Original Article

Relationships between Post-Concussion Symptoms and Functional Performance among Persons with Mild Traumatic Brain Injury in Wenzhou, China

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Abstract

OBJECTIVES: The study in Wenzhou, China aimed to describe post-concussion symptoms (PCS) and functional performance (FP) among mild traumatic brain injury (mTBI) persons during two weeks after trauma and determine the relationships between physical symptoms, cognitive symptoms, and behavioral symptoms with FP.

MATERIALS AND METHODS: This study used a correlational cross-sectional design among 108 randomly selected persons with first-ever mTBI during their follow-up visits at the neurosurgery clinic of a university hospital in China. Data was collected utilizing a demographic questionnaire, and two self-report questionnaires during August to December 2021. Data analysis used descriptive statistics and Pearson correlation.

RESULTS: Participants experienced a mild level of physical symptoms (0.47 ± 0.51), cognitive symptoms (0.55 ± 0.84), and behavioral symptoms (0.55±0.90). They also had a mild impaired FP (0.55 ± 0.70). The results revealed that the physical symptoms, cognitive symptoms, and behavioral symptoms had positive correlations with FP (r = 0.68, r = 0.58, r = 0.76, $p < 0.001$, respectively).

CONCLUSION: These findings provide scientific evidence for healthcare providers especially nurses to identify mTBI persons with high-risk symptoms and make targeted PCS management in the early stage to promote FP. In conclusion, it supports the roles of nurses in evaluating each dimension of PCS and developing individualized nursing interventions.

Keywords: mild traumatic brain injury, post-concussion syndrome, physical symptoms, cognitive symptoms, behavioral symptoms, functional performance

Traumatic brain injury (TBI) is a global public health concern as one of the most common neurological diseases. The injury not only limits the use of specific parts of the body, but it also changes the patient's work and leisure activities, interpersonal relationships, and mental abilities.[1] In 2021, there were more than 50 million people with TBI in the world.[2] The annual global incidence was 790/100,000 persons.[3] Specifically, mild traumatic brain injury (mTBI) accounts for 70-90% of TBIs, and is defined by a Glasgow Coma Scale score ranging from 13 to 15.[1] In China, the incidence of mTBI accounts for 80-90% of TBI and might be over 600/100,000 in 2019.[4] The incidence rate of TBI in China is consistent with the rates reported in other countries, so the absolute numbers of TBI exceed those of most other countries due to its large population base.[5] Wenzhou, a Chinese city with a population of more than 9 million, had 13,271 mTBI patients admitted to hospital in 2015.[6]

Generally, mortality in mTBI patients is low. While 80-100% of mTBI suffer from symptoms within 2 weeks after mTBI, 15–25% still undergo these symptoms 3 months after injury, 10-15 % have persistent symptoms which perhaps last for several months or years.[7] Post-concussion syndrome (PCS) is commonly used to describe this condition. However, most present published articles choose the term PCS for above persistent symptoms that

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can arise after mTBI.[8] In addition, more severe symptoms in the early stage following the trauma are predictive of the long-term symptoms in the future.[8] PCS are categorized into three dimensions: physical, cognitive, and behavioral symptoms, while different patients may have symptoms in different combination, intensity, and duration.[9] Headache is extremely common in all symptoms and persistent problems with memory and concentration are often reported. Behavioral symptoms like depression and anxiety are also common.[8] PCS often leads to substantial symptom burden, impaired FP, low-quality daily and social life.[8]

FP refers to the ability of mTBI engaged in activities of daily life, physical, social activity and communication, and role performance include work and other role-related tasks.[10] Indeed, it is found that mTBI generates problems in FP after injury, especially at early stage.[11] A study showed that 73% of the mTBI subjects got poor FP within 2 weeks post-injury, 53% had impaired FP at 1-month post-injury, and 22.4% were still below normal FP at 1-year post-injury.[2] Their functional problems include the physical, social, and psychological domains, such as difficulties returning to work or decreases in work efficiency, decreased abilities to perform previous daily and social activities, deteriorated relationships with people around.[12] Among adolescents, they often get poor grades and reduce leisure or sports activities.[12] The difficulties to reintegrate into society lead to decreased life satisfaction of mTBI and increased social burden.[13]

