

TWO-STEP RESILIENCE-ORIENTED INTERVENTION FOR VETERANS WITH TRAUMATIC BRAIN INJURY: A PILOT RANDOMIZED CONTROLLED TRIAL

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Abstract

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Objective: The present randomized parallel two-arm pilot study aimed to compare the efficacy of two-step resilience-oriented intervention with treatment as usual in veterans with mild to moderate traumatic brain injury.

Method: Two-step Resilience-Oriented Intervention (TROI) is a brief psychological intervention that targets cognitive (step 1) and emotional (step 2) factors of resilience and consists of six 1-hour sessions. Overall, 70 Ukrainian veterans serviced in Anti-Terrorist Operation / Joint Forces Operation were randomly assigned to an intervention group (TROI group) or a control group that underwent treatment as usual (TAU group). For pre- (T1) and post-treatment (T2) assessment the Connor-Davidson Resilience Scale (CD-RISC), Hospital Anxiety and Depression Scale (HADS), Montreal Cognitive Assessment Scale (MoCA), Neurobehavioral Symptom Inventory (NSI), Posttraumatic Stress Disorder Checklist 5 (PCL-5), Chaban Quality of Life Scale (CQLS), Positive and Negative Affect Scale (PANAS) were used.

Results: Multivariable linear regression with the treatment group, gender, baseline cognitive performance level and TBI severity as the independent variables revealed statistically significant improvements in the TROI group in resilience (CD-RISC), cognitive performance (MoCA), postconcussive symptoms (NSI), posttraumatic symptoms (PCL-5), positive affect (PANAS) and quality of life (CQLS) comparing to such in TAU group. We found no statistically significant differences between groups in depression, anxiety (HADS) and negative affect (PANAS) outcomes. Additionally, Wilcoxon signed-rank test revealed that participants who completed two-step resilience-oriented intervention had significantly improved scores for all outcomes compared to the baseline ($p < 0.05$).

Conclusions: In summary, we can tentatively conclude that adding TROI to the standard treatment measures may improve the resilience and sustainable symptoms in veterans with TBI when compared with standard treatment. Targeting cognitive and emotional factors like problem-solving, decision-making, positive thinking can promote resilience in veterans with TBI and be useful in facilitating recovery from injury. Results of this pilot study are promising, but the intervention needs to be studied in a larger trial.

Key words: resilience, veterans, traumatic brain injury, rehabilitation

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Introduction

Traumatic brain injury (TBI) negatively affects the social reintegration and readaptation of combat veterans (McCarron et al., 2019). Symptoms of TBI include a variety of manifestations, such as headaches, difficulties in concentrating, slow thinking, etc., which are associated with lower quality of life, loss of productivity, increased need for medical services and in some cases can sustain for many years (Sullivan et al., 2019). Symptoms of traumatic brain injury are reported by about 46% of all combat veterans, and in 85% of veterans with TBI, post-concussion symptoms can be

persistent (Morissette et al., 2011). Even after 5 years, 92% of veterans with traumatic brain injury need to take medication, 60% of veterans seek psychological help, 32% cannot account for their health as satisfactory, and 8% have sustainable cognitive problems (Brickell, Lange & French, 2014).

In addition to persistent post-concussion symptoms, veterans with a history of TBI commonly have a number of comorbid mental health issues. Quite a well-known issue for veterans with TBI is to have subclinical signs of post-traumatic stress, which do not reach completeness for the diagnosis of posttraumatic stress disorder (PTSD), but negatively affect recovery from

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TBI (Korte et al., 2016). Recent findings suggest that sustainable symptoms of TBI is largely caused by stress reactions after TBI, which means that postconcussive symptoms may be not only a function of neurological damage (Bryant, 2011). New directions for treatment of TBI symptoms should acknowledge treating stress factors following TBI to optimally manage the effects of the TBI (Bryant, 2011). Along with this, subclinical symptoms are easier to treat via psychological interventions (Korte et al., 2016). Veterans with persistent symptoms of deployment-related TBI also report high levels of depression and anxiety (Benavides et al., 2021; Morissette et al., 2011), and this association remains strongly even without probable PTSD (Iverson et al., 2013). Quality of life of veterans in TBI is also poor, which may be associated with declining cognitive functioning even years after injury (Merritt et al., 2021).

While symptoms in the acute period of traumatic brain injury are provoked by complex physiological changes, in the remote period the symptoms and functioning of the person with a history of TBI are increasingly affected by psychological processes – maladaptive psychological mechanisms can lead to chronic stress, which contributes to the sustainability of TBI symptoms (van der Horn, H., et al., 2019). These circumstances necessitate the study of psychological factors that contribute to the successful rehabilitation of veterans with sustaining symptoms of traumatic brain injury, increase their readaptation and reduce the severity of neurobehavioral and post-traumatic symptoms.

Resilience and TBI-related mental health issues in veterans

Among the factors that may contribute to reducing the severity of TBI symptoms and successful rehabilitation of veterans, there are some positive psychology phenomena like grit, positive affect, optimism, coping, and resilience (Rabinowitz & Arnett, 2018). Resilience can be defined as an adaptive dynamic process of restoring effective psychosocial functioning after traumatic factors (Assonov & Khaustova, 2019). Recent meta-analysis has shown that resilience is strongly associated with mental health in somatically ill patients (Färber & Rosendahl, 2018). The results of many studies suggest that TBI is not an exception. TBI consequences like cognitive deficit, problems with mood regulation, reduced self-awareness seem to have a devastating effect on resilience (Rabinowitz & Arnett, 2018). The resilience of combat veterans with a history of traumatic brain injury is less effective than in veterans without a history of trauma or in the general population, but the mechanisms that would clearly explain this are not studied well (Neils-Strunjas et al., 2017). Raising an effective resilience may be potentially helpful in reducing the symptoms of trauma, post-traumatic stress disorder, and depression. There is evidence that resilience negatively correlates with neurobehavioral symptoms of trauma even after years of TBI event (Reid, Cooper, Lu, Iverson & Kennedy, 2018). Moreover, some researchers argue that less effective resilience may be a stronger predictor of TBI symptom severity than a history of TBI itself (Sullivan et al., 2015). In addition to the association with symptoms of TBI itself, resilience can also be associated with concomitant TBI problems. For example, Elliott et al. have found that effective resilience in veterans is associated with fewer symptoms of posttraumatic stress and depression, better sleep, and quality of life regardless of the presence/

absence of trauma and total combat experience (Elliott et al., 2016; Elliott et al., 2019). Some authors assert that resilience can promote a veterans' readaptation through psychological flexibility regardless of the number of TBI (Elliott et al., 2019). While resilience was previously considered a personality trait, the most recent approaches conceptualize resilience as a multidimensional, dynamic and variable process (Helmreich et al., 2017). Unlike many personality traits, resilience has a big advantage – it can be modified – which makes it a good target for TBI interventions (Skandsen et al., 2021).

