



The Influence of Yoga on Traumatic Brain Injury Related to Sleep and Mood

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Abstract

Sustaining a Traumatic Brain Injury (TBI) has a significant effect on an individual's physical and mental abilities. Residual effects of TBI include sleep and mood disorders. Sleep disorders include any disturbance in an individual's quality of sleep and daytime functioning. Mood disorders include depression, anxiety, and adjustment to injury. Rehabilitation after TBI involves a range of therapeutic services in which a holistic approach to therapy addresses both the mind and the body. Yoga may be used to improve functioning for individuals with TBI. The purpose of this convergent mixed methods study was to examine the influence of yoga on the sleep and mood in individuals with TBI. This research study involved an eight-week yoga intervention at a large rehabilitation hospital in the southern United States. Seven individuals who sustained a TBI were recruited for the intervention. Sleep and mood were assessed pre-, mid-, and post-intervention. Upon completion of the intervention, participants and their caregivers took part in focus groups to share their perceptions of changes in sleep and mood. Data were analyzed and describe the influence of yoga on individuals with TBI. Quantitative data revealed no statistical significance, though percent change calculations of pre- and post-data showed a substantial decrease in anxiety and an improvement in adjustment to injury. Qualitative data were consistent with the calculated percent change in addition to an emerging theme of social support amongst individuals with TBI.

Keywords: Yoga; Therapy; Traumatic Brain Injury; Sleep; Mood; Depression; Anxiety; Adjustment

Introduction

A Traumatic Brain Injury (TBI) is defined as an acquired injury that is the result of direct damage to the brain [1]. A TBI can occur quickly and unexpectedly, but often has a long-term effect on an individual's physiological and neurological abilities [2,3]. In the United States, approximately 1.7 million people per year are admitted to the emergency room due to sustaining a TBI [4], many of whom continue to live with residual effects [5]. The residual effects of a TBI include, but are not limited to, trouble sleeping, changes in mood, and difficulty adjusting to life after injury [6,7]. Sleep disorders are defined as any consistent internal disturbance in sleep [8]. Regarding people with TBI, poor sleep quality is common [7] and has the potential to decrease emotional and physical abilities, as well as slow the recovery process [9]. In

addition to the negative impacts from sustaining a TBI, individuals are also susceptible to mood disorders as a residual effect of TBI. Common behavioral impairments for people with TBI include mood disorders, which can manifest as depression, anxiety, and adjustment to injury [3,6]. Depression is a common secondary factor for clinical conditions related to TBI [10]. Depression is defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [8] as depressed mood or loss of pleasure in life activities for more than two weeks, change from an individual's baseline mood, and compromised functioning. Generalized anxiety is defined in the DSM-5 as extreme or unrealistic worry for the majority of the days within six months [8]. Anxiety after TBI may first be seen as a normal reaction to trauma, but individuals with

TBI appear to have an increased risk of developing generalized anxiety in comparison to the general population [11]. Individuals with TBI also experience an adjustment to life after injury [12]. Level of adjustment after sustaining a TBI can be observed through the presence of depression, anxiety, fatigue, and irritability [13].

Due to the physical, cognitive, and emotional impacts of sustaining a TBI, treatment for TBI needs to be approached from a multidisciplinary perspective. As an emerging element of physical rehabilitation, complementary integrative health (CIH) interventions are health practices used in combination with traditional medicine [14]. CIH includes a wide variety of healing interventions that counteract illness or assist in increasing health and wellbeing [15]. CIH interventions, such as yoga, can be used as a holistic and complementary treatment to address the physical and mental needs of individuals with TBI [16-17].

