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CONTENT EXPERTISE

The Benefits of Exercise for Individuals With Traumatic Brain Injury: A Positive Psychology Approach

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The purpose of this comprehensive literature review is to explore the positive effects of exercise and positive psychology for individuals with traumatic brain injury (TBI). This review details the benefits of implementing a positive psychology approach utilizing the core tenets of this theoretical orientation. Specifically, this review summarizes the advantages of implementing exercise and positive psychology in rehabilitation counselors' treatment plans for patients with TBI. Recommendations and further considerations have been provided for rehabilitation practitioners and scholars to integrate both physical activity and optimism in the rehabilitation counseling field in the future.

Traumatic brain injuries (TBIs) account for approximately 10 million cases annually and are ranked as one of the top reasons for a disability status (O'Carroll et al., 2020). In the US alone, TBIs contribute to 30% of all deaths annually (Gardner & Zafonte, 2016). TBI is defined as an alteration in brain function or other evidence of brain pathology caused by an external force (Menon et al., 2010). High-risk environments are strong contributors to the prevalence of sustaining a TBI, as evidenced by the Iraq war where hostile war conditions for military personnel led to increased incidence of TBIs, marking it as a "signature injury," meaning it is a common injury of the war (Faul & Coronado, 2015). In addition to high- risk environments, there are a variety of factors that can contribute to individuals experiencing a TBI. TBIs adversely affect one's quality of life due to causing cognitive, behavioral, emotional, and physical deficiencies which can subsequently lead to poor interpersonal, social, and occupational functioning (Nizamutdinov & Shapiro, 2017). The repercussions for individuals who experience a TBI are profound and extensive. For example, findings suggest that TBIs, regardless of their severity, are associated with increased risks of chronic cardiovascular, neurological, and endocrine comorbidities and that comorbid diagnoses post TBI are associated with higher mortality rates (Izzy et al., 2022). In addition to increased physical illnesses associated with TBIs, TBIs are also associated with increased mental health diagnoses (Schwarzbold et al., 2008). Also adversely impacting an individuals' mental health, according to Cho and Jang (2021), 70% of individuals with TBIs experience post-traumatic amnesia and related symptoms including confusion, agitation, lack of attention, and limited self-awareness. Following injury, some individuals may face persistent

post-concussion symptoms which are defined as symptoms that were not attributed to a preexisting condition and that appeared within hours of concussion and have been present 3 months after the trauma and make an impact in 1 aspect of the person's life (Faulkner & Snell, 2023).

The recovery process for TBIs can be significantly impacted by the after -care services and often determine the long-term functional outcomes for individuals, such as potential return to work. After care services for TBI generally call for intense physical and cognitive rest post TBI; however, Zhang et. al (2022) suggests that strict rest alone does not benefit patient recovery. Improved outcomes in patients with TBIs are associated with protocols of imaging and clinical examination, robust trauma care networks, and high quality acute and post-acute care (Maas et al., 2022). Despite evidence supporting the benefits of post-acute care following a TBI (Groof et al., 2020; Ponsford et al., 2021; Zasler & Ashley, 2018), a significant portion of patients with a TBI receive inadequate rehabilitation services for post-acute TBI care (Jacob et al., 2020). Further, post-acute care reveals a pattern of inconsistent access to rehabilitation in different countries and organizations (Maas et al., 2022). Despite extensive current interventions for TBI including pharmacotherapy, psychotherapy, and cognitive rehabilitation, psychological and emotional issues are often overlooked even when the individual's physical, behavioral, and cognitive symptoms are treated (Gómez-de-Regil et al., 2019). These findings are concerning and warrant a need for more extensive assessments and a deliberate focus on increasing after care treatment for individuals with a TBI.

Lastly, during the assessment process for individuals with a TBI, healthcare providers often use the Glasgow Coma Score (GCS) to determine severity of injury as severe (3 to 8), moderate (9 t to 13), or mild (14 to 15) (Smith et al., 2019). However, this method is limiting as it relies on the subjective judgment of medical staff. Rehabilitation practitioners can assist individuals with TBIs with exercise interventions and positive psychology if they have precise information regarding the GCS score as this will determine what practices will be most effective for recovery. The assessment process can be the driving factor for treatment. For example, within the acute stage after injury, recovery is highly determined by factors within brain physiology; however, during later stages of recovery, variables such as psychosocial, economic, the environment, personality, coping strategies, and medical comorbidities are taken into consideration (Tenovuo et al., 2021), calling for more evaluation and assessment.

