

DEFENSE AND VETERANS BRAIN INJURY CENTER
RESEARCH REVIEW
ON TRAUMATIC BRAIN INJURY AND SUICIDE

This research review provides an overview of the state of science regarding comorbid traumatic brain injury (TBI) and suicide and suicide attempts. Although differentiating symptoms of suicidal self-directed violence from other co-occurring mental health conditions is inherently difficult, this review aims to present information relevant to understanding these co-occurring conditions. Specifically:

- What is the prevalence of death by suicide in the general and military populations?
- How does TBI affect risk of suicide and suicide attempts in the general and military populations?
- What individual factors affect the risk of suicide or suicide attempts?
- What is the existing guidance on TBI and suicidality, especially in the military and veteran populations?

This review will not address suicide prevention or cases in which a TBI is sustained in the course of a suicide attempt.

AUDIENCE

This research review is intended for health care providers, researchers and administrators interested in the current research literature on the relationship of TBI and suicide in military and veteran populations.

DEFINITION AND PREVALENCE OF TBI

A traumatic brain injury (TBI) is defined as a structural injury to the brain or a disruption of the normal physiological functioning of the brain resulting from an external force, such as a blow, bump, or jolt to the head, an explosive blast, or a penetrating head injury. (Woodson, 2015) TBIs range in severity from mild to severe (Woodson, 2015), and a mild traumatic brain injury (mTBI) is commonly referred to as a concussion. (Department of Veterans Affairs & Department of Defense, 2016) Severity is determined based on the results from structural imaging on computed tomography, duration of loss of consciousness, duration of alteration of consciousness, duration of post-traumatic amnesia, and Glasgow Coma Scale score. (Assistant Secretary of Defense, 2015) The vast majority of TBIs in the U.S. military population are classified as mTBI, and data suggest this is true for civilian populations as well. (Defense and Veterans Brain Injury Center, 2017; Faul, Xu, Wald, & Coronado, 2010)

Military personnel are at increased risk for TBI compared to their civilian counterparts, (Curtin, Warner, & Hedegaard, 2016), perhaps due to risks inherent in training activities, combat operations in dangerous settings, and demographic factors. More than 360,000 military service members sustained TBIs between 2000-2016, predominantly mild (82.0%). (Defense and Veterans Brain Injury Center, 2017) In two large studies of non-medically evacuated soldiers screened for Operation Iraqi Freedom (OIF)/Operation Enduring Freedom (OEF)

deployment-related TBI, 14.0% to 23.0% screened positive for TBI during their deployment, and almost all TBIs were mild. (Schwab et al., 2007; Terrio et al., 2009)

SUICIDE NOMENCLATURE

Suicide can be categorized as part of a broader group of behaviors known as self-directed violence. (Stone et al., 2017) The intention of self-injurious behavior may be suicide or a less severe form of self-injury. (Crosby, Ortega, & Melanson, 2011) When discussing suicidal self-directed violence and suicide prevention research, it is useful to begin with a review of the recommended surveillance definitions proposed by the Centers for Disease Control and Prevention. (Crosby et al., 2011) The adoption of uniform definitions and terminology of suicide-related events facilitates an understanding of findings across diverse research studies. (Klonsky & May, 2015) Key terms used in the study of suicidal self-directed violence and suicide prevention are listed in Table 1 and were developed by the CDC with input from the Department of Defense, Department of Veterans Affairs and the Coast Guard. (Crosby et al., 2011; U.S. Department of Veterans Affairs & Department of Defense, 2013)

Table 1: Self-Directed Violence Terms and Definitions

Key Terms	Definition
<ul style="list-style-type: none"> • Non-Suicidal Self-Directed Violence 	Any action taken that is self-directed and intentionally results in injury or the potential for injury to oneself. There is no evidence of implicit or explicit suicidal intent.
<ul style="list-style-type: none"> • Suicidal Self-Directed Violence 	Any action taken that is self-directed and intentionally results in injury or the potential for injury to oneself with evidence, whether implicit or explicit, of suicidal intent.
<ul style="list-style-type: none"> • Suicide 	Death resulting from self-directed injurious behavior with any intention to end one’s life as a result of this action.
<ul style="list-style-type: none"> • Suicide Attempt 	A non-fatal self-directed and potentially injurious behavior with any intention to die as a result of this action.
<ul style="list-style-type: none"> • Suicidal Ideation 	Thoughts of engaging in suicide-related behavior. These thoughts can vary in terms of frequency, intensity and duration.
<ul style="list-style-type: none"> • Suicidal Intent 	Past or present evidence (implicit or explicit) that an individual wishes to die, intends to kill themselves, and comprehends the probable consequences of their actions or potential actions. Suicidal intent can be determined retrospectively and inferred in the absence of suicidal behavior.