Studies evaluating resilience-oriented interventions for persons with TBI

There is an increasing need to develop rehabilitation programs that would be aimed at raising resilience to maximize the therapeutic effect and help to successfully reintegrate patients with a history of TBI into society (Vos, Poritz, Ngan, Leon-Novelo & Sherer, 2019; Neils-Strunjas et al., 2017). Currently, few of such psychological interventions have been developed and studied (Lukow et al., 2015). However, early studies of such interventions had shown their potential. Analysis of The Resilience and Adjustment Intervention by Kreutzer et al. (Kreutzer et al., 2018) showed that educatory, skill-building, and supporting intervention can improve resilience and reduce psychological symptoms of TBI. Another resilience-oriented intervention for families of persons with TBI and spinal cord injury, planned by Soendergaard et al. (Soendergaard et al., 2019) also pointed at the importance of developing new approaches to rehabilitation. A pilot study by Vranceanu et al. (Vranceanu, A., et al., 2020), evaluating the effectiveness of a 6-session length “Recovering together” intervention also showed effectiveness in raising resilience, although it was measured by non-specific tests. Such positive results make further research in this area promising.

A request for such programs is also seen in the rehabilitation of veterans with sustainable post-concussion symptoms as a subgroup of patients with TBI. Currently, different authors recognize the critical need to develop interventions that affect veterans' resilience to reduce post-concussion and post-traumatic symptoms (Reid, Cooper, Lu, Iverson & Kennedy, 2018; Elliott et al., 2016; George, Elman, Becerra, Berg & Borsook, 2016). Elliott et al. claim that existing resilience-oriented interventions have insufficient evidence for effectiveness in improving the mental state of veterans (Elliott et al., 2016). However, despite the urgency of this problem, there are currently very few attempts to address it. In our previous review of resilience in veterans with TBI (Assonov & Khaustova, 2020) we found only one study for the last 5 years, in which authors studied the effectiveness of resilience-oriented interventions for veterans with TBI. Church, D., Sparks, T., & Clond, M. presented positive results of their study where they evaluated the effectiveness of emotional freedom technique (EFT), which they positioned as a short-term intervention to increase resilience, reduce symptoms of TBI, insomnia, and subclinical symptoms of PTSD (Church, Sparks & Clond, 2016). Although this indicates the viability of such studies and may empirically confirm the positive effect of resilience-oriented interventions on the symptoms of trauma in veterans, among the limitations of this study was the absence of clear resilience definition and absence of specific psychometric

measures by resilience-targeted inventories like CD-RISC, which creates the need for further research in this area. Therefore, despite the existing treatment strategies, efforts are needed to develop evidence-based resilience-oriented interventions that would be specific for veterans with traumatic brain injury and could improve the effectiveness of rehabilitation interventions.

Cognitive and emotional factors of resilience as targets for new interventions

The question arises, what factors should be intervention targeted at to increase the resilience of veterans. Resilience is an umbrella term that needs to be more clarified and conceptualized. Therefore, several usable resilience models have been created in recent years, among which we could highlight some encompassing models like a resilience model in TBI, proposed by Nalder E et al. (Nalder, E., et al., 2018), a cognitive model of resilience, proposed by Parsons et al. (Parsons, S., et al., 2016) and a processual model of resilience by Stainton et al. (Stainton, A., et al., 2018). These models were designed to facilitate the selection of therapeutic targets for resilience-oriented interventions. In our opinion, in further studies, it would be more appropriate to focus on key aspects of resilience, among which these researchers distinguish some cognitive and emotional factors (Nalder, E., et al., 2018; Stainton, A., et al., 2018; Parsons, S., et al., 2016). Cognitive functioning, which is often decreased after TBI, seems to play a significant role in resilience and is highly important in successfully overcoming the negative effects of stressful events (Stainton et al., 2018). Such cognitive skills, as the ability to maintain attention and to concentrate, effectively using the memory and executive functions (adaptive problem solving, self-regulation and decision-making) may be important for resiliency-oriented rehabilitation outcomes (Nalder, Hartman, Hunt & King, 2018; Stainton et al., 2018). Effective emotional functioning also potentially serves as an important factor in the model of resilience in TBI (Nalder, Hartman, Hunt & King, 2018). Flexible processing of affective stimuli also may be crucial for resilience (Horn & Feder, 2018) Another way to raise resilience could be through cultivating positive emotions and positive affect (Helmreich et al., 2017; Lee et al., 2013). Psychological interventions that promote veterans' resilience by improving such phenomena as cognitive processing, emotional responses, and self-regulation may be useful (George, E., et al., 2016). Therefore, new resilience-oriented interventions that would affect these two groups of factors, may succeed.

Based on the aforementioned theoretical models of resilience and our reviews of prior resilience-oriented interventions (Assonov, 2021), we developed a manualized two-step resilience-oriented intervention for veterans with a history of TBI that targeted two groups of resilience factors – cognitive and emotional. The primary purpose of the present study was to conduct a pilot trial to evaluate the efficacy of this intervention.

Aims and hypotheses

This pilot study aimed to investigate the efficacy of Two-step Resilience-Oriented Intervention (TROI) for veterans with sustainable symptoms of traumatic brain injury, which focuses on cognitive and emotional factors of resilience.

It was hypothesized that:

1. There would be a significant difference in the post-treatment resilience, positive affect, and quality of life between the intervention group and treatment as usual group (supposed that there would be a significantly higher increase in the intervention group);
2. There would be a significant difference in the post-treatment neurobehavioral, post-traumatic, anxiety, and depression measures between the intervention group and treatment as usual group (supposed that there would be a significantly higher reduction in the intervention group).

