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Comparison of Decision-Making in Risk Conditions and Personality Changes in Patients with Traumatic Brain Injury and Healthy People

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ABSTRACT:
The purpose of this research is to compare decision-making in risk conditions and personality changes in patients with traumatic brain injury and healthy people. In this causal-comparative study, 15 patients with traumatic brain injury with an age range of 20 to 60 years who were hospitalized in the past 3 months to a year as the experimental group and 15 healthy people from the normal community of Rasht city as companions Referees to specialized centers with an age range of 30 to 60 years were voluntarily selected as a control group by purposive sampling. The results of the Iowa gambling task test to measure decision-making in risk-taking conditions showed that the two groups do not have a significant difference in this regard. To evaluate the personality of the patients after the injury, the Iowa Personality Questionnaire was given to the companions of the patients to rate the personality characteristics of the patient before and after the injury. The result of this evaluation showed that out of the 30 characteristics described in the questionnaire, except for the characteristics of persistence, obsession, poor choice, type "a" behavior, aggressiveness, pride, skepticism, inappropriate emotions and frugality, the patients differ in other characteristics. They showed significance after injury.

Keywords: Decision making in risk situations, Personality changes, Traumatic brain injury, Aggression

INTRODUCTION:

The annual incidence of traumatic brain injury has made it a global health challenge. The American Brain Injury Association defines post-traumatic brain injury (TBI) as a condition in which the patient has experienced a reduced or altered state of consciousness as a result of an external blow to the head, which temporarily or permanently causes partial or total impairment of ability. cognitive, physical, behavioral, emotional or psychological incompatibility in a person (Manja, 2015). Traumatic brain damage has many complications, one of which is cognitive impairment. This defect is characterized by disruption in a set of related processes such as perception, attention, memory, concentration, information processing and executive functions (Arnold et al., 2018). Traumatic brain injury can be caused by a strong blow or jolt to the head or body, or by an object that pierces the skull and enters the brain. Not all blows or blows to the head result in a traumatic injury. Some types of trauma can cause temporary or short-term problems with normal brain function, including problems with how a person thinks, perceives, moves, communicates, and acts. A more serious injury can lead to severe and permanent disability and even death. Some injuries are considered primary, meaning the injury is immediate. Other consequences of traumatic brain injuries can be secondary, meaning they can appear gradually over the next few hours, days, or weeks. These secondary brain injuries are the result of reactive processes that occur after the initial blow to the head. Every year, about 50 to 60 million people in the world suffer from traumatic brain injury, which generally occurs in third world countries (Savledge et al., 2018).

Mild traumatic brain injuries account for the largest number of traumatic brain injuries and are one of the most common causes of damage to the central system (Schultz et al., 2017). Cognitive disorders are a common complication of various types of traumatic brain injuries. The most common cognitive problems after injury are: executive function impairment (Kapp, 2018; Miguel, 2018; Tate et al., 2018), attention and concentration, memory impairment (Arnold et al., 2018) and a decrease in information processing speed (Owens et al., 2018).

Traumatic brain injury (TBI) is often complicated by changes in mood and behavior, as well as a 3-fold increase in the prevalence of personality disorders after TBI (Hibbard et al., 2000). A study provided preliminary data on personality traits before and after TBI (Gracia et al., 2011). Patients with first-time head injury were recruited from the Department of Trauma at Johns Hopkins Hospital and the Department of Brain Injury at Kernan Hospital, University of Maryland (Baltimore, MD). Participants were assessed twice: first within the first 3 months of TBI and 12 months post-TBI. The personality profile was obtained

using a 60-item abbreviated version of the personality questionnaire (NEO-PI-R) called the five-factor questionnaire (NEO-FFI) (McCree and Costa, 2004). NEO-PI-R raw scores were converted to percentile scores using published norms for age and gender (Costa & McCrae, 2008). In order to assess personality traits prior to TBI (ie, "premorbid"), at the initial visit a friend or family member was asked to retrospectively report the participant's personality traits as observed prior to TBI. A total of 41 subjects completed the NEO-PI-R profiles at baseline and 12 months. After correction for multiple comparisons, there was no statistically significant association between post-TBI personality traits and baseline clinical variables including age, sex, living status, occupation, race, education, presence of frontotemporal lesion (as assessed by computed tomography scans), activities of daily living scale, Glasgow Coma Scale score, as well as the presence of any post-TBI psychiatric diagnosis including substance abuse disorder, mood disorder, anxiety disorder, or personality change (Gracia et al., 2011). These findings are similar to Kurtz et al. (1998) who found stability of personality traits after TBI. The results of this study suggest that a relatively small change in personality traits after TBI serves as a marker of traumatic brain injury rather than injury severity or complications. This study recommends that future research include more robust studies with longer durations using personality assessments as close to the time of injury as possible and using more sensitive imaging modalities including MR and diffusion tensor imaging.