Many rehabilitation practitioners assist individuals with the recovery process following a TBI; therefore, this review will provide valuable research that can be transferred into practice as a rehabilitation practitioner. Within a rehabilitation and positive psychology approach, counselors and practitioners can implement principles and strategies related to wellness, exercise, and the biopsychosocial model to assist clients and when developing rehabilitation treatment plans. We propose that implementing positive psychology

principles and exercise activities may assist individuals with TBIs in recovery. Furthermore, by focusing on a biopsychosocial model approach, rehabilitation practitioners can recognize the biological, psychological, and social factors that impact the recovery process with a holistic lens.

TBI and Exercise

Consistent exercise, which is an intentional structured form of physical activity, has been shown to increase cognitive functioning and stimulate neuroplasticity (Cotman & Berchtold, 2002). Additionally, engaging in physical activity and exercise training has been associated with improvements in multiple areas of quality of life for individuals who have encountered a TBI (O'Carroll et al., 2020). Further, studies have shown that light aerobic exercise has a positive impact on the brains activity by decreasing the risk of post-concussive symptoms in some cases (Patel et al., 2024). While Snowden and colleagues (2023) review of aerobic exercise "suggests general consensus on the safety and effectiveness of aerobic exercise as a rehabilitative strategy post-TBI" (p. 49), there is a need for additional research regarding exercise for TBI treatment due to lack of conformity in researching the topic because of varying specific types of exercise including sample size and consistency with treatment adherence rates. Hassett et al. (2009) found no significant difference in at home exercise programs compared to supervised exercise interventions suggesting that exercise is the key factor in improving outcomes. Individuals with a TBI who also experience conditions such as depression, anxiety, and emotional lability, can benefit from exercise as a focus for intervention (Chin et al., 2015).

Physical activity also promotes brain recovery through repairing and creating new brain connections following a TBI, particularly in the hippocampus, which is the portion of the brain involved in the formation of new memories and learning (Vints et al., 2024). Additionally, positive outcomes of exercise also play a role in supporting brain changes at the molecular level through molecular machinery which is a group of molecules that support each other in performing various brain functions necessary for underlying cognitive recovery after TBI (Marques-Aleixo et al., 2012). Specifically, exercise helps increase measurable indicators of a biological state known as biomarkers which are responsible for neurons' growth, including the brain-derived neurotrophic factor (BDNF), cAMP Response Element-Binding Protein (CREB), and Insulin-Like Growth Factor 1(IGF1), which are proteins and hormones that are necessary for repair and growth in the brain and promote neurogenesis, or the process of forming new neurons in the brain (Zhang et al., 2022). In the neuroprotective pathway, exercise also boosts mitochondria in brain cells which produces energy needed for the cell to grow through increasing brain-derived neurotrophic factor (BDNF), which is a protein that supports brain cell growth. Moreover, although biomarkers related to exercise intolerance continue to be studied, no biomarker has been pinpointed yet (Antonellis et al., 2024). The increased

expression of these biomarkers and mechanisms due to exercise suggests that they elevate neuroplasticity, neuroprotection, and neurogenesis, all of which can contribute to improved recovery outcomes for individuals' post-TBI.

For rehabilitation professionals, an understanding of these mechanisms is beneficial as it highlights the importance of incorporating regular exercise into rehabilitation treatment plans. By incorporating exercise as part of a recovery plan, cognitive recovery is increased and secondary damage following a TBI can be reduced (Amorós-Aguilar et al., 2020). Apoptosis refers to the programmed death of affected cells (Deng et al., 2020). While this process can be helpful in eliminating damaged cells, and even preventing cancer, it can also be harmful if cells are removed too quickly, damaging tissues (Fulda et al., 2010). In cases of mild TBIs, primary mechanical cell death in regions of the brain occur during the initial impact; however, secondary brain damage can occur over time due to the injury leading to neuronal decline overtime (Akamatsu & Hanafy, 2020).

In addition to potentially supporting reduced secondary damage following a TBI, physical exercise may also be a safe, non-invasive rehabilitative intervention to alleviate cognitive symptoms associated with TBI (Vanderbeken & Kerckhofs, 2017). It is important to acknowledge that the benefits of exercise can extend to reduction of apoptosis, increased neurogenesis, enhanced neuroplasticity, and increased cerebral blood flow (Jaganathan & Sullivan, 2022). Thus, awareness of the connection between cognitive functioning and exercise for TBIs can enhance rehabilitation and assist rehabilitation practitioners.

