specified as “VHA” and “DoD” are these all administrative data? It would be good to specify this so that people know it is admin data vs. simply the study took place at VHA. Specifically Table 3 could say “VHA administrative databases” or similar.	Thank you, we’ve added to Table 3 to clarify that this refers to VHA or DoD administrative data.
4	There is some discussion related to standardization of risk factors/modeling adjustments -- am wondering if it is worthwhile to mention efforts made by NIH and other mechanisms that fund suicide prevention research to use common data elements	We agree. While not specifically mentioning efforts by NIH we note that future research would benefit from common data elements including measures of risk factors.

	(including measure of risk factors) to increase comparability across studies	
5	This report is excellent. Some minor comments are noted below.	Thank you.
	Excluding studies of populations known to be at high risk by virtue of mental health diagnoses or past suicide attempts likely limits the implications regarding risk and protective factors for those at heightened chronic suicide risk. This may be important to note outright.	We agree that it limits broader implications, the intent was to review risk factors in broad populations, not to look at groups that were otherwise known to be at high-risk. Our goal was to see, in general populations, what risk factors were identified. Language has been added to the report in an attempt to make this more clear.
	More description of the operationalization used to define "nontraditional" risk or protective factors and the rationale for excluding these from the review would be useful to include. Also, demographics were listed in Table 4, but weren't these excluded due to being "nontraditional"?	We've changed the term "nontraditional" to "modifiable". Due to the large amounts of research available on sex, race and age as risk factors for suicidal behaviors, we focused our report on other factors that have the potential to be modified. Studies which only reported sex, age, or race were not included in the report. However, if a study reporting other factors also reported sex, race, age, we tallied those up but did not go into detail discussing results of these factors in this report.
	For the domains categorized under community-level, it would be helpful to state the rationale for categorizing in this way, particularly for homelessness, which seems to be an individual level factor and also which isn't necessarily bound to a certain region or area.	Categorizing factors was a difficult process as many factors could conceptually fit into multiple categories. The study team, along with content experts and Technical Expert Panel members categorized each factor as best they could, given definitions provided by study authors. We agree with the reviewer and have moved homelessness to the individual domain.
	Table 1. Several of the examples would benefit from clarification or additional detail to ensure accurate categorization. For example, the "barriers to health care" example could be revised to ensure it is specific to the community; otherwise, such barriers would likely be at the individual level (e.g., personal stigma, lack of insurance) or societal level (e.g.,	We agree, and if specific barriers were judged to be at an individual level, that is where we categorized it in the evidence tables for the review. Table 1 was meant to provide a broad overview of the types of factors that exist, and how they could be categorized based on the Social-Ecological Model. These examples were derived from another systematic review. We have added a footnote to the table to cite where the examples came from.

	societal norms regarding help-seeking). Similarly, it would be worth specifying for "cultural and religious beliefs" that these are within the community. The societal level examples would also benefit from being refined accordingly (e.g., for stigma and lethal means access, this would presumably be more about broad norms or laws that enable these). Table 2, timing- were studies excluded if it was unclear if the risk factor preceded the suicide/suicide attempt? How was quality of the assessment methods of suicide attempt and suicide factored into the risk of bias ratings? Could this information be provided outright for future reviews?	Yes. We used the QUIPS tool for prognostic studies to rate risk of bias, which does include a domain for outcome assessment. Specifically, the tool asks: "*A clear definition of outcome is provided; The method of outcome measurement used is adequately valid and reliable to limit misclassification bias; The method and setting of outcome measurement is the same for all study participants."*
6	• Odd wording p10 ""feeling others' would be better off I was dead", probably easiest fix would be removing the apostrophe for others as it is not possessive and adding and if- "better off if I was dead" • The first 3 paragraphs on page 11 start with the same structure. It would read better if it did not count the number of studies in each but led with the constructs of interest for each. • The first time STARRS is mentioned (p 11), there is no full title and no description. Will the reader know what this is? • STARRS is not included in the acronyms list (p 16) • I would suggest you separate out risk from protective factors in table 4 (p 26) as it is	This was a typo that has been edited. Thank you for the suggestion. This has been edited to spell out acronym and describe the STARRS study briefly. Thank you, this has been added to the table.

	confusing to try to quickly determine which variables might be considered risk and which are protective • Love appendix C (p 46) but probably needs editing	This table is intended to show a summary of what was reported. It was often uncertain if a factor was a risk or protective factor, as many results were mixed. Thank you, you may be the first reviewer to have noticed our template placeholder language (or at least comment on it). Appendix has been edited.
7	Inconsistent use of 'risk of bias' and 'ROB', not sure it matters, just wanted to point out. some minor grammar issues (see highlights) - pg 3 line 51 - 'better of IF I was dead'. pg 5 line 26 - 'history OF TBI'. pg 6 line 38 - unclear verbiage. pg 7 line 50 - accompany used as adjective here so consider 'accompanying evidence map'; verb tense; 'as well AS'. pg 19 line 10 - perhaps a misplaced 'I'. pg 20 - consider adding box for 'societal level' and denoting 0 studies. pg 26 line 5 - BMI, consider clarify body mass index, only clarified in footnote of table.	Thank you, all of these corrections have been made.
8	The review is comprehensive and analysis excellent. I had the following questions/comments: 1) what is the rationale for limiting the studies to the past 10 years? Especially as this will bias results towards studies of OEF/OIF Veterans/soldiers. Valuable information for other cohorts (e.g. Vietnam; which are especially at high risk for suicide death/attempts) may not be fully captured within this time frame 2) some of the designations for individual, social and community were not clear to me. For example: In the initial description of the model, social isolation is listed as an example of an "individual" factor (pg 10) but in the listing on table 4, is now under social category. Similarly, not sure how homelessness is under	Thank you. We limited our search from 2011 because VA ESP conducted a review on suicide risk factors which was published in 2012, which used similar inclusion criteria to this review. Our report does include Veterans from many different service-eras, as age of participants was not an exclusion criterion. Thank you for pointing out these discrepancies. Categorizing factors was a difficult process as many factors could conceptually fit into multiple categories. The study team, along with content experts and the Technical Expert Panel members categorized each factor as best they could given the definition provided by study authors. Table 1 is just an example of how factors *could* be categorized. We've