Based on the Theory of Unpleasant Symptoms (TOUS), PCS consists of symptoms the individual is experiencing, while FP is the consequence of this experience.[10] Extensive research has showed that the quantity and severity of PCS were significantly associated with impaired FP[11] and the PCS at 2-3-week after concussion had better performance for the prediction of functional outcomes.[14] Furthermore, it is found that mTBI persons had different complaints about FP due to individualized symptoms which vary in kinds and quantity across three dimensions.[15] Interestingly, three dimensions of PCS respectively mainly influence the specific domain of the FP and their influence on FP are significantly different. Persons having mTBI with only physical symptoms generally no longer have FP problems if physical symptoms recover, while for those who have cognitive and behavioral symptoms, their FP limitations often persist for a longer duration.[15] Therefore, understanding the relationships between three dimensions of PCS with FP are crucial for personalized solutions to PCS and FP in different mTBI individuals. However, the studies about the relationships between physical symptoms, cognitive symptoms, and behavioral symptoms with FP are limited, especially in China. Considering China has many mTBI patients, most of them often leave hospital within two weeks after injury and rarely have follow-up.[16] The above obstacles may lead health providers to ignore the best intervention time and lack targeted nursing for mTBI, while inappropriate coping strategies may contribute to the prolongation of PCS and impaired FP.[17] Therefore, this study aimed to describe PCS and FP among mTBI persons 2 weeks after the trauma in Wenzhou, China and examine the relationships between physical symptoms, cognitive symptoms, and behavioral symptoms with FP. The study will provide scientific evidence for healthcare providers especially nurses how to evaluate and manage different dimensions of PCS in the early stage to promote FP.

Materials and Methods

The study employed a correlational cross-sectional study design. The study used a simple random sampling method and recruited 108 participants with first-ever mTBI who came to visit the neurosurgery clinic of a university hospital in Wenzhou, China, at 2 weeks after trauma for a follow-up.

These samples were recruited according to the following inclusion criteria:

1. Aged ≥ 18 years.
2. First-ever mTBI diagnosis.
3. Have the ability to read and write in Chinese.
4. Full consciousness, having a good orientation to person, place, and time, absence of mental illness.
5. No history of disability or physical impairment (weakness, blindness, etc.).
6. No history of other injury, and no alcohol addiction before injury.

The sample size was determined utilizing the G*Power 3.1.9.7 program, considering a statistically significant level of 0.05, a test power of 0.80, and an effect size of 0.27.[18, 19] Therefore, sample size for this study was at least 105 participants, the sample was increased to 108 participants at the end.

Instruments

This study used three questionnaires. The principal investigator was granted permission from the original authors of all instruments to use, excluding the demographic and health data questionnaires which were developed by researchers.

First, the demographic questionnaire developed by researchers, which consisted of two parts:

1. participants' general information (age, sex, marital status, occupation, educational background, living condition, income level, and working status.
2. health information (CT scan brain, loss of consciousness [LOS]).

Second, the Chinese version of The Rivermead Post-Concussion Symptoms Questionnaire (RPQ), originally developed by King and coworkers and translated into Chinese by Ling Zong, was used to measure the frequency and severity of PCS among mTBI persons at 2 weeks after trauma in this study.[20,21] The RPQ scale includes 16 items to assess the severity and disturbance of daily life of 16 different symptoms which commonly occur after TBI. There are 3 dimensions including: physical symptoms (9 items); cognitive symptoms (3 items); behavioral symptoms (4 items). The scale uses five

numerical categories; each item is scored on a scale from 0 (not experienced at all) to 4 (a severe problem). Therefore, the total scores are obtained by summing all the items and range from 0 (no change in symptoms since the injury) to 64 (most severe symptoms).[20] In this study, the instrument showed reliability with Cronbach's alpha value of 0.86.

Third, the Chinese version of The Rivermead Head Injury Follow Up Questionnaire (RHFQO), originally developed by Crawford and translated into Chinese by Ling Zong, was used to measure FP among mTBI at 2 weeks after trauma.[21,22] The questionnaire includes 10 items and addresses perceived difficulties and/or changes in the ability to perform daily activities, since prior to their head injury, including the ability of engaged in home and social activities, which were communication, mobility, behavior skills, social skills, and daily living skills.[23] The scale utilizes five numerical categories, each item is scored on a scale from 0 (no change) to 4 (a very marked change), resulting in a possible total score range of 0-40, high scores of RHFQO indicate poor FP. The reliability in this study was 0.84 of Cronbach's alpha value.