Although some further studies revealed significant improvements in cognitive measures such as memory and executive functions, other studies identified little to no change in outcomes. This indicates that more research is needed regarding cognitive impairments and exercise (Sharma et al., 2019). Research that supports cognitive improvements from exercise linked biomarkers such as BDNF, IGF-1, and VEGF to faster mental processing, faster reaction times, and enhanced attention, learning and memory (Augusto-Oliveira et al., 2023). Further, studies have also discussed the importance of exercise for improving episodic memory post-TBI, specifically the 'when' and 'where' aspects of memory (Martínez-Drudis et al., 2021). With this information, it can be assumed that exercise could be helpful for essential parts of cognitive recovery that are necessary for everyday functioning.

Based on these findings, infusing exercise into therapy plans may provide cognitive benefits for both short-term and long-term recovery. Additionally, exercise may be an essential tool in coping with common mental health comorbidities like depression and anxiety (Singh et al., 2023). Although it is a non-pharmaceutical approach, research supports that exercise as a component of a treatment plan can offer mental health benefits including improved mood outcomes which promote overall recovery of individuals with TBI (Perry et al., 2020). Wender et al. (2023) reported that exercise can improve

mood broadly, improving almost all indices of the Profile of Mood States regarding anxiety, depression, and anger—states commonly affected by TBI. These results illustrate that regular physical activity could be effective in addressing various comorbidities, including mood disturbances, within the TBI population.

Given that TBI patients generally have poor quality of life (QOL) due to mood and limited functional capacity, exercise can serve as a statistically significant intervention in improving their overall QOL (Chang et al., 2023). Further, O'Carroll et al. (2020) noted that TBI patients often have a lower aerobic capacity than their counterparts, indicating specially designed aerobic programs can improve the patients' cardiorespiratory fitness and thus affect QOL in general. QOL can also be affected by how the individual perceives themselves. If an individual incorporates physical activity into their routine, it could provide the feeling of being in good health; in contrast, reduced physical activity can lead to poor emotional health (Romanov et al., 2021).

Barriers and Challenges for TBI and Exercise

The brain is in a particularly vulnerable state immediately following a TBI; therefore, it has been encouraged that the individual limits physical activity and focuses more on physical rest (Valovich McLeod et al., 2017). During the initial impact period, the brain's metabolic demands are increased at baseline state and premature exercise could be harmful and postpone necessary rehabilitation of the damaged area (Zhang et al., 2022). Therefore, initially following a TBI, most of the body's energy should be used for recovery instead of using it on exercise. Illustrating this point further, research also indicates that exercise intolerance immediately after a TBI is connected to autonomic nervous system dysfunction as well as a weakened function of blood supply to the brain (Antonellis et al., 2024). All of this information highlights that recovery timing and intensity are essential elements to consider when suggesting exercise for individuals with a TBI because intense exercise early on may exacerbate inflammation (Mastrorilli & Vecchiolo, 2024). Identifying the ideal type of exercise and timeframe for incorporating exercise can be challenging since it considers a multitude of factors such as the individual's severity of injury and rate of recovery. For patients taking medications, particularly psychotropic drugs, the emergence of adverse reactions such as nausea or dizziness may negatively impact exercise performance due to the side effects of medications, consequently compromising the benefits of physical activity during the TBI healing process (Zhang et al., 2022). Additionally, mental health disorders that were present before or occurred following the TBI can impact decisions regarding how to incorporate exercise into a treatment plan. There is often a deterrence in cognitive ability, executive functioning and decision making if the prefrontal cortex (PFC) area of the brain has been damaged during a TBI. The PFC is the primary structure that facilitates executive functions such as planning, problem solving, and control over social interactions (Ong et al., 2019). Some of the negative repercussions of a TBI that are impactful, hard to

manage, and long-term are highly correlated to a reduction in cognitive and executive functioning such as: memory altercations, weak impulse control, and decreased decision-making capacity (Shaver et al., 2019).