Materials and Methods

Participants. The sample consisted of 70 veterans of Anti-Terrorist Operation / Joint Forces Operation in Ukraine with traumatic brain injury in the remote period (time from the moment of injury ≥ 3 years), recruited in two clinical centres: Kyiv City Clinical Hospital for War Veterans and Hospital for War Veterans "Forest Glade" of Ministry of Health of Ukraine. Participants' recruitment was conducted from December 2019 until June 2021. Participants **were potentially eligible** if they: 1) were military servicemen participated in Anti-Terrorist Operation / Joint Forces Operation and were demobilized by the time of enrolment into the study; 2) had a history of mild to moderate traumatic brain injury during military service ≥ 3 years ago; 3) were at the age from 18 to 64 years by the moment of enrollment. Participants **were excluded** if they: misused alcohol or drugs within the last six months, met full criteria for posttraumatic stress disorder, had a diagnosis of dementia or had a severe cognitive deficit (MMSE < 14), met full criteria for any psychotic disorder, had a history of severe traumatic brain injury, or were enrolled into another study by the moment of screening.

The mean age of 70 participants was 46.44 ± 7.67 years. Almost all participants (68 / ~97%) were male, and 2 (~3%) participants were female. More than half of the participants were married (40 participants, ~57,14%). The median time spent in the warzone was 1 year. With regard to TBI severity, 4/5 of participants (56 veterans) had a history of moderate TBI (contusion) and 1/5 (14 veterans) had a history of mild TBI (concussion), with a median time postinjury was 6 years (Q1-Q4 range from 3 to 7) and median number of TBIs was 1. All TBIs were blast-related and received in the warzone. At baseline level almost all participants had an impaired cognitive performance (Montreal Cognitive Assessment score < 26 points). Baseline demographic and clinical information is presented in **table 1**.

Design. This is a two-arm, parallel, randomized, non-blinded controlled pilot trial (RCT) with a control group received treatment as usual (TAU) plus a waiting list. Randomization was done by a research randomizer program (www.randomizer.org). Simple randomization via random number generation (0 – control, 1 – intervention group) for every participant was used. All participants were randomly assigned to the intervention group (TROI) or the treatment as usual (TAU) groups (allocation ratio 1:1): 1) the intervention group was enrolled into a two-step resilience-oriented intervention program and TAU; 2) the TAU group participants were included into the waiting list for intervention and received standard treatment and rehabilitation during the waitlist period (**figure 1**). Treatment as usual consisted of neuropsychological assessment, pharmacotherapy, social work, psychoeducation, and

Table 1. Baseline (T1) demographic and clinical data. Data are presented by mean \pm SD / Median [Q1-Q3] for quantitative data or N (%) for qualitative

	Overall	Intervention Group (n=35)	Treatment As Usual Group (n=35)	t/W/x ²	p
Demographic					
Base:				0	1
Kyiv City Clinical Hospital for War Veterans	48 (68,57%)	24 (68,57%)	24 (68,57%)		
Hospital for War Veterans "Forest Glade"	22 (31,43%)	11 (31,43%)	11 (31,43%)		
Age (years)	46.44 \pm 7.67	47.22 \pm 7.50	45.65 \pm 7.87	-0.854	0.396
Gender:				0	1
Female	2 (2,86%)	1 (2,86%)	1 (2,86%)		
Male	68 (97,14%)	34 (97,14%)	34 (97,14%)		
Education (years)	14 [12-16,75]	14 [12-15,5]	14 [11,5-17,0]	619	0.944
Marital status:				2.1	0.147
Married	40 (57,14%)	23 (65,71%)	17 (48,57%)		
Single	30 (42,85%)	12(34,29%)	18 (51,43%)		
Time spent in the warfare zone (years)	1(1-2)	1(1-2)	1(1-2)	573	0.599
Injury Severity:					
Mild TBI	14 (20%)	7 (20%)	7 (20%)	0	1
Moderate TBI	56 (80%)	28 (80%)	28 (80%)	0	1
TBI number	1 [1-1]	1 [1-1]	1 [1-1]	612.5	1
Time since TBI (years)	6 [5-6]	6 [4,5-6]	6 [5-7]	718	0.197
Length of hospitalization (days)	18 [17-19,75]	18 [16,5-18]	18[17,5-20]	730	0.155
Clinical					
CD-RISC	62.88 \pm 13.08	63.11 \pm 11.91	62.65 \pm 14.33	-0.145	0.885
MoCA	22.58 \pm 3.43	22.74 \pm 3.50	22.42 \pm 3.40	-0.380	0.705
<26 points cutoff	58 (82,86%)	29 (82,86%)	29 (82,86%)	0	1
\geq 26 points cutoff	12 (17,4%)	6 (17,4%)	6 (17,4%)		
NSI	43.44 \pm 12.42	45.74 \pm 10.09	41.14 \pm 14.15	-1.56	0.123
HADS-A	9.27 \pm 3.91	9.6 \pm 3.91	8.94 \pm 3.94	-0.699	0.487
HADS-D	8.04 \pm 3.38	8.54 \pm 3.01	7.54 \pm 3.70	-1.23	0.219
PCL-5	36.21 \pm 13.86	36.71 \pm 15.19	35.71 \pm 12.59	-0.29	0.765
PANAS+	25.72 \pm 4.30	25.87 \pm 4.62	25.58 \pm 4.04	-0.232	0.817
PANAS-	27.64 \pm 9.02	29.25 \pm 10.14	26.04 \pm 7.62	-1.23	0.222
CQLS	48.62 \pm 11.75	47.8 \pm 10.49	49.45 \pm 12.98	0.58	0.559

* - adjusted to unequal variances between groups

psychological counseling, depended on the individual needs and capacity of participants. For practical reasons, participants and project staff were not blinded to group assignment.

Ethical issues. All participants gave their informed consent in the written form after the procedures were fully explained. The present study is in accordance with the Helsinki Declaration and was approved by the Bioethical Expertise and Ethics of Scientific Research Committee of the Bogomolets National Medical University (protocol №127 of December 2, 2019).

