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ABSTRACT

Anecdotal and preliminary evidence suggests that Soldiers returning from a combat deployment engage in an increased number of health risk behaviors. Three potential factors driving this change were examined in this study; posttraumatic stress disorder (PTSD), concussion and traumatic brain injury (TBI), and perceived invincibility. We studied members of a combat arms brigade one month prior to a deployment to Iraq and approximately one month after their return ($N = 319$). Participants anonymously completed surveys characterizing attitudes about risk, risk propensity, invincibility, engagement in health risk behaviors, and personality. Using standardized screening instruments, participants were categorized with respect to PTSD and probable TBI. Results suggest that Soldiers engage in more alcohol use and reckless driving behaviors post-deployment. These changes were exaggerated in those who screened positive for PTSD. Perception of one's invincibility and survival skills increased post-deployment thus suggesting that participants felt less susceptible to adverse consequences and more adept at surviving dangerous situations. This study provides documentation of the pattern of health behavior in Soldiers engaged in the deployment cycle. Our findings suggest increases in the number of risks Soldiers' engage in post-deployment are not limited to those with PTSD symptomtotology. This study has implications for not only adjustment to life post-deployment at the individual level but also operational readiness.

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Over one million service members have deployed to support Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF). The conditions under which these Soldiers carry out their missions are both physically and psychologically stressful. Soldiers returning from an overseas deployment such as OIF or OEF are vulnerable to the effects of combat stress. The duress of combat does not selectively discriminate, and the mental and physical exhaustion that follows takes its toll on both the inexperienced and seasoned veteran alike. Despite sound military training and advanced technology, personal resilience is not equal for every Soldier who endures combat. Soldiers, being human, instinctively safeguard the basic need for self-preservation when threatened, and each experience is uniquely processed by the individual over the course of deployment.

Combat experience is associated with mental health problems (Hoge et al., 2004; Killgore et al., 2008; Sharkansky et al., 2000). Estimates indicate 14% of Soldiers returning from OIF and OEF experience posttraumatic stress disorder (PTSD), 14% experience major depression, and 19.5% have sustained a mild traumatic brain injury (mTBI; Tanielian and Jaycox, 2008). Of those who have suffered an mTBI during deployment, 35% experience persistent symptoms or postconcussive syndrome (PCS; Schneiderman et al., 2008). The full extent of the psychological effects of ongoing military operations is unknown.

One aspect of the psychosocial effect of combat is the reported increase in risky behaviors exhibited by Soldiers post-deployment. Killgore et al. (2008) found that Soldiers who experienced more severe and intense combat were at a slightly greater risk of engaging in high risk behaviors post-deployment. While this finding was statistically significant, the effect size was small, indicating that combat exposure only accounts for a small proportion of the variance with respect to risky behavior. It is unclear what other factors may influence risk propensity following combat exposure. Likewise, in a recent study, Thomsen et al. (2011) found that when surveyed, service members who had deployed reported engaging in more risky behaviors than those who had never deployed.

The effects of prolonged exposure to emotional stressors (e.g., combat-related) may impact regions of the brain (specifically the limbic system) in such a way that Soldiers may have difficulty adjusting to a non-wartime environment upon returning from

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a deployment (Killgore et al., 2008). Soldiers with PTSD have diminished activity in the limbic system and regions of the prefrontal cortex, which might suggest low basal arousal levels (Molina et al., 2007). Additionally, young adults with a history of head injury exhibit a greater interest in risky behaviors (O'Jile et al., 2004). One potential mechanism driving similar behavior post-deployment is the impact of psychological combat trauma–particularly perceived "near-death" experiences–on one's beliefs and behaviors related to life and death. These changes in beliefs and behaviors are not a manifestation of any mental illness but may function as a coping mechanism (Bell et al., 2001). Whereas the Thomsen et al. (2011) recent cross-sectional study reported changes in behavior from pre- to post-deployment, a longitudinal study will provide stronger evidence to our understanding of the relationships between deployment and adverse health outcomes.

The objective of this study was two-fold: 1) to evaluate risk propensity and risk behavior in Soldiers as a function of deployment using a within-subjects, longitudinal design (i.e., the same group of Soldiers was tested pre- and post-deployment), 2) to evaluate the impact of PTSD and TBI on attitudes about risk and engagement in risky behaviors. The implications of the study results with respect to promotion of health and prevention of injury are discussed.