Data Collection

Data were collected 1–5 samples per day using simple random sampling from August 2021 to December 2021. With the help of the nurse of the neurosurgery outpatient department, the researcher got written consents from the participants who met the inclusion criteria on a voluntary basis, and questionnaires were distributed. Participants took approximately 20 minutes to complete the whole set of self-report questionnaires in a designated private room.

Data Analysis

SPSS 26.0 was utilized for data analysis. The accuracy and completeness of data were screened. No missing data was found. Demographic characteristics and variables were described using descriptive statistics. Pearson's product moment correlation coefficient was used to perform correlation analyses to explore the relationships between physical, cognitive, and behavioral symptoms with FP.

Ethical Considerations

Ethical approvals were conferred by the ethics committee of Burapha University (G-HS 049/2564) and the First Affiliated of Wenzhou Medical University (2021-zz-103). The researcher explained the study information included aims, procedures, occupied time to complete the questionnaire, and human rights of the participants. Participants could withdraw from participation at any time. Only the participants who agreed to participate were given the consent form. To protect the privacy of participants, researcher guaranteed that their confidentiality was maintained, whereas the information from participants was only used for statistics and would be destroyed after one year.

Results

There were 108 participants with age ranging from 18 to 85 years old (49.26±17.89), and 38% of them were 18-44 years. Males accounted for more (61.1%). Nearly half of them had an education level of secondary/high school (46.3%). The majority of participants were married (78.7%) and lived with their family members (84.3%). More than half of the participants were employed/studying before injury (65.8%), while only 63.4% among them had returned to work/school 2 weeks after injury. About half of the participants had a history of LOS (55.6%) and abnormal brain lesions (66.7%), See Table 1.

Table 1: Demographic data of participants (n = 108).

Characteristics	n (%)
Age	
18 - 44 years	41 (38.0)
45 - 60 years	34 (31.5)
61 - 75 years	27 (25.0)
76 - 85 years	6 (5.5)
Min - Max	18 - 85
Mean ± SD	49.26 ±17.89
Gender	
Male	66 (61.1)
Female	42 (38.9)
Marital status	
Single	23 (21.3)
Married	85 (78.7)
Living condition	
Living alone	17 (15.7)
Living with family members	91 (84.3)
Level of education	
Illiterate	5 (4.6)
Less than primary	9 (8.4)
Primary school	36 (33.3)
Secondary/High school	50 (46.3)
Bachelor's level and higher	8 (7.4)
Occupation	
Employed/ Student	71 (65.8)
Unemployed	37 (34.2)
Occupational/study status after injury for	
Return to work/school	45 (63.4)
A temporary leave from work/school	20 (28.1)
Unable to return to work/school	6 (8.5)
CT scan brain	
CT showed no abnormality	22 (20.4)
CT showed fracture skull	14 (12.9)
CT showed abnormal brain lesions	72 (66.7)
History of loss of consciousness	
Yes	60 (55.6)
No	48 (44.4)

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Description of PCS

The physical symptoms were the most frequent dimension in PCS (87.0%), far more than cognitive symptoms (41.7%) and behavioral symptoms (38.0%), while the severity of cognitive symptoms (0.55 ± 0.84), behavioral symptoms (0.55 ± 0.90) were higher than physical symptoms (0.47 ± 0.51). The level of severity of the three above symptoms were mild. Among physical symptoms, headache (59.3%), dizziness (46.3%), and fatigue (41.7%) were relatively frequent compared with the remaining symptoms. For severity, headache (1.05 ± 1.18), fatigue (0.83 ± 1.19), sleep disturbance (0.81 ± 1.33) were relatively high. Poor memory (33.3%) was the most frequent and severe symptom of cognitive symptoms (0.54 ± 0.99), whereas irritability (30.6%) was the most frequent and severe symptom of behavioral symptoms (0.69 ± 1.23), See Table 2.

Description of FP

The participants had mild difficulty in FP (0.55 ± 0.70). The most difficult/changed items were "Ability to participate in previous social activities" (0.90 ± 1.28) and "Ability to maintain your previous workload or quality of work" (0.87 ± 1.24). The least difficult/changed item was "Ability to participate in conversation with one person" (0.11 ± 0.34).

Table 2: Description of the PCS (physical symptoms, cognitive symptoms, and behavioral symptoms) (n = 108).

