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Research paper

Traumatic brain injury and suicidality among military veterans: The mediating role of social integration☆

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ABSTRACT

Suicide is a widespread public health concern, including among military Veterans. Traumatic brain injuries (TBIs) and lack of social integration have both been shown to increase risk for suicidality, an outcome that includes, among other suicide-related variables, suicidal ideation, suicide attempts, and suicide death. Interestingly, TBIs have also been identified as a risk factor for social integration problems. In this cross-sectional study we investigated associations between TBI, social integration, and suicidality. Additionally, mediation analysis was used to test whether social integration mediated the association between TBI and suicidality. A sample of 1469 military Veterans (male, $n = 1004$, 67.2 %; female, $n = 457$, 32.3 %; transgender/non-binary/prefer not to say, $n = 8$, 0.5 %) completed an online survey as part of the Military Health and Well-Being Project. TBI was negatively associated with social integration ($r = -0.084$, $p < .001$) and positively with suicidality ($r = 0.205$, $p < .001$). Social integration was negatively associated with suicidality ($r = -0.161$, $p < .001$). Finally, social integration partially mediated the relationship between TBI and social integration (B = 0.121, 95 % CI [0.031–0.23]). This work shows that in the context of TBI, lack of social integration may promote suicidality. It provides support for many theories of suicide which propose social problems as a risk factor of suicide-related outcomes. It further highlights social integration as potential fodder for novel interventions for suicidality, an approach that would have transtheoretical support.

1. Introduction

Suicide is a widespread public health problem and nearly one million people die by suicide worldwide every year (World Health Organization, 2021). In 2020, suicide was among the top 9 causes of death for people aged 10–64 in the United States (US; Centers for Disease Control and Prevention, 2021). In the same period, 1.2 million Americans attempted suicide and 12.2 million had thoughts of suicide (Substance Abuse and Mental Health Services Administration, 2021). Military Veterans are a population at particular risk of suicidal behaviors (Moradi et al., 2021), with suicide rates rising faster compared to the general US population (Bryan et al., 2015; Ramchand, 2022). Given the widespread and seemingly unrelenting nature of suicide, particularly among military personnel and Veterans, researchers and clinicians have called for increased study into risk factors of suicide and suicide-related phenomena (Schafer et al., 2022a, 2022b), including suicidal ideation, attempts, and death, a category broadly referred to as *suicidality*.

Traumatic brain injuries (TBIs), defined as alterations in brain function following trauma to the head (Centers for Disease Control and Prevention, 2015), have been identified as a risk factor for suicidality among Veterans (Barnes et al., 2012), Service Members (Schafer et al., 2022a, 2022b), adolescents (Richard et al., 2015), older adults (Thompson et al., 2006), and treatment-seeking outpatients (Brenner et al., 2011). Since the early 2000s, tackling TBI within military personnel has been identified as a policy priority given heightened prevalence and risk from explosions, military training, or other combat-

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related factors (CDC, 2013; Centers for Disease Control and Prevention, 2015). Beyond increasing risk for suicidality, TBIs among Veterans also increase risk of anxiety, depression, and PTSD. This heightened risk of psychiatric conditions in the context of TBI is particularly problematic in that TBI, by way of psychiatric conditions, has been found to confer risk for physical health problems (Hoge et al., 2008).

Socio-environmental factors are frequently cited as risk, or protective, factors for suicidality (Turecki et al., 2019). More specifically, research has identified a host of social integration deficits (e.g., lack of social connection and deficits in social skills) that contribute to suicidality (Calati et al., 2019; Tsai et al., 2014; Tsai et al., 2015). Indeed, social integration difficulties have held as a risk factor nearly doubling the risk of suicidality in adolescents (Speckens and Hawton, 2005), older adults (Szanto et al., 2012), young adults (Kleiman et al., 2012), and adult outpatients (Silva et al., 2015). US military personnel, often from nontraditional family structures associated with lower levels of social integration (Griffith and Bryan, 2016), may be at heighted risk, calling for more research into the role of social integration and its link suicide in this population.

