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ORIGINAL RESEARCH

Prevalence of Persistent Post-Concussion Syndrome in Adults After Mild Traumatic Brain Injury

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Abstract

Background: Although mild Traumatic Brain Injury (mTBI) is one of the primary causes of death and disability worldwide, research on the prevalence of post-concussion syndrome (PCS) after mTBI is still extremely limited. Previous studies have shown that approximately 10-15% of mTBI patients experience PCS, yet these studies often have different methodologies and sample sizes.
Purpose: This study aimed to determine and compare the prevalence of persistent PCS (more than one month post-injury) with those without PCS in mTBI patients.
Methods: This study employed a retrospective cohort design and analyzed patient data from hospital records between July and December 2022, yielding a sample of 316 participants with mTBI. Patients with complete medical record data and active health checks for one month after being treated were taken as research subjects. PCS measurement was conducted using the Rivermead Post Concussion Symptoms Questionnaire (RPQ). Data were analyzed using an independent t-test with a two-tailed distribution to compare variables between groups (groups with PCS and without PCS).
Results: The prevalence of persistent PCS in mTBI patients was 112 (35.4%) patients. The occurrence of persistent PCS was found to be most prevalent in the second month and in motor vehicle accident-related injuries, with 49 (43.7%) patients and 80 (71.4%) patients, respectively. Problems concentrating (37.5%), headache (30.3%), and light sensitivity (32.1%) were the most common symptoms of PCS.
Conclusions: A significant proportion of persistent PCS was found, with the most prevalent occurring in the second month after mTBI and involving motor vehicle-related injuries. These findings warrant better screening guidelines and practices that patients can adopt after mTBI.

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1. Introduction

Most traumatic brain injuries (TBI), accounting for more than 71%, fall into the severe category, and more than 56.4% fall into the mild category (mTBI). The frequency of admission to hospital for TBI is 10–30% (Bo & Pearkao, 2021). Yet, only a minority of persons with mTBI are admitted to the hospital upon attending the emergency room (10–25%). Furthermore, because it excludes people who do not seek or receive medical assistance, emergency department data is likely to underestimate the incidence of mTBI (Balakrishnan et al., 2019; Messé et al., 2013). Following an mTBI, a variety of physical, affective, and cognitive symptoms are frequently brought on, including headaches, depressive symptoms, and memory loss (Cancelliere et al., 2023; Voormolen et al., 2019). These symptoms can be classified as post-concussion syndrome (PCS), which is a common complication that can occur after mTBI.

Post-concussion syndrome (PCS) is a complex condition that can occur after mTBI. The prevalence of PCS after mTBI has been reported to vary significantly, with some studies indicating that approximately 10-15% of mTBI patients experience PCS (Balakrishnan et al., 2019). However, other studies have shown that the prevalence can be as high as 35.4% (Bo & Pearkao, 2021). The duration of PCS symptoms can also vary, with some patients experiencing symptoms up to a year after their injury (Polinder et al., 2018). This variability in prevalence and duration highlights the need for further research into the mechanisms underlying PCS and the development of more specific diagnostic criteria. The symptoms experienced by patients post-TBI vary, with some experiencing more symptom changes after hospitalization in approximately 5% with persistent PCS. Persistent PCS is a condition in which physical, cognitive, emotional, or behavioral symptoms that arise from mild TBI (mTBI) persist longer than usual, typically more than three months after the injury (Yue et al., 2019; Zeldovich et al., 2020).

The role of nurses in preventing persistent PCS in traumatic brain injury (TBI) patients is crucial. Recent studies have shown that nurses can play a part in reducing the risk of PCS by conducting structured interventions (Messé et al., 2013). For instance, nurses can educate and support patients and their families about PCS symptoms and how to manage them (Heslot et al., 2021). Nurses can also monitor patients to detect PCS symptoms early and provide appropriate therapy (Voormolen et al., 2019). Furthermore, nurses can contribute to reducing patient stress through relaxation therapy and education on stress management (Messé et al., 2013). A study conducted by Bo and Pearkao (2021) indicates that nurses with stress management skills can help patients reduce the risk of PCS. Therefore, the role of nurses in preventing PCS is significant in improving the quality of life of TBI patients.