In the West, yoga focuses on three main practices: breathing (pranayama), meditation (dhyana), and physical poses (asanas) [18]. Yoga interventions have been utilized in several rehabilitation settings [19-22], for the purpose of providing a complementary form of therapy. Research on the perceptions of yoga, when integrated into inpatient rehabilitation hospitals, shows patients' rehabilitation was enhanced by the use of yoga due to the added benefit yoga provided, including self-management skills and assisting long-term recovery [21,23]. Yoga for individuals with TBI is likely a useful intervention due to the adaptability of yoga sequences, the potential physical and cognitive benefits, and the research pointing to the potential sleep and mood benefits [19-24]. While there is limited research on yoga for TBI, one small, exploratory study found that when yoga was administered 16 times over the course of eight weeks, individuals with TBI expressed improvement in physical, emotional, and mental domains [25]. In an analysis of the influence of yoga on sleep for people with TBI through sleep-wake diaries, a substantial improvement in sleep quality was found after eight weeks of yoga treatment [19]. Following an adapted yoga group intervention for individuals with TBI, participants expressed favorable improvements in comfort with approaching balance and relaxation, as well as an increased self-awareness that helped with sleep [26]. There is limited research on yoga for individuals with a TBI and yoga, thus there is need for further studies related to the influence of yoga on sleep and mood in this population. Therefore, the purpose of this study was to observe, analyze, and discuss the influence of yoga on TBI related to their sleep and mood.

Methods

Design

This convergent mixed methods pilot study examined the influence of yoga participation on sleep and mood among individuals with TBI. Quantitative data was collected using a repeated measures design, with pre-, mid-, and post-intervention assessments given. Qualitative data was collected through two post-intervention focus groups, consisting of one focus group with participants and one

with the participants' caregivers. Prior to the start of this study, approval through the Rehabilitation Hospital's Institutional Review Board (IRB) and the Clemson IRB were obtained.

Recruitment and Participants

Purposeful, criterion-based sampling was employed in this study to decrease the variation of diagnosis amongst subjects [27]. Fifteen individuals who sustained a TBI and were prior patients at a large rehabilitation hospital in the Southeastern United States, that provides a continuum of care for individuals with TBI, were contacted by the project coordinator. The project coordinator, a Recreational Therapist at the rehabilitation hospital, screened all individuals interested in the study using the Six-Item Screener (SIS) to assess cognitive status in order to determine eligibility for a program or intervention [28]. The SIS has been used as a screener into yoga studies for individuals with TBI [20]. After screening the individuals, the project coordinator reviewed the inclusion and exclusion criteria with the individuals with TBI as well as their caregivers, to determine if they met the inclusion and exclusion criteria for the study. Inclusion criteria for persons with TBI required that they:

- I. Had diagnosis of moderate-to-severe TBI, verified by the individual's Glasgow Coma Scale score upon admission to the rehabilitation hospital [29],
- II. Were a fluent speaker of English, by self-report,
- III. Were 18 years of age or older,
- IV. Were able to move into different seated, standing, and supine postures without assistance (based on self- and caregiver-report),
- V. Had a caregiver that was willing to assist with participant transportation needs throughout the study, and
- VI. Had sufficient cognitive status to participate, as determined by a score of at least 4/6 on the Six-Item Screener.

The presence of any one of the following criteria resulted in exclusion from the study:

- A. were unable to attend 12 or more yoga classes during the eight-week intervention,
- B. had current drug or alcohol abuse, per self-report, and
- C. enrollment in another intervention study that could affect sleep or mood. Inclusion and exclusion criteria were also established for caregivers of participants with TBI to ensure they were able to fulfill the role of caregiver throughout the study, although a caregiver was only required if the individual with TBI needed assistance with daily tasks.

Inclusion criteria for the caregivers required that individuals:

- a. were age 18 or older,
- b. had no prior history of TBI,

- c. were the self-identified caregiver of person with TBI,
- d. were a fluent speaker of English, per self-report, as being willing to transport participant to all yoga sessions related to the study (as needed).

Exclusion criteria for caregivers of people with TBI were as follows:

- i. were unable to report on participant for whom they provide care, and
- ii. had current drug or alcohol abuse based on self-report. All participants provided written informed consent prior to the start of the study. Participants admitted to the study were given a \$25 incentive, funded by the rehabilitation hospital research department for clinician research projects, upon completion of the study.

Intervention

Table 1: Yoga Sequence.

