Epidemiology of Acute Mountain Sickness on Jade Mountain, Taiwan: An Annual Prospective Observational Study

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Abstract

Wang, Shih-Hao, Yu-Cheng Chen, Wei-Fong Kao, Yu-Jr Lin, Jih-Chang Chen, Te-Fa Chiu, Tai-Yi Hsu, Hang-Cheng Chen, and Shih-Wei Liu. Epidemiology of acute mountain sickness on Jade Mountain, Taiwan: an annual prospective observational study. High Alt. Med. Biol. 11:43–49, 2010.—Acute mountain sickness (AMS) is a pathophysiological symptom complex that occurs in high altitude areas. The AMS prevalence is reportedly 28% on Jade Mountain, the highest mountain (3952 m) in Taiwan. We conducted this study owing to the lack of annual epidemiological data on AMS in Taiwan. Between April 2007 and March 2008, 1066 questionnaires were completed by trekkers visiting Paiyun Lodge on Jade Mountain. Information in the questionnaire included demographic data, mountaineering experience, AMS history, and trekking schedule. Weather data were obtained from the Central Weather Bureau of Taiwan. The Lake Louise AMS score was used to record symptoms and diagnose AMS. The χ²-test or the Student t-test was used to evaluate associations between variables and AMS. In our study, the AMS prevalence was 36%. It increased significantly at different rates at different locations on the Jade Mountain trail and varied significantly in different months. Rainy weather tended to slightly increase the incidence of AMS. A lower incidence of AMS was correlated with high-altitude trekking experience or preexposure (p < 0.05), whereas a higher incidence of AMS was correlated with a prior history of AMS (p < 0.05). The trekkers with AMS were significantly younger, ascended faster from their residence to the entrance or to Paiyun Lodge, and ascended slower from the entrance to the Paiyun Lodge (p < 0.05), but the differences lacked clinical significance. No differences in the incidence of AMS based on blood type, gender, or obesity were observed. The most common symptom among all trekkers was headache, followed by difficulty sleeping, fatigue or weakness, gastrointestinal (GI) symptoms, and dizziness or lightheadedness. In conclusion, the AMS prevalence on Jade Mountain was 36%, varied by month, and correlated with trekking experience, preexposure, and a prior history of AMS. The overall presentation of AMS was similar to that on other major world mountains.

Key Words: acclimatization; acute mountain sickness; expeditions to high altitude; high altitude medicine; intermittent exposure to high altitude

Introduction

Acute Mountain Sickness (AMS) is a pathophysiological symptom complex that occurs in response to a hypoxic and hypobaric environment. AMS affects many travelers to high altitude areas and occurs primarily above 2400 m above sea level (Zafren and Honigman, 1997; Hackett and Roach, 2001; Gallagher and Hackett, 2004). The worldwide incidence of AMS varies from 9% to 84% (Maggiorini et al., 1990; Honigman et al., 1993; Murdoch, 1995; Gertsch et al., 2002;
Kao et al., 2002; Barry and Pollard, 2003; Gallagher and Hackett, 2004; Pesce et al., 2005; Karinen et al., 2008). In recent years, ease of transportation has allowed increasing numbers of travelers to visit high altitude areas without appropriate altitude acclimatization, which has lead to a worldwide increase in the incidence of AMS (Zafren and Honigman, 1997). Many factors influence the incidence of AMS, including age, ascent rate, sleeping altitude, history of AMS, gender, obesity, previous exposure to high altitude, individual susceptibility, and a history of cardiopulmonary disease (Hirata et al., 1989; Honigman et al., 1993; Zafren and Honigman, 1997; Hackett and Roach, 2001; Schneider et al., 2002; Gallagher and Hackett, 2004; Maloney and Broeckel, 2005). The presentation of AMS is typically nonspecific, but it may progress to fatal high-altitude cerebral edema (Hackett and Roach, 2001). High-altitude pulmonary edema and mountain rescues may also be associated with AMS (Hackett and Roach, 2001; Wang et al., 2009). In Taiwan, for example, high-altitude, illness-related mountain rescues have accounted for 33% of medical emergencies requiring a mountain rescue in Yu-Shan National Park (Jade Mountain) since its establishment (Wang et al., 2009).

