Prevalence of acute mountain sickness in the Swiss Alps

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Abstract

Objective—To assess the prevalence of symptoms and signs of acute mountain sickness in the Swiss Alps.

Design—A study using an interview and clinical examination in a representative population of mountaineers. Positive symptoms and signs were assigned scores to quantify the severity of acute mountain sickness.

Setting—Four huts in the Swiss Alps at 2850 m, 3050 m, 3650 m, and 4559 m.

Subjects—466 Climbers, mostly recreational: 47 at 2850 m, 128 at 3050 m, 82 at 3650, and 209 at 4559 m.

Results—In all, 117 of the subjects were entirely free of symptoms and clinical signs of acute mountain sickness; 191 had one or two symptoms and signs; and 158 had more than two. Those with more than two symptoms and signs were defined as suffering from acute mountain sickness. At 4559 m 11 climbers presented with high altitude pulmonary oedema or cerebral oedema, or both. Men and women were equally affected. The prevalence of acute mountain sickness correlated with altitude: it was 9% at 2850 m, 13% at 3050 m, 34% at 3650 m, and 53% at 4559 m. The most frequent symptoms and signs were insomnia, headache, peripheral oedema, and scanty pulmonary rales. Severe headache, vomiting, dizziness, tachypnoea, and pronounced pulmonary rales were associated with other symptoms and signs and therefore characteristic of acute mountain sickness.

Conclusion—Acute mountain sickness is not an uncommon disease at moderately high altitude—that is, above 2800 m. Severe headache, vomiting, dizziness, tachypnoea, and pronounced pulmonary rales indicate severe acute mountain sickness, and subjects who suffer these should immediately descend to lower altitudes.

Introduction

People who do not live at high altitude (low land dwellers) who rapidly ascend to altitudes above 2500 m may develop one or more unpleasant symptoms such as headache, anorexia, and insomnia. If several of these symptoms, which may progressively include vomiting, shortness of breath, severe headache, and ataxia, are present the syndrome is defined as acute mountain sickness. Physical examination of these patients may disclose tachypnoea, pulmonary rales, and periorbital as well as peripheral oedema.

Only recently has the number of low land dwellers seeking adventure or recreation at high altitude greatly increased. Modern methods of rapid transportation and tight time schedules expose many tourists to altitudes above 2500 m within a few hours after leaving low land. Also, the recent proliferation of mountaineering and trekking activities allows climbers and hikers to spend weeks at altitudes higher than 4000 m. It is generally assumed that the prevalences of acute mountain sickness and its most severe forms—high altitude pulmonary oedema and high altitude cerebral oedema—have increased in an almost parallel way.[1] Data on the incidence and prevalence of these syndromes have been reported in trekkers in Nepal,[2,3] Indian soldiers,[4] and from several places in North America.[5-7] Although the Alps are visited each year by millions of tourists and mountaineers annually spend more than 90 000 nights in huts belonging to the Swiss Alpine Club (which are located above 2500 m) to our knowledge no information on the prevalence of acute mountain sickness in Europe is yet available. We assessed the prevalence of acute mountain sickness in mountain climbers at four different altitudes in the Swiss Alps.

Methods

The study was performed at four different alpine huts. Three of them were located in the Bernese Alps—that is, the Concordia hut (at 2850 m; hut 1), the Finsteraarhorn hut (at 3050 m; hut 2) and the Mönchsjoch hut (at 3650 m; hut 3). The hut at the highest altitude was the Capanna Osservatorio, Regina Margherita (at 4559 m; hut 4) in the Alps Valais.

As we intended to study a mountaineering population as completely as possible we invited all mountaineers, by using a poster at the entrance of the respective huts, to participate in the study. Most climbers volunteered to participate and were examined between about 2 pm and 10 pm. If there were too many subjects to study we selected them according to their time of arrival, so that late comers were excluded. Climbers with more severe forms of acute mountain sickness, and particularly those who had to be helped to descend or be evacuated, were always seen by us and therefore included in the study; as the presence of the medical team was well known in the respective huts sick climbers contacted us or were brought to our attention by the hut keepers. Thus the subjects with severe acute mountain sickness were included in the study.