		community as housing problems seems closer to legal and financial problems; which are individual factors.	added some clarity to the report to indicate that Table 1 is just an example. In our report, the 1 study that reported on "social isolation" grouped it together with "perceived burdensomeness" and "thwarted belongingness"; therefore, we categorized it as a relational factor in this instance. We agree with the reviewer and have move homelessness to the individual domain.
		3) I struggled conceptually with the decision to limit the review to general population and decision to not include individuals known to be at heightened risk (e.g. depression, mental illness and suicide history). However, the report contains much data exactly on these individuals. For example on, pg 18, "10 studies examined the association of previous suicide attempts or ideation with future attempt or suicide". Plus in table 4, 22 studies looked at "other mental illness". A better clarification of why these studies were included in needed. In essence, the review's finding confirm what we knew about elevated suicide risk pertaining to history of mental illness and previous attempt. I think there needs to be a better synthesis of the findings with what is already known and the decision to exclude these individuals in the review. Also, perhaps its a separate question, but would be extremely important to know what are the risk and protective factors of individuals at risk for suicide (not just general population)... as these are the individuals likely to have suicide event(s).	We were tasked with identifying risk or protective factors in a general population (eg, <50% were already at elevated risk for suicide). However, previous suicide attempt or other well-known risk factors were still reported within the general population, which is why they were included in the review as identified factors. We agree, that it is important to understand risk and protective factors of at-risk individuals, however, that was outside the scope of this review.
		4) I completely agree with the need for studies examining combination of factors.	Thank you.
	9	Page 1, line 20 (and throughout): Social-Ecological Model vs. Socio-Ecological Framework. I'm assuming these are the same?	These are the same, we have edited the report to reference the Social-Ecological Model for consistency.

		Page 4: It should be mentioned (and it may be in the body of the report) that homelessness is the result of both individual and structural factors and can be classified as both an individual- and community-level risk factor (depending on how it is conceptualized in the research). In addition, I think it would be useful to define the societal level of the SEM even if there are no studies that report on this factor.	This is described in the report, as you have noted in your following comment.
		Page 18, line 25: PTSD was not consistently associated with suicide, meaning sometimes it was and sometimes it was not?	Correct. Results were mixed.
		Page 19, line 10: A word seems to be missing?	Thank you, this was corrected.
		Page 19, lines 25-28: I do not understand this sentence.	This sentence was edited for clarity.
		Page 19, Table 4: The authors mention in Table 2 that "studies including >50% participants with increased risk of suicide due to prior suicide attempters or with specific mental or physical health conditions known to increase suicide risk" are excluded. But, clearly, previous suicide attempt/suicidal ideation is an individual-level risk factor included in 10 studies. So, just to be clear: if less than 50% of the sample had that indicator, the study was included; if more than 50%, the study was excluded?	Correct, we were tasked with identifying risk or protective factors in a general population (eg, <50% were already at elevated risk for suicide). However, previous suicide attempt or other well-know risk factors were still reported, which is why they were included in the review as identified factors.
		Table 5 provides a nice snapshot of the results!	Thank you!
		Page 28, line 24: The brief description here of the societal level of the SEM addresses my comment on page 4.	Thank you.
		Table 6: I find it interesting that tobacco use	

		shows up as particularly “risky” for suicide-related outcomes. I wonder if it would be useful to break out alcohol, tobacco, and other drug use into 3 categories so readers can see which substances are associated with risk as that seems to vary across studies (and certainly has different implications for interventions or explanations/theories for increased suicide risk).	We agree, it would be useful to break out into separate categories, unfortunately, several included studies grouped these together as a generic “substance abuse” or used diagnostic codes for Substance Abuse Disorder, and we didn’t have enough information to make this more granular.
		Page 32, line 54: I wonder if it would be useful to provide a summary of how the outcomes—suicide death and suicide attempt—were reported. Or, at least note what the differences were (e.g., timing of the event, data used to assess the event, etc.). This could be useful for researchers in determining the appropriate way to assess such outcomes in future work.	The vast majority of included studies used administrative data for suicide death (NDI, VA, etc.); suicide attempts were most often captured via self-report survey data.
		Page 35, lines 52-54: When the authors discuss “factor classifications and definitions,” are they referring to risk factors? So, are the authors suggesting that there may need to be a more uniformly agreed upon way to code or categorize variables that may predict suicide? I agree and, if that is the authors’ intent, I think it would be useful to state that in a more concrete and explicit way.	Thank you, we have elaborated on this sentence in the report to adequately convey this thought.

APPENDIX D. EVIDENCE TABLE

Appendix Table D1. Study Characteristics and Outcomes for All Low and Moderate Risk of Bias Studies (k=54)