Jade Mountain (or Yu-Shan), located at 23'N and 3952 m above sea level, is the highest peak in Taiwan. The Yu-Shan National Park (YSNP) receives 1.23 million visitors per year, and about 40,000 come to climb to the summit of Jade Mountain (Wang et al., 2009). Trekking is available throughout the year, and trekkers usually arrive by car at the Tataka Saddle staging area park entrance (altitude 2600 m), stay at Paiyun Lodge (8.5 km from the entrance, 3402 m) the next day, and reach the summit (11 km from the entrance, 3952 m) on the third day (Kao et al., 2002).

A 28% incidence of AMS has been reported among Jade Mountain trekkers (Kao et al., 2002). However, because no annual epidemiological data on AMS in Taiwan are available, we conducted a prospective, observational study from April 2007 to March 2008. Our goal was to present the incidence, risk factors, and symptoms presentation for AMS on Jade Mountain, Taiwan.

Methods

A prospective, observational study was conducted on two random days each month from April 2007 to March 2008 at Paiyun Lodge, with the exception of February 2008, when the study was restricted to the park entrance owing to the snow season. This study was approved by the institutional review board of Chang Gung Memorial Hospital, and informed consent was obtained.

Inclusion criteria were (1) trekkers who signed the informed consent for the study, and (2) trekkers who slept at Paiyun Lodge (camped outside or stayed in the lodge). Exclusion criteria were (1) 1-day tour trekkers or those who continued beyond Paiyun Lodge, (2) people who worked at Paiyun Lodge, such as lodge staff, professional mountain guides, mountaineering assistants, and cooks, and (3) trekkers who were unable to answer the questionnaire or required emergency evacuation due to trauma.

The questionnaire included demographic data of gender, age, blood type, weight (kg), and height (m); mountaineering experience, including past high altitude trekking experience and the number of days of high altitude stay during the last 2 months; and a prior history of AMS. Information on trekkers’ schedules included the departure time from their residences, arrival time at the park entrance, and arrival time at Paiyun Lodge. The Lake Louise AMS questionnaire was used to record symptoms (Roach et al., 1993). Symptoms including headache, GI symptoms (poor appetite, nausea, or vomiting), fatigue and/or weakness, dizziness or light-headedness, or difficulty sleeping were scored from 0 to 3, with 0 indicating no symptoms and 1 to 3 indicating mild, moderate, and severe symptoms, respectively.

The official record of the atmospheric temperature (°C) and the weather for each day were obtained from the Yu-Shan Weather Station, Central Weather Bureau of Taiwan, located at Jade Mountain, north peak (3844 m). Body mass index (BMI) was calculated from weight and height, and obesity was defined as a BMI > 24 (Hirata et al., 1989). Preexposure was defined as at least a 3-day stay at high altitude during the last 2 months. Time of ascent was calculated after the data were recorded, and it included the time from the residence to the Tataka entrance (h), time from the Tataka entrance to the Paiyun Lodge, and time from the residence to Paiyun Lodge. AMS was diagnosed according to a recent rise in altitude, the presence of a headache with the presence of at least one other symptom, and a total AMS score of at least 3 (Roach et al., 1993).

Statistical analysis

The descriptive statistics are presented as the number and mean with standard deviation for each variable. The $\chi^2$-square test was used to determine differences, and odds ratios (OR) were calculated among categorical variables for trekkers who developed AMS and for the differences between months and locations for trekkers who developed AMS. The Student t test was used to determine differences between numerical variables for those with AMS. A difference was deemed statistically significant if the $p$ value was less than 0.05. All statistical analyses were performed using SPSS, version 14 (SPSS, Inc.).

Results

Between April 2007 and March 2008, 1140 questionnaires were collected from trekkers on Jade Mountain, and 1066 were appropriate for analysis after excluding those that did not fit the study criteria ($n = 33$) and those that were incomplete ($n = 41$). Fewer trekkers were evaluated in February because of snow on the mountain ($n = 8$); a special application was required for entry at such times (Fig. 1).

In our study, 36% trekkers met the criteria for AMS, and the incidence of AMS was 28% ($n = 300$), with the cutoff value of an AMS score of 4 or higher. Table 1 shows the altitude, latitude, time of ascent, and incidence of AMS at major international mountains and those documented in our study. The monthly incidence of AMS was between 22% and 49%, except in February when no cases of AMS were observed (Fig. 1). The differences in the monthly incidence of AMS were statistical significantly ($p = 0.01$). Among the trekkers who did not meet the criteria for AMS, 95 had AMS scores of 3 or above without headache, 67 had AMS scores of 2 with headache and another symptom, 109 had a headache only, 153 had an AMS score of 2 or below without headache, and 258 had an AMS score of 0.