Initially the subjects completed a questionnaire (in German or Italian), which asked whether they had had acute mountain sickness on prior exposure to high altitude. The search for the presence and severity of acute mountain sickness included questions on whether subjects presently suffered from headaches (light: one score point; severe: two score points), anorexia or nausea, or both (one point), vomiting (two points), dizziness (one point), and shortness of breath at rest (one point). Insomnia (one point) was recorded on the following morning. Subsequently the subjects underwent a clinical examination with particular emphasis on clinical signs of acute mountain sickness—that is, periorbital, hand and foot oedema (one site: one point; two or more sites: two points), respiratory rate (>25 breaths min: two points; shortness of breath and tachypnoea: two points), pulmonary rales (slight:

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one point; severe: two points), and ataxia (according to the Romberg and heel to toe walking tests) (two points). Heart rate, respiratory rate, and blood pressure were recorded while the subjects were sitting. Pulmonary rales, peripheral or periorbital oedema, and ataxia, if present, were always confirmed by a second examiner. The severity of the acute mountain sickness was assessed by adding up the score points, as in the studies by Hackett *et al*,[2 3] the main difference being the inclusion of peripheral oedemas in the score.[8]

In agreement with Hackett *et al*[2 3] and Houston[6] subjects without any signs and symptoms were considered healthy, those with one to two score points were considered as being moderately disturbed by the exposure to high altitude, and those with three or more points as suffering from acute mountain sickness. High altitude pulmonary oedema was diagnosed when cyanosis, tachypnoea, and severe pulmonary rales were present.

Statistical evaluation was made by using the statistical analysis system (IBM 3990; SAS Institute, Cary, North Carolina). Non-parametric comparison of multiple samples was performed by using the Kruskal-Wallis H test and subsequent analysis was performed by the method of Nemenyi.[9] We analysed the associations between severity of acute mountain sickness and altitude and age by using a χ^2 test.

Results

GENERAL CHARACTERISTICS OF POPULATION

Altogether 466 mountaineers (386 men and 80 women) were studied: 47 in hut 1, 128 in hut 2, 82 in hut 3, and 209 in hut 4. Over 95% were low land dwellers and recreational mountaineers, but a few mountain guides were also studied. In all, 350 were non-smokers and 19 smoked more than 20 cigarettes each day; 326 occasionally consumed alcohol, 98 regularly consumed alcohol, and 42 were completely abstinent. A total of 107 subjects, all of them at hut 4, had taken acetazolamide for acute mountain sickness prophylaxis; 61 had a history of a severe disease that was not altitude related; 23 suffered from a chronic disease like diabetes mellitus or hypertension; 19 were taking regular medication; and 107 had had signs and symptoms of acute mountain sickness during previous exposures to high altitudes.

TABLE I—*Distribution of score and mean (SE) score relating to symptoms of acute mountain sickness in a population of climbers. Figures are numbers (percentages) of climbers*

Score	Hut 1 (2850 m) (n=47)	Hut 2 (3050 m) (n=128)	Hut 3 (3650 m) (n=82)	Hut 4 (4559 m) (n=209)
0	25 (53)	52 (41)	21 (26)	17 (8)
1-2	18 (38)	60 (47)	33 (40)	82 (39)
≥3	4 (9)	16 (13)	28 (34)	110 (52)
Mean (SE) score	0·85 (1·30)	1·03 (1·18)	2·11 (2·22)	3·28 (2·75)

TABLE II—*Number (percentage) of climbers with symptoms and signs of acute mountain sickness at four different altitudes*