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Barry, 2018[41] Retrospective Cohort Low	Veteran 10,000-99,999 VHA, CMS, VA SPAN, SDR	**Transition from prison to civilian life** (Reentry vs never incarcerated)	↔	↑	Homelessness, sum of 13 medical conditions, TBI, and any psychiatric disorder
Barth, 2016[31] Retrospective Cohort Moderate	Veteran (Gulf War) ≥100,000 VHA, DoD, NDI, Social Security	**Exposure to nerve gas** (1- or 2-days vs no/unknown exposure)	↔	NR	Race, branch of service, type of unit, and age
		Gulf War Veteran status (compared to non-Gulf War Veterans)	↔	NR	
Bernecker, 2019[6] Prospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS, MHSDR	**Ever bullied by unit**	NR	↑	Predictors with significant univariate associations with SA were combined to generate within-category multivariate models, which were then trimmed to exclude nonsignificant predictors. The predictors in each of these within-category multivariate models were then combined into a final second-stage model. Also adjusted for seasonality and months since survey.
		Recent interpersonal problems	NR	↔	
		Any lifetime mental disorder	NR	↔	
		More-than-mild TBI in past 5 years	NR	↔	
		Any other TBI	NR	↔	
		Spent time in jail	NR	↔	
		Responsible for death of an enemy	NR	↑	
		Recent general stressors	NR	↔	
		Enlisted rank	NR	↔	
		Number of deployments	NR	↑	
Bishop, 2020[49] Case-control Moderate	Veteran 10,000-99,999 VHA	**Depression**	NR	↑	Sleep-related breathing disorders, insomnia, nightmares, PTSD, depression, anxiety, schizophrenia, bipolar disorder,
		Anxiety	NR	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Bipolar	NR	↑	SUD, medical comorbidity, obesity, number of sleep medicine visits in the 180 days prior to the index date
		Schizophrenia	NR	↑	
		PTSD	NR	↑	
		Substance use disorder	NR	↑	
		Insomnia or nightmares	NR	↑	
		Obesity	NR	↓	
Blow, 2012[50] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, NDI	**VHA users** (compared to general population)	↑	NR	Age
Bohnert, 2017[42] Retrospective Cohort Low	Veteran ≥100,000 VHA, NDI	**Any SUD**	Male ↑ Female ↑	NR	Age, Charlson Comorbidity Index, and psychiatric diagnoses Covariance sandwich estimators were used to adjust for clustering within VHA facilities
		Alcohol use disorder	Male ↑ Female ↑	NR	
		Cocaine use disorder	Male ↑ Female ↔	NR	
		Cannabis use disorder	Male ↑ Female ↔	NR	
		Opioid use disorder	Male ↑ Female ↑	NR	
		Amphetamine or other psychostimulant use disorder	Male ↑ Female ↔	NR	
		Sedative, hypnotic, or anxiolytic use disorder	Male ↑ Female ↔	NR	
Bohnert, 2014[7] Prospective Cohort Low	Veteran ≥100,000 VHA, NDI	**Tobacco use disorder**	↑	NR	Age group, sex, Charlson score, VHA service connection, substance use disorder, bipolar disorder, depression, other anxiety disorder, posttraumatic stress disorder, and schizophrenia

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Bullman, 2018[12] Retrospective Cohort Moderate	Veteran (OEF/OIF) ≥100,000 DoD, SDR, NDI	**Single** (compared to married)	↑	NR	Race, sex, age at entry to follow-up, and year of death
		Enlisted rank	↑	NR	
		Army/Marines (compared to others)	↑	NR	
		Active duty (compared to reserves)	↔	NR	
		In first year since discharge	↑	NR	
Bullman, 2019[51] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, DoD, SDR, NDI	**Deployment to Bosnia/Kosovo**	↓	NR	Age of entry, race, and sex
Chu, 2020[8] Prospective Cohort Moderate	Active Military 1,000-9,999 STARRS, Survey	**Perceived burdensomeness**	NR	↔	Sociodemographic and Army career characteristics, months in, and survey completion
		Thwarted belongingness	NR	↔	
		Hopelessness	NR	↔	