1. Method

1.1. Participants

Volunteers were recruited from a combat battalion (approximately 800 Soldiers) of a U.S. Army Infantry Division. Approximately 30 days prior to a 12-month deployment to Iraq (October 2009–September 2010), 492 Soldiers completed the task battery (62% response rate); 387 of them returned to complete the task battery again, approximately one month post-deployment (79% retention rate). Permanent change of station, leave status, medical evacuation, or behavioral problems prior to the testing window precluded some Soldiers' post-deployment testing thus information about these individuals were unavailable. We were able to confidently match 319 pre-deployment and post-deployment datasets. Specifically, to preserve anonymity while matching a participant's dataset (pre-deployment and post-deployment data), an unidentifiable code was used to link the data. This code was generated using information provided by the participant. Thus, errors in entry yielded some unique codes that could not be matched (68 total unmatched). This study was reviewed and approved by the U.S. Army Medical Research and Materiel Command Institutional Review Board (USAMRMC IRB) and conducted in compliance with federal regulations regarding protection of human subjects in research. Since participants were allowed to skip questions they did not feel comfortable answering, the number of participants available for analysis varied by measure. Specifically, if a participant skipped a question on a measure, the score on the validated measure could not be computed accurately, thus the participant was excluded from that measure. To be included in the analysis, participants had to complete 75% of the measures. Therefore, of the 319 matched datasets, 262 datasets were eligible for analysis.

To assess the representativeness of our sample, the demographic data was compared by means of the Defense Medical Surveillance System to those of active-duty Army personnel deployed to OIF and OEF (Ruberton and Brundage, 2002).

1.2. Surveys and outcome variables

Participants were categorized into one of four groups based on responses and scores from the 17-item PTSD Checklist-Military version (Bliese et al., 2008; Kang et al., 2003) and the Brief TBI Screen (Schwab et al., 2007) both of which were administered post-deployment. The *PTSD* group consisted of participants who screened positive as determined by guidelines published by the National Center for PTSD. The *TBI* group consisted of participants who screened positive for a probable TBI. The *PTSD w/TBI* group consisted of those who screened positive for both, and the *control* group was comprised of those who screened negative for both.

The pre-deployment test battery consisted of both neuropsychological assessments and questionnaires which were presented in random order. The questionnaires included a measure of personality – the Zuckerman-Kuhlman Personality Questionnaire (five factors: sociability, neuroticism, activity, impulsive sensation seeking, aggression; Zuckerman et al., 1993); a measure of emotion regulation – the Emotion Regulation Questionnaire (two factors: cognitive reappraisal and emotional suppression; Gross and John, 2003); baseline measures of depression and anxiety levels – Beck's Depression Inventory (Beck and Steer, 1984; Beck et al., 1988b) and Beck's Anxiety Inventory (Beck et al., 1988a; Hewitt and Norton, 1993); an inventory of health risk behaviors including questions from the alcohol use disorders identification test (Saunders et al., 1993), the Centers for Disease Control and Prevention's youth risk behavior survey regarding tobacco use (Center for Disease Control and Prevention, 2009), and the Driving Behavior Questionnaire (Parker et al., 1995) as well as a question regarding Army Substance Abuse Program (ASAP) referral; a measure of risk propensity – the Evaluation of Risks Questionnaire (EVAR-English version; three factors: need-for-control, self-confidence, risk/thrill seeking; Sicard et al., 2001; Killgore et al., 2006); and a measure of perceived invincibility, the Invincibility Belief Index (IBI; total invincibility belief score and three factors: adroitness, impunity, boldness; Killgore et al., 2010). Additionally, participants completed a measure of behavioral risk-taking – the Balloon Analog Risk Task (Lejuez et al., 2002); and a behavioral decision making task incorporating uncertainty, reward, and punishment –the Iowa Gambling Task (Bechara et al., 1997, 2001, 2000). Measures of personality and self-regulatory competence were included given the relationship between these individual differences and risky behavior (respectively, Zuckerman and Kuhlman, 2000; Byrnes, 2005).

The post-deployment test battery included the same instruments and tasks as the pre-deployment test battery with the addition of the 7-item combat exposure scale (Keane et al., 1989) and the deployment concerns sub-scale of the deployment risk and resilience inventory (King et al., 2003, 2006). These items characterized the participants' actual experiences and perceptions of the environment and threats while deployed.