Symptom or sign	Hut 1 (2850 m)	Hut 2 (3050 m)	Hut 3 (3650 m)	Hut 4 (4559 m)	Total
Headache:					
None	44 (94)	116 (91)	52 (63)	58 (28)	270 (58)
Light	2(4)	11 (9)	24 (29)	104 (50)	141 (30)
Severe	1 (2)	1 (1)	6 (7)	47 (23)	55 (12)
Anorexia or nausea:					
No	45 (96)	120 (94)	67 (82)	135 (65)	367 (79)
Yes	2 (4)	8 (6)	15 (18)	74 (35)	99 (21)
Vomiting:					
No	46 (98)	126 (98)	79 (96)	186 (89)	437 (94)
Yes	1 (2)	2 (2)	3 (4)	23 (11)	29 (6)
Dizziness:					
No	47 (100)	127 (99)	75 (92)	181 (87)	430 (92)
Yes		1 (1)	7 (9)	28 (13)	36 (8)
Insomnia:					
No	40 (85)	95 (74)	46 (56)	72 (34)	253 (54)
Yes	7 (15)	33 (26)	36 (44)	137 (66)	213 (46)
Tachypnoea:					
No	46 (98)	128 (100)	80 (98)	198 (95)	452 (97)
Yes	1 (2)		2 (2)	11 (5)	14 (3)
Oedema (periorbital or peripheral):					
None	38 (81)	95 (74)	61 (74)	158 (76)	352 (76)
1 Site	7 (15)	24 (19)	11 (13)	35 (17)	77 (17)
2 Sites	2 (4)	9 (7)	10 (12)	16 (8)	37 (8)
Pulmonary rales:					
None	39 (83)	113 (88)	60 (73)	155 (74)	367 (79)
+	8 (17)	12 (9)	20 (24)	46 (22)	86 (19)
++ or +++		3 (2·3)	2 (2)	8 (4)	13 (3)
Ataxia:					
No	45 (96)	122 (95)	75 (92)	177 (85)	419 (90)
Yes	2 (4)	6 (5)	7 (9)	32 (15)	47 (10)

PREVALENCE AND DISTRIBUTION OF SCORE

A total of 117 subjects were without any signs and symptoms of acute mountain sickness; 191 presented with one or two score points; and 158 had three or more score points and were defined as suffering from acute mountain sickness. An equal distribution of scores was found between men and women.

Climbers below the age of 20 and those over 41 had mean (SE) scores of 2·33 (2·47) and 2·58 (2·59) respectively, whereas those between 20 and 40 had a score of 2·09 (2·31). The mean score of the subjects older than 41 was thus significantly higher than that of those between 20 and 40 (Nemenyi test, $p<0·05$). Furthermore, the score was independent of the duration of stay at high altitude, which was between one and four days.

RELATION OF SCORE TO ALTITUDE

The mean score of the total population increased significantly with altitude (Kruskall-Wallis test, $p<0·01$) (table I). The number of subjects with acute mountain sickness also rose, whereas that of healthy subjects dropped with increasing altitude. The prevalence of minor symptoms of acute mountain sickness, such as light headache and insomnia, increased with altitude, as did that of signs of high altitude cerebral oedema, like severe headache and vomiting (table II). This trend was paralleled by the prevalence of ataxia, which was observed in 31 (15%) of the subjects at 4559 m. Periorbital and peripheral oedemas were observed at relatively low altitudes and their frequency also slightly increased at higher altitudes.

A high incidence of discrete pulmonary rales was found in climbers without other symptoms, as in another study.[10] Pronounced pulmonary rales were found in five (2%) of the climbers at huts 2 and 3 and in eight (4%) at hut 4. These rales most likely indicated the presence of high altitude pulmonary oedema.

To assess the importance of symptoms or signs for severe acute mountain sickness the score points for individual symptoms and signs were subtracted from the mean score associated with each symptom or sign. Thereby the "corrected mean score" was obtained. This was 2·1 for light headache, 4·2 for severe headache, 3·6 for anorexia or nausea, or both, 5·0 for vomiting, 5·5 for dizziness, 2·6 for insomnia, 6·4 for tachypnoea, 2·2 for peripheral oedema at one site, 3·5 for peripheral oedema at two or more sites, 2·3 for scanty pulmonary rales, 7·0 for pronounced pulmonary rales, and 4·6 for ataxia.

BLOOD PRESSURE, PULSE RATE, AND RESPIRATORY RATE

The mean blood pressure for the entire population was 134/85 mm Hg, and this mean value as well as the extreme value were evenly distributed in climbers at different altitudes. There was no relation between changes in blood pressure and the score values. The mean pulse rate was lowest in hut 1 and increased with altitude, as did the respiratory rate.

Discussion

In this study we assessed the prevalence and severity of acute mountain sickness in a representative population of 466 climbers at various altitudes in the Swiss Alps. Although we expected a high proportion of subjects to have one or two symptoms and signs of acute mountain sickness, the prevalence of 34% of three and more (defined as the presence of acute mountain sickness), was surprising. After all, the study population comprised mostly healthy subjects who spent their leisure time in the mountains for recreation and pleasure. A small sampling error might have been present: although we attempted to study the total populations that spent the night in the respective huts this was not always possible, particularly if more than 20 tourists were present. As subjects with symptoms of acute mountain sickness presumably tend to participate in medical studies more eagerly than those without symptoms this may have led to a slight overestimation of the prevalence of acute mountain sickness.