Conner, 2013[52] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, DNI	**PTSD**	↑	NR	Age
		Bipolar	↑	NR	
		Depression	↑	NR	
		Anxiety	↑	NR	
		Schizophrenia	↑	NR	
		Substance use disorder	↑	NR	
Cooper, 2020[43] Retrospective Cohort Low	Veteran ≥100,000 VHA, DoD	**Positive score on PC-PTSD screen**	↑	NR	Demographic characteristics, mental health diagnoses, treatment, and suicide attempts
Dempsey, 2019[53] Case-control Moderate	Active Military <1,000 STARRS, SHOS-B	**Own working gun**	↔	NR	Deployment status (never vs previously) and the number of years of active service (1-4, 5-8, or ≥ 9 years)
		Storing a loaded firearm at home	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Carrying a personal gun in public	↑	NR	
Cusack, 2020[30] Cross-sectional Low	Veteran ≥100,000 VHA, NDI	**Housing instability**	↑	NR	Age, sex, race, ethnicity, medical co-morbidity, service-connected disability status, and experience of military sexual trauma
		Military sexual trauma	↑	NR	
		Service-connected disability (50-100%)	↑	NR	
Dobscha, 2014[13] Case-control Moderate	Veteran <1,000 VHA	**Endorsed thoughts or attempts at suicide**	↑	NR	Specific adjustments to model not reported
		Major depressive disorder	↑	NR	
		Anxiety disorder	↑	NR	
		Bipolar disorder	↔	NR	
		Anger	↔	NR	
		Alcohol of substance use disorder	↔	NR	
		Relationship problems	↔	NR	
		Married	↔	NR	
		Isolation	↔	NR	
		Grief or loss of a loved one	↔	NR	
		Sleep problems	↔	NR	
		Functional decline	↑	NR	
		Legal problems	↔	NR	
		Financial problems	↔	NR	
		Job or school problems	↔	NR	
		Recently moved or plans to move	↔	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Service connected	↓	NR	
Doran, 2016[14] Retrospective Cohort Moderate	Veteran (Vietnam, Gulf War) 1,000-9,999 VHA, Survey	**History of sexual abuse**	NR	↔	Age, period of service, and diagnosis (depression, anxiety disorders other than PTSD, and SUDs)
		History of physical abuse	NR	↔	
		Previous suicide attempt	NR	↑	
		Previous self-harm	NR	↑	
		Depression/anxiety	NR	↔	
		Motivated for treatment	NR	↑	
		Good coping skills	NR	↓	
		Hopelessness	NR	↑	
		Substance use disorder	NR	↔	
Finley, 2015[15] Retrospective Cohort Moderate	Veteran (OEF/OIF) ≥100,000 VHA	**Suicide related behavior**	NR	↑	Specific adjustments to model not reported
		Depression	NR	↑	
		Anxiety disorder	NR	↑	
		Bipolar disorder	NR	↑	
		Schizophrenia	NR	↔	
		PTSD	NR	↑	
		Psychiatric hospitalization	NR	↔	
		Charlson Comorbidity Index score	NR	↔	
		Insomnia	NR	↔	
		TBI	NR	↔	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Chronic pain	NR	↔	
		Enlisted rank	NR	↑	
		Service component (guard or reserve compared to active duty)	NR	↑	
Goodin, 2019[16] Case-control Moderate	Active Military <1,000 DoD	**Failed or failing intimate relationship**	↑	↑	Age, sex, education, race/ethnicity, marital status, rank, and time since last deployment
		Prior self-harm or attempt	↔	↑	
		DSM-IV diagnosed mood disorder	↑	↑	
		Substance abuse	↑	↑	
		Court proceedings, nonjudicial punishment, or a civil legal problem (*eg*, child custody dispute, other litigation)	↔	↔	
		Excessive debt or bankruptcy	↔	↔	
		Work difficulties (hazing, coworker issues)	↔	↔	
Griffith, 2017[17] Case-control Moderate	Active Military 1,000-9,999 Army & National Guard Personnel System	**Unmarried**	↔	NR	Specific adjustments to model not reported
		Military occupation	↔	NR	
		Enlisted rank	↑	NR	
		Deployment	↔	NR	
		Less time in service	↑	NR	
		Part time military status (compared to full-time)	↑	NR	
Hoffmire, 2015[54] Cross-sectional Moderate	Veteran ≥100,000	**VHA utilization** (compared to Veterans who do not use VHA)	↓	NR	Age, gender