Yoga Pose	English	Sanskrit
Introduction	Easy Seated Position	Sukhasana
	Bridge	SetuBandha Sarvangasana
Warm Up	Victorious Breath	Ujayi Pranayama
	Seated Twist	Bharadvajasana
	Forward Fold	Uttanasana
	Tabletop	Bahrmanasana
	Cat/Cow	Marjaiasana/Bitilasana
	Childs pose	Balāsana
	Locus variations (legs, arms, one leg at a time)	Salabhasana
	Sphinx	Niravalāsana
	Standing Mountain	Tadasana
	Mountain Arm Flow	Tadasana Pravaaha
Peak Poses	Warrior 1	Virabhadrasana I
	Warrior 2	Virabhadrasana II
	Triangle	Trikonasana
	Tree	Vrksasana
	Staff Pose	Seated Dandasana
Cool Down	Supine wind relieving R/L	Pawanmuktasana
	Supine Twist	Supta Matsyendrasana
	Final Resting Pose	Savasana

Yoga sessions were conducted in groups in a yoga room within a large rehabilitation hospital in the Southeastern United States. Sessions occurred twice a week for eight weeks, for a total of 16 yoga sessions. A recreational therapist who is a yoga teacher and specializes in yoga for individuals with TBI taught all yoga sessions. The sequences of yoga poses were designed based on the Love Your Brain (LYB) Foundation yoga program, which is designed for individuals with TBI [30]. The project coordinator of this study adapted the LYB yoga sequences to fit this specific study group

[31], to focus on influencing sleep and mood. Changes to the LYB protocol included increased time for meditation and a decrease in poses accomplished on hands and knees. See Table 1 for yoga sequence. Each yoga class was one hour long and included a 15-minute centering and focusing of the mind, 30 minutes of gentle physical yoga postures in supine, prone, seated, and standing positions, and 15 minutes of meditation and relaxation. The yoga sessions remained at the same level of difficulty from start to finish, in order to facilitate the transition from the rehabilitation setting to the community setting by encouraging growth towards mastery of the postures as opposed to growth in the number of postures.

Data Collection

Quantitative measures were chosen to focus on sleep and mood for individuals with TBI. Qualitative data were collected through post-intervention focus groups. The primary researcher conducted all data collection.

Quantitative Measures

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), a self-report questionnaire used to assess the quality of sleep over a one-month period [32]. The 24-items inquire about sleep duration, sleep medication, sleep latency, sleep quality, and how sleep effects an individual's daytime activity [33]. An individual may be diagnosed with poor sleep if he or she has a global PSQI score of greater than five. The PSQI has been used to screen for insomnia in individuals with TBI in post-acute care [34]. The PSQI has a diagnostic sensitivity of 89.6%, and a specificity of 86.5% when differentiating between individuals who experience 'poor' or 'good' sleep [32]. Depression was measured using the Patient Health Questionnaire-9 (PHQ-9). The PHQ-9 was developed based on the DSM-V criteria of depression [8] and can be self-administered [35]. The PHQ-9 is a nine-item depression scale that measures level of depression over the past two weeks using four-point likert responses, where 0=not at all, to 3=nearly every day [36]. Once completed, the total score was summed to assess level of overall depressive symptoms. The PHQ9 classifies level of depression based on the sum of responses, with 0-4=minimal depression, 5-9=mild depression, 10-14=moderate depression, 15-19=moderately severe depression, greater than 20=severe depression [37], and a score greater than 12 is the cutoff for being diagnosed with major depressive disorder [38]. The PHQ-9 was also effectively used in a study on combat-related TBI [39].