There are several factors that influence motivation to engage in exercise. One such factor includes mental health which may influence exercise motivation. Individuals that experience both mild and severe TBIs are often diagnosed with depression and anxiety as well as having a decrease in cognitive performance (Keatley et al., 2023). Furthermore, higher anxiety scores were detected amongst those who were exercise intolerant following a TBI (Antonellis et al., 2024). These conditions can lower motivation and increase the perceived difficulty of physical activities, providing additional barriers to the rehabilitation process (Vutakuri, 2023). Moreover, individuals with depression have poorer quality of life, health status, and psychosocial functioning when compared with individuals without depression (Perry et al., 2020). Age is another factor that affects perceived ability to participate in exercise for individuals with TBI. For instance, Pham et al. (2023), indicated that younger groups characterized by ages 45 and younger were more likely to report a lack of time to exercise, discomfort in the gym, and more fatigue versus middle aged and older groups, which was characterized by being 45 years or older, this group also was more likely to report no barriers to exercise. Although the finding of fatigue being reported more frequently among younger adults was an unexpected finding, Pham et al. (2023) speculated these findings may be due to younger adults perceiving their health less positively compared to middle-aged and older adults, who tend to have a more optimistic view of their health and perceive their physical activity participation is satisfactory for their age. Additionally, Pinto et al. (2018) report that 20% of individuals did not begin exercising due to the lack of knowledge regarding the benefits of exercise.

For example, there are currently no structured plans for initiating exercise and transitioning individuals from beginning stages of TBI recovery to further stages of TBI recovery (Zhang et al., 2022). Logistics should also be considered in order to accommodate exercises in treatment programs. Logistics can include access to professionals who will be able to offer individualized exercises for TBI patients as well as equipment necessary to exercise at home (Pinto et al., 2018). Considering that TBI survivors are highly likely to experience poverty (Young & Hughes, 2020, as cited in Snowden et al., 2023) and other disabilities (Hyder et al., 2007, as cited in Snowden et al., 2023), it is critically essential that rehabilitation professionals consider low-cost and modifiable home or community aerobic exercises.

For TBI patients, interpersonal connections such as support from family members and friends as well as supportive collaborative health care professionals can be significant in the recovery process (Green et al., 2023). The durability of one's social support is a potentially adaptable factor that may have a crucial impact on recovery after injury (Orlas et al., 2021). Protective factors such as social support, familial support, and community

involvement may contribute to addressing some barriers that individuals with TBI may encounter related to exercise behaviors. Perhaps, creating relationships with local gyms, community centers, and healthcare facilities to achieve safe environments and exercise support may be a possible way to counteract lack of accessibility. Rehabilitation practitioners may refer to a positive psychology approach to help individuals with TBIs perceive recovery with a strength- based viewpoint. Research shows that a supportive family environment and parental involvement correlates to children's resilience when healing from a TBI, leading to faster recovery in cognition and social skills (Bolikal et al., 2021). Additional research evaluating recovery outcomes found that children with limited family support and poor parental functioning showed higher rates for developing social impairment and took an average of 2 years before returning to pre-injury functioning (Anderson et al., 2023). Research indicates that a supportive family environment and parental involvement correlates to children's resilience when healing from a TBI, leading to faster recovery in cognition and social skills (Bolikal et al., 2021). These barriers and protective factors associated with engaging in exercise align with positive psychology principles and approaches.

Positive Psychology Approach

Positive psychology is the examination of positive individual experiences, optimistic character traits, and the institutions that help foster and facilitate them (Seligman, 2011). The benefits and wellbeing of Positive Psychology Interventions (PPIs) vary across individuals (Heintzelman et al., 2023). Positive psychology interventions have proven fruitful in supporting disability populations during rehabilitation and when reintegrating into society due to its strength based, rather than a deficit focused, approach (Wehmeyer, 2021). Rehabilitation professionals may want to be mindful of how the person is interacting with their environment when implementing specific PPIs. As such, the consequences of a given activity depend on the level of person-activity fit or the optimal match between an activity and the individual engaging in the act (Lyubomirsky & Layous, 2013). Rehabilitation counselors and practitioners who focus on a biopsychosocial approach will naturally examine the environment, social support, and individual characteristics when providing treatment to individuals with TBI. Consequently, the direct PPI should align with this person-centered approach during the implementation of a treatment plan. Another example of how PPIs can benefit individuals with disabilities is current research conducted by Braunwalder et al. (2022) suggesting that PPIs are specifically beneficial for individuals with chronic pain, as it enhances positive affect and cognition, which evidence shows can reduce pain levels and make discomfort more manageable. Also, there are several other components that may impact the healing and coping mechanisms for the brain injury. Evans and Cullen (2019) posit that individuals may be not only able to recover from the trauma and pain associated with the TBI, but also may be able to find renewed appreciation for life, identify greater personal strengths, and improved changes in personal

priorities. In addition to showing enhanced well-being and reduced depressive symptoms for adults, research shows that the impact from PPIs are sustainable and can have a lasting effect on individuals (Lim & Tierney, 2023).