Outside of the field of psychology, sociology contains somewhat extensive investigation into the link between social integration and suicidality. A review paper (Stack, 2021) outlined that divorce and marital separation are significant stressors which elevate the risk of suicide (Denney et al., 2015; Ide et al., 2010; Stack and Scourfield, 2015). Likewise, the authors point to research demonstrating that children are protective against suicide death among women (Agerbo, 2005; Mäki and Martikainen, 2009; Qin et al., 2003). A previous, more foundational, sociological paper (Stack, 2000) studied 84 papers and found robust support for the link between social integration and reduced experience of suicidality. The most pronounced support of social integration as a buffer from suicidality has been among the study of marital integration, wherein more than three quarters of the research found a significant relationship. Indeed, marital dissolution has long been considered a risk factor for suicide (Stack, 1980) and social integration may be the mediating factor. That is, married people as compared to non-married people experience significantly less loneliness and this is consistent with social integration being integral to a relationship with suicidality (Stack, 1998).

While the literature has largely assumed that TBIs and social integration deficits independently and uniquely contribute to suicidality, that is likely not the case. Indeed, TBIs have been shown to increase the risk of social integration difficulties. This has been evident in children (Andrews et al., 1998; Janusz et al., 2002; Rosema et al., 2012), adult outpatients (Dahlberg et al., 2006; Knox and Douglas, 2009; Struchen et al., 2011), and older adults (Ritchie et al., 2014; Kumar et al., 2020). TBIs may also hinder re-integration into civilian life after military service, an important factor for long-term outcomes among Veterans (Hays, 2016). Indeed, in an overview of the TBI and suicidality literature, Wasserman et al. (2008) called for additional research into the link between TBI, social integration, and suicidality.

Additional study into the roles of TBI and social integration towards suicidality can give us insight into the veracity of theories of suicide, particularly in the somewhat understudied group of TBI patients (Trivedi and Humphreys, 2015). Indeed, theories have been proposed to understand the causes of suicide, and many of the most commonly-studied theories (Schafer et al., 2022c) propose some aspect of deficits in social integration as a cause of suicidality. For example, the Interpersonal Theory of Suicide (Van Orden et al., 2010), Integrated Motivational-Volitional Theory (O'Connor and Kirtley, 2018), and 3-Step Theory of Suicide (Klonsky and May, 2015) propose that thwarted belonginess, social problem-solving deficits, and lack of connectedness, respectively, cause some aspect of suicidality. Importantly, research has generally supported these three theories across many samples, including: Service Members, Veterans, community members, outpatients, inpatients, adolescents, and geriatric populations (Schafer et al., 2022c). Moreover, it has been recommended to further explore the role of thwarted belonginess in predicting suicidality among military populations (Short et al., 2019).

Studying these three phenomena simultaneously could improve understanding of potential contributors to suicidality and provide fodder for novel treatment development. If social integration is found to be a mediating factor between TBI and suicidality, social integration could be an important treatment target for patients experiencing TBI, social integration deficits, and suicidality. This is particularly exciting given that treatment effects associated with even gold-standard treatments for suicidality are modest. Indeed, even after a full course of treatment of Cognitive-Behavioral Therapy or Dialectical Behavior Therapy (Hawton et al., 2016) or psychopharmacological interventions (Cipriani et al., 2005) many patients still report suicidal ideation. Positive treatment outcomes (e.g., PTSD) for military compared to civilian populations may be smaller still (Straud et al., 2019), with recommendations for robust studies to investigate treatments that target mediators, including socio-environmental factors, in military populations with TBI (McIntire et al., 2021).

Thus, in the present project we investigated the simultaneous experience of history of TBI, social integration, and suicidality. We employed a sample from a population with historically elevated rates of TBI and suicidality, military Veterans (Gardner and Yaffe, 2015; Kang et al., 2015). The elevated rates of two crucial phenomena decreased the likelihood of floor effects and allowed us to explore the relevant variables with relatively high frequency. Based on previous literature, we hypothesized that (1) TBIs would be positively and significantly associated with suicidality, (2) TBIs would be negatively and significantly associated with social integration, and that (3) social integration would be negatively and significantly associated with suicidality. As no previous literature could be used to support a hypothesis regarding the mediating role of social integration in the relationship between TBI and suicidality, we conducted exploratory analyses to determine if social integration acts as a mediator in this fashion.

2. Method

2.1. Study design and procedure

Full study design and procedures for the Military Health and Well-Being Project (Desmarais and Cacace, 2020) are listed on the Inter-university Consortium for Political and Social Research (ICPSR) website (https://www.icpsr.umich.edu/web/ICPSR/studies/38304). Briefly, Qualtrics Panels was used to collect a stratified sample of United States military Veterans who served in post-Vietnam war eras. Participants were recruited through multiple websites and then screened to ensure that they met the inclusion criteria: military service, included age range, service era, and United States residence. Researchers over sampled for Black military Veterans and women Veterans to enhance representation of more minoritized identities in military Veterans. Individuals who met all inclusion criteria were permitted to complete the survey.