PREVALENCE OF SUICIDE

General population

Suicide, which is the most extreme form of self-directed violence, is a serious public health concern worldwide. Suicide is currently identified as the 10th leading cause of death in the U.S., claiming more than 44,000 American lives per year (Centers for Disease Control &

Prevention, 2017), and the 15th leading cause of death worldwide. (World Health Organization, 2016)

Death by suicide has increased 25.0% in the U.S. since 1999. (Curtin et al., 2016) In 2014, suicide was the 10th leading cause of death in the U.S. (Kochanek, Murphy, Xu, & Tejada-Vera, 2016) A report from CDC indicates that the age-adjusted rate of suicide for adults in the U. S. was 13.0 per 100,000 in 2014. (Curtin et al., 2016)

Military and Veteran populations

According to the 2016 Department of Defense Suicide Event Report (DoDSER), the unadjusted incidence rate of suicide for active component service members across all services was 21.1 per 100,000 in 2016. (Pruitt et al., 2017) This rate is not significantly different from the suicide rate for civilians age 17-59. The DoDSER report describes the rates and numbers of suicides among different demographic groups in 2016. Rates were not reported for many smaller demographic groups. The plurality of service members who died by suicide in 2016 had: male gender, age under 30, white Caucasian race, non-Hispanic ethnicity, junior enlisted rank (E1-E4; as compared to senior enlisted or officer), high school education level, and married status. Substance abuse and adjustment disorders were the most common behavioral health diagnoses among service members who died by suicide, and mood and adjustment disorders were the most common among those who attempted suicide.

Suicide statistics for the U.S. veteran population indicate that in 2014, an average of 20 veterans per day died from suicide. Although veterans account for only 8.5% of the U.S. adult population, they disproportionately represent 17.9% of all deaths by suicide in U.S. adults. (U.S. Department of Veterans Affairs, 2016)

RISK FACTOR DEFINITION

Any characteristic that increases the likelihood an individual will consider, attempt, or die by suicide is a risk factor for suicide. (Substance Abuse and Mental Health Services Administration, 1999; Suicide Prevention Resource Center & Rodgers, 2011) For most, multiple risk factors are likely to influence risk for suicide. (Hawton & van Heeringen, 2009; Ludwig, Roy, Wang, Birur, & Dwivedi, 2017; Suicide Prevention Resource Center & Rodgers, 2011) A meta-analysis of 365 suicide studies over 50 years found that all single risk and protective factors examined had odds ratios of 4 or below for suicide, suicide attempts, and suicidal ideation. (Franklin et al., 2017) The authors argued that risk factors for these outcomes should have odds ratios of at least 750, 30, and 5, respectively, in order to be clinically significant and predictive. The Interpersonal Theory of Suicide, a widely-cited theoretical basis for understanding suicide, holds that three factors play a major role in suicides: thwarted belongingness, perceived burdensomeness, and capability to use lethal means. (Van Orden et al., 2010) Thus, any discussion of individual risk factors is inherently limited.

FACTORS ASSOCIATED WITH SUICIDE IN THE GENERAL POPULATION

In the U.S. in 2015, men were 3.5 times more likely to die by suicide than women. (Murphy, Xu, Kochanek, Curtin, & Arias, 2017) Among the five racial/ethnic groups considered, non-Hispanic American Indian or Alaska Native had the highest suicide rate of 19.9 per 100,000, followed by non-Hispanic white (18.1), non-Hispanic black (5.8), then non-

Hispanic Asian or Pacific Islander (6.7). Hispanic persons had the lowest overall suicide rate, 5.8 per 100,000. Persons aged 45-54 years were reported to have a higher suicide rate than other age groups, 20.3 per 100,000.