Post-concussion syndrome	Existence n (%)		Severity for PCS (1 = no more problem,4 = severe problem) n (%)				M	SD
	No	Yes	1 (No more problem)	2 (Mild problem)	3 (Moderate problem)	4 (Severe problem)		
Physical symptoms	14 (13.0)	94 (87.0)					0.47	0.51
Headache	44 (40.7)	64 (59.3)	37 (34.3)	11 (10.2)	10 (9.3)	6 (5.5)	1.05	1.18
Feelings of dizziness	58 (53.7)	50 (46.3)	35 (32.4)	12 (11.1)	2 (1.9)	1 (0.9)	0.64	0.83
Fatigue, tiring more easily	63 (58.3)	45 (41.7)	17 (15.7)	17 (15.7)	5 (4.7)	6 (5.6)	0.83	1.19
Sleep disturbance	71 (65.7)	37 (34.3)	12 (11.1)	9 (8.3)	6 (5.6)	10 (9.3)	0.81	1.33
Nausea and/or vomiting	90 (83.3)	18 (16.7)	16 (14.8)	2 (1.9)	0 (0)	0 (0)	0.19	0.44
Noise sensitivity, easily upset by loud noise	90 (83.3)	18 (16.7)	13 (12.0)	5 (4.7)	0 (0)	0 (0)	0.21	0.51
Blurred vision	92 (85.2)	16 (14.8)	11 (10.2)	2 (1.9)	2 (1.9)	1 (0.8)	0.23	0.66
Light sensitivity, easily upset by bright light	92 (85.2)	16 (14.8)	11 (10.2)	4 (3.7)	1 (0.9)	0 (0)	0.20	0.54
Double vision	99 (91.7)	9 (8.3)	9 (8.3)	0 (0)	0 (0)	0 (0)	0.07	0.26
Cognitive symptoms	63 (58.3)	45 (41.7)					0.55	0.84
Forgetfulness, poor memory	72 (66.7)	36 (33.3)	16 (14.8)	13 (12.0)	5 (4.6)	2 (1.9)	0.60	0.99
Poor concentration	76 (70.4)	32 (29.6)	16 (14.8)	9 (8.3)	4 (3.7)	3 (2.8)	0.54	0.99
Taking longer to think	78(72.2)	30 (27.8)	13 (12.0)	10 (9.3)	6 (5.6)	1 (0.9)	0.51	0.94
Behavioral symptoms	67 (62.0)	41 (38.0)					0.55	0.90
Being irritable, easily angered	75 (69.4)	33 (30.6)	13 (12.0)	4 (3.7)	10 (9.3)	6 (5.6)	0.69	1.23
Feeling frustrated or impatient	78 (72.2)	30 (27.8)	16 (14.8)	9 (8.3)	4 (3.7)	1 (1.0)	0.46	0.87
Feeling depressed or tearful	82 (75.9)	26 (24.1)	10 (9.3)	6 (5.6)	7 (6.5)	3 (1.7)	0.51	1.05
Restlessness	85 (78.7)	23 (21.3)	4 (3.7)	9 (8.4)	5 (4.6)	5 (4.6)	0.53	1.12

Table 3: Description of the functional performance (n = 108).

Functional performance	Possible score	Actual score	Severity n (%)					M	SD
			0 (No change)	1 (No more change)	2 (Mild change)	3 (Moderate change)	4 (Marked change)		
Ability to participate in conversation with one person	0 - 4	0 - 2	97 (89.8)	10 (9.3)	1 (0.9)	0 (0)	0 (0)	0.11	0.34
Ability to participate in conversation with 2 or more people	0 - 4	0 - 3	79 (73.2)	19 (17.6)	9 (8.3)	1 (0.9)	0 (0)	0.37	0.68
Relationship with previous friends	0 - 4	0 - 4	77 (71.3)	16 (14.8)	10 (9.3)	3 (2.8)	2 (1.8)	0.38	0.84
Performance of routine domestic activities	0 - 4	0 - 4	63 (58.3)	17 (15.7)	10 (9.3)	12 (11.1)	6 (5.6)	0.49	0.91
Finding work more tiring	0 - 4	0 - 4	76 (70.4)	13 (12.0)	9 (8.3)	6 (5.6)	4 (3.7)	0.54	0.96
Ability to cope with or handle family demands	0 - 4	0 - 4	59 (54.6)	27 (25.0)	7 (6.5)	7 (6.5)	8 (7.4)	0.59	0.96
Ability to enjoy previous leisure activities	0 - 4	0 - 4	74 (68.5)	19 (17.6)	9 (8.3)	3 (2.8)	3 (2.8)	0.60	1.09
Relationship with your partner	0 - 4	0 - 4	85 (78.7)	11 (10.2)	7 (6.5)	4 (3.7)	1 (0.9)	0.61	1.20
Ability to maintain your previous workload or quality of work	0 - 4	0 - 4	80 (74.1)	9 (8.3)	7 (6.5)	5 (4.6)	7 (6.5)	0.87	1.24
Ability to participate in previous social activities	0 - 4	0 - 4	71 (65.7)	18 (16.7)	12 (11.1)	6 (5.6)	1 (0.9)	0.90	1.28
Total scores	0 - 4	0 - 2.6						0.55	0.70