Table 2 shows the weather, demographic characteristics, mountaineering experience, and AMS history for trekkers who developed AMS and for those who did not and the
relationships between these variables and AMS. A significantly higher incidence of AMS occurred in those who had a prior history of AMS. A significantly lower incidence of AMS occurred among those who had high altitude trekking experience or preexposure. No significant differences in the incidence of AMS were found based on the number of rainy days, gender, blood type, or obesity.

Table 3 shows the atmospheric temperature, age, body weight, body height, and time of ascent for trekkers who developed AMS and those who did not. Trekkers who were younger, who ascended faster from their residence to the Tataka entrance or Paiyun Lodge, and who had a slower ascent from the Tataka entrance to the Paiyun Lodge were significantly more likely to develop AMS, but atmospheric temperature, weight, and height were not different between AMS and non-AMS groups.

Table 4 shows the cumulative percentage of each symptom in the trekkers who developed AMS and the trekkers who did not, as well as the cumulative percentage of trekkers who developed AMS at different locations. The incidence of AMS was 0.28% at the Tataka entrance and 7.41% on arrival at the Paiyun Lodge, and it increased to 31.43% after one night at the Paiyun Lodge. The rate of AMS incidence for trekkers who developed AMS at different locations on the Jade Mountain trail was statistically significant ($p < 0.001$). The most common symptom among all trekkers was headache, followed by difficulty sleeping, fatigue or weakness, GI symptoms, and dizziness or lightheadedness.

**Discussion**

In Taiwan, AMS is the most common cause of medical problems in high mountain recreational areas (Hu and Kao, 2002). The geography and mountaineering characteristics of Jade Mountain, including low latitude, good trail conditions for trekking throughout the year, diversity of climate, and the very rapid ascent, are quite different from many major world mountains. The relatively low incidence of AMS on Jade Mountain was considered to be owing to the low latitude and subtropical climate of Taiwan (Kao et al., 2002). The incidence of AMS at a given altitude may increase during periods of low pressure (Zafren and Honigman, 1997), such as rainy days or seasonal climate change (Reeves et al., 1993). We found that, in the group of trekkers who developed AMS, the incidence of

### Table 1. Altitude, Latitude, Ascent Time, and Acute Mountain Sickness (AMS) Prevalence on Main World Mountains

<table>
<thead>
<tr>
<th>Location</th>
<th>Altitude (m)</th>
<th>Latitude (°)</th>
<th>Ascent time</th>
<th>AMS prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocky Mountains, Colorado, USA</td>
<td>1920–2957</td>
<td>37N</td>
<td>1–3 day.(d)</td>
<td>25</td>
</tr>
<tr>
<td>Swiss Alps (Maggiorini et al., 1990)</td>
<td>2850</td>
<td>46N</td>
<td>2–3 d</td>
<td>9</td>
</tr>
<tr>
<td>Swiss Alps (Maggiorini et al., 1990)</td>
<td>3050</td>
<td>46N</td>
<td>2–3 d</td>
<td>13</td>
</tr>
<tr>
<td>Swiss Alps (Maggiorini et al., 1990)</td>
<td>3650</td>
<td>46N</td>
<td>2–3 d</td>
<td>34</td>
</tr>
<tr>
<td>Himalayas, Nepal (Murdock, 1995)</td>
<td>3740</td>
<td>27N</td>
<td>Direct flight to 3740 m</td>
<td>84</td>
</tr>
<tr>
<td>Mt. Jade, Taiwan (Kao et al., 2002)</td>
<td>3952</td>
<td>23N</td>
<td>1–2 d</td>
<td>28</td>
</tr>
<tr>
<td>Mt. Jade, Taiwan (this study)</td>
<td>3952</td>
<td>23N</td>
<td>20.54 h</td>
<td>36</td>
</tr>
<tr>
<td>Mt. Mauina Kea, Hawaii, USA (Gertsch et al., 2002)</td>
<td>4205</td>
<td>19N</td>
<td>3 h</td>
<td>81</td>
</tr>
<tr>
<td>Himalayas, Nepal (Gallagher and Hackett, 2004)</td>
<td>3000–5500</td>
<td>27N</td>
<td>10–13 d</td>
<td>23</td>
</tr>
<tr>
<td>Mt. Kilimanjaro, Tanzania (Karinen et al., 2008)</td>
<td>5895</td>
<td>3S</td>
<td>6 d</td>
<td>75</td>
</tr>
<tr>
<td>Mt. McKinley, Alaska, USA (Barry and Pollard, 2003)</td>
<td>6194</td>
<td>63N</td>
<td>3–7 d</td>
<td>30</td>
</tr>
<tr>
<td>Mt. Aconcagua, Argentina (Pesce et al., 2005)</td>
<td>6962</td>
<td>32S</td>
<td>5–10 d</td>
<td>39</td>
</tr>
</tbody>
</table>
AMS tended to be slightly higher (38.3%) ($p = 0.07$, OR = 1.28) on rainy days (Table 2) and when the atmospheric temperature was slightly higher (4.85°C) ($p = 0.12$) (Table 3). Significant differences in the incidence of AMS were noted according to month ($p = 0.01$) (Fig. 1), which may have been due to the seasonal climate change or different trail conditions.