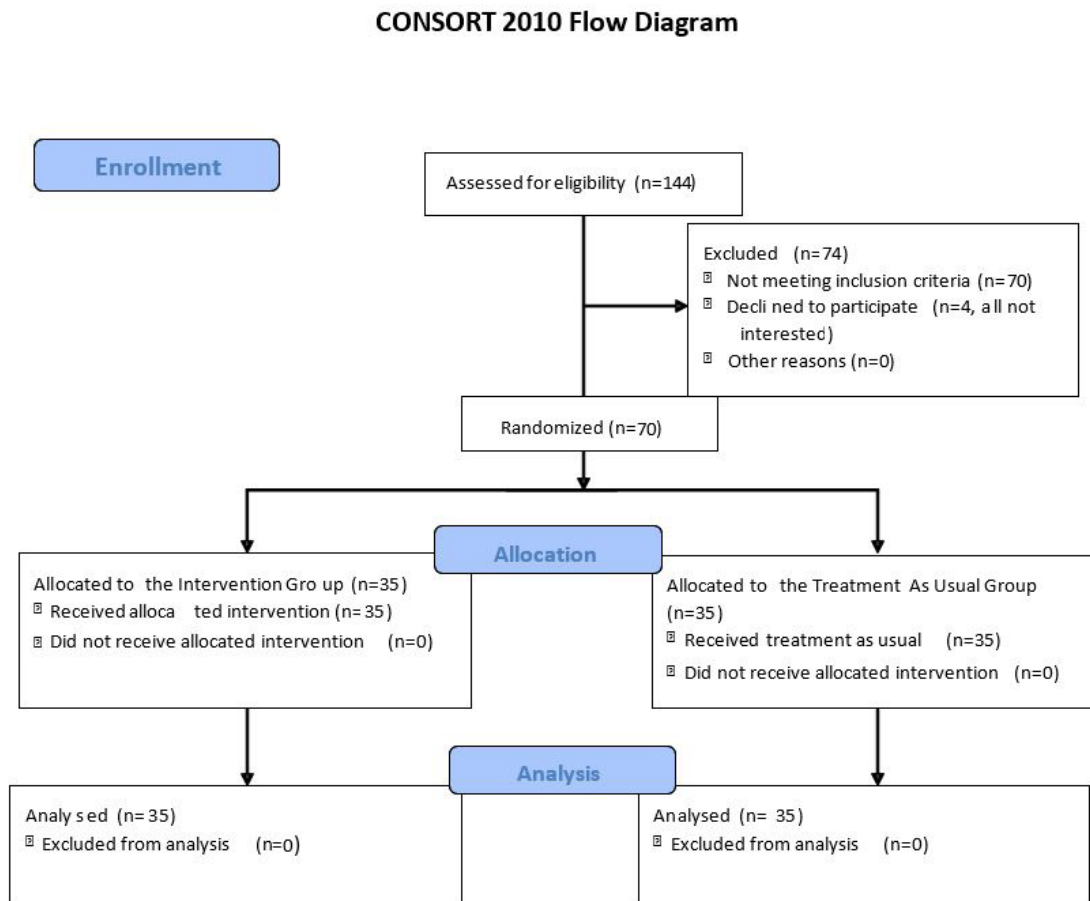
Relation to research programs. This study is a part of the research program "Dynamic biopsychosocial model of medical and psychological care (diagnosis, therapy, rehabilitation, prevention) of multidisciplinary hospitals' patients in a rapidly changing crisis society" conducted by the department of medical psychology, psychosomatic medicine, and psychotherapy of

Bogomolets National Medical University (state registration No. 0119U103910).

Procedures. Screening, assessment, and intervention were completed in rehabilitation departments of Kyiv City Clinical Hospital for War Veterans and Hospital for War Veterans "Forest Glade" of the Ministry of Health of Ukraine. Before the initiation, the study was approved by the university's institutional review board. TBI severity was assessed by department's neurologist via examination and by reviewing medical records. After giving informed consent, the participant completed baseline assessment scales and inventories and was randomized to one of two groups. Through the intervention, a researcher worked with each veteran individually. Post-treatment data were collected after the final session.

Treatment protocol. The TROI is a structured treatment program designed to enhance veterans'

Figure 1. CONSORT Flow diagram



resilience after TBI by such activities as psychoeducation, developing new skills, and promoting positive behavior. The intervention protocol was implemented throughout six 60-minute long sessions. The intervention had two steps: the first step (sessions 1-3) addressing cognitive factors of resilience, such as adaptive executive skills, memorization skills, ability to focus attention, and the second step addressing emotional factors, such as positive outlook and the ability to nourish positive emotions as well as manage the negative ones.

In the first session, the participants received psychoeducation about traumatic brain injury and resilience, defined the goals of participation and the skills needed for effective readaptation. In the second session, the participants received psychoeducation about concentrating on tasks and prospective memory, as well as trained skills for better attention and memorizing the important information. In the third session, the participants received psychoeducation about cognitive flexibility, goal setting, and problem-solving. Also, they trained patience skills and skills to prioritize and effectively solve the tasks. During the fourth session, the participants learned about emotional control and stress management, trained stress-reduction strategies, posttraumatic stress symptom identification and control skills. In the fifth session, the participants received psychoeducation about how positive and negative emotions connected to resilience and trained skills like mindfulness, positive emotion raising, self-calming, and anger management. The last, sixth, session, is focused on learning about optimism and positive thinking, as well as summing up the experience gained

during participation in the intervention program. The overview of the intervention is presented in **table 2**. At the end of each session (except the last one) participants got administered with a brief homework that should be done between sessions.

Assessment of outcome measures. Due to the well-known problem with the conceptualization of resilience, as well as the possible inclusion of broader, health-promoting interventions, resilience as an intervention outcome needs to be broadly assessed (Assonov & Khaustova, 2019; Helmreich et al., 2017). Regarding this, some authors consider the need to assess the resilience not only with a specific scale, but also to assess its factors and related outcomes, as well as the general state of the patient's mental health to obtain a complete picture (Helmreich et al., 2017; Sarkar & Fletcher, 2013). Therefore, for pre- (T1) and post-treatment (T2) assessments, we used a battery of inventories to get detailed information on resilience and other components of veterans' mental health.

Participants' resilience was measured using the Connor-Davidson Resilience Scale (CD-RISC), neurobehavioral symptoms were measured with Neurobehavioral Symptom Inventory (NSI), cognitive performance was assessed with Montreal Cognitive Assessment Scale (MoCA), anxiety and depression symptoms were assessed by using Hospital Anxiety and Depression Scale (HADS), positive and negative affect were measured using the Positive and Negative Affect Scale (PANAS). posttraumatic symptoms were measured using the Posttraumatic Stress Disorder Checklist 5 (PCL-5), quality of life was assessed with

Table 2. Overview of Two-step Resilience-Oriented Intervention (TROI) sessions, topics, and content