Given the efforts of researchers to oversample Black/African American and female Veterans, this sample reflects slightly elevated proportions of Black/African American Veterans and female Veterans. In the larger Veteran population, Black Veterans comprise 12 % and female Veterans comprise 10 % of the Veteran population. However, this sample reflects 14 % Black/African American Veterans and 32 % female Veterans.

A total of 1863 responses were collected. Qualtrics labeled 1522 of these responses as "Good Completes," which included individuals who answered all questions, who fell into the required inclusion category (Veterans who served post-Vietnam), and who completed the survey within 3 standard deviations of the average time to complete. Of these "Good Completes," 1495 respondents included their age, and were retained for all further analyses. Finally, of the 1495 "Good Completes", 1469 completed our measures of interest and were included in the

analyses in the present project. Data were collected entirely using Qualtrics online survey software.

2.2. Participants

The Military Health and Well-Being Project (Desmarais and Cacace, 2020) is an online survey study conducted through Qualtrics Panels. United States military Veterans were recruited between May 2020 through June 2020. The purpose of the study was to collect information regarding psychosocial antecedents of health and wellness, including military identity, self-stigma, daily stress, combat exposure, purpose and value, substance use, traumatic brain injury, moral injury, suicide risk, social integration and contribution, and six of eight Substance Abuse and Mental Health Services Administration dimensions of wellness (social, emotional, spiritual, intellectual, physical, and environmental components for this study).

2.3. Measures

2.3.1. Traumatic brain injury (TBI)

History of TBI was assessed via a single item on the Qualtrics questionnaire. Respondents were asked "Have you ever been diagnosed with a traumatic brain injury, or concussion?" Responses were coded as 0 = No, 1 = Yes. Single items have been used in the literature with good utility. See Lu et al. (2020), Richard et al. (2015) Wasserman et al. (2008).

2.3.2. Suicidal Behavior Questionnaire – Revised (SBQ-R; Osman et al., 2001)

The SBQ-R is a 4-item self-report questionnaire that measures four dimensions of suicidality: suicidal ideation, suicide attempt, threat of suicide attempt and self-assessed likelihood of future suicidal behavior. The first item was "Have you ever thought about or attempted to kill yourself?" with answers scored on a six-point Likert scale from 1 (*Never*) to 6 (*I have attempted to kill myself, and really hoped to die*). The second item was "How often have you thought about killing yourself in the past year" with responses ranging from 1 (*Never*) to 5 (*Very Often*). The third item was "Have you ever told someone that you were going to commit suicide or that you might try to kill yourself?" with possible responses rated from 1 (*No*) to 5 (*Yes, more than once, and really wanted to do it*). The final question was "How likely is it that you will attempt suicide someday?", with responses ranging from 0 (*Never*) to 6 (*Very likely*). A total score was calculated across the 4 items, with higher scores indicating more intense suicidality. The SBQ-R has been validated within previous military populations (Franks et al., 2021). Within this sample, Cronbach's α = 0.89, reflecting excellent internal consistency.

2.3.3. Social Well-Being: Social Integration Subscale (Keyes, 1998)

Social integration was measured on a Likert scale of 1 (*Strongly disagree*) to 7 (*Strongly agree*) using the following three questions: "I don't feel I belong to anything I'd call a community" (reverse coded), "I feel close to other people in my community" and "My community is a source of comfort". A mean score was generated with higher scores indicating greater social integration. Within this sample, Cronbach's α = 0.79, reflecting good internal consistency. Previous research indicates that gender is significantly related to social integration (Dalgard and Thapa, 2007), as such we controlled for gender in our mediational models.

2.4. Data analytic plan

Descriptive statistics for the sample were calculated for the main variables (TBI, suicidality, social integration) which are displayed in Table 1. Data analyses began by investigating the first three hypotheses. To do this, we conducted a Pearson product moment correlation relating TBI, social integration, and suicidality. Next, we compared the relative contribution of TBI and social integration towards suicidality using a linear regression. We controlled for gender, adding it on the first step of the regression. Then we added TBI and social integration into the model on the second step. Finally, conducting exploratory analyses, we investigated the mediational role of social integration between TBI and suicidality. SPSS Process Macro version 4.0 (Hayes, 2017) was used to test this mediational model, using 5000 bootstrap samples and a 95 % confidence interval. Results are reported using unstandardized regression coefficients (B).

