Physiology & Behavior 167 (2016) 202–208

Contents lists available at ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/phb

A higher baseline somatization score at sea level as an independent predictor of acute mountain sickness☆

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HIGHLIGHTS

- Described novel epidemiology and characteristics of SCL-90 pre- and post-high-altitude exposure
- Identified the associations between SCL-90 factors and AMS
- Identified the predictive role of baseline somatization score for AMS
- Found associations between non-AMS-related symptoms and SCL-90 items

ARTICLE INFO

Article history:
Received 15 April 2016
Received in revised form 28 August 2016
Accepted 12 September 2016
Available online 14 September 2016

Keywords:
Somatization symptoms
Predictor
Acute mountain sickness
Symptoms Checklist-90

ABSTRACT

Objective: The current study aimed to identify the predictive values of psychological factors that are evaluated by the Symptoms Checklist-90 (SCL-90) for acute mountain sickness (AMS).
Methods: The subjects (n = 285, non-acclimatized young Chinese men), who were recruited in July 2013, completed a case report questionnaire. In addition, their vital signs (heart rate [HR], blood pressure and pulse oxygen saturation) were measured, and their psychological factors were examined using the SCL-90 at sea level. AMS was diagnosed using the Lake Louise self-assessment scoring system in the morning of the second day after their arrival at 3450 m.
Results: Of the nine factors of the SCL-90, the AMS patients (AMS score ≥ 3) were characterized by significantly higher scores for baseline somatization [14.0 (5.0) vs. 13.0 (3.0), $p < 0.001$], obsession–compulsion, depression, anxiety and hostility compared with the non-AMS group (all p values < 0.05). Spearman's correlation analyses revealed associations between AMS scores and somatization ($r = 0.316$, $p < 0.001$), depression, anxiety, obsession–compulsion, interpersonal sensitivity, hostility, phobic anxiety, paranoid ideation and psychoticism scores (all p values < 0.001). Although all nine factors were associated with AMS in a univariate regression (all $p < 0.05$), a further adjusted logistic regression analysis indicated that only baseline somatization score (odds ratio = 1.129, $p = 0.001$) was an independent predictor of AMS. Furthermore, some non-AMS often-occurred symptoms (paresthesia, shortness of breath, reduced activity and tinnitus) were also found to be associated with the baseline SCL-90 scores.
Conclusion: AMS is correlated with the baseline somatization score at sea level, which was measured using the SCL-90. A higher baseline somatization score is also an independent predictor of AMS.

1. Introduction

Acute mountain sickness (AMS) describes a syndrome that occurs after exposure to altitudes of 2500 m or higher [1,2], which is diagnosed by Lake Louise self-score system (LLS) [2]. The incidence of AMS has been reported to range from 10 to 85% [1,3]. AMS is a critical medical issue that threatens tourists, workers and migrants who move from lower altitudes to a high altitude because of its high incidence, the resulting discomfort and the deadly risk of high-altitude cerebral edema (HACE).

☆ This work was conducted by Institute of Cardiovascular Diseases of PLA; Department of Cardiology; Department of Neurology, Xinqiao Hospital, Third Military Medical University.

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http://dx.doi.org/10.1016/j.physbeh.2016.09.008

Previous researchers have identified many risk factors for AMS[4,5], including decreased pulse oxygen saturation (SpO_2), increased HR, evaluated cerebral hemodynamics, faster climbing speeds and higher altitudes [6,7]. Furthermore, vasoconstriction, vasodilatation and increased intracranial pressure or higher perfusion pressure may participate in the mechanisms of AMS [2,8,9]. Additionally, the physiological or psychological activation of the sympathetic nervous system has also been indicated as a consequence of high-altitude exposure and as a risk factor for AMS [1,2].

Previous studies have paid particular attention to the physiological factors associated with AMS or high-altitude headache [10], but few of them have focused on the psychological aspects [11,12]. Although a few studies have focused on the effects of high altitude on mental behavior [13] and psychiatric symptoms, the associations between AMS and the associated psychiatric symptoms have not been fully investigated. New onsets of anxiety and depression after high-altitude exposure have been reported. Samuel J. Oliver and colleagues investigated physiological and psychological illness symptoms at high altitude and found that anxiety contributed to the symptom burden when altitude was gained [11]. Furthermore, a relationship between changes in negative mood states, including anxiety and cognitive performance after hypoxia exposure [14] may account for AMS symptoms. Thus, psychiatric symptoms may be associated with or even predict AMS. In addition, AMS is diagnosed using a subjective self-report questionnaire; thus, psychological factors and emotional states are critical in relation to AMS, especially for psychological and neurological clinical manifestations, which include headache, dizziness and insomnia [2].

In addition to the AMS symptoms, many other complaints (non-LLS related symptoms), such as the symptoms included in the environmental symptoms questionnaire (ESQ-III), account for a large proportion of the discomforts of high-altitude exposure. These symptoms may also limit daily work and life at high altitudes, although they are not essential for an AMS diagnosis. Therefore, it is critical and urgent to study both the AMS-related problems and the non-LLS related symptoms that affect individuals coming to high altitudes from lower altitudes. We postulated that baseline psychological factors would be associated with or predict AMS, and conducted this study with the aim of identifying the relationships between AMS and baseline psychological factors, as assessed using the Symptoms Checklist-90 (SCL-90).