On the other hand, Antonio Damasio believes that emotions play an undeniable role in making principled decisions and behaving according to our social norms. He believes that there are two-way connections between the ventromedial region (anterior part of the frontal lobe) and the limbic system (side), which is located in the lower part of the brain and is the main center of emotions. This means that the anterior part of the frontal lobe is one of the centers that processes the information related to emotions that reaches the cerebral cortex from the limbic system and the result of this processing in our decisions and social and moral behaviors - which They are also programmed in this area - it interferes. Now, if this part of the frontal lobe is damaged as a result of a lesion, the information related to emotions that come from the limbic system cannot play a positive role in making decisions and regulating a person's behavior, as a result, the patient is confused and A decision is made and his social behavior is also normalized in different forms. Personality changes such as: loss of sense of responsibility, disregard for moral norms and the like.

Traumatic brain injury can be defined as a "silent epidemic" due to its high incidence and prevalence but insufficient notoriety (Peters, 2015). The epidemiology of this type of brain injury is evolving. Traumatic brain injury is a major public health problem worldwide, as it is the most severe type of injury among accident-related events (Robiano, 2015) and affects approximately 69 million people each year (Duane et al., 2018).

To summarize the relevant literature of almost two centuries, observations of individual patients and then cohorts of patients suggest that the very wide array of personality disorders seen with forebrain damage may reflect different types of disorder. The emergence of quantitative assessment of personality disorders has further elucidated the dissociable dimensions of the disorder, although most patients have a combination of disorder subtypes (Stoss & Benson, 1984), which is consistent with factor analysis and includes a limited number of higher order dimensions. It shows considerable overlap between the dimensions of the disorder (Barash et al., 2011; Stout et al., 2003). While the association between damage to the prefrontal cortex and the development of personality disorders is well established, it is unclear whether brain damage that does not involve the prefrontal cortex is associated with acquired personality disorders. For example, a syndrome of personality changes in patients with temporal lobe dysfunction due to epilepsy was described many years ago (Beers, 2008), although the evidence for temporal lobe personality disorders has been conflicting.

On the other hand, personality changes following a brain injury are common. Even a concussion can affect the brain long after the initial injury has healed. The way we process and understand information can change as a result of trauma, so it's not surprising that our emotions are also affected. Many people suffer from social anxiety, irritability, anger, depression, feeling dizzy, generalized anxiety, mood swings, or emotional instability after an injury. While these symptoms make it seem like you are a different person now, your personality is intact, just buried under a burden of symptoms that are very hard to control. Personality is a set of characteristics and the mood of each person depends on his current situation. Typically, people's mood swings don't last for weeks or months. But after a head injury, negative moods such as sadness, anxiety, or agitation can persist, causing patients and their families to mistake emotional symptoms for personality changes. The reality is that most personality changes after a concussion are actually caused by symptoms that will go away if they receive proper treatment. According to the mentioned materials, the aim of this research is to compare decision-making in risk conditions and personality changes in patients with traumatic brain injury and healthy people.

METHODS:

The current research is a causal-comparative type of research. The statistical population of the present study included patients suffering from TBI in Rasht in 1401, who were referred to specialized centers in Rasht due to this condition. From the above society, a sample of 15 people was selected based on the entry and exit criteria using the purposeful sampling method.

