Chulalongkorn Medical Journal

Volume 63
Issue 4 *October 2019*

Article 5

10-1-2019

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Chula Med J Vol. 63 No. 4 October - December 2019;239-244 DOI : 10.14456/clmj.2019.16

Original article

An exploratory factor analysis of post-concussion syndromes in Thai people after head injury: A psychometric properties study

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Background: Thousands of patients suffer a head injury in Thailand. Some might recover completely but many are still at risk of having post-concussion syndromes (PCS) for months or years after injury. PCS has a poor diagnosis. The Rivermead Post-Concussion Symptoms Questionnaire (RPQ) is one of the instruments used for evaluating PCS.

Objectives: This study aimed to analyze the factors of PCS, and to validate the psychometric properties of RPQ in Thai people after a head injury.

Method: In a secondary analysis of data drawn from two original studies, 253 head injury patients who visited Neurosurgical Clinics of King Bhumibol Adulyadej Hospital, and the Police General Hospital, Thailand were recruited. Glasgow Coma Scores of all patients were 13 - 15. Data were collected using demographic and illness-related questionnaires, and the RPQ.

Results: The RPQ achieved adequate internal consistency with Cronbach's alpha of 0.88. An exploratory factor analysis with Varimax Rotation found 4 factors. First, "psychological symptoms" which consisted of seven items, and three items loaded to factor 2 called "cognitive symptoms". As for physical symptoms or factor 3, three items, and three were loaded. Finally, three items corresponded with factor 4 as "vision-related symptoms". The four-factor structure was based on the criteria of scree plot, eigenvalue, and factor interpretability in relation to clinical relevance.

Conclusion: This study confirmed both reliability and validity of the Thai-version RPQ. Future studies using a confirmatory factor analysis in new samples are needed to further assess the psychometric properties of the RPQ.

Keywords: Head injury, psychometrics, post-concussion syndromes, Rivermead Post-Concussion Symptoms Questionnaire.

In Thailand, the annual rate of hospitalized patients after head injury is around 60/100,000 population;[1] many patients survive, and some experience a wide array of symptomatology termed post-concussion syndromes (PCS).

Post-concussion syndromes are defined as a traumatic acceleration or deceleration injury to the head, which might invariably be associated with a period of confusion or amnesia or both and consequently be followed by a characteristic group of symptoms such as headache and poor memory. [2] The incidence of PCS depends on the diagnostic criteria used. The presence of at least 3 symptoms during a period of 3 months is required to meet the diagnostic criteria for PCS. [3]

The Rivermead Post-concussion Symptoms Questionnaire (RPQ) is based on a list of a constellation of symptoms that are identified by the World Health Organization.[4] RPQ is designed to identify post-concussion symptoms that are not prevalent prior to a head injury. The RPQ is a short and simple questionnaire.[4] RPQ is sensitive enough to measure among cases with mild to moderate levels of head injury. It is used in both clinical and self-administered settings. [4] However, the use of RPQ in head injury patients has been very limited in Thailand. [5 - 10] Hence, the objective of this study was to examine the RPQ's psychometric properties among persons with head injuries in Thailand.

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Received: November 12, 2018
Revised: March 14, 2019
Accepted: March 22, 2019

Methods

This study employed secondary data analysis. Data used in this study were obtained from two cross-sectional studies. [7, 10] The detailed study designs, sampling methods, and data collection protocols are reported elsewhere [7, 10] and are briefly described below.

Phase 1: Translation of the RPQ

Before this 16-item Thai version of the RPQ was translated, the researchers contacted the authors to get a permission to use the RPQ in the study. [4] The translation team consisted of 3 neuroscience nurses, and 2 English instructors (native English speakers who read and write Thai fluently) from the Faculty of Art, Chulalongkorn University. The 16-item RPQ was translated according to translation methodology guidelines. Then, the researchers performed a pilot testing with 60 patients with a head injury. The 60 subjects were asked to read and answer the Thai version of the RPQ. Feedback and comments from the subjects were used to refine the translation.

Phase 2: Testing psychometric properties

The current study employed secondary data analysis. Data were drawn from two studies. [7, 10] The total number of patients from the two studies was 253. They were patients with a head injury at Neurosurgical Clinics, King Bhumibol Adulyadej Hospital, and the Police General Hospital in Bangkok, Thailand. Inclusion criteria entailed the following: diagnosis of a head injury, outpatient treatment (currently not admitted to a ward), and ability to provide informed consent.