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
	VHA, DoD, State death certificate records				
Hostetter, 2019[55] Retrospective Cohort Moderate	Veteran ≥100,000 VA, DoD, SDR, NDI	**Traumatic brain injury**	↑	NR	Age, gender, psychiatric conditions, comorbidities, and other chronic conditions
Hyman, 2012[18] Cross-sectional Moderate	Active Military (OEF/OIF) ≥100,000 DoD, SDR	**Marital change (got married or divorced)**	↔	NR	Any mental health diagnosis, number of deployments to OEF/OIF, and selective serotonin reuptake inhibitor prescriptions
		Prior attempt	↑	NR	
		Mental health diagnosis	↑	NR	
		PTSD	↑	NR	
		Mental health visit	↑	NR	
		Substance misuse diagnosis	↑	NR	
		TBI diagnosis	↑	NR	
		Sleep aid prescription	↑	NR	
		Change in rank (demotion)	↑	NR	
		Enlisted rank	↑	NR	
		Number of deployments	↑	NR	
		Selective serotonin reuptake inhibitor prescriptions	↑	NR	
Ilgen, 2012[36] Retrospective Cohort Low	Veteran (OEF/OIF) ≥100,000 VHA, NDI	**Any psychiatric condition**	↑	NR	Cox proportional hazards survival model for time to suicide, controlling for sex, age, and Veterans Integrated Service Networks, adjusted for clustering at the
		Substance use disorder	↑	NR	
		Depression	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Schizophrenia	↑	NR	facility level using the covariance sandwich estimator. Separate survival models for each psychiatric diagnosis.
Ilgen, 2013[56] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, NDI	**Arthritis**	↔	NR	Age, sex, Charlson score, and concomitant psychiatric conditions
		Back pain	↑	NR	
		Migraine	↑	NR	
		Neuropathy	↔	NR	
		Headache or tension headache	↔	NR	
		Fibromyalgia	↔	NR	
		Psychogenic pain	↑	NR	
Kang, 2015[19] Retrospective Cohort Moderate	Veteran (OEF/OIF) ≥100,000 VHA, DoD, NDI	**Deployment**	↓	NR	Age at the start of follow-up, race, gender, marital status, service branch (Army, Marines/Air Force, and Navy), and rank (enlisted/officer)
		Ground troops (Army/Marine compared to others)	↔	NR	
		Enlisted rank	↑	NR	
		Time since discharge	↔	NR	
		Unmarried	↑	NR	
Katz, 2012[57] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, NDI, National Violent Death Reporting System	**VHA utilization for men under 30**	↓	NR	Age, gender
Kimerling, 2016[20] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, NDI	**Military sexual trauma**	↑	NR	Age, sex, medical morbidity, rurality, and mental health diagnoses
LeardMann, 2013[9]		**Depression**	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Prospective Cohort Moderate	Veteran, Active Military ≥100,000 DoD, NDI, Millennium Cohort Study, Armed Forces Health Surveillance Center	**Manic depressive disorder**	↑	NR	Age, sex, depression, manic-depressive disorder, heavy or binge drinking, alcohol-related problems
		Panic or other anxiety disorder	↑	NR	
		PTSD	↔	NR	
		Alcohol related problems	↑	NR	
		Physical component score	↔	NR	
		Life stressors	↔	NR	
		Military occupation	↔	NR	
		Military rank	↔	NR	
		Deployed	↔	NR	
		Deployed with combat	↔	NR	
		Number deployments	↔	NR	
		Service branch	↔	NR	
		Service component	↔	NR	
		Time deployed	↓	NR	
		Veteran status	↔	NR	
Louzon, 2016[35] Retrospective Cohort Low	Veteran ≥100,000 VHA, NDI	**Suicidal ideation (PHQ9 item 9)**	↑	NR	Age, sex, and psychiatric diagnoses, PHQ9 items 1-8
		Anxiety	↔	NR	
		PTSD	↓	NR	
		Substance use disorder	↑	NR	
		Depression	↔	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Depressive severity	↑	NR	
		Type of encounter in which PHQ9 administered	↔	NR	
Lynch, 2020[44] Retrospective Cohort Moderate	Veteran 10,000-99,999 VHA	**Sexual minority status**	↑	NR	Age
Martz, 2018[58] Retrospective Cohort Moderate	Veteran ≥100,000 (OEF/OIF) VHA, DoD, NDI, DMDC	**Tinnitus diagnosis**	↓	NR	Tinnitus diagnosis, attempted self-harm encounters, audiology or mental-health clinic visits, co-occurring health conditions, and age at first health encounter
		Previous attempt or self-harm	↑	NR	
		Tinnitus with depression and/or anxiety	↓	NR	
		Audiology or mental health clinic visit	↑	NR	
McCarthy, 2014[59] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, NDI	**Major depressive disorder**	↑	NR	BMI categories, VHA regional network, sociodemographic measures, and remaining study covariates
		Other depression	↑	NR	
		PTSD	↓	NR	
		Non-PTSD anxiety	↑	NR	
		Bipolar disorder	↑	NR	
		Schizophrenia	↑	NR	
		Eating disorder	↔	NR	
		Dementia	↔	NR	
		Any VHA mental health treatment	↑	NR	
		Substance use disorder	↑	NR	
		COPD	↑	NR	
		Head cancer	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Hypertension	↓	NR	
		Diabetes	↓	NR	
		Autoimmune disease	↔	NR	
		Hemi/paraplegia	↔	NR	
		Overweight/obese (compared to normal body mass index)	↓	NR	
Naifeh, 2017[10] Prospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS, MHSDR, Theater Medical Data Store, TRANSCOM	**General neurocognitive factor score**	↑	↑	Gender, age at neurocognitive testing, education, race/ethnicity, and history of mental health diagnosis at testing
Palframan, 2020[27] Retrospective Cohort Low	Veteran ≥100,000 VHA, DoD, NDI	**Use of Health Care for Reentry Veterans**	↔	↔	Demographic and clinical characteristics
		Use of Veterans Justice Outreach	↔	↔	
		Unmarried/single/divorced	↑	↑	
		Homelessness	↔	↑	
		Prior attempt	↑	↑	
		Alcohol and/or drug use	↑	↑	
		Anxiety	↑	↑	
		Bipolar	↑	↑	
		Depression	↑	↑	
		PTSD	↑	↑	
		Schizophrenia	↑	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Phillips, 2017[11] Prospective Cohort Low	Active Military (OEF/OIF) ≥100,000 DoD, MHSDR, DMDC, Recruit Assessment Program survey	**High school nongraduate**	↑	NR	"Given the interest in mental health conditions (depression, PTSD, and adjustment disorder) and deployment, these were maintained a priori in the final main model. All other factors were manually removed sequentially until the final model included only those that were significant (P < 0.05) or that caused a change in the hazard ratio (10% or greater) for the main exposure, TBI."
		Smoking	↑	NR	
		Military occupation (in-service)	↑	NR	
		TBI	↑	NR	
		Depression	↑	NR	
		Relationship counseling	↑	NR	
		PTSD	↓	NR	
		Time deployed	↑	NR	
		Adverse Childhood Experiences score	↑	NR	
		No social support	↑	NR	
Ravindran, 2020[60] Retrospective Cohort Moderate	Veteran ≥100,000 DoD	**Army/Marines** (compared to others)	↑	NR	Sex, age, race, and ethnicity
		Service component (active duty compared to reserves/guard)	↑	NR	
		Shorter time in service	↑	NR	
Reger, 2015[45] Retrospective Cohort Low	Veteran (OEF/OIF) Active Military ≥100,000 DoD, NDI	**Characterization of service at separation (not honorable or uncharacterized)**	↑	NR	Sex, age at cohort entry, educational attainment at cohort entry, race/ethnicity, and service branch at cohort entry
		Shorter time since separation from military service	↑		
Riberiro, 2017[61] Retrospective Cohort Moderate	Active Military 1,000-9,999 STARRS	**Inpatient, outpatient, or specialist mental health encounters 52 and 4 weeks prior to death**	↑	NR	Specific adjustments to model not reported

