



Mild traumatic brain injury and suicide risk among a clinical sample of deployed military personnel: Evidence for a serial mediation model of anger and depression



Ian H. Stanley^{a, *}, Thomas E. Joiner^a, Craig J. Bryan^{b, c}

^a Department of Psychology, Florida State University, Tallahassee, FL, USA

^b Department of Psychology, University of Utah, Salt Lake City, UT, USA

^c National Center for Veterans Studies, Salt Lake City, UT, USA

ARTICLE INFO

Article history:

Received 1 August 2016

Received in revised form

29 September 2016

Accepted 6 October 2016

Keywords:

TBI

Suicide

Suicidality

Anger

Depression

ABSTRACT

Research has demonstrated a robust link between traumatic brain injuries (TBIs) and suicide risk. Yet, few studies have investigated factors that account for this link. Utilizing a clinical sample of deployed military personnel, this study aimed to examine a serial mediation model of anger and depression in the association of mild TBI and suicide risk. A total of 149 military service members referred for evaluation/treatment of a suspected head injury at a military hospital participated in the present study (92.6% male; $M_{\text{age}} = 27.9\text{y}$). Self-report measures included the Suicidal Behaviors Questionnaire—Revised (SBQ-R), Automated Neuropsychological Assessment Metrics (ANAM) anger and depression subscales, and Behavioral Health Measure-20 depression subscale. A current mild TBI diagnosis was confirmed by a licensed clinical psychologist/physician. Overall, 84.6% (126/149) of participants met diagnostic criteria for a current mild TBI. Bootstrapped serial mediation analyses indicated that the association of mild TBI and suicide risk is serially mediated by anger and depression symptoms (bias-corrected 95% confidence interval [CI] for the indirect effect = 0.044, 0.576). An alternate serial mediation model in which depression symptoms precede anger was not statistically significant (bias-corrected 95% CI for the indirect effect = -0.405, 0.050). Among a clinical sample of military personnel, increased anger and depression statistically mediated the association of mild TBI and suicide risk, and anger appears to precede depression in this pathway. Findings suggest that therapeutically targeting anger may serve to thwart the trajectory to suicide risk among military personnel who experience a mild TBI. Future research should investigate this conjecture within a prospective design to establish temporality.

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Suicide is the tenth leading cause of death in the general U.S. adult population (Centers for Disease Control and Prevention [CDC], 2016), and the second leading cause of death among military personnel, in particular (Ramchand et al., 2011). The increased risk observed among military personnel has been intractable across the past several years, with rates steadily increasing since as early as 2001 (Hoge and Castro, 2012; Kuehn, 2009; Ramchand et al., 2011). As such, the U.S. Department of Defense (Defense Suicide Prevention Office, 2014), the U.S. Department of Veterans Affairs (Kemp and Bossarte, 2013), and the U.S. Surgeon General (2012) have identified the understanding and prevention of suicide

among military personnel as a critical public health priority.

To address the rising suicide rates within the military, it is essential to consider suicide risk factors that may be unique to this population. For one, military training- and combat-related exposures, such as explosions and falls, may result in concussive injuries that meet diagnostic threshold for a traumatic brain injury (TBI). A burgeoning area of research has demonstrated that TBIs are associated with increased risk for suicidal ideation, suicide attempts, and death by suicide across both veteran (Brenner et al., 2011; Gradus et al., 2015; Gutierrez et al., 2008) and some (Bryan and Clemans, 2013) but not all (Skopp et al., 2012) active duty samples (see Bahraini et al., 2013 for review). The association between TBI and suicide risk appears to persist across TBI severity levels, with a study of TBI patients in Denmark demonstrating standardized mortality ratios of 3.0, 2.7, and 4.1 for mild, moderate, and

* Corresponding author. Department of Psychology, Florida State University, 1107 West Call Street, Tallahassee, FL 32306-4301, USA.

E-mail address: stanley@psy.fsu.edu (I.H. Stanley).

severe TBIs, respectively (Teasdale and Engberg, 2001). That TBIs are associated with a marked increase in suicide risk is especially concerning, given that between 19.5% and 45% of military service members and veterans have experienced a probable TBI (Brenner et al., 2013; Tanielian and Jaycox, 2008).

Despite the growing evidence base linking TBIs with increased suicide risk, it remains largely unknown what factors may account for this link. As such, researchers have recently encouraged investigations into pathways accounting for the link between TBI and suicide risk (Bryan and Clemans, 2013). Although TBI symptoms span both physical (e.g., headaches) and psychological (e.g., irritability) domains, evidence suggests that TBI-related psychological symptoms are more likely to persist post-injury (Terrio et al., 2009) and have greater relevance to suicide-related outcomes. Past research has revealed that comorbid conditions and psychological consequences of a TBI include substance abuse, posttraumatic stress disorder (PTSD), apathy, and depression (Stéfan and Mathé, 2016). One of the most prevalent psychiatric diagnoses following a TBI is major depressive disorder (Koponen et al., 2002), and preliminary evidence suggests that among U.S. veterans, depression, but not PTSD symptoms, may account for the link between TBI and suicidal ideation (Gradus et al., 2015).