Session	Topics	Content (strategies and skills participants learn)
Step 1. Addressing cognitive factors of resilience		
Session 1. Introduction to the intervention program	Psychoeducation on traumatic brain injury	<ul style="list-style-type: none"> • Determine how the injury affected them; • Understanding the main symptoms of trauma;
	Psychoeducation on resilience and its factors	<ul style="list-style-type: none"> • Understanding why resilience is important for recovery from trauma; • Identifying what skills need to be developed to accelerate readaptation and what actions not to do to avoid worsening the symptoms;
Session 2. Focusing on and memorizing the important things	Concentration and focus in achieving goals	<ul style="list-style-type: none"> • Understanding why concentration problems occur after trauma; • Skills to increase concentration;
	Prospective memory and adaptation	<ul style="list-style-type: none"> • Understanding why it is more difficult to remember something after a trauma; • Understanding how good memorization is related to faster recovery; • Skills to improve memorization of necessary information;
Session 3. Cognitive flexibility, problem-solving, and goal setting	Ability to be flexible in achieving the goals	<ul style="list-style-type: none"> • Identifying what is patience and how it is connected to resilience; • Skills to increase patience for achieving the goals;
	Goal-setting strategies	<ul style="list-style-type: none"> • Skills to distinguish between significant and insignificant goals; • Skills to prioritize tasks;
	Problem-solving strategies	<ul style="list-style-type: none"> • Understanding that after a trauma it is normal to have difficulties in solving problems; • Skills to effectively solve the problems;
Step 2. Addressing emotional factors of resilience		
Session 4. Stress-management	Stress and the ways to overcome it	<ul style="list-style-type: none"> • Understanding the effects of stress on the body; • Understanding the relationship between stress, resilience, and TBI symptoms; • Learning stress management strategies;
	Controlling the symptoms of posttraumatic stress	<ul style="list-style-type: none"> • Identifying the symptoms of PTSD; • Skills to reduce the severity of post-traumatic stress symptoms;
Session 5. Emotional flexibility	Growing positive emotions	<ul style="list-style-type: none"> • Identifying positive emotions; • Understanding the connection between positive emotions and resilience; • Skills to raise gratefulness; • Reducing the blaming; • Practicing mindfulness for a good mood; • Skills to pay attention to the positive events in life;
	Managing negative emotions: anger, fear, guilt	<ul style="list-style-type: none"> • Understanding the connection between negative emotions and trauma; • Understanding the signs of anger, fear, guilt; • Using strategies to control fear, anger, and guilt; • Using complacency skills;
Session 6. Optimism and building new plans	Optimism	<ul style="list-style-type: none"> • Understanding how optimism relates to physical and mental recovery; • Positive thinking strategies;
	Summarizing the results of participation in the program	<ul style="list-style-type: none"> • Describing the goals participants plan to achieve after completing the program; • Identifying the positive changes that have taken place since participants joined the program.

the Chaban Quality of Life Scale (CQLS), Additional information regarding each measure follows.

Connor-Davidson Resilience Scale (CD-RISC). Developed by Connor, K.M., and Davidson, J.R.T. the scale contains 25 statements, each of which should be evaluated on a five-point Likert scale from 0 to 4, a higher indicator indicates better resilience (Connor & Davidson, 2003). The minimum possible score is 0, the maximum possible score is 100 points. The CD-RISC scale is internally consistent, reliable, valid, and sensitive to treatment; demonstrates that resilience can be modified and improved as a result of interventions (Connor & Davidson, 2003). Based on the data of Kreutzer et al. (Kreutzer et al., 2018), which allows suggesting that the group of TBI patients who underwent resilience-based intervention differ at least by 10 points on CD-RISC compared to the control group, and considering the data of Bumberger et al. (Bumberger et al., 2021), reporting that 10-point CD-RISC difference seems to be clinically significant, we defined 10 points as a marker of a clinically significant between-group difference. CD-RISC was a primary outcome measure of the present study.

Montreal Cognitive Assessment Scale (MoCA). MoCA was developed as a tool for identifying early forms of cognitive impairment. The scale allows evaluating cognitive domains such as short-term memory, visual-spatial skills, executive functions, attention, concentration, and working memory, language, orientation in time and space (Nasreddine et al., 2005). The minimum score is 0 points, the maximum possible score is 30 points. The result of 26 points and above is perceived as normal cognitive functioning. In the validation study of the MoCA's author, Z. Nasreddine, the clinically significant difference was defined at the level of 2 points and more (Nasreddine & Patel, 2016). In further studies, researchers considered the different changes in points to be relevant, so clinically significant differences vary from 1.22 to 2.15 points with the most common indicator as 2 or more to be a minimum for clinically meaningful improvement (Stienen et al., 2019; Wu et al., 2019; Kaminska et al., 2018; Wong et al., 2017). Therefore, a group difference of 2 or more points was defined as clinically significant in the present study as well.

Neurobehavioral symptom inventory (NSI). NSI – is an inventory, developed by Cicerone K.D. and Kalmar K. NSI is a self-questionnaire containing 22 statements about somatic, affective, sensory, and cognitive clusters of post-concussion syndrome (Cicerone & Kalmar, 1995). The subject must rate each statement on a five-point Likert scale from 0 (no - rarely or not at all) to 4 (very severe), a higher score means a more negative effect of the symptom on functioning (Cicerone & Kalmar, 1995). Then the number of points for each statement is summed, and the total score is calculated, which can range from 0 to 88. The inventory is broadly used in assessing sustainable TBI symptoms in veterans (Reid, Cooper, Lu, Iverson & Kennedy, 2018; Flaherty et al., 2018). NSI has a good internal consistency, is a reliable and valid method of studying post-concussion syndrome in veterans with TBI (King et al., 2012). Determining the clinical significance of between-group differences on NSI still remains a challenge (Soble et al., 2014). According to the previous studies, in a military setting NSI between-group differences ranging from 8 points (Belanger et al., 2016) to 12 points (Dretsch et al., 2016). We considered a meaningful change as somewhere between these markers and defined as clinically significant group difference of 10 points.

Hospital Anxiety and Depression Scale (HADS) – Developed by Zigmond and Snaith (Zigmond & Snaith, 1983), HADS is a valid tool ($\alpha = .94$), for the diagnosis of emotional states such as anxiety and depression. The scale is recommended by some researchers to measure depression and anxiety as resilience-related mental well-being (Helmreich et al., 2017). The scale contains 14 statements and two subscales: subscale T (anxiety), which includes odd statements 1, 3, 5, 7, 9, 11, 13; and subscale D (depression), which includes paired statements 2, 4, 6, 8, 10, 12, 14. Each subscale is assessed separately (Boxley et al., 2016) from 0 to 3. The minimum score for each subscale is 0 points, the maximum possible score is 21 points. A higher score means more severe symptoms. In prior studies, a clinically significant difference of HADS was found to be about 1.5 for both subscales (Puhan et al., 2008). The same framework was set in previous resilience-based interventions in the neuroscience setting as well (Vranceanu, A., et al., 2020). Therefore, a mean group difference of 1.6 or more points was defined as clinically significant.

