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INCIDENCE AND RISK FACTORS FOR ACUTE MOUNTAIN SICKNESS AMONG THAI TRAVELERS TO HIGH-ALTITUDE AREAS

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ABSTRACT

Introduction: Acute mountain sickness (AMS) is a common health problem among travelers to high altitudes. The number of Thai travelers visiting high-altitude areas is increasing. We aimed to determine the incidence and risk factors for AMS among Thai travelers visiting these high-altitude areas.

Method: A prospective cohort study was conducted among Thai travelers who visited high-altitude areas. The study population comprised of Thai travelers that sought pre-travel counselling at the Travel Clinic of the Hospital for Tropical Diseases, Faculty of Tropical Medicine, Mahidol University, in Bangkok, during 2017. Baseline characteristics, incidence of acute mountain sickness, and ascent rate, were prospectively collected and analyzed.

Results: A total of 362 participants were eligible for analysis. The mean age was 35.40 ± 9.41 years (range 20-65 years) and 70.2% of participants were female. Leh, in Ladakh, northern India, at an altitude of ~3,500 meters, was the most commonly visited high-altitude site for the study. The overall incidence of AMS was 19.89% (72/362). The median time for developing AMS was 2 days (range 1-12 days), while 37.5% (27/72) of the participants developed AMS on the 1st day in the studied high-altitude area. Cox regression analysis revealed that travelers with asthma had significantly increased risk of AMS (HR 3.54, 95% CI 1.27-9.92). Currently active smokers were also at increased risk of AMS (HR 2.81, 95% CI 1.31 – 6.04). Gender, age, BMI, dehydration, and previous medical condition (hypertension, allergic rhinitis, dyslipidemia), including rapid ascent profile, were not contributing factors for acquiring AMS. Diamox prophylaxis was not shown to be effective in AMS prevention, based on this study.

Conclusion: The overall incidence of AMS was 19.89%. The most significant risk factors were asthma and active smoking. High-risk travelers should be aware of the early signs and symptoms of AMS and seek pre-travel counseling before visiting high-altitude areas.

INTRODUCTION

Millions of people travel to high-altitude areas annually for recreational activities, such as mountaineering or trekking (Anderson, 2016). A high-altitude area has a unique and distinct geography and climate compared with sea-level areas. Increases in altitude decrease barometric pressure, reducing the partial pressure of oxygen (PO2) to roughly 70% of sea level at 3,000 m, which may eventually lead to hypoxia and hypoxemia. Hypoxemia plays an initial role in causing AMS symptoms (Hackett, 1999).

Acute mountain sickness (AMS) is an illness that can affect travelers to high-altitude areas, usually > 2,400 meters above sea level (Honigman, 1993). Incidence rates from previous studies revealed travelers developed AMS within the 23-84% range (Murdoch, 1995; Vardy, 2006; Dellasanta, 2007; Ren, 2010; McDevitt, 2010; McDevitt, 2014; Gonggalanzi, 2016). AMS is

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a common condition and is usually defined by the presence of headache and other potential symptoms, such as gastrointestinal discomfort, dizziness, lack of sleep, and loss of appetite after arrival at high altitudes within a short time period i.e. rapid ascent. AMS usually causes mild symptoms and recovery can be spontaneous within several days, but it can potentially ruin traveler vacations and decrease physical ability at altitude. No well-designed prospective study of AMS with native Thais exists at the moment, so we aimed to determine the incidence and risk factors for AMS among Thai travelers visiting high-altitude areas. Consequently, this study would reveal important information for doctors to give upcoming travelers in the form of appropriate travel recommendations.

MATERIALS AND METHODS

All participants were recruited at the Thai Travel Clinic, Hospital for Tropical Diseases, Faculty of Tropical Medicine, Mahidol University. The study was conducted as a prospective, cohort study utilizing questionnaires (electronic or paper format) and telephone interviews. Study criteria required native Thai travelers aged > 18 years who planned to travel to high-altitude areas and stay at least one night. Persons who had been at altitudes > 2,500 meters in the 4 weeks leading up to the study were excluded. The assessment of AMS in this study was based on the Lake Louise Score (LLS). The LLS is comprised of five items, which represent the most frequent symptoms of AMS: headache, lightheadedness, gastrointestinal discomfort (poor appetite, vomiting or nausea), fatigue, and difficulty sleeping, respectively. Each item is rated by the participant on the ordinal scale from 0 to 3 (0=not present, 1=mild, 2=moderate, 3=incapacitating). Each score is summed up ranging from 0 to 15. AMS is diagnosed if the total score is 5 or greater and headache is also present. The sample size was 362 participants based on previous incidence. The student t-test was used to compare means of two groups, while the Chi-square was used for categorical data, as appropriate; a P-value of <0.05 was regarded as statistically significant. Kaplan-Maier was used for univariate analysis and significant factors were analyzed using multivariable models by using Cox-regression.