The urgency to focus on persistent PCS in patients with mTBI lies in its significant impact on the quality of life and functional outcomes. Studies have shown that PCS can persist for months or even years after the initial injury, leading to long-term disability and reduced quality of life (Cnossen et al., 2018). For instance, a study by Bo and Pearkao (2021) found that 69% of patients with mTBI retained their jobs at long-term evaluations, yet 12% of these patients had to work under the adverse impacts of PCS. This highlights the importance of addressing PCS early to prevent long-term consequences. Furthermore, the prevalence of PCS is higher than previously thought, with some studies indicating that up to 35.4% of mTBI patients experience PCS (Bo & Pearkao, 2021; Cnossen et al., 2018). This underscores the need for more research into the mechanisms underlying PCS and the development of more specific diagnostic criteria. Previous studies have focused on the prevalence and characteristics of PCS, but there is still a gap in understanding the long-term impacts and the most effective interventions for managing PCS (Balakrishnan et al., 2019).

Initial assessment of post-TBI patients will provide initial information and symptoms indicating a PCS event so that preventive measures can be taken. Thus, the extent to which participants with mTBI exceeded the threshold criteria for a diagnosis of PCS was investigated in the current study. Participants were classified as having PCS when they met all RPQ criteria except the provision of previous head injury. The assessments performed determine early detection in mTBI patients with and without PCS. Accurate early results greatly determine the patient's subsequent condition, which also determines the type of action and care provided (Beauchamp et al., 2021; Cancelliere et al., 2023; Starkey, 2018). It is a good initial step to improve services and perform early detection of mTBI patients.

The research gap in the current understanding of persistent PCS lies in the inconsistent classification and variable assessment procedures used in previous studies. For instance, a study have reported prevalence rates of PCS ranging from 11% to 82%, depending on the diagnostic criteria and population assessed (Balakrishnan et al., 2019). This variability highlights the need for more standardized diagnostic criteria and comprehensive assessment tools. Furthermore, the role of pre- and post-injury factors in the development of PCS is still poorly understood, with some studies suggesting that factors such as depression, anxiety, and post-traumatic stress disorder (PTSD) may play a significant role (Mercier et al., 2018). Therefore, this study aimed to address this gap by using standard diagnostic criteria and comprehensive assessment tools to determine and compare the prevalence and characteristics of PCS with those without PCS in mTBI patients.

2. Methods

2.1 Research design

This study utilized a retrospective cohort design to examine the prevalence of persistent PCS in adults following mTBI. The specific objectives of this study were to determine the prevalence of PCS among adults who experienced mTBI and to identify the demographic and clinical characteristics associated with an increased risk of PCS. This design allows for efficient utilization of existing medical records to identify mTBI cases and monitor their outcomes over a specified 6-month period. This approach is particularly suitable for studying conditions like PCS, where longitudinal data is crucial for understanding symptom persistence and evolution over time.

2.2 Setting and samples

The sample size was calculated using G*power for one sample t-test with an effect size of 0.5 and a standard error of 5% to achieve 95% power, which resulted in 317 samples. Adding 10% of attrition yielded as many as 349 samples. Of 373 recruited m-TBI patients, a sample of 112 mTBI participants with PCS and 204 without PCS who met the inclusion and exclusion criteria was obtained (Figure 1). The sample selection in this study began with patients who had undergone hospital treatment with a diagnosis of mTBI. These patients were then assessed to determine whether they were experiencing PCS.

