Post-Concussion Syndrome and Factors Associated With Post-Concussion Syndrome Following Mild Traumatic Brain Injury

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Abstract

Background: Traumatic Brain Injury (TBI) is a worldwide public health concern especially in developing countries. This study was conducted to describe the prevalence, severity symptoms and determine factors associated with post-concussion syndrome (PCS) following mild traumatic brain injury (MTBI).

Methods: A cross-sectional study was carried out with 218 patients following MTBI after discharged hospital from one week to one year at Odor Meanchey Provincial Hospital (OMCPH) and Anlong Veng Referral Hospital (AVRH). Multiple linear regression was applied to determine factors association.

Results: Of the total 218 patients following MTBI, 79.4% had symptoms of PCS, with 5.8% re-hospitalization due to PCS. The most frequently occurring symptoms in PCS following MTBI were from headache 71.7%, being irritable 68.8%, forgetfulness 66.5%, fatigue 62.4%, and taking longer to think 57.2%. Marital status β=-.236, p=.001, loss of consciousness (LoC) at the time of injury β=-.205, p=.003, length of hospitalization β=.288, p<0.001, and readmission β=-.271, p<0.001 were statistically associated with PCS following MTBI.

Conclusion: Majority of patients had symptoms of PCS. The most frequent symptoms were headache, being irritable, and forgetfulness. Socio-demographic and injury characteristics factors play an essential role in PCS following MTBI.

Keywords: *Socio-demographics, Injury characteristics, mild traumatic brain injury, post-concussion syndrome*

Introduction

Traumatic Brain Injury is a world public health and socioeconomic problem. Approximately 69 million patients suffered from TBI globally and MTBI accounted for 75%-90% of TBI[(1)]. MTBI is generally influenced by 42 million patients annually around the globe[(2)]. About 5 to 10% of the population has a history of MTBI in their lives event[(3)]. MTBI refers to an instance of being injured to the brain which damages to the head caused by an external force[(4)]. External forces probably result from subsequent events including the head being struck by an object, the head striking an object, the head experiencing an acceleration/deceleration movement without direct external trauma to the brain, a foreign body penetrating the head, and forces generated from events including a blast or explosion, or other forces[(5)]. An external physical force probably provokes a change in conditions of consciousness, cognitive or physical functioning impairment, and behavioral or emotional functional interference leading to brain damage[(6)]. The major causes of MTBI are from falls, motor accidents, accidentally hit again something, brain striking on something, a violent attack brain trauma (blast trauma),

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and injuries related with sports[7]. According to American Academy of Neurology, MTBI can be categorized into 3 grades based on the following symptoms such as first grade in the confusion without amnesia and LoC in concussion; the second grade is the confusion with amnesia and no LoC in concussion; the third grade is LoC with a concussion[8].

A complication of MTBI is a significant issue for patients with post-MTBI. Bedaso stated that 41.5% of MTBI cases experienced PCS with at least 3 symptoms after a head injury such as headache, restlessness, fatigue, and double vision[9]. Some previous studies found that 82% of patients with MTBI after 3-12 months experienced at least one of PCS, 40.3% decreased life satisfaction, 33% had functional impairment for 3 months after injury, and only 22.4% were still not fully functional condition post-injury 1 year[10]. Similarly, 84% of MTBI had post-traumatic complaints and 45% had emotional distress for 6 months after injury[11], the low function of cognitive and decreased quality of life (QoL)[12], and chronic symptoms[13]. There are many symptoms of PCS including headaches, fatigue, vertigo/ dizziness, irritability, emotional lability or irritability, cognitive difficulty (concentration), sleep disturbance and anxiety[14]. Many factors associated with PCS following MTBI including retrograde amnesia, difficulty concentrating, disorientation, insomnia, loss of balance, sensitivity to noise, visual disturbance, severity of bodily injury, duration of LoC, duration of PTA, intracranial abnormality, time tested post-injury, possible symptom exaggeration, poor effort, depression, traumatic stress[15], experienced LoC, pre-injury psychological problem and younger age[16].

Cambodia is one of many developing and low-income countries with a total of approximately 16 million population. According to the 2014 Cambodia Demographic and Health Survey (CDHS), the prevalence of injury from accidents was 72,958 cases and 17 suffered from an injury and 1 died among 1,000 people[17]. Describing the prevalence, severity symptoms, and determining factors associated with PCS is extremely crucial for healthcare providers and patients with MTBI. Therefore, this study aimed to describe the prevalence, severity symptoms and factors associated with PCS following MTBI. The results from these findings are extremely crucial to prevent patients from the consequences of post-MTBI as the major causes of patients lose productivity, readmission, disability, and mortality rate for early intervention.