Exclusion criteria are as follows: Glasgow coma score below 13, serious current or pre-injury psychiatric issues, current severe addiction, diagnosis of a terminal illness, inability to cooperate in the study, and incapability to understand and answer the questions. Patients were asked in a clinical interview and/or records were checked whether they were ever given a psychiatric or addiction diagnosis. If this happened, their participation would then be rejected.

The questionnaire recorded subjects' gender, age, time since injury, causes of injury, and diagnosis.

Glasgow Coma Scale (GCS)

The Glasgow Coma Scale is a measure of the depth and duration of consciousness impairment and coma. [11] It assesses motor responsiveness, verbal performance, and eye opening. Brain injury can be classified using GCS into mild (GCS 13 - 15), moderate (GCS 9 - 12), and severe (GCS 3 - 8). The subjects' GCS scores were obtained from medical records.

The Rivermead Post-Concussion Symptoms Questionnaire (RPQ)

The RPQ [4] consists of 16 symptoms. Patients were asked to rate how severe each of the 16 symptoms were as follows: headache, dizziness, nausea and/ or vomiting, noise sensitivity, sleep disturbance, fatigue, being irritable, feeling depressed or tearful, feeling frustrated or impatient, forgetfulness, poor concentration, taking longer to think, blurred vision, light sensitivity (easily upset by bright light), double vision and restlessness. These symptoms are reported by severity on a scale from 0 to 4: not experienced; no problem; mild problem; moderate problem; and severe problem.

The RPQ controls for pre-morbid symptoms that may have existed prior to the injury event by comparing patient responses to symptoms that existed before their head injury. [12, 13] PCS was considered to be present when 3 or more of the symptoms listed in the RPQ were present. [14] A higher total score on the RPQ indicates a greater overall level of distress. [15, 16]

Procedure

The two studies have been approved by the ethics committee of the two tertiary hospitals (IRB number 98/2558, IRB 84/61, and 46/2561). After receiving the participant's (or his/her representative's) informed consent, the researchers determined if the subject was able to respond to the self-report questionnaires independently. If yes, the questionnaires were completed at the clinics. If no, subjects completed the questionnaire in a face-to-face interview.

Statistical analysis

Descriptive statistics were used to describe participant characteristics using SPSS version 22.0. The frequency and percentage of each response for the 16-item RPQ were also described.

Since the main purpose of this research was to examine the internal structure of the constructs that the instrument measured, an exploratory factor analysis (EFA) using a Varimax Rotation was conducted to identify the initial factor structure of the 16-item RPQ. The rationale for selecting EFA is as follows:

1. The EFA approach described how and to what extent the observed variables were related to their latent construct.
2. The authors had no prior knowledge of latent (underlying) variables and seeked to create a model. The EFA approach was a data-driven approach in which a model or theory was created.

Results

A total of 253 subjects were recruited in the two studies. [7, 10] Data sets from all 253 subjects were analyzed. Demographic and clinical characteristics of the subjects are presented in Table 1. In this sample (n = 253), there are a greater number of men (67.19%) than women (32.81%). The mean age of the subjects was 39.39 ± 12.68 years. By GCS criteria, all subjects were mildly injured. About 57.71% of the injuries had occurred more than 6 months before. Injury was caused by car accident in 75.09% of cases. The proportion of subjects reporting symptoms and intensity is demonstrated in Table 2.

Item analysis for reliability

An item analysis was conducted to test the reliability of each factor of the RPQ. Cronbach's alpha for the RPQ ranged from a 0.81 to 0.90 (Table 3) which was considered good to excellent. [17]

Table 1. Demographic and injury-related characteristics among 253 subjects.

Demographic and clinical variables	Number	%
Age	Mean = 39.39 years, SD = 12.68	
Gender		
Male	170	67.19
Female	83	32.81
Time since injury		
≥ 3 months	29	11.46
4 - 6 months	78	30.83
≥ 6 months	146	57.71
Causes of injury		
Car / Motorcycle accident	190	75.09
Fall	23	9.09
Fall from high	20	7.90
Assault	14	5.54
Sport	6	2.38

Table 2. Proportion of subjects reporting each symptom and intensity (mean scores) of these symptoms (n = 253).