Table 1
Descriptive statistics.

		n	Percent
Gender	Male	1004	67.20 %
	Female	457	32.30 %
	Transgender/non-binary/prefer not to say	8	0.50 %
Branch	Air Force/Air Force Reserve	366	24.50 %
	Air National Guard	36	2.40 %
	Army/Army Reserve	491	32.80 %
	Army National Guard,	115	7.70 %
	Coast guard/Coast Guard Reserve	42	2.80 %
	Marine Corps/Marine Corps Reserve	122	8.20 %
	Navy/Navy Reserve	323	21.60 %
Race	White	1129	75.50 %
	Black or African American	215	14.40 %
	Asian	42	2.80 %
	American Indian or Alaskan Native	13	0.90 %
	Native Hawaiian or Other Pacific Islander	10	0.70 %
Relationship status	Married	886	59.30 %
	Single	282	18.90 %
	Domestic partnership	73	4.90 %
	Divorced	211	14.10 %
	Widowed	43	2.90 %
Employment status	Employed	960	64.20 %
	Retired	358	23.90 %
	Unemployed	177	11.80 %
Age		*M* = 50.05	*SD* = 13.41
TBI	Yes	226	16.90 %
	No	1243	83.10 %
Suicidality		*M* = 5.3	SD = 3.71
Social integration		M = 3.77	SD = 0.94

3. Results

3.1. Descriptive statistics

Descriptive statistics are displayed in Table 1. The sample varied in age, gender, and branch of service. Overall, 16.9 % (*n* = 226) of the sample reported a brain injury diagnosis. The sample had an average Suicidal Behavior Questionnaire – Revised (SBQ-R) total score of 5.30 (min = 3, max = 22, *SD* = 3.71) with 72 participants (4.2 %) reporting that they had attempted suicide at some point in their lives. The SBQ-R has a cutoff score of seven or greater at which point those scores indicate that the respondent is at "high risk of suicide" (Osman et al., 2001). Given that the standard deviation of the SBQ-R mean encompasses scores of seven and above, our sample could be considered relatively elevated on suicidality. The sample had an average social integration mean score of 3.77 (*min* = 1, *max* = 7, *SD* = 0.94) reflecting that the sample on average had a moderate amount of social integration. A correlation matrix of TBI, social integration, and suicidality was computed. Results are displayed in Table 2. All study variables were significantly associated at the $p = .05$ level.

3.2. Correlations between study variables

All study variables were associated at a $p < .001$ level. TBI was

Table 2
Correlation matrix of study variables.***

Variable	*M*	*SD*	1	2	3
1. TBI	0.17	0.37			
2. Social integration	3.77	0.95	−0.084***		
3. Suicidality	5.31	3.71	0.205***	−0.161***	

Note. TBI = traumatic brain injury, suicidality = SBQ-R Total Score. Social Integration = Social Well-Being: Social Integration Subscale Mean Score.
*** $p < .001$.

inversely associated with social integration ($r = -0.084$) and positively associated with suicidality ($r = 0.205$). Social integration was inversely associated with suicidality ($r = -0.161$).

3.3. Linear regression associating TBI and social integration with suicidality

To understand the relative, simultaneous contribution of TBIs and social integration (social integration mean score) with suicidality (SBQ-R total), we conducted a multiple linear regression, with output depicted in Table 3. We entered gender on the first step to control for its effects, then added TBI and social integration into the next step. The model was significant (F[31465] = 50.99, $p < .001$, adjusted $R^2 = 0.09$). TBI was positively (B = 1.88, $t = 7.63$, $p < .001$) and social integration was inversely (B = −0.56, $t = -5.83$, $p < .001$) associated with suicidality. TBI boasted a greater contribution towards suicidality than did social integration ($z = 2.33$, $p = .02$).

3.4. The mediational role of social integration between TBI and suicidality (exploratory)

The indirect effects of TBI on suicidality via social integration were significant (B = 0.121, 95 % confidence interval [0.031–0.23]). As the direct effect of TBI on suicidality remained significant in the full mediation model (B = 1.91, 95 % CI [1.41–2.39]), social integration partially mediated the association between TBI and suicidality. Further, the paths from TBI to social integration (B = −0.21, 95 % CI [−0.34 to −0.08]) and social integration to suicidality (B = −0.57, 95 % CI [0.76–0.37]) were also both statistically significant. The effect sizes as well as *p*-values are depicted in Fig. 1.