Relationships between physical symptoms, cognitive symptoms, and behavioral symptoms with FP

It was found that there were significant positive correlations between physical symptoms (r = 0.68, $p < 0.001$), cognitive symptoms (r = 0.58, $p < 0.001$), behavioral symptoms (r = 0.76, $p < 0.001$) with FP (perceived difficulty and/or change in FP), See Table 4.

Table 4: The correlations between physical symptoms, cognitive symptoms, and behavioral symptoms with functional performance (n = 108).

	Functional performance	*p*
Physical symptoms	0.68***	< 0.001
Cognitive symptoms	0.58***	< 0.001
Behavioral symptoms	0.76***	< 0.001

Discussion

In this study, the most reported dimension of PCS was physical symptoms (87%), followed by cognitive symptoms (41.7%) and behavioral symptoms (38%), all three dimensions were of mild severity. Previous studies showed that the mTBI samples reported moderate problems of physical symptoms, mild cognitive symptoms, and behavioral symptoms at 2 weeks after injury, and the frequency were 88.9%, 48.9%, 39.9%, respectively.[24] These results were consistent with the other findings, while the severity of physical symptoms was milder. Based on TOUS, the factors affecting PCS include physiological, psychological, and situational factors. Among physical symptoms, headache, fatigue, and sleep disturbance were the most common symptoms, while double vision was the least, as shown in a study with similar results.[20, 25] However, patients suffered moderate problems from above symptoms at 2 weeks after injury in other studies.[24] Reasons that may explain why participants got milder physical symptoms in this study include younger age group and higher percentage of male participants.

Age as a physiological factor may influence the occurrence and severity of physical symptoms, participants' age more than 65 years-old endorsed headaches, dizziness, and fatigue at a greater severity than the younger, the young had a better recovery due to increased neuroplasticity when compared to the elderly.[9, 26, 27] In this study, participants had relatively young age, more than one third were 18-44 years old. In addition, current cohort studies showed that compared to men who have greater physical reserves and energy, women are at greater risk for physical symptoms.[15] While males account for a higher proportion in this study. More than one third of the participants got mild cognitive symptoms such as forgetfulness, poor attention. The results were consistent with some previous studies. Previous studies showed that 33.82% reported mild cognitive difficulties like forgetfulness and poor concentration at 2 weeks.[28] Level of consciousness (LOC) as a physiological factor may contribute to post-concussion cognitive dysfunction.[29] More than half of participants had experienced LOC, there are substantial changes in the physiological and pathological aspects of the brain, often lead to cognitive impairment.[30] Our participants suffered mild behavioral symptoms at 2 weeks after injury, including irritability, frustration, depression, and restlessness. The results were consistent with some previous studies.[28]

The RHFQO questionnaire measured the extent of their perceived difficulty/change on FP after mTBI, the results showed the participants reported difficulties and changes in their FP. Most of the participants had returned to work or school but they felt it was more difficult to perform previous activities after the injury. The results were consistent with other studies.[26] In this study, the most prevalent difficulties among FP were "ability to maintain your previous workload or quality of work" and "ability to participate in previous social activities". While previous study showed the most common changes were the ability to maintain previous work and enjoy previous leisure activities[31] More than half of participants in this study had to work for financial support due to the burdens and responsibilities of taking care of their children and ailing parents, they got significant work and social pressures after perceived changes on their work ability.[26] Furthermore, participants had a relatively high level of education and generally engaged in mental work, their work efficiency often decreased due to cognitive problems.[12] In addition, most workers who need to work 8 hours or more per day in China, as well as academically focused students, have limited time for leisure activities, their daily activities are centered on work and work-related social activities.[32] As a result, there were fewer changes in leisure activities compared to social activities.