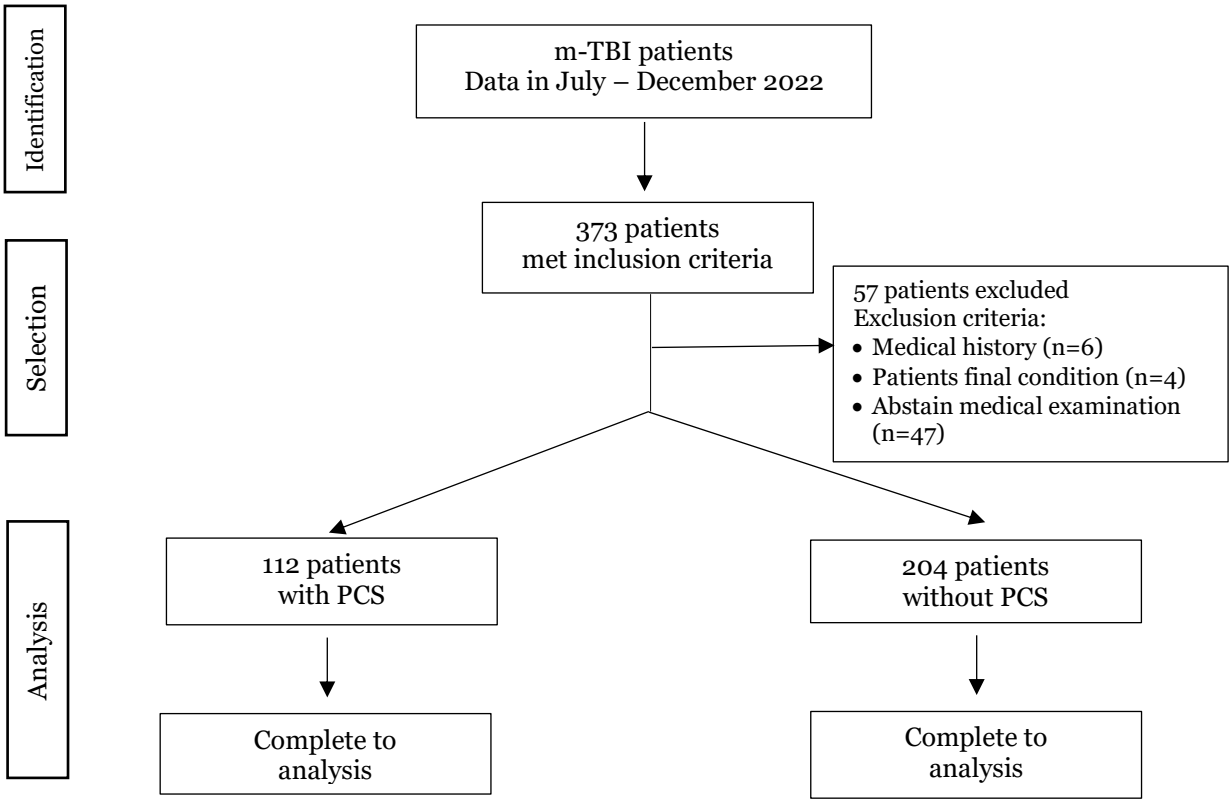

Figure 1. Flowchart of the respondents in the study

This study then employed a consecutive sampling method. All adult patients who presented to the trauma center hospital in Central Java, Indonesia, with a diagnosis of mild traumatic brain injury (mTBI) during the six-month period from July to December 2022 were included in the study. Patients were consecutively enrolled based on the availability of complete medical records and the diagnosis of mTBI. This study was conducted in a trauma center hospital located in Central Java, Indonesia. The hospital is a leading healthcare facility in the region, specializing in the treatment of traumatic injuries, including traumatic brain injuries (TBIs). It is equipped with state-of-the-art medical equipment and staffed by a team of highly skilled healthcare professionals, including neurologists, neurosurgeons, and rehabilitation specialists. The hospital

serves a diverse patient population from urban and rural areas, providing comprehensive care for a wide range of traumatic injuries. The medical record data contained demographic information, the causes of injury, length of stay, and health check compliance after being treated. The criteria for including patients in the sample of this study were patients who had been hospitalized with a diagnosis of mTBI, had complete medical records including health history, final patient condition, and no further examinations. The criteria for excluding patients from the sample were incomplete medical records and undergoing surgical interventions related to head injuries, such as skull fracture removal surgery, and patients with psychiatric problems.