Posttraumatic Stress Disorder Symptom Checklist, DSM-5 version (PCL-5). Developed by Blevins C.A. et al., PCL-5 has good internal consistency ($\alpha = .94$), reliability ($r = .82$), convergent ($rs = .74 - .85$) and discriminant ($rs = .31 - .60$) validity (Blevins, Weathers, Davis, Witte & Domino, 2015). The PCL-5 questionnaire contains 20 statements, the subject evaluates each of them on a five-point Likert scale from 0 (not at all disturbing) to 4 points (very disturbing). Statements on this scale reflect DSM-5 clusters of PTSD symptoms such as traumatic event description (criterion A), intrusion symptoms (criterion B), avoidance symptoms (criterion C), negative thoughts and emotions (criterion D), and over-reactivity symptoms (criterion E). The scores of all statements are summed and the total score is calculated. The minimum possible total score is 0 points, the maximum is 80 points. Symptoms are considered clinically significant if, by calculating the total score, the result is 33 points or higher (Blevins, Weathers, Davis, Witte & Domino, 2015). In previous studies, researchers indicated 10 as a marker of minimal clinically significant between-group differences (McGeary et al., 2021; Saper et al., 2016; Weathers et al., 2013). Therefore, following this consensus, a group difference of 10 or more points on PCL-5 was defined as clinically significant.

Chaban Quality of Life Assessment Scale (CQLS). Developed by Chaban, Khaustova, and Bezsheyko (Chaban, Khaustova & Bezsheyko, 2016), the scale contains 10 questions about satisfaction with various aspects of life, each of which should be rated on an 11-point scale from 0 (totally not satisfied) to 10 (very satisfied). CQLS is a self-assessment scale. After the patient answered all questions, the points for each statement are summed up and the total score is calculated. The minimum possible score is 0 points, the maximum possible is 100 points. The scale has 5 degrees of satisfaction with the quality of life: extremely low (0-56 points), low (57-66 points), medium (67-75 points), high (76-82 points), very high (83-100 points). It has good internal consistency ($\alpha = .905$), reliability ($r = .923$), convergent and discriminant validity (Chaban, Khaustova & Bezsheyko, 2016). There were insufficient data from other studies to establish a quantitative foundation for evaluating the level of clinical significance for this scale. After consulting with the experts, who created the scale, a group difference of 10 or more points was defined as clinically significant.

Positive And Negative Affect Schedule (PANAS).

Developed by Watson, Clark, and Tellegen (Watson, Clark & Tellegen, 1988), PANAS is a 20-item scale, widely used to measure mood and emotions. 10 items measuring positive affect, forming a positive affect subscale, and 10 items measuring negative affect, forming negative affect subscale. It was recommended as a scale to measure affect as a resilience factor (Helmreich et al., 2017). The items are rated on a five-point Likert Scale, ranging from 1 (very slightly or not at all) to 5 (extremely). The scores of all statements are summed and the total score for every subscale is calculated. The minimum possible total score for each subscale is 0 points, the maximum is 50 points. Both subscales of PANAS have a good validity ($\alpha = .89$ for positive affect scale and $\alpha = .88$ for negative affect scale) (Klimanska & Haletska, 2020). There were insufficient data from other studies to establish a reliable quantitative foundation for evaluating the level of clinical significance for this scale. We found only one resilience intervention study with a similar intervention structure that used this scale. The mean difference between intervention and control groups was 3.46 and 6.79 for the positive and negative affect subscales respectively (Steinhardt & Dolbier, 2008). Given these data, and the fact that, apparently, the two sub-scales are not independent of each other (Klimanska & Haletska, 2020; Crawford & Henry, 2004), it was decided to define 5 points as a clinically meaningful difference between the groups.

Sample size calculation. Sample sizes were based on the data from previous studies and the possibility of recruiting patients as well. For calculating was used free statistical software for medical research “EZR” (Kanda, 2012). Assuming the standard deviation (SD) for CD-RISC equal to 20.13 (Elliott et al., 2016), taking the risk α at the level of 0.05 and considering a possible drop-out rate ~10% at follow-up (Kreutzer et al., 2018), 140 people (70 in each group) was chosen to obtain at least 80% power to detect a difference of 10 points in the main study. Similar sample sizes were assumed for the secondary outcomes considering SDs for NSI equal to 19.0 (Reid, Cooper, Lu, Iverson & Kennedy, 2018), for PCL equal to 18.7 (Reid, Cooper, Lu, Iverson & Kennedy, 2018), for MoCA equal to 2.69 (Waldron-Perrine et al., 2019), for HADS equal to 1.3 and 1.2 for the depression and anxiety subscales, respectively (Flaherty et al., 2018), for PANAS equal to 9.08 and 6.21 for positive and negative affect subscales respectively (Juengst et al., 2014) to obtain the same power to detect the differences at the previously noticed levels.

The participants number of 70 in the present pilot study was chosen according to estimations made by Teare et al. (Teare et al., 2014), who recommended that

pilot study with the continuous outcome for RCT has at least 70 subjects total (or 35 per arm).

Data analysis. Prior to analysis, all data were examined for missing values (no missing data was found) and normality. Data normality was evaluated by applying both Kolmogorov-Smirnov and Shapiro-Wilk tests. Data with the normal distribution was represented as mean and standard deviation, $[M \pm SD]$. Data with distribution different from normal was represented as median, first and third quantiles, $Med[Q1-Q3]$. Bartlett’s test was used to check the equality of variances. A two-sample t-test (two-sided) was used to test for differences among baseline scores between the groups if variances are equal. In case of unequal variances, the Welch test was used. Multivariate linear regression was used to model each outcome with the treatment group, gender, baseline cognitive performance level, and TBI severity as the independent variables. The results were presented as a t-test coefficient, non-standardized coefficients, standard error, and a 95% confidence interval (95% CI). As an indicator of clinical significance (Page, 2014) a Cohen’s effect size was calculated. To analyze the changes from the baseline in the TROI group Wilcoxon signed-rank test with continuity correction was used. Post-hoc power calculation for each outcome was done. The significance level was set at $p < 0.05$. Data was stored in a table form in Microsoft Excel 2019 and analysis was performed in the free statistical software for medical research “EZR” (Kanda, 2012).