Although the cutoff value of an AMS score of 3 or higher may have overestimated the true AMS prevalence, because difficulty sleeping and/or fatigue are rather normal at an unaccustomed location and after prolonged exercise. In our study, the AMS prevalence was higher than that reported in the literature for Jade Mountain (Kao et al., 2002), even with a cutoff value of an AMS score of 4 or higher (between 28% and 36% vs. 27%) (Table 1), which may have been owing to

### Table 2. Weather, Demographic Characteristics, Mountaineering Experience, and Acute Mountain Sickness (AMS) History for Trekkers Who Developed AMS and Trekkers Who Did Not, and the Relationship with AMS

<table>
<thead>
<tr>
<th>Variables</th>
<th>AMS $^a$ (n = 384)</th>
<th>Non-AMS $^a$ (n = 682)</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainy days</td>
<td>240</td>
<td>386</td>
<td>0.07</td>
</tr>
<tr>
<td>Female</td>
<td>128</td>
<td>225</td>
<td>0.96</td>
</tr>
<tr>
<td>Blood type A $^b$</td>
<td>102</td>
<td>169</td>
<td>0.55</td>
</tr>
<tr>
<td>Blood type B $^b$</td>
<td>89</td>
<td>181</td>
<td>0.26</td>
</tr>
<tr>
<td>Blood type O $^b$</td>
<td>161</td>
<td>278</td>
<td>0.73</td>
</tr>
<tr>
<td>Blood type AB $^b$</td>
<td>22</td>
<td>38</td>
<td>0.98</td>
</tr>
<tr>
<td>High altitude trekking experience</td>
<td>209</td>
<td>451</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Preexposure</td>
<td>27</td>
<td>90</td>
<td>0.003</td>
</tr>
<tr>
<td>History of AMS</td>
<td>82</td>
<td>92</td>
<td>0.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>140</td>
<td>242</td>
<td>0.80</td>
</tr>
</tbody>
</table>

$^a$AMS, trekkers who developed AMS; Non-AMS, trekkers who did not develop AMS.

$^b$Twenty-six trekkers did not provide their blood type.

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### Table 3. Atmospheric Temperature, Age, Body Weight, Body Height, and Time of Ascent for Trekkers Who Developed Acute Mountain Sickness (AMS) and Trekkers Who Did Not

<table>
<thead>
<tr>
<th>Variables</th>
<th>AMS $^a$ (n = 384)</th>
<th>Non-AMS $^a$ (n = 682)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric temperature (°C)</td>
<td>4.9 (2.2)</td>
<td>4.6 (2.5)</td>
</tr>
<tr>
<td>Age $^b$</td>
<td>37 (12)</td>
<td>42 (12)</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>64.4 (13.1)</td>
<td>64.1 (11.2)</td>
</tr>
<tr>
<td>Body height (m)</td>
<td>1.7 (0.1)</td>
<td>1.7 (0.1)</td>
</tr>
<tr>
<td>Time from residence to the Tataka entrance (h)$^b$</td>
<td>13.6 (5.6)</td>
<td>14.6 (6.1)</td>
</tr>
<tr>
<td>Time from the Tataka entrance to the Paiyun Lodge (h)$^b$</td>
<td>6.4 (1.5)</td>
<td>6.2 (1.5)</td>
</tr>
<tr>
<td>Time from residence to the Paiyun Lodge (h)$^b$</td>
<td>20.1 (5.8)</td>
<td>20.8 (6.3)</td>
</tr>
</tbody>
</table>

$^a$AMS, trekkers who developed AMS; non-AMS, trekkers who did not develop AMS.

