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Prevalence of and risk factors for acute mountain sickness among a cohort of high-altitude travellers who received pre-travel counselling☆

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Summary *Background:* Acute mountain sickness (AMS) is common in high-altitude travellers, and may lead to life-threatening high-altitude cerebral oedema. To better target pre-travel counselling, we aimed to characterize the risk factors for AMS that may be identified prior to departure.
Methods: We performed a descriptive study of high-altitude travellers who consulted at a travel clinic before departure. Data were collected by phone after their return, using a standardized questionnaire.
Results: 162 adults were enrolled. Most subjects (81.5%) were informed about AMS before departure, by a medical doctor in 40% of cases. AMS symptoms were reported by 77 travellers (47.5%). Variables significantly associated with AMS symptoms were female sex (56% versus 38.5%, $p = 0.01$), trip organised by a travel agency (55.2% versus 43.3%, $p = 0.03$), travel duration (mean, 4.2 ± 3.5 weeks in patients with AMS, versus 6.6 ± 7.5 weeks in patients without AMS, $p = 0.014$), and acetazolamide use (71.4% versus 47.5%, $p = 0.045$). In multivariate

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analysis, only female sex was independently predictive of AMS (adjusted OR 2.15 [1.14—4.40]). *Conclusions:* AMS symptoms occur in almost half of high-altitude travellers. Women, and travellers leaving for short duration, within trips organised by travel agencies, should be targeted for enhanced pre-travel counselling to prevent AMS.

1. Introduction

Acute mountain sickness (AMS) develops at high-altitude when the adaptive capacities of the human body to acute hypoxia fail. The risk of AMS is significant above 2500 m, and its prevalence is correlated with altitude, estimated at 9%—25% at 2500 m, and at 47—75% above 4500 m [1—5]. Most of the time, AMS is benign, although high-altitude cerebral oedema (HACE) or high-altitude pulmonary oedema (HAPE) are life-threatening complications. Each year, millions of people travel above 2500 m [6]. Increasing proportions of these travellers are older than 40 years, and suffer from comorbidities [7]. Pre-travel consultations aim to reduce potential risks by screening for conditions that may complicate or even contra-indicate a stay at high-altitude, and by providing advice tailored to the characteristics of the traveller, and travel plans. The diagnosis of AMS is not straightforward because it is based on non-specific symptoms. However, the association of headache, nausea, vomiting, insomnia and anorexia (Table 1), which arise within 4—8 h following arrival at altitudes above 2500 m, is suggestive. These symptoms generally are most severe on the second or third day, and disappear on the fourth [6].

The most important risk factor for AMS is low chemoreceptor sensitivity to hypoxia, which should be suspected in travellers with previous history of AMS [8]. Other risk factors are rapid ascent, absolute altitude >3500 m, intensive exertion, medical history of migraine or neck intervention (surgery, radiotherapy), anaemia, and use of sedatives [9,10]. Others potential risk factors are disputed, including: female sex, living at an altitude below 1000 m, obesity, alcohol consumption, and young age [6].

A better characterization of travellers most at-risk of AMS would allow targeted interventions directed at these high-risk travellers. We aimed to identify variables that are predictive of the risk of AMS, and that may be identified during the pre-travel consultation, so that counselling may be targeted to the most at-risk high-altitude travellers.

Table 1 Hackett score (from [11]).

Symptoms	Score
Headache relieved after a first degree analgesic[a]	1
Nausea	1
Loss of appetite	1
Insomnia	1
Dizziness, light-headedness	1
Headache not relieved after a first degree analgesic[a]	2
Vomiting	2
Dyspnoea at rest	3
Unusual level of asthenia	3
Oliguria	3
Total	/18

Interprétation:
Total = 1—3: slight acute mountain sickness (AMS).
Total = 4—6: mild AMS.
Total >6: severe AMS.
[a] Paracetamol, ibuprofen or acetylsalicylic acid.

2. Methods

2.1. Study participants

We performed a descriptive study among high-altitude travellers who consulted from July 2009 to June 2011 at the travel clinic located in the Rennes University Hospital, which serves as a referral centre for the area (population catchment, one million inhabitants). We identified individuals who travelled above 2500 m with the use of the travel clinic database, which contains basic demographic data, and limited information about the travel (i.e. countries, duration, number of participants), through the following steps: i) selection of patients travelling to a country where a significant proportion of tourists are high-altitude travellers: Peru, Bolivia, (thereafter the 'SA' group, for South America), Tanzania and Kenya (thereafter, the 'K' group, for Kilimanjaro); ii) for the 'K group', an additional selection was performed to focus on travellers likely to attempt an ascent of Mount Kilimanjaro: only travellers aged 25—50 years, leaving for at least 2 weeks, and not travelling with children younger than 15 years old, were selected. These additional criteria were created to enrich the population sample with the travellers most likely to reach high-altitude (i.e. active, young adults, who travel long enough, without children). Then, a single investigator (MS) attempted to contact each selected traveller by phone during the month following his return in France. If the traveller could not be reached, a message was left explaining the purpose of the study and two further attempts were made by phone. After providing oral informed consent, each subject was interviewed and data were collected on a standardized questionnaire during the phone call. The study was reviewed and approved by an institutional review board (Département de Médecine Générale de l'Université de Rennes I). Written informed consent and approval by the Ethics Committee were waived, because the study was strictly descriptive, and data recorded in an anonymised manner with