One chief psychological consequence of a TBI that has received relatively sparse empirical attention with regard to suicidality is anger. Among a large sample of military personnel with ($N = 661$) and without ($N = 1024$) a history of TBI, Bailie et al. (2015) found that TBI is associated with increased problems with the experience, expression, and control of anger; in this study, 93.3% of the clinical subsample and 91.4% of the nonclinical subsample had a *mild* TBI diagnosis. The construct of anger is hypothesized to consist of a spectrum of subdomains, such as irritability, aggression, and hostility (Potegal and Stemmler, 2010). Although a relatively robust body of literature has examined TBI and these subdomains (Alderman, 2003; Kim et al., 1999; Rao et al., 2009), few studies have examined the impact of TBI on the broad spectrum of anger (Bailie et al., 2015), and only one study of which we are aware has investigated TBI, anger, and suicidality among military personnel. That is, Brenner et al. (2015) examined the State-Trait Anger Expression Inventory-2 (STAXI-2) among a sample of 133 military veterans with and without a history of a moderate-to-severe TBI and suicide attempts. There was no statistically significant between-group difference in STAXI-2 scores, although veterans with a suicide attempt history and a TBI had an approximately 25% higher anger expression index score than veterans with a suicide attempt history and no TBI as well as veterans with a TBI and no history of a suicide attempt. Thus, this initial finding suggests that anger may be a key factor in the association of TBI and suicide risk.

However, a single study does not provide sufficient insight into the role of anger in the association of TBI and suicide risk; replication across distinct samples is needed. Moreover, it is imperative that research examines the interplay of TBI, anger, and suicide risk within a mediation model, in order to classify anger as a possible mechanism amenable to therapeutic intervention. Given the dearth of research in this domain, it is also important to examine the broad construct of anger (encompassing irritability, aggression, and hostility; Potegal and Stemmler, 2010) in order to parse apart this heterogeneous construct in future research.

The psychological consequences of TBIs noted above, including anger and depression, also have established relevance to suicide risk. Namely, a constellation of risk factors for suicide has been identified that generally includes two categories—overarousal states (e.g., anger) and underarousal states (e.g., depression)—and although these two categories seemingly represent polarities, serious suicidal crises are characterized by the simultaneous presence of overarousal and underarousal states (Chu et al., 2015; Joiner

and Stanley, 2016). Data from a nationally-representative study in the U.S. indicate that anger experience and expression is associated with increased rates of suicide ideation, plans, and attempts; moreover, anger uniquely predicts who among suicide ideators have made a suicide attempt (Hawkins and Cougle, 2013). Data from psychiatric outpatients suggest that perceived burdensomeness—a core component of the interpersonal theory of suicide (Joiner, 2005; Van Orden et al., 2010), in which one believes that one's death is worth more than one's life to others—accounts for the link between anger and *suicidal ideation*. The interpersonal theory of suicide implicates perceived burdensomeness in the pathogenesis of suicidal desire; however, other variables are crucial to the understanding of *suicide attempts* (Van Orden et al., 2010). Regarding anger and suicide among military populations, past research of nondeployed soldiers indicates that intermittent explosive disorder (IED), a disorder largely characterized by problematic anger (American Psychiatric Association, 2013), predicts suicide attempts among suicide ideators (Nock et al., 2014).

It is, therefore, crucial to further elucidate the ways by which anger contributes to suicidality, including through its relation to other psychiatric conditions, such as depression. A substantial empirical base has identified depression as a risk factor for suicide (Brown et al., 2000; Minkoff et al., 1973); psychological autopsy studies suggest that most suicide decedents have a depressive disorder at the time of death (Cavanagh et al., 2003). Separate research has suggested that, although distinct constructs, anger and depression are highly interrelated (Fava et al., 1993; Luotonen, 2007), with some studies suggesting that anger is specific to depressive as compared to anxiety disorders (Koh et al., 2002).

1. The present study

The primary aim of this study was to determine if the relationship between mild TBI and suicide risk is statistically accounted for by anger and depression symptoms among a clinical sample of military personnel referred for evaluation/treatment of suspected head injury at a TBI clinic within a military combat support hospital in Iraq. We hypothesized that the indirect effects of anger and depression symptoms would significantly account for the relationship between mild TBI and suicide risk. We also hypothesized that the order of the variables would matter, such that anger precedes depression in its association of mild TBI and suicide risk in a serial mediation model. To our knowledge, this is the first study examining anger, particularly as it serves as a precursor to depression symptoms, as a mediator potentially accounting for the link between mild TBI and suicidality. Although ideally an investigation into the pathways by which a mild TBI increases suicide risk among military personnel would employ a prospective design, such an undertaking would require substantial financial, administrative, and human participant resources.

2. Materials and methods

2.1. Participants

Participants included 147 military personnel and 2 civilian contractors ($N = 149$) who were referred to a TBI clinic within a military hospital in Iraq during a 6-month span in 2009 for evaluation/treatment of a suspected head injury. Patients were predominantly male (92.6%) and white (71.4%). Respondents had an average of 6.7 ($SD = 5.4$) years in the military and were deployed between 0 and 6 times (mean = 0.8, $SD = 1.1$); the majority was in the Army (79.9%) and junior enlisted (rank E1-E4; 55.8%). See Table 1 for additional participant characteristics.

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