We additionally conducted these mediational analyses controlling for gender. The findings held significant even with this covariate, with the overall model explaining 9 % of variance in levels of suicidality. The entire model was significant, with social integration partially mediating the association between TBI and suicidality (B = 0.121, 95 % confidence interval [0.038–0.23]). Significant direct effects were also found between TBI to social integration (B = −0.21, $p = .001$), social integration to suicidality (B = −0.57, $p < .001$) and TBI to suicidality (B = 1.88, $p < .001$).

Table 3
Linear regression of social integration and traumatic brain injury towards suicidality.

Model		Unstandardized coefficients	*SE*	Standardized coefficients	*t*	*p*
		B		Beta		
1	(Constant)	3.45	0.28		12.333	0
	Gender	1.385	0.197	0.181	7.03	0
2	(Constant)	5.306	0.462		11.492	0
	Gender	1.365	0.191	0.178	7.156	0
	Social integration	−0.569	0.098	−0.145	−5.826	0
	TBI	1.88	0.247	0.19	7.625	0

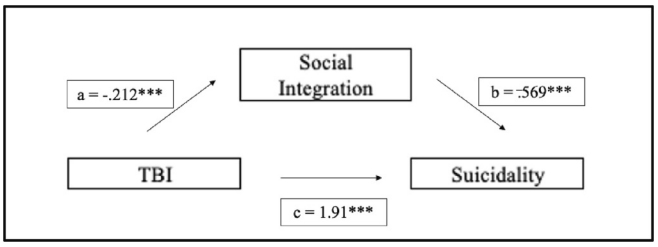

Fig. 1. The mediational role of social integration in the relationship between TBI and suicidality. TBI = Traumatic Brain Injury, Suicidality = SBQ-R Total Score. Social Integration = Social Well-Being: Social Integration Subscale Mean Score. *** = $p < .001$.

3.5. The mediational role of social integration between TBI and item level SBQ-R scores (supplementary analyses)

We conducted additional analyses to investigate the mediational role of social integration between TBI and item level responses on the SBQ-R controlling for gender. Item 1 measured suicidal thoughts and suicide attempts. Item 2 measured frequency of suicidal ideation over the past year. Item three measured suicidal communications in telling others that the respondent was going to attempt suicide. Item 4 measured the likelihood that a respondent may attempt suicide someday. Every mediational model was significant, indicating that social integration partially mediated the link between TBI and many aspects of suicidality. These results are held within the Supplementary Materials.

3.6. The mediational role of social integration between TBI and high vs low SBQ-R scores

We conducted additional supplementary analyses to investigate the mediational role of social integration between TBI and SBQ-R when conceptualized as a binary outcome. Again, analyses controlled for gender. Suicidality as a binary (high/low) outcome. These additional analyses were performed as the measure of suicidality was largely zero-inflated. Conducting analyses with a binary outcome allowed for the potential detection of smaller effects. High versus low SBQ-R scores were determined by conducting a mean split. Low scores on the SBQ-R (coded = 0) were from the minimum score of three to the mean of 5.3. High scores on the SBQ-R (coded = 1) were from 5.4 to the maximum of 22. Social integration mean was correlated at ($r = -0.143$, $p < .001$) with suicidality (high/low) indicating that higher scores social integration were more frequently seen in the portion of the sample with low suicidality. Likewise, a *t*-test indicated that Veterans with TBIs endorsed on average higher rates of suicidality ($t = 7.589$, $p < .001$) Findings related to these supplementary analyses are consistent with analyses measuring suicidality as the SBQ-R total score as well as SBQ-R item level scores. Social integration partially mediated the link between TBI and suicidality (high/low).

4. Discussion

4.1. Overall findings

In the present project we investigated the cross-sectional associations between TBI, social integration, and suicidality among a large sample of military Veterans. In addition, we explored the mediational path from TBI to suicidality through social integration. Within our sample, we found that TBI is positively and significantly associated with suicidality, TBI is negatively and significantly associated with social integration, social integration is negatively and significantly associated with suicidality. An exploratory mediation model found that social integration partially mediates the relationship between TBI and suicidality. Our findings suggest that tackling deficits in social integration may, at least

partly, decrease the risk of suicide in military Veterans with TBI.