Anxiety was measured using the Generalized Anxiety Disorder-7 (GAD-7) survey. The GAD-7 is a seven-item anxiety scale that measures level of anxiety of the past two weeks using four-point likert responses, where 0=not at all, to 3=nearly every day [40]. This self-report questionnaire has shown reliability and validity [40,41] and can be used to analyze anxiety in the general population [41]. The GAD-7 classifies level of anxiety based on the sum of responses, with 0-4=minimal anxiety, 5-9=mild anxiety, 10-14=moderate anxiety, 15-21=severe anxiety, and a score greater

than 10 is the cutoff for being diagnosed with generalized anxiety disorder [40]. The GAD-7 was validated in primary care facilities [36] but has also been used to measure anxiety in a study on sleep and psychological conditions after sustaining TBI [42] and used to measure anxiety related to mild TBI related to combat [39]. Adjustment was analyzed using Part B of the Mayo-Portland Adaptability Inventory (MPAI-4). The MPAI-4 has four parts, each of which address a different aspect of adjusting to injury. Part B was selected due to the specific focus on adjustment to injury related to an individual's mood (irritation, aggression, pain, depression, anxiety, fatigue, social interaction, self-awareness, and sensitivity to symptoms). The rating scale ranges from 0-4, from 0=no problem to 4=severe problem that interferes with activities more than 75% of the time [43]. A sum score of 0-7= mild limitations, 8-15=mild to moderate limitations, 16-24=moderate to severe difficulties, and >25=severe limitations with a score of less than seven indicating a good outcome [44]. This scale was designed to assist in the clinical evaluation of participant adjustment during the post-acute (post hospital) period following an acquired brain injury [13]. This scale has been used in multiple rehabilitation settings, including post-acute rehabilitation, comprehensive day treatment, and community-based rehabilitation [45-47].

Qualitative Data Collection. As a convergent mixed methods study, this intervention was best examined through multiple forms of data, addressing research questions in a general and broad quantitative fashion, as well as providing a narrative and explanatory qualitative aspect [48]. The participant focus group focused on the participant's experience in the yoga intervention, giving an account of their experience, any change they noticed in sleep, depression, anxiety, or adjustment to injury, and any additional comments they had about the influence of yoga over the past eight-weeks. The caregiver focus group facilitator asked similar questions and focused on the caregiver's observation of participant behavior over the past eight-weeks. These focus groups were held in the private yoga room at the rehabilitation hospital and recorded using two audio recorders.

Data Analysis

Quantitative Analysis

Descriptive statistics were used to describe demographics, which included age, gender, marital status, race, work status, education, time (in years) since injury, and cause of injury. Nonparametric analysis was indicated because of the low sample size; thus, the Friedman Test was used to compare mean ratings of each assessment, using the Statistical Package for the Social Sciences (SPSS) software version 24. Comparisons were made between the group mean Pittsburgh Sleep Quality Index (PSQI) scores, depression scores (PHQ-9), anxiety scores (GAD-7), and adjustment scores (MPAI-4, Part B) from pre, mid, and post-intervention assessments. To further examine the quantitative results using the means from each assessment, percent change was

calculated using the following formula:

$$\text{Pre-intervention} = \frac{[(\text{post-intervention value} - \text{pre-intervention value}) / \text{pre-intervention value}] \times 100\%}{}$$

Qualitative Analysis

The qualitative focus groups were transcribed verbatim to increase descriptive validity [49], and participants and caregivers were assigned a subject number to ensure confidentiality. The project coordinator observed the focus groups to ensure interpretive validity [49], reporting that the project coordinator and primary researcher shared the same perceptions of the focus group discussion. After initial transcription, the primary researcher reviewed the qualitative data for themes, and categorized the responses based on their connection to sleep, depression, anxiety, and adjustment to injury. The project coordinator and an additional researcher reviewed the transcripts from the focus groups before and after analysis to check for consistency and establish inter-rater reliability [50]. In accordance with Creswell and Creswell's sequential process of qualitative analysis [50], focus group transcriptions were organized and read thoroughly by the primary researcher. Coding was deductive, to identify patterns within the data relevant to predetermined outcomes (i.e., sleep and mood), and to determine the existence of any emergent codes.

Mixing Quantitative and Qualitative Data

Qualitative and quantitative data were collected and analyzed separately [50]. After individual data analysis, quantitative and qualitative data were compared to discover converging or differing results [48].