2.3 Measurement and data collection

Data collection in this study was conducted by two nurses working at the hospital, who were subsequently referred to as research assistants. These assistants were responsible for collecting data from patients who had undergone hospital treatment with a diagnosis of mTBI. To ensure they collected data with consistent information, the assistants were trained beforehand on how to collect data correctly and accurately. This training included an introduction to the definition and inclusion and exclusion criteria, as well as instructions on how to fill out the data sheets. To ensure the validity and reliability of the sheets used, this study utilized data sheets that had been tested and verified previously (Cnossen et al., 2018). These sheets were designed to collect relevant and accurate data about the patient's medical history, final condition, and no further health examinations. Interrater reliability in this study was ensured by using previously verified data sheets and training the assistants who collected the data. Moreover, the collected data was processed and analyzed using previously verified methods, employing the Bland-Altman test. The results showed a p-value of 0.905 with a 95% CI of -0.51 to 0.44, indicating that the difference between assistants was much smaller than the maximum tolerable difference. Thus, this study can ensure that the data collected is valid and reliable and the results can be trusted.

Consistency and accuracy in data collection, comprehensive training and standardized procedures were implemented for research assistants involved in the study. These procedures included steps consisting of the development of detailed training materials that were created, including a data extraction manual that outlined the standard protocol, definitions of key variables, and step-by-step instructions for data entry. The manual also provided examples and scenarios to clarify potential ambiguities. Research assistants were given the opportunity to practice data extraction using a sample of medical records. During these practice sessions, they implemented the standard protocol and received direct feedback from the senior researcher. This hands-on approach helped identify and address any issues early in the process. To further ensure consistency, a calibration exercise was conducted. In this exercise, all research assistants independently extracted data from the same set of medical records. The results were then compared, and any discrepancies were discussed and resolved. This process helped align the interpretation and application of the protocol among all team members. Throughout the data collection period, the senior researcher provided ongoing support and oversight. Periodic quality control audits were conducted to ensure adherence to the protocol. A small portion of the data collected was randomly selected and re-evaluated by the senior researcher to verify accuracy and consistency.

The data for this study were extracted from patient medical records at the trauma center hospital in Central Java, Indonesia. To ensure the accuracy and reliability of the data, several verification methods were employed. A standardized data extraction protocol was developed to guide the collection of relevant information from the medical records. First, this protocol included detailed instructions on the specific data fields to be collected, definitions of key variables, and criteria for inclusion and exclusion. Second, a double data entry method was used to minimize errors. Data extracted from the medical records were entered by two independent researchers, and the results were compared. Any discrepancies were reviewed and resolved through consensus. After data extraction, the dataset underwent a rigorous data cleaning process. This involved checking for missing values, outliers, and inconsistencies. Corrections were made based on the original medical records to ensure the integrity of the data.

Observation sheets containing post-concussion symptoms, cognitive failure, anxiety, depression, sleep behavior, and post-traumatic stress disorder were used to recap data from the patient's medical record. Patients with complete medical record data and active health checks for one month after treatment were selected as research subjects. Their characteristics, including age,

adolescence, gender, time of onset of injury (hours), and mechanism of injury, were retrieved. The authors found 57 incomplete medical records, which were excluded from the study.