1.3. Quality control and statistical design

All responses were recorded electronically using the psychological experiment software E-prime (version 2.0) and exported into Microsoft Office 2007 Excel for organization. Any questions that were skipped were identified in the dataset. As the responses were recorded electronically, the data file included the participants' reaction time to give a response which was recorded from the onset of the presentation of a question. Any reaction times that were less than a reasonable amount of time (which varied by instrument) to have read the question or observe the screen (whether by error or intentional) were marked as skipped questions in the dataset. All data were then imported to SPSS software (version 17.0) and analyzed using mixed model 4 (group: *PTSD, TBI, PTSD w/TBI, control*) × 2 (combat deployment: *pre-*, *post-*) analyses of variance (ANOVAs) and post-hoc tests. Given the unequal sample sizes between groups, Levene's test of homogeneity of variance was

conducted. Additionally, a between-subjects ANOVA was conducted to compare the 4 groups' responses on the deployment concerns and combat experiences surveys. Finally, a multiple linear regression was conducted to evaluate potential predictors of probable PTSD (e.g., pre-deployment psychological disturbance).

2. Results

The sample was primarily composed of U.S. Army Soldiers with an infantry military occupational specialty (MOS). The top three most frequently reported MOSs were Infantry (32.6%), Armor Crewman (17.6%), and Combat Medic (5.6%). Although the demographic characteristics of our sample were largely similar to the reference group obtained from the Defense Medical Surveillance System, the rank distributions and age were slightly lower in our sample due to an undersampling of officers (Table 1). Females were also underrepresented in our sample which is to be expected given that we sampled from an infantry battalion.

A one-way ANOVA indicated significant differences between groups for the combat experiences survey scores such the *control* group scored lower than the other 3 groups, $F(3, 242) = 7.031$, $p < 0.001$ (Fig. 1). Similarly, a one-way ANOVA showed that *PTSD* and *PTSD w/TBI* groups scored higher on the deployment concerns survey than *control* and *TBI* groups, $F(3, 243) = 14.998$, $p < 0.001$ (Fig. 2).

Post-deployment scores of aggression, activity, neuroticism, perceived invincibility, adroitness, risk/thrill seeking, self-confidence, depression symptoms, frequency of drinking episodes, and referrals to the Army Substance Abuse Program (ASAP) increased across all participants. Participants' scores of sociability and need for control decreased post-deployment. Smokers reported smoking less post-deployment and of those who reported riding a motorcycle, helmet-use decreased post-deployment (Table 2). There were no significant main effects or interactions for the following measures: Zuckerman-Kuhlman Personality Questionnaire (impulsive sensation seeking subscale), Emotion Regulation Questionnaire, Invincibility Belief Index (impunity and boldness subscales), Balloon Analog Risk Task, and Iowa Gambling Task.

Overall, the results showed that the *PTSD* and *PTSD w/TBI* groups scored higher on aggression, neuroticism, risk/thrill seeking; and reported more drinks consumed during a drinking episode, more frequent drinking episodes, feeling the need to cut down on drinking, and using more alcohol than intended than the *control* group. Similarly, the *PTSD w/TBI* groups scored higher on aggression than the *TBI* group, higher on neuroticism than the *PTSD* and *TBI* groups, and reported more drunk-driving episodes than the *control* group. The pattern of depression and anxiety was such that the *PTSD w/TBI* group scored the highest followed by the *PTSD* group, *TBI* group, and *control* group in decreasing order. Both the *control* and *TBI* groups scored higher on sociability than the *PTSD* and *PTSD w/TBI* groups. The *PTSD* and *PTSD w/TBI* groups reported more frequent episodes of speeding (both highway and residential) than the *control* and *TBI* groups. Finally, of those who reported smoking, the *PTSD* group reported smoking more cigarettes per day than the *control* group.

Table 1
Demographic characteristics of study groups of soldiers compared across conditions; frequency (percent).

Characteristic	Reference group ($N = 113{,}582$)	Army study sample ($N = 262$)
Age		
18–24 yr	45,427 (40)	139 (53.6)
25–29 yr	29,172 (25.7)	70 (27.0)
30–39 yr	29,245 (25.7)	38 (14.7)
40 yr or older	9738 (8.6)	12 (4.6)
Missing values		3
Sex		
Male	101,786 (89.6)	258 (99.2)
Female	11,796 (10.4)	2 (0.7)
Missing values		2
Race or ethnic group		
Caucasian	82,193 (72.4)	187 (71.4)
African American	20,819 (18.3)	31 (11.8)
Hispanic	12,617 (11.1)	32 (12.2)
Other	6006 (4.2)	12 (4.6)
Education		
No high-school diploma	935 (0.7)	22 (8.4)
HS diploma or some college	101,114 (71.2)	220 (83.9)
College graduate	16,136 (11.4)	20 (7.6)
Military grade		
Enlisted personnel		
E1-E4	70,291 (49.5)	166 (63.4)
E5-E6	37,648 (26.5)	77 (29.3)
E7-E9	12,292 (8.7)	12 (4.6)
Officer	21,805 (15.4)	7 (2.6)
Prior combat experience		
Yes	Not available	127 (48.5)
No	Not available	135 (51.5)