RESULTS

The demographic data of the participants during pre-travel visits is shown in Table 1. 362 Thai travelers completed the pre-travel questionnaires. 70.2% (n=254) of participants were female and 29.8% (n=108) were male. The overall mean was 35.40 ± 9.41. The mean BMI was 22.68 ± 3.92; 26% (n=94) of the participants had at least one previous medical condition, and allergic rhinitis (n=35,9.7%) was the most common diagnosis, followed by hypertension (n=16,4.4%). 93.70% (n=337) of the participants had never smoked, whereas 18 were active smokers and 7 had already quit. The most popular high-altitude destination for the study was the Ladakh region of northern India (111 participants; 30.70%), followed by Annapurna Base Camp in Nepal (n=63,17.40%) at 59.40% (n=215). (Figure 1)

The incidence of AMS among the total 362 participants was 19.89% (72/362). Many of those affected experienced AMS from the first day of travel at the studied high-altitude sites (37.5%, n=27). The mean and median number of days to develop symptoms of AMS was 2.93 and 2, respectively. (Table 2)

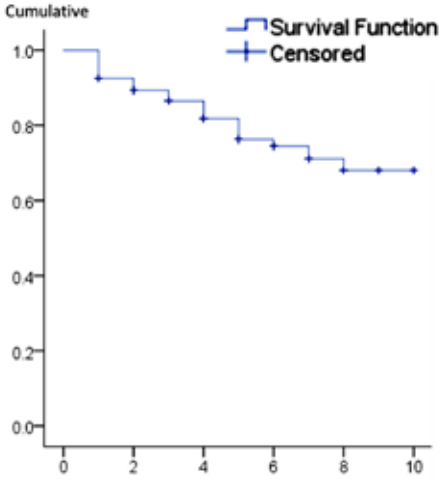
Multivariate analysis showed persons having previous medical conditions consistent with asthma or current active smoking were found to be associated with the increased development of AMS. Asthma increased the risk of developing AMS four-fold (HR 3.54, 95% CI 1.27-9.92). Current active smoking was found to have a three-fold higher risk of AMS (HR 2.81, 95% CI 1.31 – 6.04). Higher age, obesity, using Diamox for prophylaxis, rapid ascent profile, or encountering maximum altitudes of 4,200 meters or more above sea level, were not associated with the development of AMS. (Table 3)

88.89% (64/72) of persons who developed AMS experienced no impact on their journey. Only 6.94% (5/72) cancelled their trip, while only 4.17% (3/72) visited a doctor on site, resulting in one cancellation (1.39%; 1/72).

Table 1 Demographic data of total participants

	Total (N=362)	AMS (N=72)	Non-AMS (N=290)	P-value
Female gender	254 (70.20%)	50 (69.44%)	204 (70.34%)	P = 0.88#
Mean age (years)	35.40 ± 9.41	37.68 ± 11.78	34.83 ± 8.67	P = 0.06*
BMI	22.68 ± 3.92	23.34 ± 3.95	22.52 ± 3.90	P = 0.11*
U/D				
• HT	16 (4.4%)	3 (4.2%)	13 (4.5%)	P = 0.91#
• Asthma	9 (2.5%)	5 (6.9%)	4 (1.4%)	P = 0.01!
• Allergic rhinitis	35 (9.7%)	5 (6.9%)	30 (10.3%)	P = 0.71!
• Migraine	5 (1.4%)	2 (2.8%)	3 (1%)	P = 0.26#
• Other	31 (8.6%)	9 (12.5%)	22 (7.6%)	
Smoking status				
• Never smoke	337 (93.10%)	63 (87.5%)	274 (94.48%)	P = 0.03#
• Currently smoking	18 (5.00%)	8 (11.11%)	10 (3.49%)	
• Quit smoking	7 (1.90%)	1 (1.38%)	6 (0.2%)	
AMS Awareness	260 (71.80%)	45 (62.50%)	215 (74.14%)	P = 0.05#
History AMS	118 (32.60%)	21 (29.2%)	97 (33.4%)	P = 0.49#
Destination				
Leh, India	111(30.70%)	22 (30.6%)	89 (30.7%)	P = 0.98#
Annapurna base camp, Nepal	63 (17.40%)	10 (13.9%)	53 (18.3%)	P = 0.38#
Everest base camp, Nepal	34 (9.40%)	9 (12.5%)	25 (8.6%)	P = 0.31#
Cusco, Peru	33 (9.10%)	9 (12.5%)	24 (8.3%)	P = 0.27#
Kinabalu, Malaysia	25 (6.90%)	4 (5.6%)	21 (7.2%)	P = 0.61#
Other	96 (26.50%)	18 (25.71%)	78 (26.90%)	P = 0.98#