4.2. Comparison with existing literature

Our work was robustly consistent with the consensus of previous literature. First, our finding that TBI is a risk factor for suicidality supports previous studies with Service Member and military Veteran populations (Barnes et al., 2012; Schafer et al., 2022a, 2022b) and civilian populations (Brenner et al., 2011; Richard et al., 2015). In a recent study of 2674 Americans who died by suicide (Ahmedani et al., 2017), TBI had the greatest odds of suicide (aOR 8.80, $p < .001$) out of 17 physical health conditions, with researchers emphasizing particular urgency to identify protective factors for patients with TBI and other diseases of the brain associated with suicide (e.g., migraine headache and stroke).

The present study found that a TBI diagnosis increased social integration difficulties within military Veterans, extending similar findings among civilian populations (Kumar et al., 2020; Rosema et al., 2012; Struchen et al., 2011). Moreover, in the general population, social integration has been negatively associated with suicidality among adult outpatients (Silva et al., 2015) and older adults (Szanto et al., 2012), with our findings emphasizing the protective role of social integration within a Veteran population.

Notably, our work extends previous research in demonstrating that when these three constructs are investigated simultaneously, social integration partially mediates the cross-sectional relationship between TBI and suicidality. In other words, relative social integration deficit accounted for a significant portion of the relationship between TBI and suicidality. Although TBI was cross-sectionally related to suicidality, when social integration was added into the model, it accounted for some of the relationship between TBI and suicidality. These findings are consistent with a lack of social integration driving the link between TBI and suicidality.

Given the higher prevalence of TBIs and suicide among military personnel and Veterans, identification of social integration as a possible protective factor holds promise for supporting members of these at-risk populations. The importance, and challenges, of social integration is evident in qualitative studies with Veterans. In one study (Libin et al., 2017), the involuntary separation from the military due to acquiring TBI was described as compounding the physical pain, with participants emphasizing some of the challenges with community reintegration, including the interactions with health care providers and loved ones. Building on existing good practice (Kind et al., 2016), enhancing social integration among Veterans and/or individuals with TBIs requires a whole-community approach, for example by providing support for families and caregivers (Baker et al., 2017; Keeling et al., 2020). Moreover, families having good levels of communication during active duty has been identified as protective factors for positive reintegration post-deployment (O'Neal et al., 2018). This emphasizes the importance of promoting positive social integration well in advance of separation from the military, involving all members of the family.

4.3. Implications for theories of suicide

Our findings give broad support for many theories of suicide that propose social integration deficits as risk factors for suicidality. Indeed, the Interpersonal Theory of Suicide (Van Orden et al., 2010), Integrated Motivational-Volitional Theory (O'Connor and Kirtley, 2018), and 3 Step-Theory (Klonsky and May, 2015) all specifically state thwarted belonginess, social problem-solving deficits, and lack of connectedness are associated with suicidality, respectively. Studies with Veterans, including those with TBI, about re-integration after military retirement emphasize inner conflicts around their new position in society, lack of belonging, and a loss of the military culture and community (Libin et al., 2017; Orazem et al., 2017). These conflicting identities and self-perceptions about their role in the world may contribute to feelings of thwarted belongingness, a factor underlying suicidality. Theoretically, tackling social integration deficits could protect against suicidality, by enhancing feelings of belonging and future research should test the different facets of social integration to see which holds greatest promise among Veterans and individuals with TBI.

Beyond psychological theories of suicide, sociologists have proposed theories of suicidality. Whereas the Interpersonal Theory of Suicide (Van Orden et al., 2010), Integrated Motivational-Volitional Theory (O'Connor and Kirtley, 2018), and 3 Step-Theory (Klonsky and May, 2015) all conceptualize social integration on the individual level, one of the earliest theories of suicide (Durkheim and Suicide, 1952), sociological and otherwise, conceptualized social integration much more as a role/community level characteristic. The conceptualization of social integration as a matter of roles (e.g., parent, spouse, caregiver, friend, etc.) represents a divergence from that of thwarted belongingness, social problem-solving deficits, and lack of connectedness wherein respondents are often measured on their ability to call on their community for help, assistance, support, and inclusion. (But notably, this is a fairly exact antithesis to the perceived burdensomeness of the Interpersonal Theory of Suicide, wherein people feel as though they cannot competently contribute to the lives of their loved ones.)

A substantial amount of investigation has taken place to understand the link between sociological integration (i.e., roles including marriage partner) and suicidality. Indeed, sociologists have published over 50 studies investigating the role of marriage as a protective factor against suicide. A meta-analysis on that body of literature (i.e., 170 effect sizes from 36 studies) found that divorced men (as compared to married men) experienced a four-fold increase in the risk of suicide death (Kyung Sook et al., 2018). For women, divorce was associated with a nearly three-fold increase in the risk of suicide death.