Inclusion criteria included experience of traumatic brain injury at least 3 months and at most one year before conducting the research, age range from 20 to 60 years, alertness and motor and physical ability to conduct the research, right of superiority, voluntary consent to conduct the research. Exclusion criteria were simultaneous suffering from other brain diseases such as epilepsy or tumor, history of diabetes and metabolic syndromes, mental retardation, severe physical and motor disability, receiving cognitive rehabilitation services in the last 6 months. Also, in order to compare patients with normal people, 15 people from the normal community of Rasht were selected voluntarily to participate in the research from among the companions who referred to specialized centers. From all the participants of the normal group, the GHQ (general health) test was first taken to ensure the absence of psychological problems in the clients. None of the subjects in the normal group had a history of concussion, epilepsy or any other type of brain or psychiatric disease. All the normal group was right superior and their age range was 30 to 60 years and they had minimum education.

Tools:

Iowa gambling assignment 1 (IGT)

The Iowa Gambling Task is the same as Beccarat's Gambling Task, which became known as the Iowa Gambling Test because he, Damasio and Tranel held professorships at the University of Iowa at the time of its creation. This task was primarily designed to assess real-life decision-making in patients with damage to the ventral-medial prefrontal cortex. Today, in addition to the original version of Bekara et al., its software version has been standardized in different populations and provides the opportunity for clinical experts and researchers to conduct more accurate and easier studies. The assignment of Iowa consists of four categories of cards, and the choice of each category of cards brings a certain amount of profit and loss. That is, by choosing any of the cards, the subject may win or lose a certain amount. The decks of cards are known by different names in different studies, but referring to the original study of Bekara et al., they mostly named it decks of A, B, C, and D cards based on English letters. A and B cards have bigger rewards, but their losses are also higher. On the contrary, C and D card categories contain small rewards, but their fines and losses are relatively less. Therefore, by choosing them, one gets more points after several attempts. In the form of instructions, the subject is only told that some decks of cards are better than others. Experimental studies show that the subjects generally after 20 (Maya and McClelland, 2004) to 40 (Brand, Reknor, Grabenhors and Becara, 2007) efforts of risk parameters and risky decisions take on a more obvious face. This means that most of the subjects are informed about the possibility of their loss. The driving force behind the development and transformation of this task is due to patients with damage in the ventral-middle region of the prefrontal cortex. Bekara et al.'s study showed that these patients chose more harmful options compared to the control group and patients with damage in other areas of the brain. The main characteristic of these patients is a clear disregard for the long-term consequences of decisions and an inability to learn from repeated mistakes. These patients often make decisions that lead to financial losses, loss of social image and even loss of family and friends. The theory underlying this task is based on two fields of study. First, clinical and applied neuroscience studies (Reiman and Becara, 2010), which mainly have a serious effect in the works of Damasio, Becara and Tranel, and secondly, cognitive studies in the field of risk decision making. Extensive studies have been conducted in each of these areas since the introduction of the Iowa test. Smolska et al. (2006) reported the validity of this test using Cronbach's alpha method for the whole scale as 0.89.

Iowa Personality Questionnaire

The Iowa Personality Questionnaire was designed by Donlan, Conger, and Borzett through content analysis and is used to briefly measure the same dimensions evaluated with the Multidimensional Personality Questionnaire made by Telgen. The length of the multidimensional personality questionnaire was an obstacle to use in many research applications, because the original form contained 300 items and the latest version contains 276 items. In fact, Patrick et al recognized the need for a short form of this questionnaire and they designed a shortened form of 155 questions of the multidimensional personality questionnaire from its original source. However, 155 questions may be too long for research applications, so the Iowa Personality Inventory for Personality Change Scale (ISPC; Barash et al., 1997, 2017) provides a standardized assessment of 30 traits that may result in a Altered neurological status, with features related to emotional functioning, social and interpersonal behavior, decision-making and goal-directed behavior, behavioral control, and insight. Four of the 30 are control scales that provide ratings of features that would not be expected to be impaired as a result of brain damage, and ratings that indicate marked change on these scales (in relation to the pattern of ratings on the scale). clinical) are invalid in identifying ratings. Information is obtained from the spouse or a family member who had regular and significant contact with the patient before and after the neuropathological disease. Each feature is introduced with a brief definition focused on behavior. Assessors make two ratings for each characteristic: "before," which describes the patient's typical functioning as an adult, and "now," which describes their functioning in the past year (or post if of the disease is not so long, then, performance during the period of months from the onset of the acute period). Traits are rated on 7-point scales, with higher ratings reflecting increased impairment: 1, indicating very good performance; 3, the assumed "medium" level is characteristic. 5, shows that the characteristic is somewhat problematic. and 7

indicates severe disorder. Points along the scale are accompanied by rating instructions with multiple behavioral examples to increase reliability (Schwartz, 1999). The ISPC (Iowa Scale Personality Change) is a modified version of the Iowa Rating Scale of Personality Change (Barash & Anderson, 1993), for which psychometric analyzes generally found very high interrater agreement with weighted difference rating on all scales ranging from 0.80 to .0.96.