A 2018 CDC report found that in the U.S., 54.0% of people who died by suicide did not have a known mental health condition. (Stone et al., 2018) This result appears to contrast with prior work showing a strong relationship between psychiatric conditions and suicide. A 2004 meta-analysis of 27 studies reported that 87.3% of subjects had a mental disorder. A 2017 meta-analysis found that prior psychiatric hospitalization increased risk of suicide with a weighted odds ratio of 3.57. (Franklin et al., 2017) Prior suicide attempt and prior suicide ideation were associated with weighted odds ratios of 2.24 and 2.22, respectively. Other significant factors reported in that meta-analysis were lower socioeconomic status (odds ratio 2.20) and stressful life events (odds ratio 2.18).

FACTORS ASSOCIATED WITH SUICIDE IN SERVICE MEMBER AND VETERAN POPULATIONS

A 2017 large-scale retrospective study of over 100,000 active-duty enlisted male Marines reported a number of factors associated with death by suicide. In the multivariable model, the following factors were the most significant: certain occupational categories, particularly nonqualified (hazard ratios ranged from 1.60 to 15.60 for different categories); TBI diagnosis (hazard ratio 4.09); and receiving relationship counseling (hazard ratio 3.71). To a lesser magnitude, depression diagnosis (hazard ratio 2.36), having less than a high school education (hazard ratio 2.17), and smoking at the time of enlistment (hazard ratio 1.91) also contributed to risk of suicide death. (Phillips, LeardMann, Vyas, Crum-Cianflone, & White, 2017)

A retrospective case-control study matched 1,764 U.S. service members who died from suicide with control service members. In the multivariate analysis, mTBI, PTSD, and alcohol dependence were not associated with suicide. (Skopp, Trofimovich, Grimes, Oetjen-Gerdes, & Gahm, 2012) Suicide was associated with mood disorder (odds ratio 1.6, 95% confidence interval [CI] 1.37 to 1.80), partner relationship problems (odds ratio 2.0, 95% CI 1.51 to 2.63), and family circumstance problems (odds ratio 2.0, 95% CI 1.25 to 3.04).

Two studies of veterans receiving care from the Veterans Health Administration show a relationship between psychiatric conditions and suicide. Ilgen et al. found that among more than 3 million veterans, those with any psychiatric diagnosis had a hazard ratio of 2.60 (95% CI 2.47 to 2.74) for death by suicide as compared to those without any such diagnosis. (Ilgen et al., 2010) The largest hazard ratio was reported for bipolar disorder, 3.19 (95% CI 2.94 to 3.46). A follow-up study by the same researchers with a larger cohort confirmed the association between diagnosed mental health condition and suicide (hazard ratio 4.41, 95% CI 2.57 to 7.55 for OEF/OIF veterans; hazard ratio 2.48, 95% CI 2.27 to 2.71 for non-OEF/OIF veterans). (Ilgen et al., 2012)

Two 2016 studies using a DoDSER database suggested that life circumstances may contribute to suicide risk. A latent class analysis of 424 service member suicides found that factors including a failing intimate relationship, substance abuse history, mental health diagnosis, and prior self-injury were the most commonly endorsed indicators assessed. (Skopp,

Smolenski, Sheppard, Bush, & Luxton, 2016a) A case-control study compared 85 U.S. soldiers who died from suicide to control soldiers. The largest effects on suicide risk were a failing intimate relationship (odds ratio 7.22, 95% CI 3.55 to 14.67), legal difficulties (odds ratio 4.73, 95% CI 1.77 to 12.62), and substance abuse (odds ratio 3.35, 95% CI 1.57 to 7.12). (Skopp, Zhang, Smolenski, & Reger, 2016b)

FACTORS ASSOCIATED WITH SUICIDE IDEATION OR ATTEMPTS IN SERVICE MEMBER AND VETERAN POPULATIONS

For military service members, stressful military events, including deployment and combat experience, can increase risk for suicidal ideation. (Vanderploeg et al., 2015) Psychiatric disorders have been consistently reported as a risk factor for suicide ideation and attempts in studies of civilian, service member, and veteran populations. (Finley et al., 2015; Maguen, Skopp, Zhang, & Smolenski, 2015; Pietrzak et al., 2010; Simpson & Tate, 2007) Post-traumatic stress disorder (PTSD) has been found to be associated with increased risk of suicide ideation. (Krysinska & Lester, 2010; Pompili et al., 2013) In a study of OEF/OIF veterans, those who screened positive for PTSD were 4.5 times more likely to report suicidal ideation. (Jakupcak et al., 2009)

