AEROBIC CAPACITY AND ALTITUDE SICKNESS DURING HIMALAYAS TREK

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ABSTRACT

The aim was to determine relations of physical fitness and high-altitude sickness symptoms and drug usage in non-athletes visiting hypoxic environment.

Subjects, 17 males (age 47.8 ± 10.65), participated in 26-days trek (2500-6476m). Before the trip an all-out treadmill test was performed (maximal speed/ grade and estimated VO₂max recorded). At every new sleeping altitude, the information about drug consumption and altitude sickness symptoms was noted. There were 7 subjects without symptoms. Others had headaches, insomnia and breathing distress. The used drugs were paracetamol, propyphenazone caffeine mixture, ibuprofen and aspirin. There were significant correlations between the occurrence of the symptoms and time on the treadmill (-0.504), achieved speed (-0.601) and grade of treadmill (-0.601), while no correlations between the physical fitness parameters and drug usage was confirmed. Then the subjects were divided in 2 groups according to VO₂max (age adjusted). The age and the BMI of both groups were not significantly different ($p=0.576$ and 0.758 , respectively). The Mann Whitney-U test showed the differences in both, the altitude sickness symptoms and in drug usage. The group with better estimated aerobic capacity had significantly less symptoms ($Z=2.44$; $p=0.012$) and consumed expectedly less drugs ($Z=2.08$; $p=0.030$). Altogether, the presence of the high-altitude sickness symptoms was not high apart from the expected tiredness. The level of physical fitness seems to be related to lower chance of high-altitude sickness, but it is not a guarantee to avoid it. Still an improvement in aerobic capacity before the ascent should still be considered.

Key words: altitude sickness, hypoxia, physical fitness

INTRODUCTION

The expansion of the tourist agencies organizing Himalayan tours is frequented by generally less active population and out of a pure curiosity. In recent years the high-altitude tourism is increasingly popular even among so called non-athletic population. The relationship between the aerobic capacity in recreational population and the occurrence of the altitude sickness symptoms was not studied extensively.

Overexertion in less prepared population often leads to medical problems and not rarely to lethal outcome. Acute mountain sickness symptoms include often difficulty sleeping, shortness of breath with exertion, dizziness or light-headedness, fatigue, headache, loss of appetite, nausea or vomiting, rapid heart rate and the more serious symptoms might include pulmonary or cerebral edema. When it comes to mountain sickness, fitness alone doesn't grant you protection.

Older findings suggested no correlation between AMS scores and hypoxic ventilatory response (usually connected with good adaptation to altitude) with VO₂max measured by treadmill or shuttle run (Milledge et al., 1991).

In a recent paper by Rossetti et al. (2017) there was a conclusion that subjects who were more prepared, meaning with greater sea-level fitness experienced effort during hiking, and did not suffer from worse acute mountain sickness or arterial oxygen desaturation. Some researchers suggest that the training in normobaric hypoxia at sea level does not reduce the incidence of symptoms within a rapid ascent to 4559 m, but it seems that it prevents AMS at lower altitudes (Schommer et al., 2010).

Aim

As there are confounding results regarding the influence of overall physical preparation on acute mountain sickness (AMS) symptoms as well as on

the amount of medications needed to treat it, the aim was to determine relations of physical fitness and high-altitude sickness symptoms and drug usage in non-athletes visiting hypoxic environment.

METHODS

The study included 17 adult male non-athletes (originating from the same village, who participated in a 26-day long tour in Himalaya at the end of 2017) Subjects (age 47.8 ± 10.65), participated in a trek at 2500-6476m.

Participants provided written informed consent and the study was approved by Ethics committee of the Faculty of Kinesiology, University of Zagreb. All study procedures were in accordance with the Declaration of Helsinki. 10 days prior to the depar-

ture the initial measurements were performed and included blood work (as a part of health check) and ergometry on a treadmill in a laboratory on altitude of 122m above the sea level. The all-out treadmill test, overseen by cardiologists was performed according to the standardized Bruce stress test protocol (a graded test till complete exhaustion (Bruce, 1973).

Even though the goal was to exclude the possible coronary heart diseases, the aim was also to estimate the cardiovascular fitness. The treadmill speed and incline increased every three minutes and from achieved time and given the treadmill speed and grade test the maximal aerobic capacity was estimated.

The itinerary is shown in Table 1.