After collecting the data in order to evaluate the research question, the obtained information was analyzed using descriptive statistics methods such as average, maximum and minimum, and at the inferential level using analysis of variance.

Foundings:

Decision-making in risk-taking conditions between the two research groups has been evaluated using the Iowa gambling task software test.

Table 1: One-way analysis of variance results for comparing decision-making in risky conditions (Iowa gambling task)

Variables	SS		df	S^2	F	Significant
Select card A	Between groups	48.133	1	48.133	0.896	0.352
	Within groups	1503.333	28	53.690		
	Total	1551.467	29			
Select card B	Between groups	13.333	1	13.333	0.194	.663
	Within groups	1926.533	28	68.805		
	Total	1939.837	29			
Select card C	Between groups	53.333	1	53.333	0.834	0.369
	Within groups	1791.333	28	63.976		
	Total	1844.667	29			
Select card D	Between groups	112.133	1	112.133	1.265	0.270
	Within groups	2481.067	28	88.610		
	Total	2593.200	29			
Preference for good choices	Between groups	43.200	1	43.200	0.086	0.772
	Within groups	14132.267	28	504.724		
	Total	14175.467	29			

By observing the sig values in table (1) that in all five variables the frequency of choice in card a, the frequency of choice in card b, the frequency of choice in card c, the frequency of choice in card d and the total score of preference for good choices is greater than 0.05. It can be concluded that there is no significant difference in risk decision making between the two research groups.

Table 2: Paired t analysis to evaluate personality characteristics of patients before and after injury (Iowa Questionnaire)

variables	level	Mean	Std.Deviation	T	Sig
IRRITABILITY	Before	2.08	0.900	-4.062	0.002
	Now	3.08	1.165		
LACK OF INITIATIVE	Before	2.50	1.446	-3.400	0.006
	Now	3.92	0.996		
PERSEVERATION	Before	2.67	0.888	-2.171	0.053
	Now	3.17	0.835		

DEPRESSION	Before	1.75	0.754	-3.800	0.003
	Now	3.33	1.435		
IMPULSIVITY	Before	2.25	1.545	-4.005	0.002
	Now	3.17	1.946		
OBSESSIVENESS	Before	2.83	1.697	-1.820	0.096
	Now	3.25	1.422		
MOODINESS	Before	2.83	1.337	-2.345	0.039
	Now	3.50	1.508		
LACK OF STAMINA	Before	1.92	1.311	-3.339	0.007
	Now	3.67	1.775		
variables	**level**	**Mean**	**Std.Deviation**	**T**	**Sig**
LACK OF PERSISTENCE	Before	2.42	0.793	-2.966	0.013
	Now	3.08	1.311		
LACK OF PLANNING	Before	2.67	1.073	-2.419	0.034
	Now	3.50	1.168		
INFLEXIBILITY	Before	2.25	1.215	-2.345	0.039
	Now	2.92	1.084		
POOR JUDGMENT	Before	3.50	1.446	-1.000	0.339
	Now	3.75	1.485		
ANXIETY	Before	2.00	1.348	-2.611	0.024
	Now	3.25	1.357		
INSENSITIVITY	Before	2.33	0.888	-2.966	0.013
	Now	3.00	1.537		
SOCIAL INAPPROPRIATENESS	Before	2.50	0.798	-2.803	0.017
	Now	3.33	1.371		
DEPENDENCY	Before	2.83	2.125	-4.311	0.001
	Now	4.00	1.595		
IMPATIENCE	Before	2.42	0.793	-2.244	0.046
	Now	3.58	1.443		
variables	**level**	**Mean**	**Std.Deviation**	**T**	**Sig**
"TYPE A" BEHAVIOR	Before	3.50	1.732	-0.834	0.422
	Now	3.92	1.379		