An analysis of 3,916 U.S. soldiers with self-reported history of suicidal ideation examined risk factors for subsequent self-reported suicide attempt. The largest effects were seen for low controllability of suicidal thoughts (odds ratio 3.0, 95% CI 1.9 to 4.9), extreme risk-taking or “tempting fate” often (odds ratio 2.7, 95% CI 1.7 to 4.1), and failure to answer questions about the characteristics of one’s suicidal thoughts (odds ratio 6.7, 95% CI 2.5 to 18.3). (Nock et al., 2018) Recent onset of ideation and presence and recent onset of a suicide plan were also reported as risk factors, but odds ratios were provided only for subgroups.

The Army Study to Assess Risk and Resilience in Service members (STARRS) yielded a number of publications on suicide, suicide attempts, and related issues among service members (Ursano et al., 2014) and is now being followed by a longitudinal study called STARRS-LS. (U.S. Department of Defense, 2018) Data from 9,791 suicide attempters and a sample of 183,826 control person-months found that the strongest predictor of suicide attempt was a mental health diagnosis during the previous month, with an odds ratio of 18.2 (95% CI, 17.4 to 19.1) among enlisted soldiers and 90.2 (95% CI 59.5 to 136.7) among officers. (Ursano et al., 2015) A subsequent analysis of Army STARRS data showed that those currently deployed or previously deployed have a higher risk of suicide attempt than those never deployed (currently deployed: OR, 4.0; 95%CI, 2.9 to 5.6; previously deployed: OR, 2.7; 95%CI, 1.8 to 3.9). (Ursano et al., 2016) Other publications provide information on specific military occupations, (Ursano et al., 2017c), the influence of suicide attempts among unit members, (Ursano et al., 2017a), and the relationship between improvised explosive device (IED) events and suicide. (Ursano et al., 2017b)

A study of 273,591 veterans (16% with TBI history) receiving care from the Department of Veterans Affairs reported a connection between TBI, PTSD, and suicide attempts. The authors found an increase of suicide attempts among those with deployment-related TBI compared to those without TBI (hazard ratio 3.76, 95% CI 3.15 to 4.49). (Fonda et al., 2017) A further analysis showed that psychiatric conditions mediated 83% of the association between TBI and attempted suicide, with PTSD having the largest impact (hazard

ratio 2.62, 95% CI 2.23 to 3.07 for PTSD alone, and hazard ratio 2.98, 95% CI 2.59 to 3.43 for comorbid PTSD and TBI history).

The above-mentioned studies based on DoDSEER data reported on factors contributing to suicide attempts. A latent class analysis of 1,433 service member suicide attempts found that legal/administrative problems, history of substance abuse, and workplace difficulties were endorsed more often than other factors. (Skopp et al., 2016a) A case-control study compared 191 U.S. soldiers who attempted suicide to control soldiers. The largest effects on suicide risk were a failing intimate relationship (odds ratio 5.10, 95% CI 2.72 to 9.58), any history of mood disorder (odds ratio 4.14, 95% CI 2.07 to 8.29), and substance abuse (odds ratio 4.01, 95.0% CI 2.13 to 7.55). (Skopp et al., 2016b)

TBI AND RISK FOR SUBSEQUENT SUICIDE

Population-level investigations have consistently found elevated rates of death by suicide, as well as suicide attempts and suicide ideation in individuals with a positive history of TBI. A systematic review conducted by Bahraini et al. supported an increased risk of suicide among persons with TBI history compared to those with no TBI history. (Bahraini, Simpson, Brenner, Hoffberg, & Schneider, 2013) Some non-military studies have reported that the risk of death by suicide may be three to four times higher for individuals with TBI than for the general population. (Simpson & Tate, 2007) A surveillance study of 20 years of data from Canadian health and vital statistics databases found that persons with mild TBI were three times more likely to die of suicide compared to the general population. (Fralick, Thiruchelvam, Tien, & Redelmeier, 2016) The authors found that those who sustained their injury on a weekend were at slightly higher risk than those who sustained their injury on a weekday.