The Rivermead Post-Concussion Symptoms Questionnaire (RPQ) was an instrument used to measure PCS in patients who had experienced mTBI. This instrument is designed to assess common symptoms in PCS patients and consists of 16 items divided into several dimensions, such as headaches, irritability, and memory problems. These items are divided into several dimensions, each representing a specific category of symptoms associated with PCS. Dimension of headache includes items related to the frequency, severity, and impact of headaches experienced by the patient. Dimension of irritability assesses the patient's level of irritability and emotional sensitivity, including how these feelings affect their daily functioning. The last dimension, memory problems, focuses on difficulties related to memory, including problems with short-term and long-term memory. The RPQ scores range potentially from 0 to 52, where higher scores reflect greater severity of post concussive symptoms. The RPQ has been validated through several studies and has shown good validity and reliability (Barlow, 2016; Starkey et al., 2018). In this study, the instrument was translated by a language expert, and three experts reviewed it for content validity to ensure that the meaning of the items remained unchanged. The I-CVI and S-CVI of the Indonesian versions were 0.84 and 0.87, respectively. The instrument was then tested for its validity using the Pearson product-moment test on 30 respondents outside the samples used in this study. The results showed that the r-count was greater than the r-table ($r>0.344$), indicating that the instrument was valid. The reliability test was also conducted to measure its internal consistency, with Cronbach's alpha value of 0.812. It indicated that the instrument was reliable and could be used.

2.4 Data analysis

Data were expressed as means, standard deviations (SD), medians, and interquartile ranges (IQR) in descriptive statistics. When the Kolmogorov-Smirnov test indicated that a normal distribution was assumed to hold, independent t-tests with a two-tail distribution were performed to compare variables between groups. Categorical data were presented as percentages and numbers. The independence of the post-injury existence of PCS across years was examined using the Chi-square test with $p<0.05$ regarded as a significant value.

2.5 Ethical considerations

The research protocol received approval from the Ethics Committee of Universitas Muhammadiyah Gombong, with number 076.6/II.3.AU/F/KEPK/V/2022. Access to medical records was restricted to authorized personnel only. All patient identifiers were removed or anonymized to protect patient privacy. The data were stored in secure, password-protected databases to prevent unauthorized access. Informed consent was given to the respondents before data collection. The review board evaluated the study's protocols and ensured that the research adhered to ethical standards while safeguarding patient rights.

3. Results

3.1 Characteristics of the participants

A total of 316 patients diagnosed with head injuries were included in the study. The average PCS occurred in patients of productive age (M=27.8, SD=2.02) with a time for injuries of about 7 hours. Patients who had motorcycle accidents had a higher prevalence of PCS (71.4%). In addition, this study found that PCS events occurred most frequently in the second month post-TBI (43.7%). The prevalence of PCS, in the range of 1–6 months after concussion, was prominent in the first two months, and it started to lower significantly up to 6 months (3.6%) (Table 1).

3.2 Prevalence and characteristics of persistent PCS

Table 2 illustrates the prevalence of persistent Post-Concussion Syndrome (PCS) in mild Traumatic Brain Injury (mTBI). This study found 112 patients (35.4%) experiencing PCS and 204 (64.6%) patients without PCS. These results highlight that a significant proportion of mTBI patients continue to experience symptoms, while the majority recover without lasting effects. Furthermore, the most common symptoms found in PCS were headaches and difficulty concentrating, as seen in Table 3.

Table 1. Participant's characteristics (n=316)

Characteristics	m-TBI with PCS (n=112)		m-TBI without PCS (n=204)		*p*
	f(%)	M(SD)	f(%)	M(SD)	
Age (years)		27.8(2.02)		29.1(1.82)	0.712
Time from injury (hours)		7.51(5.22)		9.23(5.74)	0.774
Gender					
Male	87 (77.6)		166 (81.3)		0.872
Female	25 (22.4)		38 (18.7)		0.781
Mechanism of injury					
Fall	24 (21.4)		68 (33.3)		< 0.001
Sports related	5 (4.5)		12 (5.9)		0.512
Motor vehicle accident	80 (71.4)		117 (57.3)		<0.001
Other	3 (2.7)		7 (3.5)		0.122
PCS period					
1 month	27 (24.1)				
2 months	49 (43.7)				
3 months	15 (13.4)				
4 months	11 (9.8)				
5 months	6 (5.3)				
6 months	4 (3.6)				