UNEMOTIONAL	Before	2.00	0.953	-3.188	0.009
	Now	2.92	1.165		
SOCIAL WITHDRAWAL	Before	3.08	1.379	-2.930	0.014
	Now	4.92	1.379		
AGGRESSION	Before	2.83	1.337	-1.773	0.104
	Now	3.17	1.749		
INDECISIVENESS	Before	3.00	1.128	-3.000	0.012
	Now	3.75	1.545		
VANITY	Before	2.17	1.030	-1.915	0.082
	Now	2.67	0.778		
SUSPICIOUSNESS	Before	2.75	0.452	-1.483	0.166
	Now	3.08	0.996		
APATHY	Before	2.58	0.669	-2.171	0.053
	Now	3.08	1.240		
FRUGALITY	Before	3.83	1.697	-1.483	0.166
	Now	4.17	1.697		
variables	**level**	**Mean**	**Std.Deviation**	**T**	**Sig**
INAPPROPRIATE EMOTION	Before	2.75	0.965	-2.690	0.021
	Now	4.42	1.564		
MANIPULATIVENESS	Before	2.08	0.996	-2.548	0.027
	Now	2.67	1.155		
EASILY OVERWHELMED	Before	1.83	1.030	-3.223	0.008
	Now	2.92	1.165		
LACK OF INSIGHT	Before	2.08	0.669	-3.527	0.005
	Now	3.00	1.044		

By observing t, which all have negative values, it can be concluded that the numerical values after the injury are higher than before the injury, and this means that the person with TBI has a difference in the described personality characteristics after the injury compared to before the injury. but by observing the sig values, the significance of this difference can be evaluated. Regarding the personality traits of irritability, lack of action, depression, impulsiveness, moodiness, lack of stamina, lack of perseverance, lack of planning, inflexibility, anxiety, indifference, social inadequacy, dependence, impatience, Apathy, social isolation, indecisiveness, demagoguery, indifference, being easily pressured and lack of insight, sig<0.05, which shows the significance of the difference.

DISCUSSION:

Decision-making is usually considered a complex, multi-step process that is strongly related to hot and cold executive functioning and is crucial for patients' daily life functioning and independence. However, the results are not always consistent with some studies reporting large changes in decision-making processes while others do not. Decision-making deficits after TBI can have debilitating consequences in many aspects of life for human patients, but little research has examined these problems in animal models of brain injury. The present study shows that there is no significant difference in decision-making in risk-taking conditions of sick people compared to healthy people.

This finding is consistent with the research results of Trinity et al. (2019) which is based on animal samples. Also, Poladi et al. (2020) showed in their research that there is no significant difference between the two studied groups in risk taking with the Iowa test.

To evaluate the personality of the patients after the injury, the Iowa Personality Questionnaire was given to the companions of the patients to rate the personality characteristics of the patient before and after the injury. The result of this evaluation showed that out of the 30 characteristics described in the questionnaire, except for the characteristics of persistence, obsession, poor choice, type "A" behavior, aggressiveness, pride, skepticism, inappropriate emotions and thrift, the patients differ in the rest of the characteristics. They showed significance after the injury. According to Mazo's research (2013), people's moods do not last for weeks or months. But after a head injury, negative moods such as sadness, anxiety, or agitation can persist, causing patients and their families to mistake emotional symptoms for personality changes. The reality is that most personality changes after a concussion are actually symptoms that will go away if you get the right treatment. Messina (2015) presents his findings that the hippocampus is a part of the brain known for converting short-term memories into long-term memories. Memories show a person how to react to the environment or the world around them, including determining emotional response. About 63 percent of patients at the Cognitive FX Center have abnormal fMRI scans in one or both of their hippocampi. In other words, there are many opportunities in a brain injury to disrupt the brain's normal processing, an injury that makes the brain unable to process information and emotions normally and makes the patient vulnerable to unpleasant mood swings. But these mood changes should not last forever. Brain dysfunction after concussion is not the same as irreversible brain damage. In a theoretical research (2019), it is stated that Lin (2010) and colleagues in their longitudinal study found significant changes in the mental-psychological aspect of patients' quality of life during one year after brain injury. Dwan (2019) and colleagues also found TBI patients to be at greater risk for developing depressive symptoms. Diaz et al. (2014) believe that a large number of patients need depression treatment after traumatic brain injury. The research of Nazari et al. (2010) showed that in addition to the physical and physical damage caused by the trauma, the existence of chronic stress and social and economic problems that are the result of such injuries can justify the symptoms of depression and other personality disorders.