Positive Psychology and the Biopsychosocial Model

It may be advantageous for rehabilitation practitioners to consider the facets within the biopsychosocial model when working with individuals with TBI. Individuals who encounter a TBI may have varying symptoms due to the biological, psychological, and social factors related to the individual and the injury (Register-Mihalik et al., 2020). The 'biopsychosocial model' considers that causes and/or treatment of targeted disabilities addresses adjustment and quality of life which typically include biological, psychological and social factors, as well as the synergy between these domains (Bolton, 2022). Therefore, a holistic approach would allow practitioners to also include techniques embedded from Positive Psychology such as highlighting the strengths and assets of the individual within each of these factors. For example, if an individual is highly extroverted and they flourish in group settings, perhaps group therapy with other individuals experiencing a TBI would be an effective option for this particular individual.

Furthermore, it is also recognized that physical activity leads to potentially better public health outcomes in general due its biopsychosocial effects (John et al., 2020). Often, biopsychosocial models refer to physical activity behavior from a comprehensive approach examining the biological, psychological, and social aspects; therefore, leading to great potential for an exhaustive, transdisciplinary perspective on physical behavior (John et al., 2020). Within this context, it would be advantageous that rehabilitation professionals consider implementing a biopsychosocial model approach in conjunction with physical activity when assisting individuals with TBI.

Individuals who encounter a TBI may have varying symptoms due to the biological, psychological, and social factors related to the individual and the injury (Register-Mihalik et al., 2020) which is why the biopsychosocial model is an ideal model for treatment. For example, the injury history, expression and recovery, and susceptibility to depression, anxiety, cognitive dysfunction, and access to medical personnel may vary from one person to another (Register-Mihalik et al., 2020). Also, population-level surveys have indicated an association between a lifetime history of TBI and elevated psychological distress, cannabis use, alcohol use, suicidal ideations, and attempted suicides which are additional risk factors to consider in tailoring treatment (Chan et al., 2022). Additionally, attention problems commonly assessed after pediatric traumatic brain injury have been shown to be influenced by an array of biological, environmental, and social factors which are additional aspects to consider in tailoring treatment (Bolikal et al., 2021). The consideration of factors such as access to treatment and resources, biological differences related to sex, and the predisposition to mental illnesses provides valuable insight on how practitioners can best support clients in their recovery process.

Within biological factors in the biopsychosocial lens, when considering sex, research supports that TBIs affect both women and men differently (Mamman et al., 2024). In regards to sex differentiation in determining the recovery outcomes of TBI there are distinct markers. Even when sustaining mild TBIs, women face poorer outcomes comparable to men sustaining severe TBIs (Mikolić et al., 2021). Following mild TBIs women had a higher percentage of unfavorable outcomes such as higher risk of depression, anxiety, and PTSD, as well as poorer quality of life due to poorer health (Starkey et al., 2022). These unfavorable outcomes for women may be due to social misconceptions that women are not as likely to sustain TBIs when compared to men which subsequently also leads to women being undiagnosed (Oliverio et al., 2020). Differences in care for TBI treatment between men and women may vary due to the type of TBI, severity of injury, and the cause of the TBI. Men generally sustain the majority of TBIs and the most severe TBIs. Men also generally receive longer and extensive care to support their recovery in comparison to women due to men being involved in more high risk sports and activities as well as careers with occupational hazards (Mollayeva et al., 2021). Understanding the nuanced outcomes of TBI across genders reveals distinct recovery trajectories for men and women, highlighting the importance of considering gender as a factor in personalizing TBI interventions (Teterina et al., 2023). Research further supports integrating gendered experiences of individuals with TBIs, as tailoring positive psychology interventions to align with gender-specific preference can optimize their effectiveness (Thompson et al., 2014). Similarly, when using exercise as an intervention, considering individual factors such as gender is insightful in creating a treatment plan that will better promote physical activity and address barriers for TBI survivors (Burgess et al., 2024).

Additional social and biological factors also contribute to TBI prognosis such as race and ethnicity. Although less studied, epidemiological research suggests that racial and ethnic minorities face higher incidence of sustaining TBIs as well as higher TBI related mortalities (Saadi et al., 2022). Multicultural and socioeconomic barriers are key factors related to the biopsychosocial model in receiving care and include inadequate coverage from insurance towards treatment interventions, mistrust of medical facilities and providers, and immigration status. As a result of considering the life-altering impacts of sustaining a TBI, including the significant financial strain, it is critical to continue exploring this condition in the general population, but also within groups that have been vulnerable to health care disparities (Maldonado et al., 2023).