Swedish researchers conducted a large longitudinal study and found that TBI patients are three times more likely to die by suicide when compared to matched controls from the general population without a history of TBI (Fazel, Wolf, Pillas, Lichtenstein, & Langstrom, 2014), and the same rate of increase in suicide death one year post-TBI was found in a study by Harrison-Felix et al. (Harrison-Felix et al., 2009) A population study of TBI severity and suicide found that more severe TBI has a greater effect on the risk of death by suicide. Groups with concussion, cranial fracture, and cerebral contusion or traumatic intracranial hemorrhage had mortality ratios from suicide of 3.0, 2.7, and 4.1, respectively. (Teasdale & Engberg, 2001) However, the extent to which TBI severity impacts risk of suicide and suicide attempts has not been studied extensively, and further investigation is needed. (Bahraini et al., 2013)

The pattern of elevated risk for death by suicide after TBI has also been observed in military and veteran populations but not universally. Brenner et al. (2011) conducted a large-scale retrospective study of veterans who received care from the Veterans Health Administration (n = 49,626 with TBI history, n = 389,035 without TBI history). They found that veterans with a history of TBI were 1.5 times more likely to die by suicide compared to veterans with no diagnosis of TBI. (Brenner et al., 2011) In a large-scale retrospective study of over 100,000 active-duty enlisted male Marines, TBI diagnosis was one of six variables significantly associated with an increased risk of death by suicide (hazard ratio for TBI 4.09, 95% CI 2.08 to 8.05). (Phillips, LeardMann, Vyas, Crum-Cianflone, & White, 2017)

In contrast to the above positive findings, a retrospective case-control study matched 1,764 U.S. service members who died from suicide with control service members. In the multivariate analysis, mTBI, PTSD, and alcohol dependence were not associated with suicide. (Skopp et al., 2012) Statistics on the association between suicide and moderate or severe TBI were not reported. The difference in findings may be due to the case-control design, which contrasts with the above cohort designs.

Suicide is a rare event. As Franklin et al. argued, even if a person has a three-fold elevated risk of death by suicide, “in absolute terms they would still have a near-zero risk of dying by suicide that year.” (Franklin et al., 2017) The studies cited here suggest that TBI could increase risk of death by suicide by up to three- to four-fold, but the overall risk of suicide death remains low for civilians, service members, and veterans. (Curtin et al., 2016; Pruitt et al., 2017; U.S. Department of Veterans Affairs, 2016)

TBI AND RISK FOR SUBSEQUENT SUICIDE ATTEMPTS

A study by Fisher et al. examined the prevalence rate of suicide attempts in a large sample (n = 8,547) of community-dwelling individuals with history of moderate to severe TBI. (Fisher et al., 2016) Suicide attempts were reported at a rate of 800 to 1,700 per 100,000, with the highest rates in the first year after injury and the lowest rates after 15 to 20 years of follow-up.

A large study of OEF/OIF veterans (n = 273,591) receiving care from the Department of Veterans Affairs found that the risk of suicide attempt was 25.0% higher among those with deployment-related TBI compared to those without deployment-related TBI. (Fonda et al., 2017) In that study, PTSD, mood disorder, anxiety disorder, and substance use disorders mediated the increase in risk. However, deployment-related TBI is not universally associated with increased suicide attempts in the literature. A prospective study of three combat brigades (n = 7,742) found that deployment-related TBI was not significantly related to self-reported post-deployment suicidal ideation, plans, or attempts. (Stein et al., 2015)

TBI may contribute to risk of suicide or suicide attempt indirectly, by increasing the risk of psychiatric conditions including PTSD (Yurgil et al., 2014) or substance abuse. (Johnson, Eick-Cost, Jeffries, Russell, & Otto, 2015; Miller et al., 2013) Results from service member and veteran populations show that PTSD is associated with suicide or suicide attempt. (Finley et al., 2015; Skopp et al., 2012) A study of veteran suicides found that substance, alcohol, or drug abuse increased the risk of suicide (hazard ratios 2.47, 2.48, 2.33, respectively). (Ilgen et al., 2010)

PROTECTIVE FACTORS

Researchers have identified factors that appear to reduce the chances an individual will consider, attempt, or die by suicide regardless of TBI status. Quantitative information about the magnitude of protective effects was not found in this literature review. The VA/DoD Clinical Practice Guideline (U.S. Department of Veterans Affairs & Department of Defense, 2013) recommends assessing for protective factors but acknowledges that information on this topic is more limited than information on risk factors. Protective factors listed in the guideline are provided in Table 3.