The findings of the present study showed that TBI affects some personality traits of the patient and leads to changes in moods and behavior after the injury. These findings, in line with the results of the aforementioned researches, suggest a significant difference before and after the injury in most of the personality characteristics of the patient. Finally, the results of this research regarding the confirmation of the deficiencies in the executive functions of TBI patients are in line with many Previous studies are (Malek, 2004; Tate et al., 2018; Bidard et al., 2018). Also, the findings confirm the findings of previous researchers regarding the persistence of executive function dysfunction in TBI patients after one year of injury and are inconsistent with the research results of Rockers et al. (2018) who reported that the executive functions of the severe TBI group and average, they suffer significant damage, but the results of the MTBI group's executive functions do not show any difference with the healthy group. Perhaps this lack of significance can be related to the sample size, the age range of the patients, or the tools used by these researchers.

Limitations

One of the limitations of the research is that the sample selection was done by the available method instead of random method due to the special conditions of the patients and their lack of consent and sometimes their families to participate in the research. It is also not possible to use a large statistical sample.

Offers

It is obvious that the findings of the present research, along with the results of similar researches, represent the dimensions of the psychological problems of the affected people and pave the way for interventional researches and creating effective treatments focused on cognitive functions. Therefore, in the rehabilitation of injured people, evaluation of hot and cold executive functions can be used. At the same time, although the results of this study are inconsistent with some previous researches, the findings of this research can be considered as a scientific result.

REFERENCES:

1. Arnould, A., Rochat, L., Dromer, E., Azouvi, P., & Van der Linden, M. (2018). Does multitasking mediate the relationships between episodic memory, attention, executive functions and apathetic manifestations in traumatic brain injury?. *Journal of neuropsychology*, *12*(1), 101-119.
2. Barres, B. A. (2008). The mystery and magic of glia: A perspective on their roles in health and disease**.** Neuron, 60, 430-440.
3. Bedard, M., Taler, V., & Steffener, J. (2018). Long-term prospective memory impairment following mild traumatic brain injury with loss of consciousness: findings from the Canadian Longitudinal Study on Aging. The Clinical Neuropsychologist, 32(5), 1002-1018.
4. Brand, M. , Recknor, C. E., Grabenhorst, F., & Bechara, A. (2007). Decisions under ambiguity and decisions under risk: Correlations with executive functions and