Methods and Materials

This cross-sectional study was applied to a purposive sampling method. A questionnaire phone call interview was conducted to collect data from July to September 2020. The study was conducted at OMCPH and AVRH, which was under supervised from OMCPHD, Cambodia. All fulfilled patients from the inclusion criteria were purposively chosen proportional to the size of the samples to a total of 218 patients.

Dependent Variables

The dependent variable was PCS following MTBI. The Revermead Post-Concussion Syndrome Questionnaire (RPQ) was utilized to assess patients who experienced physical, emotional and cognitive symptoms. A 5-point scale was rated on patients ‘experience of each of 16 items (0: not experienced at all, 1:no more of a problem, 2: mild problem, 3: moderate problem, and 4:severe problem). A total of 64 scores were summed from 16 questions, representing that higher scores indicate greater severity of PCS.

Independent Variables

The independent variables (IVs) were age, sex, marital status, education level, employment, cause of MTBI, LoC, alcohol consumption, length of hospitalization, other sustained injuries, duration of PCS occurring, and readmission.

Statistical Analysis

All analyses were performed using the Statistical Package of Social Science (SPSS). Demographic characteristics (age, sex, marital status, education level, and employment) and Injury Characteristics (cause of MTBI, LoC, alcohol consumption, length of hospitalization, other sustained injuries, duration of PCS occurring, and readmission) were analyzed by using descriptive statistics, which reported frequency and percentage for category variable, mean, standard

deviation, minimum, and maximum for continuous variable. Multiple linear regression was utilized to predict the association between IVs and PCS following MTBI.

Results

Among 218 recruited patients aged from 18 to 83 years, the mean age was 35-year-old (*SD* = 15.292), 59.2% were patients aged from 18 to 35 years old. 72.9% were males and 60.1% were married (see table 1).

The average year of education was 6.36 years (*SD* = 4.047), 44% and 39.4% completed secondary and primary school respectively. Most patients 81.2% were employed.

Table 1: The Patient Demographic Data (*n* = 218)

Characteristics	Frequency	Percentage (%)
Age (year) Range=18-83 unit	$\overline{X}$ = 35	SD = 15.292
18-35	129	59.2
36-55	61	28.0
≥56	28	12.8
Sex		
Female	59	27.1
Male	159	72.9
Marital status		
Married	131	60.1
Single	87	39.9
Education level Range=0-18 unit	$\overline{X}$ = 6.36	SD=4.047
No formal education	23	10.6
Primary education (1-6 years)	86	39.4
Secondary education (7-12 years)	96	44.0
Tertiary education (13 years or higher)	13	6.0
Employment		
Unemployed	41	18.8
Employed	177	81.2

$\overline{X}$ = Mean, *SD* = standard deviation

Motor vehicle collision (MVC) accounted for 70.6%, followed by 29.4% from Non-Motor vehicle collision (non-MVC). 69.7% were LoC during the time of injury, and more than one third 39.4% consumed alcohol at the time of injury.

The mean days of the patient's hospitalization were 3.41 (*SD* = 2.106).

More than half (54.6%) had other sustained injuries at the time of injury.

79.4% had PCS happened after MTBI and 90.8% had 1-24 weeks of PCS happened after MTBI. The majority of the participants 94.2% did not readmit to the emergency department (ED) (table 2).

Table 2 Participant's injury characteristic (*n* = 218)

Characteristic	Frequency	Percentage(%)
Cause of MTBI		
Motor vehicle collision	154	70.6
Non-Motor vehicle collision	64	29.4
LoC at the time of injury		
Yes	152	69.7
No	66	30.3
Alcohol Consumption at the time of injury		
Yes	86	39.4
No	132	60.6
LoH Range =1-12 days	$\overline{X}$ = 3.41	SD=2.106
Mode=2	Mdn=3.00	
Other sustained injuries at the time of injury		
Yes	119	54.6
No	99	45.4
The signs and symptoms happen after MTBI		
Yes	173	79.4
No	45	20.6
The duration of signs and symptoms happened after MTBI	n=173	
1-24 weeks	157	90.8
25-48 weeks	16	9.2
The readmission/revisit to the ED	n=173	
Yes	10	5.8
No	163	94.2

Mdn = median, sd = standard deviation

The finding displayed the mean scores of PCS ranged from 1-42 were 14.66 (SD=9.739). The most frequently occurring PCS following MTBI were from headache (71.7%), being irritable (68.8%), forgetfulness (66.5%), fatigue (62.4%), and taking longer to think (57.2%). The least five occurring symptoms were feeling depressed (46.2%), sleep disturbance (43.4%), noise sensitivity (38.7%), double vision (29.5%), and nausea or vomiting (22.5%) (see table 3).