Note. Military grades of E1-E4 represent lower enlisted, E5-E6 represent junior non-commissioned officers (NCOs), and E7-E9 represent senior NCOs. Missing values are not represented, as some participants chose not to answer all questions. Percentages may not sum to 100 due to rounding. Reference group includes active-duty only Army personnel deployed to OIF in 2010.

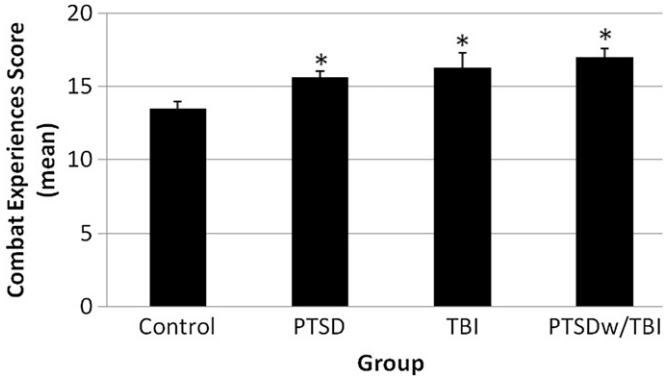

Fig. 1. Bar graph of mean combat experiences score by group. Error bars represent standard error of the mean. * indicates a significant difference from *control* group at $p < 0.05$.

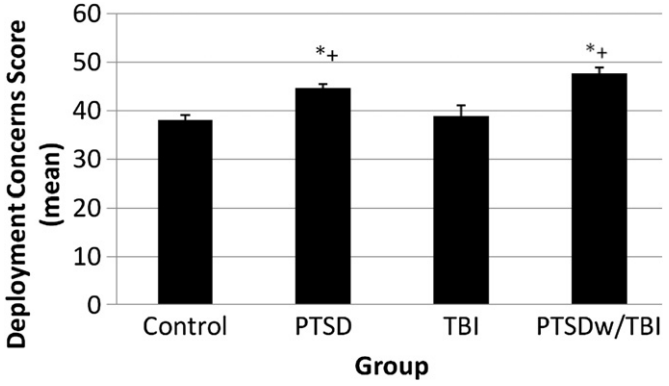

Fig. 2. Bar graph of mean deployment concerns score by group. Error bars represent standard error of the mean. * indicates a significant difference from control group at $p < 0.05$. + indicates a significant difference from *TBI* group at $p < 0.05$.