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Rosellini, 2017[21] Retrospective Cohort Moderate	Active Military 10,000-99,999 STARRS	**Sexual assault victim status**	NR	↑	Number of follow-up months between the month of the assault and the month of starting treatment
Ryan, 2020[62] Case-control Moderate	Active Military 1,000-9,999 DoD	**Depression or bipolar disorder**	↑	NR	Bipolar disorders, depression disorders, adjustment disorders and unspecified mental disorders
		≥ 1 outpatient or inpatient encounter	↑	NR	
Schinka, 2016[63] Retrospective Cohort Moderate	Veteran 10,000-99,999 VHA, NDI	**Homelessness**	↑	NR	Specific adjustments to model not reported
Schinka, 2018[64] Retrospective Cohort Moderate	Veteran 10,000-99,999 VHA, NDI	**Homelessness**	↑	NR	Diagnosed medical and psychiatric comorbidities, substance abuse, and use of VA
Shen, 2016[28] Retrospective Cohort Low	Veteran (OEF/OIF) Active Military ≥100,000 NDI, TRICARE, DMDC	**Recently divorced**	↑	NR	All variables in table, plus sex, race, age, marital status, dependent quantity, rank, Armed Forces Qualifying Test percentile, and military occupational specialty
		Prior self-inflicted injuries	↑	NR	
		Major depression	↑	NR	
		Bipolar disorder	↑	NR	
		Anxiety disorder	↑	NR	
		Other psychotic disorder	↑	NR	
		PTSD	↓	NR	
		Substance use disorder	↑	NR	
		Major non-drug related offense	↑	NR	
		Demotion	↑	NR	
		Military rank	↔	NR	
		Deployed	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Service branch	↔	NR	
		Service component (reserves vs active duty)	↓	NR	
		Time since separation from service	↑	NR	
Shiner, 2020[46] Retrospective Cohort Low	Veteran (Vietnam, OEF/OIF) ≥100,000 VHA, DoD, NDI	**Demographics** (age, sex, race, rurality)	↔	NR	Age, race, sex rurality
Skopp, 2016[22] Case-control Moderate	Active Military 10,000-99,999 DoD	**Failed intimate relationship w/in last 90 days**	↑	↑	Age, sex, education, race/ethnicity, marital status, rank, year, deployment to Iraq, deployment to Afghanistan, duration of last deployment, and time since last deployment
		Prior history of self-harm, anytime in the past	↔	↑	
		Any DSM-IV mood disorder any time in the past	↑	↑	
		History of substance abuse, last 90 days	↑	↑	
		Military or civilian legal problems, last 90 days	↑	↔	
Trofimovich, 2013[47] Retrospective Cohort Low	Active Military (OEF/OIF) 1,000-9,999 DoD, DMDC	**Combined infantry, gun crews, and seamanship specialists**	↑	NR	Sex, age group, and history of deployment to OEF/OIF
Ursano, 2015[65] Retrospective Cohort Moderate	Active Military (OEF/OIF) ≥100,000 DoD, STARRS	**Gender** (female)	NR	↑	Sociodemographic characteristics (sex, age at entry into Army service, current age, race, educational level, and marital status) with suicide attempts, followed by separate models evaluating incremental predictive effects of the length of service,
		Age at Army entry (≥ 25 years)	NR	↑	
		Current age (< 21)	NR	↑	
		Education level (< high school)	NR	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Length of service (1-2 years)	NR	↑	deployment status, and the presence or recency of a mental health diagnosis
		Deployment status (never or previously)	NR	↑	
		Time since most recent mental health diagnosis (1 month)	NR	↑	
Ursano, 2016[66] Retrospective Cohort Moderate	Active Military (OEF/OIF) ≥100,000 DoD, STARRS	**Gender** (female)	NR	↑	Logistic regression models included a dummy predictor for calendar month and year to control for increasing rates of suicide attempt from 2004 to 2009. Coefficients of other predictors were averaged within-month associations based on the assumption that effects of other predictors do not vary over time.
		Education (< high school)	NR	↑	
		Time in Service (1-2, 3-4 years)	NR	↑	
		Mental health diagnosis (depression, PTSD, SUD)	NR	↑	
Ursano, 2017a[48] Retrospective Cohort Low	Active Military ≥100,000 VHA, DoD, STARRS	**Combat arms or combat medic**	↑	NR	Logistic regression models include gender, age, age at Army entry, current age, race/ethnicity, education, marital status, time in service (≤ 1 year, 2 years, 3-4 years, 5-10 years, > 10 years), deployment status (never, currently, or previously deployed), and military occupation. The model also included a dummy predictor variable for calendar month and year to control for secular trends
Ursano, 2017b[33] Retrospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS	**Military occupation** (combat arms)	NR	↑	Logistic regression models that included basic sociodemographic and service-related variables (sex, age at entry into the Army, current age, race/ethnicity, educational level, marital status, time in service, deployment status, unit size, and number of past-suicide attempts) and included a dummy predictor variable for calendar month and year to control for secular trends
		Unit suicide attempts in the past year (>1)	NR	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Ursano, 2017c[32] Retrospective Cohort Moderate	Active Military (OEF/OIF) ≥100,000 DoD, STARRS	**IED frequency per month**	NR	↑	The multivariate model included sociodemographic variables (gender, current age, race, education, marital status), service-related variables (rank, time in service, deployment status), historical time (January 2004 to May 2007 vs June 2007 to December 2009), and combat operational variables (IED frequency [scaled in multiples of 1,000], combat deaths and injuries [scaled in multiples of 100], soldiers deployed and redeployed [scaled in multiples of 100,000].
		Deployment status (never)	NR	↑	
		Time in service (< 2 years)	NR	↑	
Ursano, 2018a[23] Retrospective Cohort Moderate	Active Military ≥100,000 DoD, STARRS	**Gender** (female)	NR	↑	Each 2-way interaction was examined separately in a model that included all of the sociodemographic and service-related variables but not the other 2-way interactions
		Education (< High school)	NR	↑	
		Age at army entry (< 21)	NR	↑	
		Time in service (1, 2, 3-4 years)	NR	↑	
		Deployment status (never or previously deployed)	NR	↑	
		Delayed Promotion (late)	NR	↑	
		Demotion in past year	NR	↑	
		Military occupation (combat arms or combat medic)	NR	↑	
		Marital Status	NR	↔	
Ursano, 2018b[25] Retrospective Cohort Moderate	Active Military 10,000-99,999 STARRS	**Marital status (never married)**	NR	↑	Univariate associations
		Education (high school, some college, and ≥ college)	NR	↓	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Risk Factors Reported	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Race (black, Hispanic, Asian, and other)	NR	↓	
		Military Rank (E1 – E2, E3)	NR	↑	
Ursano, 2018c[24] Retrospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS	**Never or previously married**	NR	↔	Sociodemographic characteristics (sex, race/ethnicity, educational level, and marital status), age at US Army entry, time in service before first deployment, duration of first deployment, dwell time, a dummy predictor variable for calendar month and year to control for secular trends, deployment status, and previous mental health diagnosis before second deployment
		Previously deployed	NR	↑	
		Previous mental health diagnosis before second deployment	NR	↑	
		Duration of first deployment, >13 months	NR	↑	
		Dwell Time, <6 months	NR	↑	
		Deployment status (previously deployed)	NR	↑	
		Time in service before first deployment (≤ 12 months)	NR	↑	
Ursano, 2018d[26] Retrospective Cohort Moderate	Active Military ≥100,000 DoD, STARRS	**Any history of family violence**	NR	↑	Socio-demographics (current age, race/ethnicity, education, marital status) and service-related variables (age at Army entry, time in service [1-2 years, 3-4 years, 5+ years], deployment status [never, currently, or previously deployed], and military occupation [combat arms vs. others]). Models also included a dummy predictor variable for calendar month and year to control for secular trends.