Headache $\overline{X}$=1.34 (*SD*=1.002) and being irritable $\overline{X}$=1.31 (*SD*=1.015) are the most severe symptoms while nausea or vomiting $\overline{X}$=.32 (*SD*=.636) and double vision $\overline{X}$=.50 (*SD*=.826) are the least severe symptoms compared to other symptoms of PCS.

Table 3: Post-Concussion Syndrome (*n* = 173)

Symptoms	n (%) Frequency of symptoms	$\overline{X}$ (SD) severity of symptoms
Range 1–42-unit, Min = 1, Max = 42		
Headaches	124 (71.7)	1.34 (1.002)
Being irritable	119 (68.8)	1.31 (1.015)
Forgetfulness	115 (66.5)	1.27 (1.017)
Fatigue	108 (62.4)	1.11 (.979)
Taking longer to think	99 (57.2)	1.06 (.998)
Feeling frustrated or impatient	97 (56.1)	.98 (.979)
Feelings of dizziness	97 (56.1)	1.00 (1.006)
Blurred vision	91 (52.6)	.99 (1.043)
Light sensitivity	86 (49.7)	.90 (.998)
Poor concentration	81 (46.8)	.83 (.967)
Feeling depressed or tearful	80 (46.2)	.82 (998)
Restlessness	80 (46.2)	.80 (.950)
Sleep disturbance	75 (43.4)	.79 (1.001)
Noise sensitivity	67 (38.7)	.65 (.901)
Double vision	51 (29.5)	.50 (.826)
Nausea and/or vomiting	39 (22.5)	.32 (.636)
Total	173 (100)	14.66 (9.739)

Simple linear regression analysis on factors associated with PCS following MTBI

Employment (p=.368), alcohol consumption at the time of injury (p=.329), another sustained injury (p=.07), and duration of PCS occurring (p=.396) were not significantly associated with PCS following MTBI (table 4).

Age was statistically significantly associated with PCS following MTBI (p=.003). PCS increased by 0.224 with every increase in age. Age explained 50% of the variance in PCS.

Length of hospitalization is statistically associated with PCS (p=.000). PCS increased by 0.282 with every increase in the length of hospitalization, which explained 8% of the variance in PCS.

Sex (p=.012)., marital status (p=.00), an education level (p=.003), causes of MTBI (p=.011), LoC at the time of injury (p=.048), and readmission (p=.001) were predicted to be statistically significantly associated with PCS but with every decreased score on each factor.

PCS decreased by .191 on sex, .273 on marital status, .223 on education, .192 on causes of MTBI, .150 on LoC at the time of injury and .246 on readmission.

Table 4: Factors associated with PCS following MTBI on simple linear regression analysis (n = 173)

Variable	Constant	ß	R2	F	p
Age	9.627	0.224	0.50	8.991	.003
Sex	21.68	-.191	0.37	6.5	.012
Marital status	22.207	-.273	.075	13.784	.00
Education level	18.12	-.223	0.05	8.94	.003
Employment	11.71	.069	.005	.814	.368
Cause of MTBI	17.549	-.192	.037	6.548	.011
LoC at the time of injury	18.86	-.150	.023	3.96	.048
Alcohol consumption at the time injury	12.21	.075	.006	.958	.329
Length of hospitalization	10.14	.282	.08	14.77	.000
Other sustained injury	18.54	-.138	.019	3.32	.07
Duration of PCS occurs	14.866	-.065	.004	.726	.396
Readmission	34.52	-.246	.06	10.99	.001

$P < .05$ = Significant

Multiple linear regression analysis on factors associated with PCS following MTBI

Marital status, LoC at the time of injury, length of hospitalization, and readmission are significant predictors of PCS with (R^2=.243, F(4,168)=13.492,p-value=<.001).

The results revealed that marital status (*β*=-.236, *p*=.001), LoC at the time of injury (*β*=-.205, *p*=.003), length of hospitalization (*β*=.288, *p*<.001), and readmission (*β*=-.271, *p*=<.001) were statistically associated with PCS following MTBI.

Table 5: Factors associated with PCS following MTBI on multiple linear regression analysis (n = 173)

Variable	B	ß	p	95% CI	
				Lower	Upper
Constant	44.149		<.001	31.515	56.783
Marital status	-4.715	-.236	.001	-7.378	-2.051
LoC at the time of injury	-4.534	-.205	.003	-7.527	-1.542
Length of hospitalization	1.313	.288	<.001	.709	1.917
Readmission	-11.269	-.271	<.001	-16.918	-5.620

P < .05 = Significant, R = .496, R^2 = .243, R^2 Adjust = .224, *F* (4, 168) = 13.492

Discussion and Recommendation

Discussion

The results of prevalence, severity symptoms, and factors associated with PCS following MTBI represent several aspects of the respondents with MTBI after a hospital discharged.