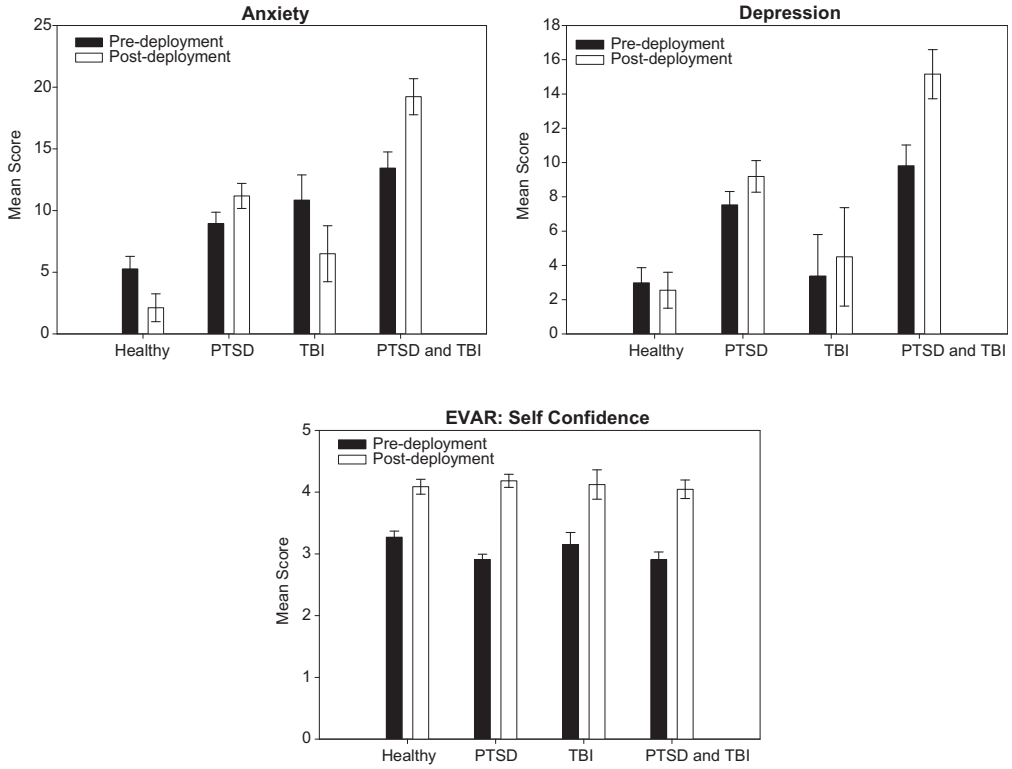

Fig. 3. Bar graphs of interaction effects of combat deployment and group on anxiety, depression, and self-confidence.

All groups showed an increase in self-confidence (i.e., enhanced sense of assuredness and preference for danger), however, the quantity of this increase was greater in the *PTSD* and *PTSD w/TBI* groups than the others. The *control* and *TBI* groups showed a decrease in anxiety levels post-deployment whereas the *PTSD* and *PTSD w/TBI* groups showed an increase. Post-deployment depression symptoms decreased for the *control* group while increasing for all other groups.

To evaluate the extent to which pre-deployment psychological disturbance (anxiety and depression), combat experiences during deployment, concerns and threat during deployment, and previous combat deployment impacted PTSD score post-deployment, a multiple linear regression was conducted. The model showed that measures of depression pre-deployment and perceived threat during deployment significantly predicted PTSD score and accounted for 32.6% of the variance, $R^2 = 0.326$, $F(5, 180) = 17.383$, $p < 0.001$. Specifically, Beck's depression inventory score pre-deployment, $\beta = 0.257$, $t(185) = 3.655$, $p < 0.001$, and deployment concerns score (post-deployment), $\beta = 0.341$, $t(89) = 5.267$, $p < 0.001$, were significant predictors of PTSD scores. Pre-deployment anxiety, combat experience, and previous deployment were not significant predictors.

3. Discussion

The results of this study strongly suggest that changes in attitudes about risk, risk propensity, and health risk behaviors occur after a combat deployment. Specifically, participants reported increased frequency of alcohol consumption and referrals to ASAP after returning home. Participants who were motorcycle riders reported decreased frequency of helmet use post-deployment. The magnitude of these changes was amplified in participants who screened positive for PTSD. While the statistical significance of the effects of combat deployment, PTSD, and TBI is important, these findings are strengthened by the medium to large effect sizes found as well. The implications of these findings touch a broad range of concerns including public health, return-to-duty and operational readiness, personal safety, and readjustment to life after a deployment.

Participants' responses indicate a greater sense of invincibility and adroitness post-deployment compared to pre-deployment as well as self-confidence. As described by Killgore et al. (2006), the self-confidence factor on the EVAR indicates preference for danger and "being strengthened by hostile situations." Thus, the increases seen in self-confidence may be reflective of an increase in perceptions of one's ability to survive or, rather, one's invincibility. This altered self-perception is understandable, as these Soldiers had recently survived a uniquely dangerous period of life, thus amplifying the perception of their survival abilities and diminishing their perceived susceptibility to negative consequences. These alterations may function as a coping mechanism such that emotional stability is fostered by moving forward from the experience rather than dwelling on the idea that one might not have survived (Bell et al., 2001). Survival is unconsciously attributed to one's exceptional survival skills or invincibility. While this may promote emotional stability and health, the consequence of this altered perception is that a Soldier may engage in dangerous behaviors. Also, there is no indication as to if and when these coping behaviors become a negative habit versus a helpful strategy. The extent to which this altered perception and behaviors serve as an effective coping mechanism is unknown.

Interestingly, participants' personality traits related to risk-taking changed across the deployment cycle. Personality was traditionally thought to be relatively stable once adulthood is reached. Recent review shows that personality continues to adapt and develop across adulthood typically in the positive direction (McCrae and Costa, 1994; Roberts and Mroczek, 2008). The results of the current study suggest that aspects of personality may seem

Table 2
Summary of results of 4 (PTSD, TBI, PTSD w/TBI, control) X 2 (pre-, post-deployment) ANOVAs (ns refers to not significant).

