Incidence and Severity of Acute Mountain Sickness and Associated Symptoms in Children Trekking on Xue Mountain (3,886 m), Taiwan

Fei-Ying Cheng, MD
Department of Emergency Medicine,
MacKay Memorial Hospital, Taipei, Taiwan
Introduction

• **Acute mountain sickness (AMS):**
  A patho-physiological response to a hypoxic and hypobaric environment at altitudes above 2500 m

• **Cardinal symptoms: Headache**
• Other associated symptoms: dizziness, fatigue, GI symptoms (anorexia/nausea/vomiting), sleep disturbance

• Mostly self-limited, resolves within 1-3 days after descent
Incidence and Risk Factors

• **Incidence:**
  Approximately 25% at moderate altitudes, 50-85% at high altitudes


• **Risk factors:**
  Lack of acclimatization, rapid ascent, high sleeping altitude, previous AMS history


• **Others:** *Young age,* female gender, obesity, low residence altitude, physical fitness, concurrent medical illness
Study Design

- A prospective observational study

- **197** healthy primary school children, **age 11-12 years**
- 111 males, 86 females

- Residence level: all below 500 m
- No high altitude exposure (> 2500 m) in previous 3 months
Evaluation of AMS

• **The Lake Louise Questionnaire**

• A recent gain in altitude, at > 2500 m above the sea

• Headache

• **A total AMS score of ≥ 3**, with presence of at least one other symptom

• The AMS evaluation was done by trained medical staff.
### Subject Characteristics

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Total (N = 197)</th>
<th>AMS group (N = 80)</th>
<th>Non-AMS group (N = 117)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td>†0.033</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>111 (56.3%)</td>
<td>54 (48.6%)</td>
<td>57 (51.4%)</td>
<td></td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>86 (43.7%)</td>
<td>26 (30.2%)</td>
<td>60 (69.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Mean body weight, kg</strong></td>
<td>45.1±10.8</td>
<td>47.8±12.1</td>
<td>43.1±9.3</td>
<td>†0.008</td>
</tr>
<tr>
<td><strong>Mean body height, cm</strong></td>
<td>152.0±7.1</td>
<td>152.9±7.7</td>
<td>151.3±6.6</td>
<td>0.113</td>
</tr>
<tr>
<td><strong>Mean body mass index, kg/m^2</strong></td>
<td>19.4±3.7</td>
<td>20.2±4.0</td>
<td>18.7±3.4</td>
<td>*0.008</td>
</tr>
<tr>
<td>Menstruation (% of females)</td>
<td>13 (15.1%)</td>
<td>6 (23.1%)</td>
<td>7 (11.7%)</td>
<td>0.398</td>
</tr>
<tr>
<td>High altitude experiences</td>
<td>150 (76.1%)</td>
<td>65 (81.3%)</td>
<td>85 (72.6%)</td>
<td>0.380</td>
</tr>
<tr>
<td>Previous AMS history</td>
<td>14 (7.1%)</td>
<td>4 (5%)</td>
<td>10 (8.5%)</td>
<td>0.636</td>
</tr>
</tbody>
</table>

Abbreviations: AMS, acute mountain sickness; BMI, body mass index.

Data are presented as mean ± SD.
Overall and Daily Incidence

AMS Incidence (%)

Total: 40.6%
Day 1 (2460 m): N/A
Day 2 (3100 m): N/A
Day 3 (3100 m): N/A

*p < 0.001
Overall and Daily AMS Scores

AMS: $3.02 \pm 2.46$

* $p < 0.001$
Overall Frequency of AMS Scores

- AMS score ≥3: 27.5%
- Severe AMS: score ≥7: 3.9%
Prevalence of Symptoms in Males and Females

* $p < 0.05$
### Overall Prevalence of Symptoms on Different Days

<table>
<thead>
<tr>
<th>symptom</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>14.7</td>
<td>46.2*</td>
<td>31.3</td>
<td>58.4</td>
</tr>
<tr>
<td>Dizziness</td>
<td>14.2</td>
<td>40.6†</td>
<td>41.7†</td>
<td>61.9</td>
</tr>
<tr>
<td>Fatigue</td>
<td>11.2</td>
<td>27.9</td>
<td>32.3*</td>
<td>45.7</td>
</tr>
<tr>
<td>GI symptoms</td>
<td>3.6</td>
<td>12.7</td>
<td>22.4*</td>
<td>28.9</td>
</tr>
<tr>
<td>Sleep disturbance</td>
<td>N/A</td>
<td>57.9*</td>
<td>49.5</td>
<td>74.6</td>
</tr>
</tbody>
</table>

Abbreviations: AMS, acute mountain sickness; GI symptoms, gastrointestinal symptoms.

- **Day 1**: Qika Hut, 2,460 m. Day 2: Sanliuju Hut, 3,100 m. Day 3: Sanliuju Hut, after reaching the summit of Xue Mountain (3,886 m).
- **b.** The sleep disturbance score of Day 1 is not taken into account by the analysis, because all subjects slept at home (near sea level) the day before trekking.
- **c.** McNemar’s test was used to determine the difference in prevalence of each symptom from day to day.

† $p<0.05$ indicates that the prevalence of dizziness was higher on Day 2 and Day 3 compared with Day 1. However, there was no significant difference between Day 2 and Day 3.

* $p<0.05$ indicates a statistically higher prevalence compared with other days.
Daily Prevalence of Symptoms in AMS and non-AMS groups.

< 7 % has symptom

* p < 0.05
Daily AMS Score for Each Symptom

![Graph A](image1)

![Graph B](image2)

![Graph C](image3)

* $p < 0.05$
Conclusion

- **The AMS incidence: 40.6%**, higher than adults at similar altitudes (32-36% on Jade Mountain, 3952 m, Taiwan).

- The AMS symptoms were common but mild, overall AMS score <2: 72.5%
- **Males** are more susceptible to AMS in our study.

- Subjects experienced less AMS and AMS-associated symptoms on Day 3, probably due to the effect of acclimatization and medication.
- **Sleep disturbance** was the most prevalent and severe symptom.

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Syue Mountain

格高 3886 公尺
Altitude of 3886 meters
Thank You for Listening!