It is known in the field that there seems to be a reciprocal effect with individuals who have substance use disorders (SUDs) and their increased incidence in having a TBI over time, otherwise known as the Chicken or The Egg Phenomenon (Olsen & Corrigan, 2022). For example, studies show that intoxication, regardless of whether by alcohol, cannabis, or other drugs, increases the likelihood of TBIs and injuries overall (Olsen & Corrigan,

2022). Data also suggests that early life TBIs result in increased prevalence for SUDsin later life (Cannella et al., 2019). These results demonstrate that the focus of TBI interventions should not only be the symptoms manifested with brain injury, but also the potentially chronic neuropathology as a result of these impairments (Sharma et al., 2019). Referring to the biopsychosocial model when treating individuals with TBIs allows for practitioners to investigate and assess individuals for potentially developing SUDs. On the contrary, a medical model approach would not consider the social or environmental factors related to a co-occurring disorder of SUD and TBI.

Implications for Rehabilitation Practitioners

In summary, this article revealed how both exercise and positive psychology may be effective practices to implement during the treatment process when rehabilitation professionals are assisting individuals with TBIs viewing recovery from a biopsychosocial lens. TBIs are complex injuries that manifest differently with regards to the source of the injury, severity, and brain regions impacted, as well as accompanying symptoms, showing that treatment interventions will look very different for each patient. A recent study examining the literature of TBI and rehabilitation by Sveen et al. (2020) revealed that a significant proportion of the literature on TBI rehabilitation interventions explained the long-term phase for the individuals' path. The authors noted that the focus was primarily on daily living skills, physical, emotional and cognitive functioning while employment, life and recreation after injury, and the role of the family and social network had sporadic focus within the literature (Sveen et al., 2020). Rehabilitation professionals must acknowledge that the responses to an adverse event such as a traumatic brain injury (TBI) differ among individuals is essential (Rapport et al., 2020). Therefore, it is vital for rehabilitation practitioners to understand the factors that contribute to the recovery process for individuals with TBIs. Additionally, practitioners should be wary of the implications that can arise during treatment for individuals recovering from TBIs as well as the relevant factors that can positively or negatively impact recovery outcomes for patients. Rehabilitation practitioners can benefit from using this data when working with clients with TBIs to assess the individuals' symptoms, providing effective resources and support for recovery, and suggesting adjunct services if needed to expedite the best effective care.

Conclusion

This article summarizes the benefits of exercise to promote recovery following a TBI, the application of positive psychology interventions, and the advantages for rehabilitation professionals in adhering to the biopsychosocial model. Due to the significant negative impacts on long-term health (Izzy et al., 2022) and mental health (Schwarzbold et al., 2008) of experiencing a TBI, rehabilitation professionals should incorporate evidence-based interventions to assist clients during recovery. As such, PPIs, and exercise interventions are both highly supported with positive benefits in the evidence-based literature.

The authors also addressed specific barriers and challenges for individuals to engage in exercise following a TBI while noting some potential protective factors to combat these challenges.

There are overall benefits of exercise such as increased cognitive functioning and stimulating neuroplasticity (Cotman & Berchtold, 2002). The safety and effectiveness of exercise for TBI is generally supported in the rehabilitation field (Snowden et al., 2023). There are numerous advantages of incorporating exercise in post-acute care for individuals with TBI including: repairing or creating new neural connections and promoting hippocampal neuroplasticity (Vints et al., 2024; Zhang et al., 2022); supporting the molecular mechanisms driving cognitive recovery (Marques-Aleixo et al., 2012); lessening cognitive symptoms associated with the injury (Vanderbeken & Kerckhofs, 2017); creating heat shock proteins that protect against various types of cell death (Kim et al., 2020); enhancing multiple areas related to quality of life (O'Carroll et al., 2020); boosting self-perceptions of being in good health (Romanov et al., 2021); modulating effects on brain activity (Patel et al., 2024); reducing in mental health conditions and symptoms (Chin et al., 2015; Singh et al., 2023; Wender et al., 2023), and potentially decreasing the risk of post-concussive symptoms (Patel et al., 2024). Therefore, when rehabilitation professionals utilize regular exercise in treatment planning for individuals with a TBI, cognitive recovery is enhanced and secondary damage is minimized (Amorós-Aguilar et al., 2020). In conclusion, this review provided ample knowledge to suggest that rehabilitation professionals could integrate PPIs and exercise behaviors into the treatment plans in practice while referring to the biopsychosocial model as a foundation.

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