Table 2. Prevalence of PCS in mTBI (n=316)

mTBI	Frequency (f)	Percentage (%)
mTBI with PCS	112	35.4
mTBI without PCS	204	64.6
total mTBI	316	100

As presented in Table 3, some symptoms of persistent PCS that appeared were headaches (30.3%), light sensitivity (32.1%), difficulty concentrating (37.5%), poor sleep (16.1%), depression (16.9%), or anxiety (14.3%). On the other hand, double vision (0.9%), restlessness (2.4%), and cognitive failure (2.4%) occurred in mTBI patients without PCS with a smaller presentation.

Table 3. Characteristics of persistent PCS symptoms (n=316)

Characteristics	m-TBI with PCS (n=112)	m-TBI without PCS (n=204)
	f (%)	f (%)
Headache	34 (30.3)	12 (5.8)
Problems concentrating	42 (37.5)	8 (3.9)
Frustration	26 (23.2)	6 (2.9)
Dizziness	23 (20.5)	13 (6.4)
Irritability	21 (18.7)	14 (6.8)
Memory problems	18 (16.1)	13 (6.4)
Depression	19 (16.9)	9 (4.4)
Longer to think	18 (16.1)	8 (3.9)
Light sensitivity	36 (32.1)	12 (5.8)
Sleep disturbance	18 (16.1)	15 (7.3)
Noise sensitivity	16 (14.3)	10 (4.9)
Fatigue	13 (11.6)	8 (3.9)
Nausea	15 (13.4)	7 (3.4)
Blurred vision	12 (10.7)	8 (3.9)
Restlessness	10 (8.9)	5 (2.4)
Double vision	8 (7.1)	2 (0.9)
Cognitive Failure	10 (8.9)	5 (2.4)
Anxiety	16 (14.3)	7 (3.4)
Sleep Behaviour	15 (13.4)	8 (3.9)
PTSD	25 (22.3)	12 (5.8)

4. Discussion

This study was conducted to determine the prevalence and compare patients with mTBI with PCS and without PCS. The prevalence of Post-Concussion Syndrome (PCS) in patients with mTBI was found to be 35.4%, with the most common symptoms being concentration problems, headaches, and light sensitivity. The prevalence in this study was in line with the result of a previous study. Beauchamp et al. (2021) showed that the prevalence of PCS in patients with mTBI varied from 11% to 82%, depending on the diagnostic criteria used. However, this study's result was higher than some studies that used more conservative diagnostic criteria (Cancelliere et al., 2023; Starkey, 2018). For example, Cancelliere et al. (2023) reported a lower prevalence when stricter criteria were applied. Another study conducted by Starkey (2018) showed that the prevalence of PCS was found in mTBI patients after one month of treatment, with figures ranging from 25% to 35%.

The differences between conservative and modern diagnostic criteria can indeed result in varying prevalence rates for PCS. Conservative diagnostic criteria, such as those established by DSM-IV or ICD-10, tend to be more restrictive in terms of symptoms and duration, which may lead to lower prevalence rates. Conservative criteria typically require several symptoms to persist for a specific duration after the injury to be diagnosed as PCS (Starkey, 2018). On the other hand, modern diagnostic criteria, such as those adopted in DSM-5, are more inclusive and adaptive to individual variations in symptom experiences following mild traumatic brain injury (mTBI). These criteria allow for a PCS diagnosis based on a broader range of manifestations and variability in symptom duration. Consequently, the prevalence of PCS tends to be higher when using modern criteria (Beauchamp et al., 2021; Cancelliere et al., 2023).