comparisons of two different gambling tasks with implicit and explicit rules. Journal of Clinical and Experimental Neuropsychology 29 (1), 86-99
5. Costa Jr, P. T., & McCrae, R. R. (2008). The Revised Neo Personality Inventory (neo-pi-r). Sage Publications, Inc.
6. Diaz, A. P., Schwarzbold, M. L., Thais, M. E., Cavallazzi, G. G., Schmoeller, R., Nunes, J. C., ... & Walz, R. (2014). Personality changes and return to work after severe traumatic brain injury: a prospective study. Brazilian Journal of Psychiatry, 36, 213-219.
7. Donnellan, M. B., Conger, R. D., & Burzette, B. G. (2005). Criterion- related validity, self-other agreement, and longitudinal analyses for the Iow Personality Questionnaira: A short alternative to the MPQ. Journal of Recearch in Personality, 39, 458-485.
8. Dwan, T., & Ownsworth, T. (2019). The Big Five personality factors and psychological well-being following stroke: a systematic review. Disability and rehabilitation, 41(10), 1119-1130.
9. Dwan, T., Ownsworth, T., Donovan, C., & Lo, A. H. Y. (2017). Reliability of the NEO Five Factor Inventory short form for assessing personality after stroke. International psychogeriatrics, *29*(7), 1157-1168.
10. Gracia-Garcia, P., Mielke, M. M., Rosenberg, P., Bergey, A., & Rao, V. (2011). Personality changes in brain injury. The Journal of neuropsychiatry and clinical neurosciences, 23(2), E14-E14.
11. Hibbard, M. R., Bogdany, J., Uysal, S., Kepler, K., Silver, J. M., Gordon, W. A., & Haddad, L. (2000). Axis II psychopathology in individuals with traumatic brain injury. Brain Injury, *14*(1), 45-61.
12. Lin MR, Chiu WT, Chen YJ, Yu WY, Huang SJ, Tsai MD. Longitudinal changes in the health-related quality of life during the first year after traumatic brain injury. Arch Phys Med Rehabil (2010); 91(3): 474-80
13. Miguel, M. (2018). Traumatic brain injury in 2017: exploring the secrets of concussion. The Lancet Neurology, 17(1), 13-15.
14. Malec, J. F., Brown, A. W., & Moessner, A. M. (2004). Personality Factors and Injury Severity in the Prediction of Early and Late Traumatic Brain Injury Outcomes. Rehabilitation Psychology, 49(1), 55.
15. Mangia, A. L. (2015). Cognitive assessment and rehabilitation of subjects with traumatic brain injury.
16. Mazzeo, F., Motti, M. L., Messina, G., Monda, V., Ascione, A., Tafuri, D., ... & Monda, M. (2013). Use of nutritional supplements among south Italian students of physical training and sport university. Toxicology, 9, 21-6.
17. McCrae, R. R., & Costa Jr, P. T. (2004). A contemplated revision of the NEO Five-Factor Inventory. Personality and individual differences, 36(3), 587-596.
18. Messina, G., Monda, V., Moscatelli, F., Valenzano, A. A., Monda, G., Esposito, T., ... & Monda, M. (2015). Role of orexin system in obesity. Biology and Medicine, *7*(4), 1.
19. Nazari, R., Khairkhah, F., Dehshiri, M. R., Jaberi, A., & Bijani, A. (2010). Cognitive Abilities and Psychological Health after Traumatic Brain Injury (TBI). Journal of Babol University of Medical Sciences, *12*(3), 58-63.
20. Owens, J. A., Spitz, G., Ponsford, J. L., Dymowski, A. R., & Willmott, C. (2018). An investigation of white matter integrity and attention deficits following traumatic brain injury. Brain injury, *32*(6), 776-783.
21. Peeters, W., van den Brande, R., Polinder, S., Brazinova, A., Steyerberg, E. W., Lingsma, H. F., & Maas, A. I. (2015). Epidemiology of traumatic brain injury in Europe. Acta neurochirurgica, *157*(10), 1683-1696.
22. Rakers, S. E., Scheenen, M. E., Westerhof-Evers, H. J., de Koning, M. E., van der Horn, H. J., van der Naalt, J., & Spikman, J. M. (2018). Executive functioning in relation to coping in mild versus moderate-severe traumatic brain injury. Neuropsychology, 32(2), 213.
23. Reimann, M., Bechara, A. (2010). The somatic marker framework as a neurological theory of decision-making: Reviwe conceptual comparisons, ans future neuroeconomics research Journal of Economic Psychology, 31, 767-776
24. Rubiano, A. M., Carney, N., Chesnut, R., & Puyana, J. C. (2015). Global neurotrauma research challenges and opportunities. Nature, *527*(7578), S193-S197.
25. Savulich, G., Menon, D. K., Stamatakis, E. A., Pickard, J. D., & Sahakian, B. J. (2018). Personalised treatments for traumatic brain injury: cognitive, emotional and motivational targets. Psychological medicine, *48*(9), **1397-1399.**
26. Shultz, S. R., McDonald, S. J., Haar, C. V., Meconi, A., Vink, R., van Donkelaar, P., & Christie, B. R. (2017). The potential for animal models to provide insight into mild traumatic

brain injury: translational challenges and strategies. Neuroscience & Biobehavioral Reviews, *76*, 396-414.
27. Tate, D. F., Wade, B. S., Velez, C. S., Drennon, A. M., Bolzenius, J. D., Cooper, D. B., & Gutman , B. A. (2018). Subcortical shape and neuropsychological function among US service members with mild traumatic brain injury. Brain imaging and behavior, 1-12.
28. Tate, R. L. (1999). Executive dysfunction and characterological changes after traumatic brain injury: two sides of the same coin?. Cortex, *35*(1), 39-55.