*T-test, # Chi-square, ! Fisher-exact test



Day	N	%
1	27	7.46
2	10	2.76
3	8	2.21
4	11	3.04
5	10	2.76
6	2	0.55
7	2	0.55
8	1	0.28
12	1	0.28
Incidence	**72**	**19.88**

Fig 1- Cumulative incidence of acute mountain sickness

Table 2 Multivariate analysis of factors relating to AMS

Risk factors	HR	95% CI	P-value
Age > 40 years	1.66	0.98 – 2.80	0.57
BMI ≥ 25	1.01	0.57 – 1.80	0.97
Asthma	3.54	1.27 – 9.92	0.16
Current active smoker	2.81	1.31 – 6.04	0.008
AMS awareness	0.69	0.42 – 1.15	0.15
Taking Diamox (appropriate dose)	0.26	0.03 – 1.90	0.18
Maximum altitude reached >4,200 MABSL	0.76	0.45 – 1.29	0.31
Rapid ascent on first day of high altitude	1.24	0.74 – 2.08	0.42

MABSL = Meters above sea level

Table 3 Impact of AMS

Impact	No.	%
No impact	64	88.89
Cancellation	5	6.94
Visiting doctor	2	2.78
Cancellation and visiting doctor	1	1.39

DISCUSSION

Acute mountain sickness (AMS) seemed to be a common problem among the study respondents. The overall incidence of AMS was 19.89% based on various destinations. Previous studies have reported both higher and lower prevalence of AMS than our findings (1-19). Previous studies also focused only on a specific location and the cut-off points for LLS varied among those studies. Individual location had different altitudes and ascent rates. A majority of the participants travelled mostly on foot in the high-altitude area of Nepal, not by vehicle or airplane, unlike in Ladakh, northern India, and the Andes in Peru, where travel to the destination was commonly via airplane. The former gave more time for acclimatization at lower altitudes, while the latter provided less time, mostly 1 or 2 hours before arriving at high altitude, which consequently increased the risk of AMS. High-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE), which are severe forms of high altitude illness, were not discussed in our study because the participants were unable to make a clinical diagnosis for either condition.

Three participants visited a doctor on site. The first participant had fever symptoms with cough. Upper respiratory tract infection was suspected and an oral antibiotic was administered, including an official discharge summary from the hospital. The second and third participants went on the same trip and developed similar symptoms of severe AMS (LLS = 13). However, they had no official medical treatment reports as the information provided was only verbal. They reportedly visited a local doctor and received an unknown intramuscular injection. HAPE or HACE could not be ruled out.

RISK FACTORS

Asthma

Although there was only a small number of asthmatic participants in our study, asthma was a strong promoting factor from our analysis. A study conducted at Aconcagua (Argentinian Andes), on a

person having asthma showed an inverse relation between lowest oxygen saturation after hypoxic exercise test and maximal Lake Louis score during the expedition (Seys, 2013). However, this research had no control group. In contrast, another study done in Kilimanjaro (Tanzania, Africa) and the North Col of Mount Everest (Nepal) showed that asthmatic patients had insignificant differences in terms of successful climbing rates, LLS, other physiologic parameters, and exacerbation. However, these studies included only mild stable asthmatics (Stokes, 2008; Huismans, 2010).

Smoking status

In our study, active smokers were found to be at three times higher risk of AMS than non-smokers. Previous studies had similar findings (McDevitt, 2014; Vinnikov, 2014; Vinnikov, 2015). Numbers of cigarettes used per day and current smoking status were strongly associated among high-altitude miners. Moreover, pattern of airflow obstruction found among participants was a mediator of AMS also. However, smoking status and pattern of airflow obstruction were not related to each other (Vinnikov, 2015).

Nevertheless, several studies have found smoking to be significantly protective against AMS, in particular some studies from China (Wu, 2012; You, 2012; Song, 2014). They found smokers had impaired endothelial function reducing the production of NO, one of the responsible factors for the acute symptomatology of AMS (Wu, 2012). Lower exhaled NO fraction was inversely correlated with severity of LLS (You, 2012). Several studies reported an association between smoking and it potential as a protective factor for AMS, although they were not statistically significant (Ziaee, 2005; Pesce, 2005; Mairer, 2010).

Limitation

We tried to reduce bias and confounders as much as possible. However, we accept that some exist in this study. Every participant came to get pre-travel consultation before their trip; as a result, they may have paid more care and protected themselves against AMS as far as practicable, so the actual incidence of AMS within the normal population might not be similar to the findings of this study. Since a small of number of study participants were current active smokers or asthmatics, the true risk factors for these both of these conditions may be affected.

CONCLUSION

The overall incidence of AMS was 19.89% and the most significant risk factors for AMS were asthma and currently active smoking. High-risk travelers should be aware of the early signs and symptoms of AMS and seek pre-travel counseling before visiting high-altitude areas.

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