CMS=Centers for Medicare and Medicaid Services; DMDC= Defense Manpower Data Center; DoD=Department of Defense; IED=improvised explosive device; NDI=National Death Index; OEF/OIF=Operation Enduring Freedom/Operation Iraqi Freedom; MHSDR=Military Health System Data Repository; NR=not reported; PC-PTSD=Primary Care Posttraumatic Stress Disorder Screen; PTSD=Posttraumatic Stress Disorder; SHOS-B=Soldiers Health Outcomes Study; STARRS=Study to Assess Risk and Resilience in Servicemembers; SDR=VA/DoD National Suicide Data Repository; TBI=traumatic brain injury; VHA=Veteran's Health Administration; VA SPAN=Veteran's Administration's Suicide Prevention Applications Network

Appendix Table D2. Study Characteristics and Outcomes Related to Military Occupation as a Risk Factor Among Low and Moderate Risk of Bias Studies (k=7)

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Military Occupational Categories (Risk Factor)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Griffith, 2017[17] Case-control Moderate	Active Military 1,000-9,999 Army & National Guard Personnel System	**Combat military occupation (yes/no)**	↔	NR	Specific adjustments to model not reported
LeardMann, 2013[9] Prospective Cohort Moderate	Veteran, Active Military ≥100,000 DoD, NDI, Millennium Cohort Study, Armed Forces Health Surveillance Center	**Combat specialist**	↔	NR	Age, sex, depression, manic-depressive disorder, heavy or binge drinking, alcohol-related problems
		Health care	↔	NR	
		Functional support, service and supply	↔	NR	
		Mechanical or electrical repair	↔	NR	
		Other	↔	NR	
Phillips, 2017[11] Prospective Cohort Low	Active Military (OEF/OIF) ≥100,000 DoD, MHSDR, DMDC, Recruit Assessment Program survey	**Occupational Grade E01 – E03 (reference group)**	↔	NR	"Given the interest in mental health conditions (depression, PTSD, and adjustment disorder) and deployment, these were maintained a priori in the final main model. All other factors were manually removed sequentially until the final model included only those that were significant (P < 0.05) or that caused a change in the hazard ratio (10% or greater) for the main exposure, TBI."
		Occupational Grade E04 – E07	↓	NR	
Trofimovich, 2013[47] Retrospective Cohort Low	Active Military (OEF/OIF) 1,000-9,999 DoD, DMDC	**Infantry, gun crews, and seamanship specialists**	↔	NR	Sex, age group, and history of deployment to OEF/OIF
		Electrical/mechanical equipment repairers	↔	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Military Occupational Categories (Risk Factor)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
		Functional support and administration	↔	NR	
		Service and supply handlers	↔	NR	
		Communications and intelligence specialists	↔	NR	
		Electronic equipment repairers	↔	NR	
		Health care specialists	↔	NR	
		Other technical and allied specialists	↔	NR	
		Craftsworkers	↔	NR	
		Tactical operations officers	↔	NR	
		Health care officers	↔	NR	
		Groups with < 25	↔	NR	
Ursano, 2017a[48] Retrospective Cohort Low	Active Military ≥100,000 VHA, DoD, STARRS	**Combat arms**	↑	NR	Logistic regression models include gender, age, age at Army entry, current age, race/ethnicity, education, marital status, time in service (≤ 1 year, 2 years, 3-4 years, 5-10 years, >10 years), deployment status (never, currently, or previously deployed), and military occupation. The model also included a dummy predictor variable for calendar month and year to control for secular trends.
		Special Forces	↔	NR	
		Combat medic	↑	NR	
		Other	↔	NR	
Ursano, 2017b[33]	Active Military	**Combat arms**	NR	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Military Occupational Categories (Risk Factor)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Retrospective Cohort Moderate	10,000-99,999 DoD, STARRS	**Other**	NR	↔	Logistic regression models that included basic sociodemographic and service-related variables (sex, age at entry into the Army, current age, race/ethnicity, educational level, marital status, time in service, deployment status, unit size, and number of past-suicide attempts) and included a dummy predictor variable for calendar month and year to control for secular trends
Ursano, 2018a[23] Retrospective Cohort Moderate	Active Military ≥100,000 DoD, STARRS	Combat arms	NR	↑	Each 2-way interaction was examined separately in a model that included all of the sociodemographic and service-related variables but not the other 2-way interactions
		Special forces	NR	↔	
		Combat medic	NR	↑	
		Other	NR	↔	

DMDC= Defense Manpower Data Center; DoD=Department of Defense; NDI=National Death Index; OEF/OIF=Operation Enduring Freedom/Operation Iraqi Freedom; MHSDR=Military Health System Data Repository; NR=not reported; PTSD=Posttraumatic Stress Disorder; STARRS=Study to Assess Risk and Resilience in Servicemembers; TBI=traumatic brain injury; VHA=Veteran's Health Administration;

Appendix Table D3. Study Characteristics and Outcomes Related to Deployment Status Among Low and Moderate Risk of Bias Studies (k=14)