Construct	*F*	df	*p*	*Partial* η^2	Comparison	*p*
Main effect of combat deployment (pre, post)						
Sociability	6.938	1, 229	0.009	0.029	pre > post	0.009
Aggression	9.242	1, 233	0.003	0.038	pre < post	0.003
Activity	39.877	1, 235	<0.001	0.145	pre < post	< 0.001
Neuroticism	13.052	1, 230	<0.001	0.054	pre < post	< 0.001
IBI: Total invincibility	48.14	1, 226	<0.001	0.176	pre < post	< 0.001
IBI: Adroitness	106.996	1, 237	<0.001	0.311	pre < post	< 0.001
EVAR: Risk/thrill seeking	22.504	1, 258	<0.001	0.080	pre < post	< 0.001
EVAR: Self-confidence	157.48	1, 258	<0.001	0.379	pre < post	< 0.001
EVAR: Need for control	14.488	1, 258	<0.001	0.053	pre > post	< 0.001
Depression	4.682	1, 173	0.032	0.026	pre < post	0.032
Frequency of smoking	4.758	1, 169	0.031	0.027	pre > post	0.031
Frequency of drinking	3.946	1, 250	0.048	0.016	pre < post	0.048
Referred to ASAP	4.042	1, 250	0.045	0.016	pre < post	0.045
Motorcycle helmet use	5.164	1, 65	0.026	0.026	pre > post	0.026
Impulsive sensation seeking	0.786	1, 227	0.376	0.003	ns	
Cognitive reappraisal	0.003	1, 238	0.955	0.000	ns	
Emotional suppression	0.043	1, 241	0.836	0.000	ns	
IBI: Impunity	3.545	1, 241	0.061	0.014	ns	
IBI: Boldness	2.523	1, 232	0.114	0.011	ns	
Anxiety	0.024	1, 245	0.878	0.000	ns	
Drunk driving						
Cigarettes per day	0.109	1, 170	0.742	0.001	ns	
Alcoholic drinks per day	3.380	1, 247	0.067	0.013	ns	
Frequency of speeding	0.022	1, 253	0.883	0.000	ns	
Drunk driving	2.860	1, 245	0.092	0.012	ns	
Used more alcohol than intended	0.606	1, 244	0.437	0.002	ns	
Main effect of group (PTSD, TBI, PTSD w/TBI, Control)						
Sociability	5.932	3, 229	0.001	0.072	*control > PTSD*	0.002
					control > PTSD w/TBI	0.001
					TBI > PTSD	0.034
					TBI > PTSD w/TBI	0.009
Aggression	6.973	3, 233	<0.001	0.082	*control < PTSD*	0.001
					control < PTSD w/TBI	< 0.001
					TBI < PTSD w/TBI	0.035
Neuroticism	16.594	3, 230	<0.001	0.178	*control < PTSD*	< 0.001
					control < PTSD w/TBI	< 0.001
					TBI < PTSD w/TBI	0.001
					PTSD < PTSD w/TBI	0.019
EVAR: Risk/thrill seeking	3.332	3, 258	0.02	0.037	*control < PTSD*	0.007
					control < PTSD w/TBI	0.008
Anxiety	26.735	3, 245	<0.001	0.247	*control < PTSD*	< 0.001
					control < TBI	0.012
					control < PTSD w/TBI	< 0.001
					PTSD < PTSD w/TBI	< 0.001
					TBI < PTSD w/TBI	< 0.001
Depression	19.038	3, 173	<0.001	0.248	*control < PTSD*	< 0.001
					control < PTSD w/TBI	< 0.001
					PTSD < PTSD w/TBI	0.002
					TBI < PTSD w/TBI	< 0.001
Cigarettes per day	3.029	3, 170	0.031	0.051	*control < PTSD*	0.003
Alcoholic drinks per day	3.392	3, 247	0.019	0.096	*control < PTSD*	0.008
					control < PTSD w/TBI	0.006
Frequency of speeding	8.957	3, 253	<0.001	0.092	*control < PTSD*	< 0.001
					control < PTSD w/TBI	< 0.001
					TBI < PTSD	0.04
					TBI < PTSD w/TBI	0.007
Frequency of drinking	5.03	3, 250	0.002	0.057	*control < PTSD*	0.001
					control < PTSD w/TBI	0.001
Felt need to cut down drinking	3.468	3, 235	0.017	0.042	*control < PTSD*	0.045
					control < PTSD w/TBI	0.002
Drunk driving	2.667	3, 245	0.048	0.032	*control < PTSD w/TBI*	0.01
Used more alcohol than intended	5.816	3, 244	0.001	0.067	*control < PTSD*	< 0.001
					control < PTSD w/TBI	< 0.001
Activity	0.521	3, 235	0.668	0.007	ns	
Impulsive sensation seeking	2.083	3, 227	0.103	0.027	ns	
Cognitive reappraisal	2.268	3, 238	0.081	0.028	ns	
Emotional suppression	1.023	3, 241	0.383	0.013	ns	
IBI: Total invincibility	0.103	3, 226	0.958	0.001	ns	
IBI: Adroitness	0.022	3, 237	0.995	0.000	ns	
IBI: Impunity	0.244	3, 241	0.865	0.003	ns	
IBI: Boldness	0.253	3, 232	0.859	0.003	ns	
EVAR: Self-confidence	0.768	3, 258	0.513	0.009	ns	
EVAR: Need for control	1.055	3, 258	0.369	0.012	ns	