2. Methods

2.1. Participants and procedures

2.1.1. Participants

This prospective observational study was designed to identify the predictive values of baseline SCL-90 scores at sea level for AMS after high-altitude exposure. The participants (285 young Chinese soldiers on an altitude-training mission) were recruited in July 2013 at sea level (400 m) in Chongqing and were assessed at 3450 m after a four-day bus trip. The inclusion criteria were as follows: healthy Chinese men between 16 and 30 years old; subjects did not take medication or receive any intervention before ascending. However, severe headache subjects were treated with NSAIDs or *Sanlietong* (Taiji medicine, Xi'an, China) as necessary at high altitude. Subjects with any of the following conditions were excluded: cerebrovascular diseases, cardiovascular diseases, neuro-psychosis, respiratory diseases, malignant tumors and disorders of the liver or kidneys.

The study was thoroughly explained to all of the volunteers, and all of them signed informed consent forms prior to their examinations. This study was reviewed and approved by the Ethics Committee of Xinqiao Hospital at the Second Clinic Medical College of the Third Military Medical University.

2.1.2. Procedures

The baseline parameters were examined in Chongqing before their trip using structured case report forms [i.e., age, body mass index (BMI), smoking and alcohol consumption]. The physiological measurements were conducted during routine examinations prior their travel. Blood pressure was measured using a sphygmomanometer (HEM-6200, OMRON, China) after a 30-min rest period. The subjects' HR and SpO_2 were also measured using a pulse oximeter (NONIN-9550, Nonin Onyx, USA). Histories of traumatic brain injury, psychiatric disorder/treatment, physical injuries, AMS (high-altitude headache) and high-altitude exposure over the past 2 years were also recorded on the case report form. The primary version of the SCL-90 was used to measure the subjects' psychiatric symptoms (Appendix 1) [15–17]. The subjects were questioned using the SCL-90 checklist, which includes 90 items (9 factor categories). These items were presented out of order and were translated into Chinese[17]. Our trained physicians performed the physiological evaluations of HR, blood pressure and SpO_2.

The AMS questionnaires were performed at 3450 m (Xin Duqiao, 8:00–10:00 in the morning on the fifth day after one night's rest, Fig. 1A) after the participants had completed a four-day trip from sea level (400 m from Chongqing) via bus. AMS-related symptoms (i.e. the LLS symptoms, headache, dizziness, gastrointestinal symptoms, difficulty sleeping and fatigue/weakness) and non-LLS related symptoms were recorded. AMS was diagnosed based on the LLS scores. Subjects whose LLS score was 3 or higher and who had a headache were identified as having AMS. Furthermore, many other frequently occurring non-LLS related symptoms that threaten health and daily life at high altitudes, including lethargy, constipation, dim eyesight, dyspnea and cough, were also queried in the case report form (as present or not present).

2.2. Statistical analysis

Normally distributed variables [i.e., age, BMI, HR, systolic blood pressure (SBP), diastolic blood pressure (DBP) and SpO_2] were expressed as the mean ± standard deviation (SD). Non-normally distributed variables (the nine factors of the SCL-90) were expressed as median (quartile range). The AMS + (with AMS) and AMS − (without AMS) groups were compared using independent samples T tests or Mann-Whitney U-tests, as appropriate. The relationships between AMS score and each of the aforementioned parameters were analyzed using Spearman's correlations. Univariate and adjusted logistic regressions were performed to identify the independent variables associated with AMS (Fig. 1B, the statistical analysis chart).

3. Results

Data were excluded if the subjects' demographic information or other items were missing (e.g., lack of demographic information, AMS symptoms or the sub-items of the SCL-90); totally 280 valid case report forms and examinations were collected. The mean age and BMI of the subjects in this study were 20.88 ± 2.42 years and 21.28 ± 2.28 kg/m^2 respectively. The percentages of participants who smoked or consumed alcohol were 26.0% and 4.5% respectively. At sea level, the mean SBP, DBP, HR and SpO_2 were 112.44 ± 10.94 mmHg, 67.64 ± 8.84 mmHg, 70.20 ± 9.82 beats per min and 97.37 ± 1.15%. The incidences of AMS, headache and dizziness were 24.7%, 41.9% and 50.2% (Fig. 2A). Furthermore, the incidences of non-LLS related symptoms were shown in Fig. 2B.

The descriptive statistics for the nine factors of the SCL-90 were shown in Fig. 3(a–i). Most of the 280 individuals were characterized by normal or mild scores on the nine factors of the SCL-90 (Table 1). More specifically, 186 subjects had a somatization score between 12 and 24, and 135 had an anxiety score between 10 and 20. Mild obsession–compulsion characterized a proportion of the participants (185). Regarding depression, 119 participants reported mild depression. The reported incidences of positive hostility (130), phobic anxiety (70)