This discrepancy highlights the ongoing challenge in PCS research regarding the standardization of diagnostic criteria to ensure more accurate and comparable prevalence estimates. This study emphasized problems concentrating, headaches, and light sensitivity as the most common symptoms, whereas another study, such as the one by Voormolen et al. (2019), found a higher prevalence of emotional and sleep-related symptoms. This variation may be due to differences in patient populations, assessment tools, or reporting practices. The average age of 27.8 years and male predominance in our sample suggested that younger males are particularly at risk for PCS following mTBI. This finding aligns with the demographic profiles commonly seen in trauma and sports-related injuries, which disproportionately affect young men (Cancelliere et al., 2023; Voormolen et al., 2019). The prominence of concentration problems, headaches, and light sensitivity as primary symptoms underscored the cognitive and neurological impact of mTBI. These symptoms can significantly impair daily functioning and quality of life, emphasizing the need for interventions to reduce symptoms (Voormolen et al., 2019). To sum up, the variability in PCS prevalence across studies could be attributed to differences in diagnostic criteria, assessment methods, and sample characteristics.

This study found the average age of PCS patients to be 27.8 years. This is consistent with several studies that indicate a higher incidence of PCS among young adults (Losoi et al., 2016). For example, a study by Bo and Pearkao (2021) also found similar age distributions, suggesting that younger individuals might be more susceptible to or report PCS more frequently. In this study, it was found that most adolescents experienced PCS. PCS in adolescents is a significant problem because of the unique developmental stage they are experiencing. Adolescents are particularly vulnerable to the effects of mTBI because their brains are still maturing, which can exacerbate the impact of a concussion injury. Studies have shown that adolescents are more likely to experience prolonged PCS symptoms, such as headaches, dizziness, difficulty concentrating, and emotional disturbances, compared to adults (Cancelliere et al., 2023; Starkey et al., 2018). These symptoms can significantly impact their academic performance, social interactions, and overall quality of life. Furthermore, lack of prompt and appropriate intervention can lead to long-term consequences, making it critical to promptly identify and manage PCS in this age group (Voormolen et al., 2019). The higher prevalence in males observed in our study is also supported by the literature. The male predominance of PCS cases is due to higher exposure to risk factors such as exercise and accidents (Bo & Pearkao, 2021; Dean et al., 2012; Starkey et al., 2018).

The study results showed that patients with Post-Concussion Syndrome (PCS) had different clinical characteristics compared to patients without PCS. Patients with PCS often experience symptoms such as headaches, irritability, light sensitivity, and concentration issues. Patients with PCS are generally younger compared to those without PCS. Risk factors associated with PCS

include younger age, male gender, and more severe head injuries. Patients with PCS more frequently experience more severe head injuries compared to those without PCS (Balakrishnan et al., 2019; Mercier et al., 2018). Symptoms that can be used to differentiate PCS from non-PCS in mTBI patients are complaints of concentration problems and headaches. In patients without PCS, these complaints are not found simultaneously (Dean et al., 2012; Voormolen et al., 2018).

Even though the number of people with PCS decreased from 0 to 6 months, PCS still persisted in the 6th month after mTBI. This could suggest that those who have continuous symptoms of PCS more than six months after the acute injury are expected to have a chronic, unremitting syndrome (Ashina et al., 2021; Voormolen et al., 2018). This is in agreement with earlier studies that revealed that people suffering from PCS are less likely to spontaneously recover (Auclair-Pilote et al., 2021; Mayer et al., 2013). It may be useful to develop medical policies or algorithms that require anyone who visits the ED with a TBI to be screened for PCS one month after the injury, in light of the knowledge that an evaluation six months following the injury can forecast the long-term effects of the concussion (Cooksley et al., 2018; Voormolen et al., 2019).

Reducing PCS symptoms can be done by forming support groups, and online resources can be an effective solution (Rytter et al., 2019). Other alternatives, such as relaxation techniques, stress management, and education on how to manage PCS symptoms, can also be recommended (Biagianti et al., 2020; Minen et al., 2019). The rehabilitation process is carried out on patients when they show initial symptoms of treatment in the hospital or by looking at the causes and mechanisms of the injuries that they have experienced (Haider et al., 2020).