Table 2 (*continued*)

Construct	*F*	df	*p*	*Partial* η^2	Comparison	*p*
Frequency of smoking	2.222	3, 169	0.086	0.026	ns	
Referred to ASAP	0.584	3, 250	0.626	0.007	ns	
Motorcycle helmet use	0.958	3, 65	0.418	0.042	ns	
Interaction						
Anxiety	8.563	3, 245	< 0.001	0.095	See Fig. 3	
Depression	3.421	3, 173	0.019	0.560	See Fig. 3	
Self-confidence	2.655	3, 258	0.049	0.030	See Fig. 3	
Sociability	2.100	3, 229	0.101	0.027	ns	
Aggression	1.060	3, 233	0.367	0.013	ns	
Activity	1.542	3, 235	0.204	0.019	ns	
Neuroticism	2.585	3, 230	0.054	0.033	ns	
Impulsive sensation seeking	0.054	3, 227	0.983	0.001	ns	
Cognitive reappraisal	0.175	3, 238	0.913	0.002	ns	
Emotional suppression	1.605	3, 241	0.189	0.020	ns	
IBI: Total invincibility	0.830	3, 226	0.479	0.011	ns	
IBI: Adroitness	1.464	3, 237	0.225	0.018	ns	
IBI: Impunity	1.012	3, 241	0.388	0.012	ns	
IBI: Boldness	0.635	3, 232	0.593	0.008	ns	
EVAR: Risk/Thrill seeking	0.720	3, 258	0.541	0.008	ns	
EVAR: Need for control	1.623	3, 258	0.184	0.019	ns	
Drunk driving						
Frequency of smoking	2.392	3, 169	0.069	0.028	ns	
Cigarettes per day	1.327	3, 170	0.267	0.023	ns	
Alcoholic drinks per day	1.918	3, 247	0.127	0.023	ns	
Frequency of speeding	0.732	3, 253	0.534	0.009	ns	
Frequency of drinking	0.677	3, 250	0.567	0.008	ns	
Drunk driving	0.982	3, 245	0.402	0.012	ns	
Referred to ASAP	1.199	3, 250	0.311	0.014	ns	
Used more alcohol than intended	0.929	3, 244	0.427	0.011	ns	
Motorcycle helmet use	0.799	3, 65	0.499	0.036	ns	

altered by the life experience of a combat deployment independent of psychological injury. This finding can be summed up as the commonly reported anecdote "you are just not the same" after a deployment. However, the permanence of this "alteration" was not assessed thus making it impossible to interpret whether this change is simply a short-term adaptation effect or if it is long-term.

In our study, Soldiers exhibiting PTSD symptoms were highly susceptible to changes in attitude, perception, and behavior. Those who screened positive for PTSD reported more frequent reckless driving in both residential and built-up areas as well as highway driving. The *PTSD* and *PTSD w/TBI* groups also reported more frequent alcohol consumption and quantity consumed during a drinking episode. Of the participants who reported smoking, those with PTSD symptoms smoked more heavily than the healthy participants overall. Drunk driving and feelings of need to cut down on alcohol consumption were also reported as occurring more frequently post-deployment in the *PTSD* and *PTSD w/TBI* groups. While health risk behaviors increased post-deployment regardless of TBI or PTSD, the range of behaviors and frequency of behaviors reported overall were exaggerated in those screened positive for PTSD.