These findings showed that physical, cognitive, and behavioral symptoms had significant positive relationships with FP (perceived difficulty and/or change in FP) (r = 0.68, r = 0.58, r = 0.76, $p < 0.001$ respectively). This means three dimensions of PCS all contribute to more FP problems, which is consistent with the scientific justification of TOUS, as the theory indicated that symptoms influence performance and people with more numerous or more severe symptoms tend to have lower FP.[10] This study showed that physical symptoms were highly correlated to FP. It was consistent with findings from other studies, for example, a study found that physical symptoms had significant correlations with FP at two weeks after mTBI, headache, and fatigue, often impacted the ability to engage in daily activities, and lead to substantial declines in social and occupational performance.[33] For instance, mTBI usually rest and reduce daily activities when headache and dizziness occur, thus the performance of routine domestic activities got worse. If patients suffer from sleep disorder, elementary cognitive functioning declines rapidly.[34] There was also a significant relationship between cognitive symptoms with FP. Memory deficits and other cognitive symptoms can contribute to FP problems in various aspects of academic and vocational tasks that heavily rely on cognitive functioning.[35] Workers may struggle with problem-solving and decision-making due to poor cancellation, then affecting their work efficiency.[36] Students may face challenges in remembering academic knowledge on account of forgetfulness and taking

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longer to think, leading to lower academic performance.[26] For those who were unemployed, their social aspects of FP were also impaired by prolonged unemployment due to cognitive decline, because a degraded work environment may result in a decline in confidence in socializing with others.[34, 37]

Finally, behavioral symptoms had the most significant relationship with FP in the present study. A recent study showed that those who present with greater emotional stress are more likely to have impaired FP.[24] Higher behavioral symptoms like depression and anxiety were significant predictors of an incomplete function recovery at 2 weeks after trauma.[38] Moreover, TOUS explained that FP can also feedback to symptoms, so the functional impairment can exacerbate emotional symptoms in turn.[39] Behavioral symptoms such as depression can affect the patient's FP in the social domain, and decline in social skills can lead to worse depression or more symptoms like anxiety.[11]

Conclusion

The study results indicated that mTBI persons had mild problems with PCS and FP at 2 weeks after the trauma. Another major finding was that all three dimensions of PCS were significantly correlated to FP. These can help healthcare providers especially nurses identify and assess high-risk symptoms among mTBI persons in the early stage, then develop targeted intervention to prevent persistent symptoms and promote FP and finally help them recover and improve their quality of life. This study also provides related nursing knowledge of the importance of regular follow-up in the early stage among mTBI. Lastly, future research should also include longitudinal study for continuing follow up PCS and FP for 6 months to manage effective recovery in mTBI patients.

Conflicts of interest

No potential conflict of interest relevant to this article reported.

