



Short communication

The effect of sleep quality in Sherpani Col High Camp Everest

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ABSTRACT

Recently, an increasingly higher volume of travelers deciding to get the experience of hiking to the highest summit worldwide has been noted. However, high altitude environments have adverse effects on the normal bodily function of individuals accustomed to living at low altitudes. The purpose of this study was to record sleep quality and physiological responses of 8 climbers during a 7 days stay at Sherpani Col High Camp Everest in an altitude of 5700-m. Eight experienced climbers (Age: 48 ± 9.2 yrs, Height: 176.3 ± 7.1 cm, Body mass: 76.9 ± 11.7 kg, weekly exercise $> 80\% \text{HR}_{\text{max}} > 270 \text{min}^{-1}$) participated in the study. The climbers recorded their sleep quality daily and one hour after waking up via a questionnaire (Groningen Sleep Quality Scale, GSQS), levels of perceived exertion (Borg CR10 Scale), heart rate (HR, bpm^{-1}) and oxygen saturation in blood (SpO_2 , %) using the pulse oximeter Nonin Onyx Vantage 9590 (USA). Climbers also filled out questionnaires regarding how sleepy they felt (Epworth Sleepiness Score, ESS) 12 h post waking-up. Repeated measures ANOVA were used in order to examine possible variations between variables. Results showed statistical significant differences in the HR and SpO_2 parameters, (HR: $86.5 \pm 5.2 \text{bpm}^{-1}$, $p < 0.05$; SpO_2 : $85.3 \pm 2.4\%$, $p < 0.05$). The subjective evaluation of GSQS, ESS and perceived exertion using a Borg CR10 Scale may be affected by the extreme hypoxic environment and the daily hike-climb which results in low blood oxygen saturation.

1. Introduction

Recently, an increasingly higher volume of travelers deciding to get the experience of hiking to the highest summit worldwide, has been noted (Mount Everest, 2019). However, high altitude environments have adverse effects on the normal functioning of the humans' body accustomed to living at low altitudes because of the change in barometric pressure which causes decrease in the amount of oxygen leading to hypobaric hypoxia (San et al., 2013). The study of those changes is of great interest. The reduced oxygen content of the blood induces breathing instability, with periods of deep and rapid breathing alternating with central apnea, known as high-altitude periodic breathing (San et al., 2013). Moreover, the cold, the wind, noisy or smelly tent companions and long-distance travel can also disturb the sleep.

The purpose of this study was to record the sleep quality and physiological responses of 8 climbers during a 7 days stay at Sherpani Col

Table 1
Climbers characteristics.

	Mean \pm Sd
Age, years	48.0 ± 9.2
Height, cm	176.3 ± 7.1
Body mass, kg	76.9 ± 11.7
BMI, kg/m^2	24.6 ± 2.3
BSA, m^2	1.9 ± 0.3
Previous experience in climbing, yrs	10.1 ± 8.7
Exercise type	Indoor skiing, swimming, running, cycling, fitness
Exercise, hours/day	2.0 ± 0.3
Exercise, frequency/week	4.5 ± 0.5

Abbreviations: BMI: body mass index, BSA: body surface area.

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Table 2
Climbers results.

Days	HR (bpm ⁻¹)	SpO ₂ (%)	GSQS	ESS	Borg CR-10 Scale	Temperature (°C)
1	87.9 ± 9.7	83.0 ± 3.7	8.6 ± 1.4	9.9 ± 0.4	8.9 ± 1.0	1.5 ± 0.1
2	87.1 ± 8.5	82.9 ± 4.3	8.8 ± 1.5	9.8 ± 0.7	8.9 ± 0.8	5.0 ± 0.5
3	86.6 ± 11.9	84.3 ± 3.3	8.5 ± 1.2	9.4 ± 1.8	7.8 ± 2.4	5.0 ± 1.0
4	84.8 ± 10.5	86.9 ± 1.6	9.1 ± 0.4	10.0 ± /	8.5 ± 0.5	5.0 ± 1.1
5	95.1 ± 13.8	87.1 ± 5.5	8.5 ± 0.5	10.0 ± /	8.0 ± /	5.0 ± 0.6
6	81.4 ± 9.3	84.6 ± 4.4	8.3 ± 2.1	9.4 ± 1.4	8.5 ± 0.9	0.6 ± 1.8
7	78.8 ± 9.1	89.4 ± 1.8	8.4 ± 1.1	9.0 ± 1.4	8.5 ± 1.1	5.0 ± 0.9

Abbreviations: ESS: Epworth sleep scale, GSQS: Groningen sleep quality scale, HR: heart rate, SpO₂: oxygen saturation.

High Camp Everest in an altitude of 5700-m.

2. Methods

2.1. Participants

Eight healthy male experienced climbers (Table 1) participated in our study. Climbers for a 7 days stay at Sherpani Col High Camp Everest in an altitude of 5700-m.

2.2. Measures

The climbers, daily and one hour after waking up, recorded their sleep quality via a questionnaire (Groningen Sleep Quality Scale, GSQS), perceived exertion (Borg CR10 Scale), heart rate (HR, bpm⁻¹) and oxygen saturation in blood (SpO₂, %) using the pulse oximeter Nonin Onyx Vantage 9590 (USA). Climbers also filled out questionnaires regarding how sleepy they felt (Epworth Sleepiness Score, ESS) 12 h post waking-up. Environment temperature was also being recorded by Elitech RC-61S (Elitech Technology, Inc., UK). All climbers, during night, were sleeping in tents.

2.3. Statistical analysis

The Kolmogorov–Smirnov test was used in order to determine data normality. For continuous variables, Repeated measures ANOVA were used in order to examine with Tukey post hoc testings were used to identify differences between successive (daily) measurements. The level of significance was set to $p < 0.05$ and the data are presented as mean value and standard deviation (Mean ± SD). All statistical analyses were performed using the SPSS 22 statistical package (SPSS Inc., Chicago, IL, USA).

3. Results

The results (Table 2) show statistically significant differences in the

HR and SpO₂ parameters between successive measurements at each time point (day) (HR: $86.5 \pm 5.2 \text{ bpm}^{-1}$, $p < 0.05$; SpO₂: $85.3 \pm 2.4\%$, $p < 0.05$) and high values, but no statistical significance of the scores of questionnaires (GSQS, 8.7 ± 0.3 , $p > 0.05$; ESS, 9.7 ± 1.3 , $p > 0.05$; Borg CR10 Scale, 8.5 ± 0.4 , $p > 0.05$), during the period staying at the camp.

4. Discussion

Past studies have shown that the subjective evaluation of GSQS, ESS and the perceived exertion using a Borg CR10 Scale may be affected by the extreme hypoxic environment (~14% O₂) and the daily hike-climb, which result in low blood oxygen saturation (Jafarian et al., 2008; Lombardi et al., 2013; Calbet and Lundby, 2009). However our study did not prove a statistical significance for those factors. Heart rate and oxygen saturation seem to have statistical significance according to our study. At this point we should refer to our study's limitations, mainly due to a relatively small number of participants, and encourage further studies to establish those relationships that we found.

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