**Title:** A factor analysis of post-concussion syndromes: A validation study in Thai people after head injury

**ชื่อเรื่อง**: การวิเคราะห์องค์ประกอบของกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือน: การศึกษาในคนไทยที่ได้รับบาดเจ็บที่ศีรษะ

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**ABSTRACT**

**Background:** Thousands patients suffered head injury in Thailand. Some might recover completely. Of these, many were at risk of having post-concussion syndromes (PCS) for months or years after their injury. PCS was poorly understood etiology and no objective findings. The Rivermead Post-Concussion Symptoms Questionnaire (RPQ) was a specific instrument measuring PCS. The current study was designed to describe the structures of PCS; and whether the RPQ was suitable for Thai people.

**Objectives:** This study were aimed to explore the structures of PCS, and to validate the psychometric properties of the RPQ in Thai people after head injury.

**Methods:** Two hundred and fifty-three head injury patients were recruited from out-patient clinics of King Bhumibol Adulyadej Hospital, and Police General Hospital in Bangkok, Thailand. Data were collected by using a demographic and illness-related questionnaire, and the RPQ.

**Results:** The RPQ achieved adequate internal consistency with Cronbach’s α of 0.88. A principal components analysis with varimax rotation found that seven items of the factor 1 named “Psychological symptoms”. Three items loaded to the factor 2 called “Cognitive symptoms”. For the physical symptoms or factor 3, three items were loaded. Finally, three items corresponded with the factor 4 as “Vision-related symptoms”. Cronbach alpha coefficients among each factor ranged from 0.81 to 0.90.

**Conclusion**: This study confirmed both reliability and validity of the RPQ. However, other aspects of psychometrics studies were still needed.

**Keywords:** Head injury, Thai people, psychometrics, post-concussion syndromes, RPQ

**บทคัดย่อ**

**เหตุผลของการทำวิจัย** : ประเทศไทยมีผู้ป่วยบาดเจ็บศีรษะจำนวนมาก บางคนหายจากโรคแต่หลายคนเผชิญกับกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือนที่อาจจะคงอยู่เป็นเวลาหลายเดือนหรือหลายปีหลังได้รับบาดเจ็บ กลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือนเป็นสิ่งที่วินิจฉัยได้ยาก The Rivermead Post-Concussion Symptoms Questionnaire (RPQ) เป็นเครื่องมือที่ใช้ในการประเมินกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือน การศึกษานี้มีเป้าหมายเพื่อศึกษาองค์ประกอบของกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือนและศึกษาความเหมาะสมในการใช้แบบประเมิน RPQ ในคนไทย

**วัตถุประสงค์:** เพื่อศึกษาองค์ประกอบของกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือนและทดสอบคุณสมบัติของแบบประเมิน RPQ ในคนไทยที่ได้รับบาดเจ็บศีรษะ

**วิธีการทำวิจัย:** ผู้ป่วยบาดเจ็บสมองจำนวน 253 คน ที่มาติดตามการรักษา ณ หน่วยตรวจโรคประสาทศัลยศาสตร์ โรงพยาบาลภูมิพลอดุลยเดชและโรงพยาบาลตำรวจ เครื่องมือที่ใช้ในการวิจัยคือ แบบสอบถามข้อมูลส่วนบุคคลและประวัติการเจ็บป่วย แบบประเมินกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือน

**ผลการศึกษา:** ค่าความเที่ยงของแบบประเมิน RPQ คำนวณด้วยค่าสัมประสิทธ์ครอนบาคได้ 0.88 ซึ่งเป็นค่าที่ดี ผลการวิเคราะห์ตัวประกอบและหมุนแกนแบบวาริเมกซ์ ได้องค์ประกอบของกลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือน 4 องค์ประกอบ โดยองค์ประกอบที่ 1 คืออาการทางด้านจิตใจ มี 7 ข้อรายการ องค์ประกอบที่ 2 อาการทางด้านการคิดรู้ มี 3 ข้อรายการ องค์ประกอบที่ 3 คืออาการทางร่างกาย มี 3 ข้อรายการ และองค์ประกอบที่ 4 คืออาการทางสายตา มี 3 ข้อรายการ

**สรุป:**การศึกษานี้เป็นการยืนยันว่าแบบประเมิน RPQ มีความตรงและความเที่ยงที่ดีและเหมาะสมที่จะใช้กับคนไทย การศึกษาเกี่ยวกับคุณสมบัติข้ออื่นของ RPQ ควรทำต่อไปในอนาคต

**คำสำคัญ**: บาดเจ็บศีรษะ คนไทย ความเที่ยงและความตรงของเครื่องมือ กลุ่มอาการภายหลังสมองได้รับการกระทบกระเทือน

**Background**

In Thailand, an annual rate of hospitalized patients after head injury was around 60.1/100 000 population (1). Though, many patients survived, some experienced a wide array of symptomatology termed the post-concussion syndromes (PCS).