Results

There were no statistically significant differences in any of the demographic and injury characteristics between the TROI and TAU groups at baseline ($p > 0.05$). Also, no statistically significant differences in demographic and injury characteristics were observed between the samples from different clinical bases at baseline ($p > 0.05$). Independent samples t-tests revealed no statistically significant differences at baseline between the TROI and TAU groups ($p > 0.05$), which can be seen in **table 1**. The groups didn’t significantly differ in the length of hospitalization as well.

Means and SDs for groups for resilience, cognitive performance, postconcussive symptoms, posttraumatic symptoms, positive affect, and quality of life compared to such in the TAU group presented in **table 3**.

After adjusting for TBI severity, baseline cognitive level and gender, the TROI group demonstrated a significantly higher increase in resilience, cognitive performance, positive affect, and, to a lesser extent, in quality of life, as well as significantly higher decrease in posttraumatic symptoms, and, to a lesser extent, in neurobehavioral symptoms (**table 4**).

Table 3. Post-treatment (T2) outcome means and standard deviations for TROI and TAU groups

	Intervention Group (n=35)	Treatment As Usual Group (n=35)	Power
CD-RISC	76.40 ± 14.37	63.31 ± 12.86	0.968
MoCA	27.05 ± 1.99	24.42 ± 2.86	0.970
NSI	27.85 ± 7.22	33.57 ± 11.47	0.550
HADS-A	6.34 ± 3.72	7.02 ± 3.31	0.116
HADS-D	5.48 ± 2.64	6.65 ± 3.21	0.260
PCL-5	16.80 ± 9.61	29.97 ± 9.75	1.000
PANAS+	32.58 ± 4.88	25.79 ± 4.60	0.830
PANAS-	20.79 ± 10.79	20.66 ± 6.74	0.130
CQLS	64.22 ± 16.80	54.85 ± 12.89	0.646

Table 4. Post-treatment (T2) outcome measurement differences for the TROI group and TAU group

Outcome	TROI – TAU at post-treatment					
	Difference	95% CI	Standard error	t	ES (d)	p
CD-RISC	12.81	6.19; 19.42	3.31	3.87	0.96	<0.001
MoCA	2.53	1.33; 3.72	0.59	4.23	1.06	<0.001
NSI	-4.64	-8.83; -0.44	2.09	-2.21	-0.59	0.030
HADS-A	-0.48	-2.14; 1.16	0.82	-0.58	-0.19	0.558
HADS-D	-1.04	-2.46; 0.36	0.70	-1.48	-0.39	0.143
PCL-5	-12.77	-17.46; -8.08	2.34	-5.44	-1.36	<0.001
PANAS+	6.78	4.05; 9.51	1.35	5.01	1.43	<0.001
PANAS-	-0.80	-6.08; 4.48	2.61	-0.30	0.01	0.760
CQLS	8.98	1.62; 16.35	3.68	2.43	0.62	0.017

As it can be seen in **table 5**, Wilcoxon signed-rank test with continuity correction revealed that participants who completed two-step resilience-oriented intervention while undergoing standard rehabilitation procedures had significantly improved scores for all outcomes compared to the baseline ($p < 0.05$), and all measures achieved a clinically significant difference.

During the participation, no one of the participants reported unintended effects or any harm from participating. Participants who received TROI left good reviews and highly rated the combined program. After completing the program, they were asked to rate TROI from 0 to 10, where 0 means “Not useful at all” and 10 means “Highly useful”. The median grade was 9 [8 – 10]. Some comments from participants include:

- “It was useful for better understanding where my symptoms came from and what to do with them.”
- “It gave me some methods for better memorizing.”
- “I realized how important positive emotions are for wellbeing and resilience.”
- “It helped me to understand that positive things happen to me every day, sometimes I just didn’t realize that.”
- “Now I am confident that I will be able to compensate all the issues which may concussion rewarded me with.”

has been a growth in the total amount of interventions incorporating positive psychology constructs like resilience into TBI rehabilitation (Rabinowitz & Arnett, 2018; Rohling et al., 2009). Although there is a need for more research, interventions aimed at boosting resilience integrate many positive psychology principles and concepts and are also associated with better mental health and adjustment after brain injury, which makes them very promising (Rabinowitz & Arnett, 2018). However, in the veterans’ rehabilitation setting there is a deficit of such studies.

The present study added to the growing body of literature focused on resilience-oriented interventions for patients with a history of TBI and sustainable neurobehavioral complaints. We found that two-step resilience-oriented intervention was associated with improvements in self-reported resilience, cognitive performance, postconcussive symptoms, posttraumatic symptoms, positive affect, and quality of life in veterans with mild to moderate TBI. Comparing to the TAU group, there was also a nonsignificant reduction in anxiety and depression.

At the beginning of the study, we had several hypotheses about the possible results.

The 1st hypothesis asserted that there would be a significant increase in resilience of participants in the

Table 5. Post-treatment (T2) to pre-treatment (T1) outcome measurement differences for the TROI group using Wilcoxon signed-rank test with continuity correction

Outcome	Post-treatment (T2) – Pre-treatment (T1)			
	Median difference	V	ES (d)	p
CD-RISC	+14	527	1,00	<0.001
MoCA	+3	502.5	1,51	<0.001
NSI	-17	13	-2,03	<0.001
HADS-A	-3	119	-1,56	0.006
HADS-D	-3	38	-1,08	<0.001
PCL-5	-21	24	-0,85	<0.001
PANAS+	+6	271	1,17	<0.001
PANAS-	-14	52	1,41	0.016
CQLS	18	553	-0,80	<0.001

Discussion

Culturing resilience may be an important part of recovery and improving physical and mental health (Galatzer-Levy et al., 2018). The lack of focus on resilience may explain why typical interventions do not achieve a lasting positive effect in rehabilitation after TBI (Kreutzer et al., 2016). During the last years, there

TROI group comparing to TAU group participants, as measured by CD-RISC. As it can be seen from statistically and clinically significant differences, this hypothesis was fully supported. Kreutzer et al. had shown that resilience can be improved and that by resilience-oriented interventions it is possible to improve the psychological symptoms of TBI (Kreutzer et al., 2018). The present study complements these results and provides

prior evidence that resilience is a dynamic construct (Stainton, A., et al., 2018) and not a static trait. Thus, we have obtained evidence that by targeting cognitive and emotional factors in a single intervention, we can improve resilience.