Results

Overall, 15 people were contacted and invited to participate in eight weeks of yoga. Ultimately, seven people passed the SIS, met the inclusion criteria, and committed to the study, while eight declined despite having passed the SIS, citing scheduling conflicts, distance from home, lack of interest, and inability to commit to eight sequential weeks. Six people completed the study, five of whom had caregivers, while one person dropped out of the study 1.5 weeks prior to completion due to travel conflicts. Of the six participants who completed the study, four (67%) were female, and the average age was 31, with the ages ranging from 21-43 years old. The majority of participants were White (66%), and most were single (83%). Half of participants had a graduate degree, although 50% were unable to work. The average time since injury was 4.67 years. On average, participants attended 14 of the 16 sessions, with an attendance rate of 89% based on total number of sessions offered. See Table 2 for additional participant demographics. In the following sections, both quantitative data and qualitative data are provided by outcome, as the intent of this convergent mixed methods design was to compare converging or differing results [48]. See Table 3 for the mean pre and posttest, p-value, and percent change.

Table 2: Participant demographics.

Participant Number	Gender	Age	Race	Marital Status	Education	Employment	Years since TBI	Cause of TBI
1	F	35	Hispanic/Latino	Single	Bachelor's Degree	Unemployed	13	Car hit pedestrian
2	M	40	White	Married	Graduate Degree	Unemployed	1	Tree branch fell on head
3	F	27	White	Single	Graduate Degree	Unable to work	3	Fell off horse
4	M	43	White	Single	Graduate Degree	Unable to work	5	Assault
5	F	22	Black/ African American	Single	Some college	Unable to work	2	Gun Shot Wound
6	F	21	White	Single	High school Graduate	Student	4	Gun Shot Wound

Table 3: Participant demographics.

Assessment	Mean ± SD Pre Test	Mean ± SD Post Test	p-value	Percent Change
PSQI	5.33±3.01	5.00±2.83	p=0.48	-5.66%
PHQ9	4.57±5.03	3.89±3.41	p=1.00	-14.88%
GAD7	4.71±3.25	2.83±2.40	p=0.31	-39.90%
MPAI-4, Part B	6.29±4.35	2.67±3.67	p=0.25	-57.61%

Sleep

The Friedman Test revealed that quality of sleep did not differ significantly when comparing pre-, mid-, and post-intervention PSQI scores ($X^2=1.46$; $p=0.48$). The percent change from the pre- and post-intervention scores yielded a result of -5.7% change, indicating a minor decrease in reported issues related to sleep. The qualitative data on sleep was convergent with the quantitative data, supporting that there was no significant change in sleep quality for most participants. Most caregivers and participants commented on an improvement in sleep since the individual sustained the injury, but most did not identify further improvement as a result of the yoga intervention. However, one caregiver believes yoga has enabled her loved one to have deeper rest while sleeping. The caregiver stated that her loved one has “deeper sleep, she sleeps longer in the morning, has trouble to wake up, and she dreams. And she remembers her dreams!” In addition, one participant commented on her ability to sleep, saying sleeping in the past year “I would hear any little noise, it’d just bother me and wake me. So, sleep with earplugs, I slept with earplugs and an eye mask for light. Now I’m much better and I don’t need earplugs or a mask.”

Depression

The quantitative and qualitative data showed converging results regarding depression, as neither form of data collection identified substantial changes following the yoga intervention. The Friedman Test showed insignificant results regarding pre-, mid-, and post-PHQ-9 data ($X^2=0$, $p=1.00$), while the percent change from the pre- to post-intervention assessment was -14.9%, indicating a slight decrease in depression. Depression was briefly highlighted in the participant focus group, as one individual stated “I’ve never seen

myself as depressed,” and later said “I don’t think I’m depressed but again, the doctors have attributed my past tiredness and sluggishness to depression, and they say that now that I am active, it helps that aspect.”