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Deployment Status Variable (study categories)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Barth, 2016[31] Retrospective Cohort Moderate	Veteran (Gulf War) ≥100,000 VHA, DoD, NDI, Social Security	**Gulf War Veteran status** (compared to non-Gulf War Veterans)	↔	NR	Race, branch of service, type of unit, and age
Bernecker, 2019[6] Prospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS, MHSDR	**Number of prior deployments (range 0 – 4)**	NR	↑	Predictors with significant univariate associations with SA were combined to generate within-category multivariate models, which were then trimmed to exclude nonsignificant predictors. The predictors in each of these within-category multivariate models were then combined into a final second-stage model. Also adjusted for seasonality and months since survey.
Bullman, 2019[51] Retrospective Cohort Moderate	Veteran ≥100,000 VHA, DoD, SDR, NDI	**Deployment to Bosnia/Kosovo (never deployed is referent)**	↓	NR	Age of entry, race, and sex
Griffith, 2017[17] Case-control Moderate	Active Military 1,000-9,999 Army & National Guard Personnel System	**Deployed (yes/no)**	↔	NR	Specific adjustments to model not reported
Hyman, 2012[18] Cross-sectional Moderate	Active Military (OEF/OIF) ≥100,000 DoD, SDR	**Number of deployments to OEF/OIF: 0**	↔	NR	Any mental health diagnosis, number of deployments to OEF/OIF, and selective serotonin reuptake inhibitor prescriptions
		Number of deployments to OEF/OIF: 1	↑	NR	
		Number of deployments to OEF/OIF: ≥ 2	↑	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Deployment Status Variable (study categories)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Ilgen, 2012[36] Retrospective Cohort Low	Veteran (OEF/OIF) ≥100,000 VHA, NDI	**Deployment to OEF/OIF (yes/no) (no referent group)**	↑	NR	Cox proportional hazards survival model for time to suicide, controlling for sex, age, and Veterans Integrated Service Networks, adjusted for clustering at the facility level using the covariance sandwich estimator. Separate survival models for each psychiatric diagnosis.
Kang, 2015[19] Retrospective Cohort Moderate	Veteran (OEF/OIF) ≥100,000 VHA, DoD, NDI	**Deployment (yes/no) (no referent group)**	↓	NR	Age at the start of follow-up, race, gender, marital status, service branch (Army, Marines/Air Force, and Navy), and rank (enlisted/officer)
LeardMann, 2013[9] Prospective Cohort Moderate	Veteran, Active Military ≥100,000 DoD, NDI, Millennium Cohort Study, Armed Forces Health Surveillance Center	**OEF/OIF not deployed (referent)**		NR	Age, sex, depression, manic-depressive disorder, heavy or binge drinking, alcohol-related problems
		OEF/OIF deployed without combat	↔	NR	
		OEF/OIF deployed with combat	↔	NR	
		Number of deployments: 0 (referent)	↔	NR	
		Number of deployments: 1	↔	NR	
		Number of deployments: >1	↔	NR	
Phillips, 2017[11] Prospective Cohort Low	Active Military (OEF/OIF) ≥100,000 DoD, MHSDR, DMDC, Recruit Assessment Program survey	**OIF/OEF deployment: never (referent)**		NR	"Given the interest in mental health conditions (depression, PTSD, and adjustment disorder) and deployment, these were maintained a priori in the final main model. All other factors were manually removed sequentially until the final model included only those that were significant (P < 0.05) or that caused a change in the hazard ratio (10% or greater) for the main exposure, TBI."
		OIF/OEF deployment: deployed	↓	NR	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Deployment Status Variable (study categories)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
Shen, 2016[28] Retrospective Cohort Low	Veteran (OEF/OIF) Active Military ≥100,000 NDI, TRICARE, DMDC	**Not deployed (referent)**		NR	All variables in table, plus sex, race, age, marital status, dependent quantity, rank, Armed Forces Qualifying Test percentile, and military occupational specialty
		Deployed during the current quarter	↓	NR	
		Deployed in the previous 3 quarters	↑	NR	
		Deployed in the previous 4 to 7 quarters	↑	NR	
		Deployed in the previous 8 to 11 quarters	↑	NR	
		Deployed in the previous 12 to fifteen quarters	↑	NR	
		Deployed in the previous 16 or more quarters	↔	NR	
Ursano, 2015[65] Retrospective Cohort Moderate	Active Military (OEF/OIF) ≥100,000 DoD, STARRS	**Deployment status: never**	NR	↑	Sociodemographic characteristics (sex, age at entry into Army service, current age, race, educational level, and marital status) with suicide attempts, followed by separate models evaluating incremental predictive effects of the length of service, deployment status, and the presence or recency of a mental health diagnosis
		Deployment status: currently (referent)	NR		
		Deployment status: previously	NR	↑	
Ursano, 2017c[32] Retrospective Cohort Moderate	Active Military (OEF/OIF) ≥100,000 DoD, STARRS	**Never deployed**	NR	↑	The multivariate model included sociodemographic variables (gender, current age, race, education, marital status), service-related variables (rank, time in service, deployment status), historical time (January 2004 to May 2007 vs June 2007 to December 2009), and combat operational variables (IED frequency [scaled in
		Currently deployed (referent)	NR		
		Previously deployed	NR	↑	

Author, Year Study Design Sample Size	Population Sample Size Data Source(s)	Deployment Status Variable (study categories)	Outcome and Direction of Effect*		Adjustments to Model
			Deaths	Attempts	
					multiples of 1,000], combat deaths and injuries [scaled in multiples of 100], soldiers deployed and redeployed [scaled in multiples of 100,000].
Ursano, 2018a[23] Retrospective Cohort Moderate	Active Military ≥100,000 DoD, STARRS	**Deployment status: Never**	NR	↑	Each 2-way interaction was examined separately in a model that included all of the sociodemographic and service-related variables but not the other 2-way interactions
		Deployment status: currently (referent)	NR		
		Deployment status: previously deployed	NR	↑	
Ursano, 2018c[24] Retrospective Cohort Moderate	Active Military 10,000-99,999 DoD, STARRS	**Currently deployed (referent)**	NR		Sociodemographic characteristics (sex, race/ethnicity, educational level, and marital status), age at US Army entry, time in service before first deployment, duration of first deployment, dwell time, a dummy predictor variable for calendar month and year to control for secular trends, deployment status, and previous mental health diagnosis before second deployment
		Previously deployed	NR	↑	

DMDC=Defense Manpower Data Center; DoD=Department of Defense; IED=improvised explosive device; NDI=National Death Index; OEF/OIF=Operation Enduring Freedom/Operation Iraqi Freedom; MHSDR=Military Health System Data Repository; NR=not reported; PTSD=Posttraumatic Stress Disorder; STARRS=Study to Assess Risk and Resilience in Servicemembers; SDR=VA/DoD National Suicide Data Repository; TBI=traumatic brain injury; VHA=Veteran's Health Administration