$^b$p < 0.05 (Student t test).
differences between our study and the report by Kao and colleagues (2002). First, because trekkers may have forgotten about their previous illness after a descent to 2659 m (Kao et al., 2002), we collected the data at Paiyun Lodge (3402 m) rather than when trekkers left through the Tataka entrance (2659 m), as did Kao and colleagues. Second, to avoid the possible influence of a very limited population, small sample size, or specific weather conditions, we investigated the incidence of AMS in the trekkers on 24 days over an entire year, rather than the trekkers on a single summer afternoon (Kao et al., 2002). Third, we diagnosed AMS using a cutoff value for an AMS score of 3 or higher in our study, rather than using the Lake Louise definition without any cutoff value for the AMS score (Kao et al., 2002). Thus, the true AMS prevalence on Jade Mountain may be between 28% and 36%.

Among the major world mountains with altitudes similar to that of Jade Mountain, the AMS prevalence was 34% in the Swiss Alps at 3650 m (Maggiorini et al., 1990), 84% in the trekkers that flew directly to 3740 m in the Himalayas (Murdoch, 1995), and 81% in the trekkers that ascended very rapidly to 4205 m on Mt. Mauna Kea, Hawaii, USA (Gertsch et al., 2002) (Table 1). It is believed that a rapid ascent results in a higher incidence of AMS (Maloney and Broeckel, 2005; Murdoch, 1999; Zafren and Honigman, 1997). Thus, the extremely fast ascent resulted in a much higher incidence of AMS in Murdoch’s or Gertsch’s reports than in our study, even with a similar altitude. In contrast, for major world mountains with altitudes higher than Jade mountain, the AMS prevalence was 30% for Mt. McKinley (Barry and Pollar, 2003), 39% for Mt. Aconcagua (Pesce et al., 2005), and 23% at an altitude of 3000 to 5500 m in the Himalayas (Gallagher and Hackett, 2004) (Table 1). The AMS prevalence in the last three reports was similar to or lower than that in our report, which may have been owing to the slower ascent rate of these study populations than that common for Jade Mountain trekkers (Table 1).

The relationship between a history of AMS and demographic factors such as age, gender, and obesity has been reported in studies of the incidence of AMS (Hirata et al., 1989; Roach et al., 1995; Zafren and Honigman, 1997; Hackett and Roach, 2001; Basnyat and Murdock, 2003; Rodway et al., 2003; Gallagher and Hackett, 2004). On Jade Mountain, we found that those who had a prior history of AMS had a significantly higher incidence of AMS during this study (Table 2), and those who had high-altitude trekking experience or preexposure had a significantly lower incidence of AMS (Table 2). Some reports have indicated that women or obese individuals may have a higher incidence of AMS (Hirata et al., 1989; Honigman et al., 1993). However, no significant differences in the incidence of AMS based on gender or obesity were found in our study (Table 2). Further, although no previous studies have reported the relationship between blood type and AMS, no relationship between AMS and blood type was found in Jade Mountain trekkers (Table 2). In addition, the trekkers with AMS were significantly younger, ascended faster from their residence to the entrance or to Paiyun Lodge, and ascended slower from the entrance to the Paiyun Lodge (p < 0.05): but the differences lacked clinical significance because they were so little, with huge overlap between the trekkers who developed AMS and those who did not (Table 3).

Although late summit arrival times are a key feature of nonsurvivors on Mt. Everest (Firth et al., 2008), and slower ascent from the Tataka entrance to the Paiyun Lodge was significantly correlated with AMS on Jade Mountain, the relationship lacked clinical significance because of the small differences in ascent rates between the AMS and non-AMS groups on Jade Mountain (Table 2). However, the high AMS prevalence that resulted from rapid rates of ascent not only occurred in extreme conditions (direct flight or rapid transport from sea level), but also occurred among trekkers on some major world mountains, such as Mt. Kilimanjaro (75%) (Murdock, 1995; Gertsch et al., 2002; Karinen et al., 2008) (Table 1). This may be because the mountain lodges are separated by 1000 m of elevation on the Mt. Kilimanjaro Marangu route (Karinen et al., 2008), and similar conditions occur on Jade Mountain; the elevation gain and average time from the Tataka entrance to Paiyun Lodge is 800 m and 6.28 h, and there is no suitable place for an overnight stay along the way.