Symptoms	Frequency (%)	Intensity (mean scores)
Headache	77.10	1.90
Sleep disturbance	71.50	1.54
Fatigue	71.10	1.22
Taking longer to think	65.60	1.37
Dizziness	61.70	1.42
Light sensitivity	61.70	1.15
Forgetfulness	60.90	1.25
Blurred vision	60.90	1.18
Noise sensitivity	60.50	0.99
Double vision	56.90	1.07
Poor concentration	54.50	1.05
Being irritable	53.00	0.88
Feeling depressed or tearful	49.40	0.71
Nausea and/or vomiting	37.50	0.83
Feeling frustrated	34.40	0.52
Restlessness	29.60	0.42

Table 3. Cronbach's alpha for the RPQ.

Scale	Mean	SD	Cronbach alpha coefficient
Psychological symptoms	6.33	4.86	0.81
Cognitive symptoms	3.68	3.41	0.90
Physical symptoms	4.16	3.43	0.81
Vision-related symptoms	3.41	3.24	0.88
Total scale	14.18	9.46	0.88

Construct validity

The Bartlett's test of Sphericity, Chi-square test = 1151.617, $P < 0.01$, indicated that correlations between items were sufficiently large for EFA. The Kaiser-Myer-Olkin Measure of Sampling Adequacy was conducted. KMO = 0.762 which was above the recommended threshold of 0.6.

An exploratory factor analysis was performed. Since there was no single criterion to be used for deciding the number of factors in a model, several measures were used including eigenvalues greater than 1, and factor loading larger than 0.4. [17]

The 4 extracted factors were found. Factors 1, 2, 3, and 4 corresponded with psychological symptoms, cognitive symptoms, physical symptoms, and vision-related symptoms, respectively. All 16 items converged with a loading score of more than 0.4 on their corresponding domains (Table 4).

Table 4. Exploratory factor analysis for assessing construct validity of the RPQ among 253 subjects.

Domains and Items	% of Variance	Factor 1	Factor 2	Factor3	Factor 4
Psychological symptoms	37.758				
Noise sensitivity		0.568			
Sleep disturbance		0.478			
Fatigue		0.468			
Being irritable		0.737			
Feeling depressed or tearful		0.746			
Feeling frustrated		0.791			
Restlessness		0.415			
Cognitive symptoms	11.965				
Forgetfulness			0.880		
Poor concentration			0.867		
Taking longer to think			0.826		
Physical symptoms	10.530				
Headache				0.801	
Dizziness				0.848	
Nausea and/or vomiting				0.795	
Vision-related symptoms	7.512				
Blurred vision					0.872
Light sensitivity					0.889
Double vision					0.852

Discussion

As a result of an exploratory factor analysis, four factor-structures of the RPQ explained 67.76% of the variance in the pattern of relationships among the items. All four factors had high reliabilities. A high internal consistency reliability coefficient for the RPQ (0.81 - 0.90) indicated that items on the RPQ were very similar to each other in content (homogeneous).[17]

The factor analyses demonstrated that symptoms were compatible with 4 separated factors (psychological symptoms: 7 items; cognitive symptoms: 3 items; physical symptoms: 3 items; and vision-related symptoms: 3 items). The findings were congruent with the findings reported by Lundin A, *et al*. [18] However, the findings were inconsistent with others. [19-21] They reported only three factors including physical symptoms, cognitive symptoms, and emotional symptoms. Vision-related symptoms and other physical symptoms were loaded into one factor.

Looking at the overall prevalence of symptoms belonging to these four factors, somatic symptoms, especially headache and dizziness, were most prevalent, followed by psychological, then cognitive symptoms, and auditory/visual symptoms were least prevalent. For psychological symptoms, sleep disturbance and fatigue were the most reported by the patients. Patients frequently experienced "Taking longer to think" and "Forgetfulness" as cognitive symptoms. Finally, "Restlessness" and "Nausea/vomiting" were rarely reported by the subjects. However, Smith-Seemiller L, *et al*. [22] reported that cognitive symptoms were more prominent in patients with a head injury.

Conclusions

The findings from this study show that the RPQ displays adequate psychometric properties when used with Thai patients. An exploratory factor analysis was an advantageous statistical method used to examine the construct validity of an instrument. However, EFA was not a sufficient tool to test the theoretical foundations of the RPQ, a confirmatory factor analysis should be conducted to gain further knowledge in this area. For example, studies investigating the fitness of the 4-factors model using a confirmatory factor analysis with larger sample size should be conducted.

Acknowledgements

The authors would like to offer our heartfelt gratitude to King Bhumibol Adulyadej Hospital, and the Police General Hospital, and the subjects for their contribution in this study.

Conflict of interest

The authors, hereby, declare no conflict of interest.

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