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References

1. Haarbauer-Krupa J, Pugh MJ, Prager EM, et al. Epidemiology of chronic effects of traumatic brain Injury. *J Neurotrauma.* 2021;38(23):3235-47. doi: 10.1089/neu.2021.0062.
2. Mikolić A, Polinder S, Steyerberg EW, et al. Prediction of Global Functional Outcome and post-concussive symptoms after mild traumatic brain Injury: external validation of prognostic models in the collaborative european neurotrauma effectiveness research in traumatic brain injury (CENTER-TBI) Study. *J Neurotrauma.* 2021;38(2):196-209. doi: 10.1089/neu.2020.7074.
3. Lefevre-Dognin C, Cogné M, Perdrieau V, et al. Definition and epidemiology of mild traumatic brain injury. *Neurochirurgie.* 2021;67(3):218-21. doi: 10.1016/j.neuchi.2020.02.002.
4. Gao G, Wu X, Feng J, et al. Clinical characteristics and outcomes in patients with traumatic brain injury in China: a prospective, multicentre, longitudinal, observational study. *The Lancet Neurology.* 2020;19(8):670-7. doi:10.1016/S1474-4422(20)30182-4.
5. Feng J, van Veen E, Yang C, et al. Comparison of care system and treatment approaches for patients with traumatic brain injury in China versus Europe: A CENTER-TBI survey study. *J Neurotrauma.* 2020;37(16):1806-17. doi: 10.1089/neu.2019.6900.
6. Zhang M, Chen G, Dai X, et al. Prevalence of human papillomavirus in Wenzhou, China: a cross-sectional study of 127 938 outpatient women. *BMJ open*. 2022;12(12):e066698. doi: 10.1136/bmjopen-2022-066698.
7. Asselstine J, Kristman VL, Armstrong JJ, et al. The Rivermead Post-Concussion Questionnaire score is associated with disability and self-reported recovery six months after mild traumatic brain injury in older adults. *Brain Inj* 2020;34(2):195-202. doi: 10.1080/02699052.2019.1682670.
8. Skjeldal OH, Skandsen T, Kinge E, et al. Long-term post-concussion symptoms. *Tidsskr Nor Laegeforen* 2022;142(12). doi:10.4045/tidsskr.21.0713.
9. Balakrishnan B, Rus RM, Chan KH, et al. Prevalence of Postconcussion Syndrome after mild traumatic brain injury in young adults from a single neurosurgical center in east coast of Malaysia. *Asian J Neurosurg* 2019;14(1):201-5. doi: 10.4103/ajns.AJNS_49_18.
10. Lenz ER, Pugh LC, Milligan RA, et al. The middle-range theory of unpleasant symptoms: an update. *ANS Adv Nurs Sci* 1997;19(3):14-27. doi: 10.1097/00012272-199703000-00003.
11. Herrold AA, Smith B, Aaronson AL, et al. Relationships and Evidence-based theoretical perspectives on persisting yymptoms and functional impairment among mild traumatic brain injury and behavioral health conditions. *Mil Med* 2019;184(Suppl 1):138-47. doi: 10.1093/milmed/usy306.
12. Yue JK, Levin HS, Suen CG, et al. Age and sex-mediated differences in six-month outcomes after mild traumatic brain injury in young adults: a TRACK-TBI study. *Neurol Res* 2019;41(7):609-23. doi: 10.1080/01616412.2019.1602312.
13. Nelson LD, Temkin NR, Dikmen S, et al. Recovery after mild traumatic brain injury in patients presenting to US level I Trauma Centers: A transforming research and clinical knowledge in traumatic brain injury (TRACK-TBI) Study. *JAMA Neurol* 2019;76(9):1049-59. doi: 10.1001/jamaneurol.2019.1313.
14. Mikolić A, Steyerberg EW, Polinder S, et al. Prognostic models for global functional outcome and post-concussion symptoms following mild traumatic brain injury: A collaborative European NeuroTrauma Effectiveness Research in Traumatic Brain Injury (CENTER-TBI) *Study. J Neurotrauma* 2023;40(15-16):1651-70. doi: 10.1089/neu.2022.0320.