The 2nd hypothesis asserted that there would be a significant decrease in neurobehavioral symptoms' severity in the TROI group comparing to TAU group participants, as measured by NSI. While being statistically significant, the differences were not clinically meaningful, so that hypothesis was supported only partly. Although neurobehavioral symptoms of TBI and resilience have a negative correlation (Reid, Cooper, Lu, Iverson & Kennedy, 2018), the knowledge about causal relationships is still limited. The approach to pharmacological treatment was the same in both groups, so it can be assumed that the change in psychological functioning influenced the perception of somatic symptoms, although not significantly. Given that psychological factors can contribute to recovery after TBI (Snell et al., 2014), the impact of resilience on recovery sounds quite possible.

The 3rd hypothesis asserted that there would be a significant decrease in posttraumatic stress symptoms' severity in the TROI group comparing to TAU group participants, as measured by PCL-5. As it can be seen from statistically and clinically significant differences, this hypothesis was fully supported. Given that PTSD and TBI result in similar symptoms and possibly have common pathophysiologic elements (Hendrickson et al., 2018), it is not a surprise that participants had quite high grades on PCL-5 even without having the clinical diagnosis of PTSD. Resilience negatively correlates with symptoms of posttraumatic stress in veterans unrelatedly to TBI (Elliott et al., 2016; Elliott et al., 2019). Our research complements this data. Thus, we can cautiously assume that, by cultivating resilience, it is possible to reduce the severity of PTSD symptoms in veterans with TBI. Further research is needed.

The 4th hypothesis asserted that there would be a significant increase in cognitive functioning in the TROI group comparing to TAU group participants, as measured by MoCA. As it can be seen from statistically and clinically significant differences, this hypothesis was fully supported. Cognitive functioning is critical for resilience (Parsons, S., et al., 2016). With the results of current research, we can assume that it is possible to improve resilience by developing problem-solving, planning, memorization, and focusing skills. So far, this is the only study to our knowledge that has examined the effect of interventions targeting cognitive factors of resilience in veterans with TBI, which requires further study of the connection between cognitive functioning and resilience.

The 5th hypothesis asserted that there would be a significant increase in emotional functioning in the TROI group comparing to TAU group participants, as measured by PANAS and HADS. However, we found that there is no statistical and clinical difference in the reduction of negative emotions but a statistically significant and clinically meaningful difference in raising positive emotions. Therefore, we can say that the hypothesis is partly supported. Some researchers argue that resilience is connected with more rare manifestations of negative emotions in veterans with TBI (Elliott et al., 2015). In the present study, we found that targeting negative emotions among other factors during the intervention may increase resilience, however, the groups didn't differ significantly in negative emotions at post-treatment. The possible explanation may be that resilience is potentially more

associated with experiencing positive emotions rather than negative ones. Some researchers argue that positive affect is strongly associated with resilience, playing a crucial role in self-motivation and self-improvement (Treichler et al., 2020; Armenta et al., 2017). The results of our research complement this data, providing evidence that developing positive thinking skills and cultivating positive emotions can promote resilience. Positive affect deserves further study as a therapy target in the rehabilitation of TBI (Rabinowitz & Arnett, 2018), especially in the rehabilitation of veterans with blast-related injuries. Further research involving more participants is needed, especially to analyze the difference in persistence of the effect.

The 6th and last hypothesis asserted that there would be a significant increase in quality of life in the TROI group comparing to TAU group participants, as measured by CQLS. While being statistically significant, the differences were not clinically meaningful, so that hypothesis was supported only partly. There is evidence that the resilience of veterans with TBI is connected with better quality of life (Elliott et al., 2016; Elliott et al., 2019). At the moment, we cannot confirm that the impact on resilience significantly improves the quality of life of veterans with TBI. The lack of improvement in the quality of life after the intervention is especially interesting in the light of these findings and, regarding the pilot design of the present study, requires further research.

Overall, this study provides evidence that targeting cognitive and emotional factors of resilience with psychological interventions can promote it in veterans with TBI and be useful in facilitating recovery from injury. There are prior results, that need to be re-evaluated and complemented in the study with more veteran participants.

Incorporating combined resilience-oriented approaches into the rehabilitation of veterans with traumatic brain injury as an addition to standard therapy allows clinicians to approach veterans' recovery in a new way. Influencing resilience by combining cognitive and emotional factors as therapeutic targets can accelerate the recovery of veterans with TBI and has some advantages, as it is short-term, easy to be explained to veterans, and can be combined with other approaches. Due to their block structure, such interventions can be supplemented by other blocks, or, conversely, become part of other interventions. Thus, patient care becomes defragmented, integration appears and it becomes possible to target different vectors of mental health at once. Such combined approaches may enrich current rehabilitation treatments as well as give the green light to the development of new interventions that implement the principles of positive psychology into neurorehabilitation.

Limitations

The strengths of the study include randomizing the allocation to groups, the active control group that received a comparable standard treatment, obtaining full pre- and post-treatment data for the groups, and a manualized treatment protocol. Another strength is an attempt to assess both positive and negative psychological phenomena. However, while the overall findings are promising, there also were several limitations to the study. Inherent for non-pharmacological treatment trials, there is an impossibility of blinding participants and intervention appliers. Pre- and post-treatment assessments were not blinded, however, all of the pre-

and post-treatment measures were either objective (in the form of testing, like MoCA) or self-reported by the participant, not rated by the researcher (like any other assessment tool used in the study). From this study, it could not be figured out which factor or even group of factors (cognitive/emotional) should be aimed at for a greater effect on cultivating resilience and reducing symptoms. Some caution is required in interpreting the demographical and clinical results due to the pilot nature of the study and the small sample size. The intervention was conducted only at two clinical centers, so the question of generalizability remains open. The researcher could be a potential confounding variable. The results may not be generalized to a population with severe TBI or non-veterans.

Conclusion

In summary, based on the evidence provided by the present study, we can tentatively conclude that adding TROI to the standard treatment measures may improve the resilience and sustainable symptoms in veterans with TBI when compared with standard treatment. Targeting cognitive and emotional factors like problem-solving, decision-making, positive thinking can promote resilience in veterans with TBI and be useful in facilitating recovery from injury. Results of this pilot study are promising, but the intervention needs to be studied in a larger trial. Future studies should also include the follow-up assessment to address the sustainability of the intervention's effect, which will be conducted after we receive enough fulfilled inventories from the participants over time. Augmenting a standard treatment with skill-building intervention, focused on compensating impaired cognition and raising positive affect may add value to the rehabilitation of veterans with TBI and improve resilience.

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