PCS was 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 followed by a characteristic group of symptoms such as headache, and poor memory (2). The incidence of PCS depended on the diagnostic criteria used. The presence of at least 3 symptoms at 3 months was required to meet the diagnostic criteria for PCS as defined by the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) (3). Many medical and psychological tests for PCS diagnosis were provided.

The Rivermead Post-concussion Symptoms Questionnaire (RPQ) was based on a list of a constellation of symptoms that were identified by World Health Organization. The RPQ was designed to identify post-concussion symptoms that were not prevalent prior to head injury. The RPQ was a short, and simple questionnaire. The RPQ was sensitive enough to measure among cases with mild to moderate levels of head injury. It was used in both clinical and self-administered settings (4).

It was clear that the use of the RPQ in head injury patients has been very limited in Thailand (5, 6, 7, 8, 9, 10). Hence, the researchers examined the RPQ’s psychometric properties among persons with head injury in Thailand.

**Objectives of the study**

To describe the structures of the PCS, and to examine the psychometrics of the RPQ including reliability and validity in Thai patients after head injury.

**Methods**

Data used in this study were collected as part of two cross-sectional studies (7, 10). The studies were approved by the ethics committee of two tertiary hospitals (IRB number 98/2558, IRB 84/61, and 46/2561). All participants signed consent forms before enrolled in the study. The current study was carried out into two phases: Translation phase and psychometric property testing phase.

***Phase 1***

Before this 18-item Thai version of the RPQ was translated, the researchers contacted the author to get a permission to use the RPQ in the study (4). The translation team consisted of three neurosciencenurses, and two English instructors (native English speakers who readand write Thai fluently) fromthe Faculty of Art, Chulalongkorn University. The 18-item RPQ was translated according to translation methodology guidelines. Then, the researchers performed a pilot testing with sixty patients with head injury. The sixty participants were asked to read and answer the Thai version of the RPQ. The researchers also solicited feedbacks and comments to refine the translation further.

*Phase 2*

The participants were 253 patients with head injury at Neurosurgical clinics, King Bhumibol Adulyadej Hospital, and Police General Hospital in Bangkok, Thailand. Inclusion criteriaentailed the following: diagnosis of head injury, outpatient treatment (currently not admitted to a ward), and ability to provide informed consent.

Exclusion criteria wereas 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 was the case, their participation was rejected.

**Measures**

 *Demographic and illness-related questionnaire*

 The questionnaire recorded participants’ gender, age, time since injury, causes of injury, and diagnosis.

 *Glasgow Coma Scale (GCS)*

The Glasgow Coma Scale was a measure of the depth and duration of consciousness impairment and coma (11). It assessed motor responsiveness, verbal performance, and eye opening. It classified brain injury into mild (GCS 13–15), moderate (GCS 9–12), and severe (GCS 3–8). The participants’ GCS score was obtained from medical records.

*The Rivermead Post-Concussion Symptoms Questionnaire (RPQ)*

The RPQ (4) consists of 16 symptoms, and 2 opened questions. Patients were asked to rate how severe each of the 16 symptoms as follows: [headache](https://en.wikipedia.org/wiki/Headaches), [dizziness](https://en.wikipedia.org/wiki/Dizziness), [nausea](https://en.wikipedia.org/wiki/Nausea) and/ or [vomiting](https://en.wikipedia.org/wiki/Vomiting), noise sensitivity, sleep disturbance, [fatigue](https://en.wikipedia.org/wiki/Fatigue_%28medical%29), being irritable, feeling depressed or tearful, feeling frustrated or impatient, forgetfulness, poor concentration, taking longer to think, blurred vision, [light sensitivity](https://en.wikipedia.org/wiki/Light_sensitivity) (easily upset by bright light), [double vision](https://en.wikipedia.org/wiki/Double_vision) and restlessness. These symptoms are reported by severity on a scale from 0 to 4: not experienced; no more of a 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 are present (14). A higher total score on the RPQ indicates a greater overall level of distress (15, 16).