15. Permenter CM, Fernández-de Thomas RJ, Sherman AL. Postconcussive Syndrome. 2023 Aug 28. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan. PMID: 30521207.
16. Cheng P, Yin P, Ning P, et al. Trends in traumatic brain injury mortality in China, 2006-2013: A population-based longitudinal study. *PLoS Med* 2017;14(7):e1002332. doi: 10.1371/journal.pmed.1002332.
17. Guty E, Riegler K, Meyer J, et al. Symptom factors and neuropsychological performance in collegiate athletes with chronic concussion symptoms. *Arch Clin Neuropsychol* 2021;36(5):746-56. doi: 10.1093/arclin/acaa092.
18. Faul F, Erdfelder E, Buchner A, et al. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behav Res Methods* 2009;41(4):1149-60. doi: 10.3758/BRM.41.4.1149.
19. Guty E, Arnett P. Post-concussion Symptom Factors and neuropsychological outcomes in collegiate athletes. *J Int Neuropsychol Soc* 2018;24(7):684-92. doi: 10.1017/S135561771800036X.
20. King NS, Crawford S, Wenden FJ, et al. The Rivermead Post Concussion Symptoms Questionnaire: a measure of symptoms commonly experienced after head injury and its reliability. *J Neurol* 1995;242(9):587-92. doi: 10.1007/BF00868811.
21. Zong L, Zhu S, editors. The study of the incidence of post-concussion symptoms and its related influencing factors. National Academic Conference of Psychiatry of Chinese Medical Association; 2011.
22. Crawford S, Wenden FJ, Wade DT. The Rivermead head injury follow up questionnaire: a study of a new rating scale and other measures to evaluate outcome after head injury. *J Neurol Neurosurg Psychiatry* 1996;60(5):510-4. doi: 10.1136/jnnp.60.5.510.
23. Chen DY, Hsu HL, Kuo YS, et al. Effect of age on working memory performance and cerebral activation after mild traumatic brain Injury: a functional mr imaging study. *Radiology* 2016;278(3):854-62. doi: 10.1148/radiol.2015150612.
24. de Guise E, Bélanger S, Tinawi S, et al. Usefulness of the rivermead postconcussion symptoms questionnaire and the trail-making test for outcome prediction in patients with mild traumatic brain injury. *Appl Neuropsychol Adult* 2016;23(3):213-22. doi: 10.1080/23279095.2015.1038747.
25. Bedaso A, Geja E, Ayalew M, et al. Post-concussion syndrome among patients experiencing head injury attending emergency department of Hawassa University Comprehensive specialized hospital, Hawassa, southern Ethiopia. *J Headache Pain* 2018;19(1):112. doi: 10.1186/s10194-018-0945-0.
26. Karr JE, Iverson GL, Berghem K, et al. Complicated mild traumatic brain injury in older adults: Post-concussion symptoms and functional outcome at one week post injury. *Brain Injury* 2020;34(1):26-33. doi: 10.1080/02699052.2019.1669825.
27. Skandsen T, Stenberg J, Follestad T, et al. Personal factors associated with postconcussion symptoms 3 months after mild traumatic brain injury. *Arch Phys Med Rehabil* 2021;102(6):1102-12. doi: 10.1016/j.apmr.2020.10.106.
28. Barker-Collo S, Theadom A, Starkey N, et al. Factor structure of the Rivermead Post-Concussion Symptoms Questionnaire over the first year following mild traumatic brain injury. *Brain Inj* 2018;32(4):453-8. doi: 10.1080/02699052.2018.1429659.
29. Merritt VC, Greenberg LS, Meyer JE, et al. Loss of Consciousness is Associated with elevated cognitive intra-individual variability following sports-related concussion. *J Int Neuropsychol Soc* 2021;27(2):197-203. doi: 10.1017/S1355617720000727.
30. McMahon P, Hricik A, Yue JK, et al. Symptomatology and functional outcome in mild traumatic brain injury: results from the prospective TRACK-TBI study. *J Neurotrauma* 2014;31(1):26-33. doi: 10.1089/neu.2013.2984.
31. Kasch H, Jensen LL. Minor head injury symptoms and recovery from whiplash injury: a 1-year prospective study. *Rehabil Process Outcome* 2019;8:1179572719845634. doi: 10.1177/1179572719845634.
32. Li F, Lu L, Chen H, et al. Disrupted brain functional hub and causal connectivity in acute mild traumatic brain injury. *Aging* 2019;11(22):10684-96. doi: 10.18632/aging.102484.
33. Losoi H, Silverberg ND, Wäljas M, et al. Recovery from mild traumatic brain injury in previously healthy adults. *J Neurotrauma* 2016;33(8):766-76. doi: 10.1089/neu.2015.4070.
34. Killgore WDS, Vanuk JR, Shane BR, et al. A randomized, double-blind, placebo-controlled trial of blue wavelength light exposure on sleep and recovery of brain structure, function, and cognition following mild traumatic brain injury. *Neurobiol Dis* 2020;134:104679. doi: 10.1016/j.nbd.2019.104679.
35. Westfall DR, West JD, Bailey JN, et al. Increased brain activation during working memory processing after pediatric mild traumatic brain injury (mTBI). *J Pediatr Rehabil Med* 2015;8(4):297-308. doi: 10.3233/PRM-150348.
36. Gorgoraptis N, Zaw-Linn J, Feeney C, et al. Cognitive impairment and health-related quality of life following traumatic brain injury. *NeuroRehabilitation* 2019;44(3):321-31. doi: 10.3233/NRE-182618.
37. Kim GU, Park S, Kim S. Functional health in korean middle-aged women with poor sleep quality. *Int J Nurs Knowl* 2020;31(4):232-9. doi: 10.1111/2047-3095.12275.
38. van der Naalt J, Timmerman ME, de Koning ME, et al. Early predictors of outcome after mild traumatic brain injury (UPFRONT): an observational cohort study. *Lancet Neurol* 2017;16(7):532-40. doi: 10.1016/S1474-4422(17)30117-5.
39. Blakeman JR. An integrative review of the theory of unpleasant symptoms. *J Adv Nurs* 2019;75(5):946-61. doi: 10.1111/jan.13906.