Anxiety

No significant difference in anxiety was found using the Friedman Test ($X^2=2.33$, $p=0.31$). However, the percent change from pre- to post-test was -39.9%, representing a substantial decrease in anxiety after the yoga intervention. Complementing the percent change calculation, both caregivers and participants provided meaningful comments related to a decrease in anxiety during focus groups. Caregivers stated that yoga was “calming,” “relaxing,” and “increased the awareness” of their loved ones. Participants shared similar thoughts, using the words “calming” and “relaxing” throughout their discussion of their yoga experience. One caregiver stated: What my daughter seems to get out of it more than anything is the mindfulness and the meditation and just calming her down. Because we go at a high pace, and so this is a good way for her to just relax and help her brain get better. In addition, another caregiver said “she’s maybe more relaxed I would say. Less anxious.” Later on, this same caregiver explained, that yoga “sets her back and somehow it’s relaxing in order to let other things than the panic in her mind.” Participant responses aligned with the caregiver perspectives, as participants commented, “yoga has always relaxed me,” and “it helps me loosen up.” Another participant expressed her appreciation of yoga, saying: It’s perfect how the practice slows down, repeats, and just focuses on just a healthy mind. So, whereas out in the world, we’re supposed to go, go, go. Here we can just slow down, be in our minds, be present, and just be.

Adjustment

Though quantitative data regarding adjustment to injury produced non-significant findings based on the Friedman Test ($X^2=2.80$, $p=0.25$), the calculated percent change from the pre- to post-intervention MPAI-4 Part B assessment was -57.6%, indicating a considerable decrease in issues related to adjustment to injury. In addition, the qualitative data showed an improvement in adjustment. Qualitative data showed an increased interest in activity and self-esteem, as well as a decrease in irritability from the perspective of both the caregivers and the participants. When asked about a change in amount of activity for individuals with TBI, one caregiver said, "he's interested in doing more than just this." When asked the same question, a participant stated, "I do want to do more activities outside of the house." Moreover, one participant explained, "I do have more endurance of being able to take on more activities throughout the course of the day." Caregivers emphasized an increase in self-esteem following the yoga intervention. One caregiver commented on the relationship between improvement in self-esteem, and the eight weeks of yoga, saying:

Self-esteem I think is a big problem. I mean, a huge problem. But um, maybe for the past two months she, I think she's more aware and more in acceptance. So, it seems like the self-esteem is less of a problem.

While another caregiver explained that her husband is considering taking initiative on a project that she relates to an increase in self-esteem. Concerning irritability, a caregiver stated her son is "definitely getting more pleasant to be with," and a participant said "yoga, being mindful, the whole practice of presence and really being intentional and present with what you're doing has positively affected the way I approach anything." Social Support in the TBI Community. Though not included in the purpose of this study, appreciation of the community that formed as a result of the yoga intervention was evident as a theme throughout the caregiver and participant focus groups. In the profound words of a caregiver, yoga has provided "a place [for the participants] to be injured." Caregivers expressed "it's just nice to be with people who are maybe dealing with the same things," "they need groups to socialize, to exchange because they're very lonely," and yoga has "been wonderful for him because the rest of the time he is in the home alone." In line with caregiver responses, a participant stated that yoga helps in "having community support others who know your situation, experience, having gone through the same things." One participant expressed an appreciation of the ability to share experiences, saying "it's better to have friends that you can meet actually, all of you, and to know that they're doing the same thing that you have to." The community developed through yoga is unique due to the emphasis on rest and relaxation, which one caregiver highlighted by saying "yoga allows them to have time to think... we're not the ones that are gonna settle down with them like 'ah, let's rest'...we don't have the time and probably not the patience either."

Discussion

The primary purpose of this pilot study was to examine the influence of yoga on individuals TBI related sleep quality and mood after eight weeks of bi-weekly yoga. There was not a substantial change in sleep based on the PSQI. The data in this study differ from previous research that found yoga to improve sleep [19,51]. Though sleep disorders are common for individuals with TBI [7], the majority of this study population did not express complaints with sleep prior to or after the yoga intervention, resulting in little to no change in quantitative and qualitative results related to sleep. Considered to be a residual effect of sustaining TBI [52], depression was expected to be present in this study population. The pre-intervention average depression score from the PHQ9 was 4.57, (just beneath the mild depression score of 5-10), showing that participants did not initially experience significant depression symptoms. Depression was not significantly impacted by the yoga intervention, though the percent change showed a slight reduction in depressive symptoms, consistent with previous research claiming yoga yielded decreased reports of depression [53]. The findings of this study support previous work that yoga has the potential to decrease symptoms of anxiety [7,16,54]. Though quantitative measures yielded insignificant results, the percent change showed a substantial decrease in symptoms of anxiety. The qualitative data also demonstrated a reduction in anxiety, which participants identified was due to the emphasis on the calming and relaxing effect of yoga. Furthermore, a study by Verma et al. identified a decrease in anxiety continued beyond the yoga session was supported by caregiver and participant perspective shared during the focus groups [7].