**Procedure**

After receiving the participant’s (or his/her representative’s) informed consent, the researchers determined if the participant was able to respond to the self-report questionnaires independently. If yes, the questionnaires were completed at the clinics. If no, participants completed the questionnaire in a face-to-face interview.

**Statistical analysis**

Descriptive statistics, a principal component factor analysis was conducted using a varimax rotation.

**Results**

 A total of 253 participants were enrolled. Demographic and clinical characteristics of the participants were presented in Table 1. In this sample (n = 253), there were a greater number of men (67.19%) than women (32.81%). Age mean was 39.39 years (SD ± 12.68 years). By GCS criteria, all participants were mildly injured. About 57.71% the injury had occurred more than 6 months. Injury was caused by car accident (75.09%).

**Table 1** Demographic and injury-related characteristics among 253 patients

|  |  |  |
| --- | --- | --- |
| 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 patients reporting each of 16 symptoms and mean intensity of these symptoms (n=253)

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

*Psychometric properties of the RPQ*

Internal consistency of the scales and the total score estimated by Cronbach’s alpha met standard psychometric criteria (Table 3). Cronbach’s alpha for RPQ ranged from 𝛼 0.81 to 0.90 which was considered good to excellent (17).

Table 3: Scale properties

|  |  |  |  |
| --- | --- | --- | --- |
| Scale | Mean | SD | Cronbach α 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*

Before the factor analysis of the RPQ, correlations between the 16 items were analyzed by non-parametric Spearmans rank correlation. Then, the Bartlett’s test of sphericity was employed. Also, the Kaiser-Myer-Olkin Measure of Sampling Adequacy (KMO) was conducted.

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: Result of principal component analysis to assess construct validity of the RPQ among 253 patients after head injury

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Domains and Items | % of Variance | Factor 1 | Factor 2 | Factor3 | Factor 4 |
| **Psychological symptoms** | 37.758 |  |  |  |  |
| Noise sensitivity |  | .568 |  |  |  |
| Sleep disturbance |  | .478 |  |  |  |
| Fatigue |  | .468 |  |  |  |
| Being irritable  |  | .737 |  |  |  |
| Feeling depressed or tearful |  | .746 |  |  |  |
| Feeling frustrated |  | .791 |  |  |  |
| Restlessness |  | .415 |  |  |  |
| **Cognitive symptoms** | 11.965 |  |  |  |  |
| Forgetfulness |  |  | .880 |  |  |
| Poor concentration |  |  | .867 |  |  |
| Taking longer to think |  |  | .826 |  |  |
| **Physical symptoms** | 10.530 |  |  |  |  |
| Headache |  |  |  | .801 |  |
| Dizziness |  |  |  | .848 |  |
| Nausea and/or vomiting |  |  |  | .795 |  |
| **Vision-related symptoms** | 7.512 |  |  |  |  |
| Blurred vision |  |  |  |  | .872 |
| Light sensitivity |  |  |  |  | .889 |
| Double vision |  |  |  |  | .852 |

**Discussion**

Findings of the study provided an evidence as to whether the RPQ was valid for use with Thai patients after head injury. The Thai version of the RPQ demonstrated an acceptable internal consistency and construct validity (17). The factor analyses demonstrated that symptoms were compatible with 4 separated factors. The findings were congruent with the findings reported by Lundin et al (18). However, the findings were inconsistent with others (19, 20, 21). They reported only three factors including physical symptoms, cognitive symptoms, and emotional symptoms. Vision-related symptoms and other physical symptoms was loaded into one factor. The factor analysis of this study did not provide any information on the order of symptoms within each factor. Also, the observed RPQ symptom structure did not allow any conclusions about etiological mechanisms, since corresponding data from control groups were not available.

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 were least prevalent. For psychological symptoms, sleep disturbance and fatigue were mostly 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 patients. However, the findings were not consistent with other study. Smith-Seemiller et al (22) reported that cognitive symptoms are more prominent in patients with head injury.

**Conclusions**

The findings from this study suggested that the RPQ was a useful instrument for eliciting PCS. Moreover, the measure could be used to determine whether an intervention was effective in patients after head injury. The RPQ displayed adequate psychometric propertieswhen used with Thai patients. Further research was still required. For example, studies investigating its responsiveness, and sensitivity should be conducted.

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