The difference in the conceptualization of social integration in psychological vs sociological investigations highlights an important question in mechanism. It is possible that the loss of connection or emergence of thwarted belongingness (as psychological theories suggest) is responsible for increased risk of suicide among divorced people. It is likewise possible that the loss of sociological roles and the emergence of perceived burdensomeness are responsible for the increased suicide risk. Future research should attempt to clarify the role of individual/psychological level versus sociological/role level social integration in the development of suicidality.

Importantly, based on the present project it is unclear the exact mechanism that is driving the relationship between TBI and suicidality. The reason for that is two-fold: (1) these data are cross-sectional and as such we cannot assume or infer causal mechanisms or temporal relationships; (2) social integration is a broad construct that could encompass many or all of the theoretically relevant variables related to social deficits (e.g., thwarted belonginess, social problem-solving deficits, or lack of connectedness). Regardless of the specific theoretical variable at play, these findings indicate that relative social integration deficits may account, at least in part, for the link between TBI and suicidality.

4.4. Implications for future research and clinical work

According to the regression (adjusted $R^2 = 0.09$) and the mediation ($R^2 = 0.09$), TBI and social integration accounted for 9 % of the variance in suicidality. Although these are fairly small effect sizes, they are both clinically and statistically meaningful in that the reduction of 10 % of risk in suicidality could mean a substantial reduction in the number of Veteran lives lost to suicide.

These findings have potential implications for the treatment of patients with suicidality. Whereas Cognitive-Behavioral Therapy and Dialectical Behavior Therapy are broad and can target myriad maladaptive, unhelpful, or unrealistic cognitions, our findings could support treatment based in a trans-theoretical model of improving deficits in social integration. In other words, treating social integration deficits in patients with suicidality regardless of what theory it is based on could be

a source of reduction in suicidality for patients with a history TBI. Indeed, this could be a way to improve upon current treatments which boast only modest effects. To further explore this relationship, future work could investigate links between TBI followed by social integration and then by suicidality in a longitudinal fashion.

Moreover, to support individuals who may not wish to engage with mental health services, there is scope for researchers to consider the role of less formal support services in providing an alternative environment to develop the skills aligned with social integration. For example, positive outcomes have been identified within a group-based yoga intervention with psychoeducational components for people with TBIs and their caregivers (Donnelly et al., 2020). Peer support groups for Veterans (Drebing et al., 2018) and patients with brain injuries (Hughes et al., 2020) may also offer the space to optimize social integration. Given that many military Veterans do not seek professional help for suicidal ideation (Nichter et al., 2020), such approaches may support individuals at risk of being under identified as needing help.

4.5. Implications for sociological work

The sociological literature houses a fairly extensive investigation into the link between social integration and suicidality. Work within sociology consistently evidences that social integration is strongly associated with lower risk of suicidality (Agerbo, 2005; Denney et al., 2015; Ide et al., 2010; Mäki and Martikainen, 2009; Qin et al., 2003; Stack, 2000; Stack, 2021; Stack and Scourfield, 2015). However, it should be noted that in the sociological work social integration is conceptualized from a structural/role level. For example, social integration is measured by tapping into the role of marriage partner, parent, friend, or caregiver to an ailing parent. It is assumed that partners are insulated from suicide by the responsibilities attached to their role (caring for a spouse, children, friend, and/or parent). However, our work offers a divergent, slightly differing conceptualization of social integration by which Veterans reported on the level to which they felt integrated into/were able to rely on members of their communities. They responded based on prompts that assessed the level that they in turn could count on their community, not the sociologically traditional sense, that their community could count on them.

Given that a wide swath of sociological literature measures social integration based on the roles that people play (e.g., marriage partner, parent, caregiver, friend, etc.), we recommend that future research investigate these roles as they relate to suicidality within this sample. Sociological literature generally does not study these phenomena in Veterans and data capable of addressing this relationship are readily available in the Military Health and Well Being Study. Thereby, a future project such as the one proposed here would be both novel and completed with relative ease. Importantly, TBI (which has been strongly related to psychiatric and physical health problems) could increase risk of divorce which in turn could increase risk of suicidality.