Although not statistically significant, adjustment to injury did substantially improve, as indicated in the percent change calculation and the qualitative data. In congruence with the claim that yoga contributes to overall adjustment for individuals with TBI [55], this yoga intervention contributed to a decrease in irritability, and an increase of interest in activities. In addition, focus group discussions showed considerable improvement of self-esteem and self-awareness, supporting previous work that demonstrated the ability to improve emotional awareness through yoga after sustaining TBI [56]. The yoga intervention focused on awareness of the body and the mind by encouraging participants to bring awareness to specific body parts at time and acknowledge certain emotions that may come up. The focus on awareness throughout each yoga session likely contributed to the comments on increased self-esteem and awareness, consistent with the study results on the impact of an 8-week yoga program for individuals with TBI that indicated an improvement in self-perception [57]. A theme of social support through the yoga intervention became apparent through the focus group discussions. In a study on social support for individuals with TBI, Stålnacke [58] found reports of low-quality social support due to lack of social interaction. Consistent with results from other yoga studies [59-62], caregivers and participants described the yoga

sessions as beneficial due to the sense of camaraderie with people who have similar life changes due to sustaining TBI. Caregivers expressed the need for their loved ones to be with other people due to their loss of friends since sustaining TBI. Discussions during both caregiver and participant focus groups indicated an appreciation of the shared experience yoga provides. Participants in an inpatient rehabilitation setting benefited from the social interaction provided by yoga [21] supporting the theme of social support that emerged from this pilot study.

Implications for Further Research and Practice

The diverging results from quantitative measures and qualitative interpretations specific to the influence of yoga on sleep and mood indicate a need for further investigation. In order to expand this study, future research should consider including only those with current complaints related to sleep and mood and involve a larger sample size. Future studies may also consider the use of a yoga sequence that becomes progressively more challenging, as the content of the yoga intervention used in this study maintained the same level of difficulty from start to finish. A progression of poses may produce more substantial results, as challenging activities are more likely to produce change [63]. Yoga is a valuable therapy that can be implemented in a rehabilitation setting [21,23,64]. Attendance was high due to the location of the yoga intervention, since the rehabilitation hospital was a familiar place to all participants. Participants and caregivers also stated that they would like to see yoga included in TBI rehabilitation and they also identified the desire for the yoga intervention to continue and be offered individuals in outpatient programs. The qualitative data supported the value of yoga within a TBI rehabilitation setting as it can decrease anxiety, improve adjustment to injury, and promote social support within the TBI community.

Limitations

Due to the nature of research, this pilot study has limitations. This study took place in one rehabilitation hospital in the southeast and cannot be generalized to all yoga programs within a rehabilitation hospital. Second, while we aimed to observe the influence of yoga on ten people, only six people remained committed to the study from start to finish, resulting in a small sample size, where it is difficult to determine statistically significant changes in outcomes. More clearly stating attendance requirements when recruiting participants may increase commitment to the study. This study was not blind to the primary researcher or the participants, as the primary researcher was in direct contact with the participants, and the participants were informed of the purpose of the study when recruited for the study. Due to the pilot nature of this study, no control group was observed in comparison with the individuals receiving the yoga intervention. By adding a control group, researchers may be able to further understand the influence of yoga versus other environmental and social influences. Finally, the yoga sessions were not designed to build on themselves, but

rather involved the same primary moves with variations according to the yoga instructor's preference. A yoga sequence that becomes progressively more challenging may yield stronger results.

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