We used the scoring system that was originally developed by Hackett *et al*[2 3] and we added score points for the presence of peripheral and periorbital oedema as these authors had shown that these types of oedema are associated with acute mountain sickness. This scoring system has been used in studies on the pathophysiology and treatment of acute mountain sickness.[8 11 12] The score has been shown to correlate inversely with arterial oxygen saturation and pressure and directly with the alveoloarterial oxygen difference in various stages of acute mountain sickness.[10]

The mean score, the proportion of subjects with acute mountain sickness, and the prevalence of individual symptoms and signs of acute mountain sickness rose with altitude. Houston interviewed 3906 people at various skiing resorts in Colorado between 2000 m and 2800 m and found that 12% suffered from three or more symptoms.[6] Thus, although there are methodological differences, the prevalence found in Colorado is comparable with the 9% and 13% prevalences of acute mountain sickness that we found at 2850 m and 3050 m, but it is lower than the 25% prevalence found in 454 subjects studied at 2000 m in the Rocky Mountains by questionnaire.[7] In that study, however, 5% of the subjects reported similar symptoms at sea level. Hackett *et al*, studying trekkers in Nepal at an altitude of 4200 m, found in two different studies prevalences of acute mountain sickness of 52·5% and 43%.[2 3] Of the trekkers who flew to 2300 m and ascended to 4200 m in two days, 47% suffered from acute mountain sickness. This prevalence is almost identical with that found in this study in hut 4 at 4559 m, which is frequently reached on the second or third day of exposure to high altitude. Furthermore, comparable numbers have been reported from Mount McKinley[1] and in mountaineers rapidly ascending Mount Rainier (4392 m), where as many as 67% of the climbers studied were found to suffer from acute mountain sickness.[5]

The fact that subjects younger than 20 and those older than 40 tended to have a higher score than those aged between 20 and 40 is compatible with a lot of anecdotal evidence. It is conceivable that the young mountaineers overexercise more readily and do not pay attention to warning symptoms of acute mountain sickness, hence they are at risk of developing the full blown syndrome of acute mountain sickness. On the other hand, older mountaineers could be more susceptible because of the coexistence of clinically asymptomatic degenerative lesions of the cardiorespiratory system.

The 80 women in our study were equally affected by acute mountain sickness as the 386 men. An equal distribution of acute mountain sickness between the sexes was also found in the study in Nepal.[2 3] The more serious forms of acute mountain sickness are, however, at least in the Alps, more common in men: 49 men but only one woman had to be air rescued because of high altitude pulmonary oedema or high altitude cerebral oedema, or both, in the Swiss Alps during 1980-4.[13]

The presence of rales and tachypnoea, which may indicate early high altitude pulmonary oedema, was associated with the highest corrected score and thus with cerebral symptoms of acute mountain sickness. This is compatible with the well accepted opinion that patients with the severe pulmonary form of acute mountain sickness commonly also suffer from the cerebral form, and vice versa. Cerebral symptoms and signs like severe headache and ataxia were probably caused by some degree of cerebral oedema and were likewise associated with a high corrected score.

The fact that blood pressure was identical in all groups stratified according to score is compatible with the fact that the cardiovascular system is not primarily affected in acute mountain sickness.

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ANY QUESTIONS

If a person's blood cholesterol concentration is below 5 mmol/l and his or her weight is normal is there any evidence to show that he or she should limit the amount of dietary fat or high cholesterol foods?

A non-obese person fortunate enough to have a serum cholesterol concentration below 5 mmol/l has a low risk of developing coronary heart disease. The slope of the curve that relates serum cholesterol concentration to the risk of coronary heart disease is shallow below 5 mmol/l with only a small reduction in predicted risk between 4 and 5 mmol/l. Even the most ardent advocates of cholesterol reduction would restrict their efforts to concentrations of 5·2 mmol/l or over.[1] A person in good health with a serum cholesterol concentration below this cut off point should be left to enjoy the diet on which this satisfactory equilibrium has been attained without further attempts at dietary manipulation. It remains true, of course, that a cholesterol concentration below 5 mmol/l does not provide immunity from coronary heart disease, only a reduced probability of its occurrence.—M G DUNNIGAN, *consultant physician, Glasgow*

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