The research found out who were more likely to get PCS and, therefore, needed more attention and a stricter follow-up policy. High-speed injuries (MVA) and injuries in teenagers were risk factors for PCS (Lagarde et al., 2014; Losoi et al., 2016). In the bivariate analysis, it was not statistically significant that women were more likely to have PCS than men. Our results concur with those of other studies. Prior research has hypothesized that the increased frequency of mood and anxiety problems in this population is what makes women and adolescents more prone to PCS (Barlow, 2016; Cnossen et al., 2018). Nurses can play a role in reducing the risk of PCS by performing early and structured interventions. The study by Bo & Pearkao (2021) and Yue et al. (2019) showed that nurses skilled in stress management can help patients reduce the risk of PCS. With skills in stress management, nurses can help patients manage the physical and psychological symptoms that often occur after mild brain injury, such as headaches, fatigue, and anxiety. Early intervention by nurses, including education about PCS, regular monitoring of the patient's condition, and the use of relaxation and stress management techniques can significantly reduce the likelihood of developing PCS in patients (Cooksley et al., 2018; Dean et al., 2012).

5. Implication and limitation

The findings of this study have several important implications for clinical practice and patient outcomes. The high prevalence of PCS in patients with mTBI, as observed in this study, highlights the need for early identification and intervention for individuals at risk. Health workers, especially nurses, can play a crucial role in implementing these preventive measures. In terms of clinical practice, the identification of common PCS symptoms, such as headaches and difficulty concentrating, underscores the importance of routine screening for these symptoms in patients with mTBI. Early recognition and management of these symptoms can prevent the progression to persistent PCS. By incorporating regular assessments into standard care protocols, healthcare providers can reduce the long-term impact of PCS on patients' quality of life. In terms of economic and social aspects, the study's findings suggest that preventing PCS can lead to significant economic benefits. Patients without PCS can avoid additional medical costs associated with prolonged treatments and therapies for persistent symptoms. Moreover, enabling patients to return to work and daily activities more effectively can increase productivity and economic gains for both individuals and society.

The current study contained some limitations. First, because it was not prospective from the moment of the injury, recollection bias might have impacted the results. Second, not all medical staff were assured to complete accurate paperwork because this study relied on data from medical records. Aside from these problems, this study had a number of benefits, such as enrolling a large number of eligible patients and having full medical record data based on similar demographics.

6. Conclusion

The study found that 35.4% of patients with mTBI experienced persistent post-concussion syndrome (PCS) after one month. The occurrence of PCS was most prevalent in the second month, with 43.7% of patients experiencing it. The most common symptoms indicating PCS were problems concentrating, headache, and light sensitivity. These findings warrant better screening guidelines and practices that patients adopt after mTBI. Additionally, positive social changes can enhance access and support for patients with PCS. Establishing support groups and online resources, providing self-care guides, and developing coordinated recovery programs can assist patients in facing the challenges following mild traumatic brain injury. The rehabilitation process is carried out on patients when they show initial symptoms of treatment at the hospital or by looking at the causes and mechanisms of the injuries experienced. Future research can find predictors to minimize the incidence of PCS and take the best measures for mTBI cases in hospitals. Further prospective research studies that follow a cohort of patients from the time of injury through their recovery would be particularly beneficial. These studies should include larger and more diverse populations to enhance the generalizability of the findings. Specifically, longitudinal cohort studies that track patients over extended periods can provide detailed insights into the trajectory of PCS development and identify critical periods for intervention. Integrating validated screening tools and questionnaires into clinical practice will aid in identifying patients with potential PCS and ensuring appropriate management.

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Author contribution

PAWS conducts data collection and analysis on research results, writes manuscripts, and submits articles and manuscript revisions. FK, AO, and SKDS direct the types of research methods and provide input on the analysis and discussion in writing manuscripts.

Conflict of interest

All authors declare no conflict of interest.

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