In fact, even comparatively slower trekkers on Jade Mountain ascend more rapidly than on other major world mountains (Table 1). Thus, it is impossible for trekkers to ascend gradually after traveling above 3000 m, to avoid ascending more than 300 m per day, or to stay an additional night for every 2 or 3 days of ascent (600 to 900 m), all strategies that would allow for sufficient acclimatization to avoid AMS on mountains such as Mt. Kilimanjaro and Jade Mountain (Zafren and Honigman, 1997; Murdoch, 1999; Maloney and Broeckel, 2005; Karinen et al., 2008). Trekkers who climb such routes are forced to make rapid ascents and might be exposed to a higher risk for AMS. Thus, the allocation of lodging facilities might influence the ascent rate and further affect the incidence of AMS. Appropriate arrangement of trail and lodging facilities is an important issue in an era in which high altitude travel has become more popular.

AMS is a pathophysiological symptom complex in response to hypoxic–hypobaric conditions and requires time to develop (Zafren and Honigman, 1997; Maloney and Broeckel, 2005). Headache is usually the first symptom of AMS, and some trekkers may have symptoms that might be associated with AMS, but their AMS scores will fall below the threshold for AMS because of a lack of associated headache or because they have only one mild symptom in addition to headache. Thus, among trekkers who did not meet the AMS criteria for our study, trekkers with headache but no other symptoms (n = 109) or with one mild symptom (n = 67) could represent early or very mild AMS. However, we found that trekkers developed AMS at a significantly increased rate at different locations of the Jade Mountain trail (p < 0.001) (Table 4). Our findings agree with reports that a 6- to 12-h lag from the time one enters a high altitude area to the onset of AMS symptoms is typical, although it may be as short as 1 h or as long as 4 days (Singh et al., 1969; Hackett and Roach, 2001; Rodway et al., 2003; Maloney and Broeckel, 2005). Further, the incidence of AMS at the Tataka entrance (2600 m) was 0.28% in our study (Table 4), which was much lower than Honigman’s report in Colorado at a similar altitude (Honigman et al., 1993) (Table 1). This may be because sleeping time was included in the 14-h trip from the trekker’s residence to the Tataka entrance in our study, and hence in the “lag” of AMS onset. Finally, the most common symptoms among trekkers in our study were headache, followed by difficulty sleeping, fatigue and/or weakness, GI symptoms, and dizziness or light-headedness (Table 4). The same symptom presentations were also noted on Mt. Kilimanjaro, which has many similarities with Jade Mountain, including low latitude and rapid ascent (Karinen et al., 2008). Many reports have stated that headache
is the most common symptom in high altitude areas (Hackett et al., 1976; Broome et al., 1994; Serrano-Duenas, 2005), and difficulty sleeping was the second most common symptom in trekkers on Jade Mountain (Kao et al., 2002). Although difficulty sleeping may be attributed to respiratory dysrhythmia resulting from repetitive periodic breathing (Weil, 1985), overcrowding at Paiyun Lodge or the unaccustomed location for trekkers might influence the quality of sleep and be a contributing factor to their difficulty in sleeping on Jade Mountain.

Acknowledgments

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Limitations

We did not investigate high altitude cerebral edema (HACE) or high altitude pulmonary edema (HAPE). In fact, only one trekker had HACE and one developed HAPE in our study population, and they required emergency evacuation after answering our questionnaire at Paiyun Lodge. We also did not discuss the incidence of drugs used to prevent AMS because of the very low incidence of drug use, including acetazolamide (n = 56) or Rhodiola (n = 29), in our study populations. One study criterion excluded trekkers who were unable to answer the questionnaire or required emergency evacuation owing to trauma. It is believed that some major traumas in high altitude areas are secondary to severe high altitude illness. However, no trekkers met this exclusion criterion for our study. Finally, selection bias might be a possible limitation of our study. For example, no trekkers developed AMS in February during the snowy season (Fig. 1). According to YSNP policy, trekkers during that period were required to be experienced in snow climbing and this factor may have resulted in the low incidence of AMS. However, even in nonsnow months, the YSNP policy limits the number of trekkers entering the Jade Mountain trail per day to protect the environment. If the number of trekkers exceeds the limit, YSNP officials issue park entry permits and arrange accommodations by drawing lots 30 days in advance. In fact, drawings are performed almost every day, except in the snow season. Our study was blind to the drawing mechanism; therefore, the trekkers might be considered nearly randomized and the selection bias minimal.

Conclusions

AMS prevalence among Jade Mountain trekkers was 36%, increased at different rates at different locations on the Jade Mountain trail, and varied by month. The incidence of AMS was associated with time of year, trekking experience, pre-exposure, and prior AMS history. No difference in the incidence of AMS was observed based on blood type. Finally, the overall presentation of AMS was similar to that observed on other major world mountains.

Acknowledgments

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Disclosures

The authors have no conflicts of interest or financial ties to disclose.

References


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