This current study showed that headache and being irritable symptoms are the most common dangerous symptoms that patients need to be cautious because it has been the main leading causes of patients into the severity following MTBI. This study is consistent with a study conducted in Hawassa city Ethiopia[9]. The most frequently occurring symptoms of PCS following MTBI were headache, being irritable, and forgetfulness. This study demonstrated that headache, dizziness, and fatigue accounted for 56.88%, 44.5%, and 49.54%, respectively. However, a study demonstrated that up to 84% of 910 participants reported one or more post-traumatic complaints ($\overline{X}$=5.8, *SD*=4.6), which headache accounted for 51%, dizziness 55%, and fatigue 56% at 2 weeks following MTBI[11]. The difference could be the variation in study setting, health care system, and socio-economic conditions among study respondents.

A study conducted in New Zealand (NZ) stated the top five symptoms of PCS frequently happened at one year following MTBI were headache, fatigue, forgetfulness, poor concentration, and taking longer to think[12]. Similarly, this study demonstrated the top five frequently occurring symptoms of PCS less than one year were headache, being irritable, forgetfulness, fatigue, and taking longer to think. It could be considered that PCS symptoms are universal and not unique to TBI and can happen as a result of other medical status or acute illness.

Socio-demographic characteristic such as age and sex were not significantly associated with PCS following MTBI. This present study is in line with other previous

studies conducted in Ethiopia and America[9,15]. This finding indicated that there was no effect on PCS symptoms of some demographic data from the subjects.

Marital status had a statistically significant association with PCS. This is probably because those who get married have the high responsibilities for supporting family and taking good care of their children which make them have less time to take rest post-injury. This present study is consistent with studies in Morocco[18].

Educational level and the cause of MTBI found no significant association with PCS. The results stated that there was no difference among education level and the cause of MTBI of the participants. This is probably participants received the same level of health care services following MTBI. This current study is in line with a study conducted in America[15].

Employment, alcohol consumption, and duration of PCS occurring were not significantly associated with PCS. The differences may be these variables have no impact on PCS. A study in Norway revealed that there was a negative association between alcohol use and PCS following MTBI[19]. This study is consistent with studies conducted in Sweden[20].

LoC at the time of injury was significantly predicted with PCS. This means that those who have LoC at the time of injury have the severity of the axonal injury and severe injury than those who no LoC even though they have MTBI. Consistent with a study conducted in America[16].

The participants who stayed longer in the hospital had higher scores than those who stay shorter in the hospital. Patients who stayed longer in the hospital could be at higher risks with PCS because might be they had other sustained injuries at the time of injury compared to those who had a single MTBI. However, the study by Voomolen[21] found no significant association between a number of days of patients being hospitalized and PCS.

Other sustained injuries at the time of injury were not significantly predicted with PCS. The results in this study demonstrated that other sustained injuries at the time of injury could not influence the nerve system, which is closely linked to the brain, therefore, it negatively impacted the occurring of PCS. This is in contrast with a study in Finland[22].

Readmission had a significant prediction with PCS. The findings of the present study indicated that those who were not readmitted to the hospital, PCS scores decreased .271 (p=.001) which was supported by a study conducted in Southeastern America[23].

Conclusion

Majority of patients had occurring PCS following MTBI, with roughly 5.8% being revisited in the hospital. Headache and being irritable are the most severe symptoms while nausea or vomiting and double vision are the least severe symptoms. Marital status, LoC at the time of injury, length of hospitalization, and readmission are statistically associated with PCS following MTBI among patients admitted at a surgical unit in OMCPH and AVRH.

Recommendations

The following recommendations were highly considered.

National level:

Clinical education and self-care counselling by providing booklets, videos, or applications for MTBI patients, family members, and caregivers should be offered by health care providers to enhance other diseases and PCS-related knowledge.

Local level:

Family members, caregivers especially MTBI patients should be encouraged to enrol in health education for the prevention of PCS following MTBI.

Future study:

Longitudinal studies on PCS following MTBI require to be conducted with head trauma and follow up with MTBI patients and address how people benefit from the intervention program and reduce the patient's readmission rate.

Ethical Considerations: This research was conducted after getting approval from Khon Kaen University Ethics Committee in Human Research (N_o. HE632156) and National Ethics Committee for Health Research (N_o. 122 NECHR), MoH of Cambodia for protecting the rights of the participants.

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