Table 3: Protective factors listed by VA/DoD Clinical Practice Guideline for Assessment and Management of Patients at Risk for Suicide (U.S. Department of Veterans Affairs & Department of Defense, 2013)

Categories	Protective factors listed by VA/DoD Clinical Practice Guideline
Social Context Support System	<ul style="list-style-type: none"> • Strong interpersonal bonds to family/unit members and community support • Employed • Intact marriage • Child rearing responsibilities • Responsibilities/duties to others • A reasonably safe and stable environment
Positive Personal Traits	<ul style="list-style-type: none"> • Help seeking • Good impulse control • Good skills in problem solving, coping and conflict resolution • Sense of belonging, sense of identity and good self-esteem • Cultural, spiritual, and religious beliefs about the meaning and value of life • Optimistic outlook — Identification of future goals • Constructive use of leisure time (enjoyable activities) • Resilience
Access to Health Care	<ul style="list-style-type: none"> • Support through ongoing medical and mental health care relationships • Effective clinical care for mental, physical and substance use disorders • Good treatment engagement and a sense of the importance of health and wellness

A review focused on the military population cites social support, psychological factors such as resilience, and mental health treatment as protective factors. (Nock et al., 2013) The non-profit Suicide Prevention and Resource Center describes effective mental health care, connectedness to individuals, family, community, and social institutions, problem-solving skills, and contact with care providers as protective factors. (Suicide Prevention Resource Center & Rodgers, 2011) A 2017 report by the National Center for Injury Prevention and Control highlights the importance of access to mental health services and suicide care as a means to reduce suicide risk factors. (Stone et al., 2017)

Brenner et al. conducted a small qualitative study of military veterans with a history of TBI, history of mental health treatment, and history of suicidality (a majority reporting suicidal ideation within 1 year). The most common factors cited as protecting against suicide attempt included social support (including the support of friends and family, as well feelings of responsibility for loved ones), a sense of purpose regarding the future, religion and spirituality,

and engagement with mental health treatment. (Brenner, Homaifar, Adler, Wolfman, & Kemp, 2009)

CURRENT CLINICAL GUIDELINES

The VA/DoD Clinical Practice Guideline for Assessment and Management of Patients at Risk for Suicide (U.S. Department of Veterans Affairs & Department of Defense, 2013) recommends immediate assessment of suicide risk after an individual is identified as suicidal. TBI is identified as one of several medical factors that may increase suicide risk. This guideline makes several specific recommendations for the development of a collaborative treatment plan involving the “patient, clinical team and, if the patient consents, others such as family members, unit members/command, community organizations or other resources available to the patient” with comorbidities including TBI history. First, treatment plans for suicidal individuals with TBI history should include evidence-based treatments for TBI in addition to suicide intervention. Treatment for TBI in persons at risk of suicide may require modification (e.g., dispensing limited doses of medications). Information regarding effectiveness in a TBI population should be considered to optimize risk reduction. Finally, treatment plans should include family members (with patient consent) and command for active-duty service members. (U.S. Department of Veterans Affairs & Department of Defense, 2013) The guideline addresses a number of pharmacological and non-pharmacological treatments but does not endorse specific treatments for persons with TBI history at risk of suicide. The guideline does not address screening for suicidality in a primary care setting.

CONCLUSIONS

As the 10th leading cause of death in the U.S., suicide is a public health issue. (Murphy et al., 2017) Within the service member and veteran populations, this issue has received increased attention with many efforts to understand the etiology and to prevent further occurrences. (U.S. Department of Defense, 2018) This research review summarizes current scientific literature on suicide and suicide attempts and its relationship to TBI with a focus on military/veteran relevance.

It is unclear to what extent TBI history contributes to the risk of suicide or suicide attempt, but evidence described in this research review suggests there is a modest effect. Efforts to understand resiliency and other protective factors for suicidal behavior are being studied. Neuroimaging, biomarkers, precision medicine, and other emerging technologies may provide information regarding protective and pathological mechanisms related to suicide behavior and TBI.

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