Personality dimensions related to sociability, aggression, and neuroticism differed between groups such that *PTSD* and *PTSD w/TBI* groups were less sociable, more aggressive, and more neurotic than the *control* and *TBI* groups. These differences did not interact with phase of testing (pre- versus post-deployment) suggesting that personality may play a role in resilience to PTSD. Anxiety and depression decreased post-deployment for healthy participants whereas these variables increased for those who screened positive for PTSD. For all Soldiers, pre-deployment is a stressful time where tight training schedules demand one's time as well as preparation for the family left behind (e.g., finances, wills, childcare, thoughts of injury or death). For those who return relatively healthy, post-deployment is a time of relief (e.g., reconnecting with family and friends, familiarity and predictability, feelings of safety and security) which is not the case for those experiencing psychological problems.

3.1. Practical implications

Engaging in risky behaviors such as alcohol use and smoking puts not only individual health and safety in jeopardy, but also family safety and public health. The findings of this study expand beyond health risk behaviors and suggest that perception of risks and attitudes about invincibility are altered after a combat deployment. This skewed perception of risk endangers more aspects of a Soldier's life than off-duty health and safety–operational readiness is another area of a Soldier's life that is potentially open for hazardous consequences. If a Soldier engages in risky behavior while still in a combat environment, consequences could be fatal; once redeployed and returned-to-duty, military operations may be compromised due to a Soldier's disproportionate view of risk. However, the permanence of this skewed perception is still unknown and further research is needed to address this topic.

3.2. Study limitations and future research

While the results of this study provide a characterization of the pattern of health risk behaviors and attitudes about risk across the deployment cycle as well as illuminating differences in behaviors and attitudes between those who screened positive for PTSD and/or TBI and those who did not, there are limitations that should be considered when interpreting these data. First, given the nature of a quasi-experimental study, PTSD and TBI were not randomly assigned and thus resulted in unequal sample sizes. Since unequal sample size lends to a violation of the assumption of homogeneity, a statistical test of the assumption supported the robustness of the findings. Secondly, the only injury information collected was related to PTSD and TBI whereas the experience of sustaining other

injuries during deployment may have also influenced participants' responses. Third, the groups were categorized based on a self-report screening tool which is far less sophisticated than the standard methods applied for diagnosing PTSD and TBI. The significant results obtained despite this crude method of assessment, however, lend strength to the findings. Fourth, some participants were unavailable for testing post-deployment due to behavioral problems or medical evacuation prior to the testing window; these untested subgroups could exhibit different patterns of post-deployment risk-taking behavior. Also, participants were allowed to skip questions they did not feel comfortable answering. These factors lend to concerns of differential attrition. Finally, the sample studied was not a random sample of Soldiers but rather a convenience sample which poses a threat to the external validity of these results. To address this limitation, the representativeness of the sample was presented.

Whereas this study contributes to the understanding of changes in risk attitudes by documenting the pattern of engagement in risky behavior across the deployment cycle, much work is yet to be done. Specifically, the time course of these changes is unknown. A longitudinal assessment extending at a least a year after redeployment would shed light on the longevity of this problem. Likewise, a more controlled and sophisticated investigation into the impact of PTSD, with and without a history of TBI, on risk attitudes and health risk behaviors is needed to develop causal inferences about the relationship between PTSD and risk-taking. Studies are currently underway to model the predictive value of individual differences (e.g., personality, emotion regulation, combat experiences, deployment concerns) on risk attitudes and risk behaviors.

4. Conclusions

The results of this longitudinal study support previous anecdotal and between-subjects evidence suggesting that Soldiers are more likely to engage in risky behaviors post-deployment compared to pre-deployment. Changes were evident in all groups of Soldiers, but were most pronounced in those screening positive for PTSD (with or without TBI).

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Contributors

Amanda M. Kelley was primarily responsible for the design of the study and selection of measures, conducting literature searches, the development and conception of hypotheses, the supervision of data collections, conducting the statistical analyses, and writing the manuscript.

Jeremy R. Athy was primarily responsible for the data coding, ensuring quality control of the data, and calculating survey scores. He assisted in development of the design and selection of measures. In addition, he assisted in the data collections, interpretation of the results and editing of the manuscript.

Timothy H. Cho assisted in the interpretation of the results and made substantial contributions to preparation of the manuscript.

Bradley Erickson was primarily responsible for the coordination of the data collection and assisted in the selection of measures, data collections, data organization, interpretation of the results, and editing of the manuscript.

Melody King assisted in the selection of measures, data collections, data organization, and interpretation of the results.

Pedro Cruz assisted in the data collections, data organization, and interpretation of the results.

Conflict of interest

None of the authors declare any potential or actual conflict of interest.

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