4.6. Implications for risk prediction

A substantial amount of previous work has investigated risk prediction of suicidal ideation, suicide attempts, and suicide deaths (Schafer et al., 2022c). The body of literature has culminated in the finding that in order to predict suicidal ideation, suicide attempts, and suicide death, many (e.g., dozens or hundreds) variables are needed. Indeed, singular constructs like the ones studied in the present paper as well as theoretically-relevant constructs are not accurate predictors of suicide-related outcomes. This indicates that singular risk factors should not be used in the prediction of any suicide-related outcome. Notably, however even the most accurate of predictive models (with AUCs upwards of 0.90) often contribute little knowledge and understanding towards factors that contribute to the development, maintenance, and exacerbation of suicide-related behaviors. For example, many predictive models include data related to zip codes, birthdate, and race, factors which surely are related to suicidal outcomes. Unfortunately, these factors are not helpful in understanding why specific individuals are at heightened risk at any given time. For a full discussion of risk prediction versus understanding of development of suicidal outcomes, see Schafer et al. (2022c).

4.7. Limitations

Our study boasts many strengths including a large sample of diverse respondents, an array of interesting and related variables, and appropriate analyses. However, our findings should be interpreted in light of some limitations. For example, our data are cross-sectional in nature, eliminating our ability to infer causal inference or temporal antecedence between variables. Additionally, all data are self-report survey data, which introduces potential bias. This is particularly salient with regard to self-report of TBI as it is likely that at least some Veterans have experienced a TBI (mild or severe) without receiving diagnoses. Further problematic, TBIs were measured as present versus absent, omitting measurement of the number, severity (i.e., mild, moderate, or severe), recency of TBIs that have been experienced, and even if the TBI had been acquired during military service. It is possible that the number, severity, recency, and context of TBIs relate to social integration and/or suicidality (Madsen et al., 2018; Ritchie et al., 2014). However, those data were not measured during data collection and as such those questions could not be investigated in the present study.

Further, the measurement of suicidality within the dataset limited some inferences that are of interest to researchers. Specifically, as designed the suicide-related outcome of *suicidality* was highly heterogenous. The SBQ-R combined measurements of previous attempts, current level of ideation, plans for suicide, as well as desire for suicide. This heterogenous measure is in sharp contrast to the discrete suicide-related outcomes that theories propose, namely categories of suicidal ideation, suicide attempt, and suicide death. This aspect of measurement limited our ability to directly and stringently test hypotheses to relate to existing theories. Notably, authors conducted supplementary analyses to explore the link between TBI, social integration, and the four items of the SBQ-R. Results related to these additional analyses were consistent with the total measure of SBQ-R, indicating that social integration mediated the link between TBI and each item of the SBQ-R (i.e., past suicide attempts, frequency of suicidal ideation, threat of suicide attempt, self-reported likelihood of future suicidal behavior). We report these supplementary findings with a caveat that item level analyses of the SBQ-R is not a validated metric of each of these more narrow facets of suicidality. Thus, we recommend caution when interpreting these findings.

Further, the sample was comprised entirely of military Veterans. While this gives insight into the experience of some United States Veterans, it reduces generalizability to other high risk samples including adolescents, older adults, and incarcerated individuals, among others. Indeed, given that researchers oversampled Black/African American and female Veterans, these findings may not generalize fully to Veterans who fit other demographic groups (e.g., Native American male Veterans). Further contributing to constraints upon generalizability is the context during which these data were collected. Surveys were distributed and completed during May 2020 through June 2020. These were the early days of the COVID-19 pandemic and a time when schools, business, and non-profit organizations were still in lockdown in efforts to slow the spread of coronavirus. Further, deaths related to COVID-19 were high, economic certainty was low, and the hope of a coronavirus vaccine was distant. The stressors related to this time likely contributed to elevated rates of psychopathology, including suicidality (as is consistent with anxiety, depression, and eating pathology (Schafer et al., 2022a, 2022b)). Thus, we recommend caution implementing findings related to this sample in the broader population, as this sample likely represents one with elevated psychopathology.

4.8. Conclusion

Rates of TBIs and suicidality are elevated among military Veterans. Among a sample of 1469 military Veterans, our findings indicated that lifetime history of TBI was related to reduced social integration and increased suicidality. Further, reductions in social integration were related to increased suicidality. Findings from an exploratory mediational model evidenced that social integration deficits partially mediated the link between TBI and suicidality, highlighting social integration as a potential source of investigation as a treatment target in patients with comorbid TBI history and suicidality.

Declaration of competing interest

The authors have no conflicts of interest to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2023.06.047.

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