Table 1. *The itinerary of the track*

Location
Phakding (2645m)*
Namche Bazaar (3440m)*
Kumjung (3700m)*
Thyangboche (3870m)*
Dingboche (4360m)*
Dongla (4930)*
Gorak Shep (5170 m), after Base camp (5335m)
Pheriche (4280m)*
Namche Bazaar (3440m)*
Lukla (2840)*.
Chutanga (3020m)*
Thuli Kharka (4300m)*
Khote (3660 m)*
Thangnag (4356m)*
Khare (5045m)*
High Camp (5780m)*
Khare (5045m)*, after Mera Peak (6464m)
Khote (3660m)*
Thuli Kharka (4300m)*
Lukla (2840m)*, over Zatrwa La (4610m)
Lukla (2840m)*-

RESULTS

The descriptive data of the initial testing of the subjects are shown in Table 2.

Table 2. *General data and Bruce treadmill test final data*

	Mean	Minimum	Maximum	Std.Dev.
Age (y)	47,78	23,00	66,00	10,653
Height (cm)	182,78	165,00	198,00	8,243
Weight (kg)	88,44	70,00	112,00	10,165
BMI	26,47	19,72	30,38	2,337
Bruce test duration (min)	15,39	11,00	20,00	2,789
HR at end	150,39	121,00	173,00	13,695
METs achieved at the end	14,91	11,10	18,50	2,141

Mean aerobic capacity of the subjects was 52.18 was ml·kg/min. The minimal value was 38.8 while the estimated maximum was 64,75 ml·kg/min. There were 7 subjects without symptoms. Others had headaches, insomnia and breathing distress. The used drugs were paracetamol, propyphenazone caffeine mixture, ibuprofen and aspirin. There were significant correlations between the occurrence of the symptoms and time on the treadmill (-0.504), achieved speed (-0.601) and grade of treadmill (-0.601), while no correlations between the physical fitness parameters and drug usage was confirmed.

Then the subjects were divided in 2 groups according to VO₂max (age adjusted). The age and the BMI of both groups were not significantly different ($p=0.576$ and 0.758 , respectively). The Mann Whitney-U test showed the differences in both, the altitude sickness symptoms and in drug usage. The group with better estimated aerobic capacity had significantly less symptoms ($Z=2.44$; $p=0.012$) and consumed expectedly less drugs ($Z=2.08$; $p=0.030$).

DISCUSSION

In some papers the acetazolamide was proven way to prevent or cure mountain sickness even though Bradwell and al. (2018) found in a randomized study that it reduces exercise capacity following a 5-day ascent to 4559 m. Even though the acetazolamide might reduce the symptoms of acute mountain sickness (Hung et al., 2019, Gonzales et al., 2018) none of the subjects in this study used any drugs of that type in order to prevent or cure mountain sickness. Altogether, they consumed 24 tablets of Caffetin (which is over-the-counter combination of paracetamol 250mg, propyphenazone 210 mg, caffeine 50mg and codeine phosphate 10mg), 5 cap-

sules of ibuprofen 400mg, 5 tablets of Aspirin plus C and 20 sore throat lozenges during the journey. Looking at the diary where the consumption was noted it could immediately be seen that the total used amount of the drugs was not very high.

We can say that only seven out of 17 participants who did not report any serious health-related problems when asked about headache, vertigo, dizziness, appetite, severe respiratory symptoms, and insomnia is a relatively low number. Especially considering the fact that the participants were not top-level athletes, rather recreational population. Of the remaining 10 participants with AMS, 7 reported occasional mild headache and 2 moderate to severe headache. There was one case of diarrhea and more than half of them reported occasional insomnia. Most of those were reported during the first part of the journey. Symptoms started from day 5 to day 12 (3440m to 5360m and back to 3440m). During the second part of the trekking, (day 13 to day 26 from 3440m to 6476m and back to 1440m), there were even less adverse events, that is only 5 reported headaches. Most of those occurred at High Camp (5780m) and after climbing to Mera Peak (6476m). Also, one person coughed and 5 had sore throat, both symptoms seemingly unrelated to mountain sickness but rather to acute respiratory infection. Looking at the time of the occurrence of the symptoms there is a possibility that the first part of the trip actually served as an adaptation period which was to be expected.

The most interesting finding in the study is the proven relation between the cardiorespiratory fitness and occurrence of the symptoms of the acute mountain sickness which was seen only after the

sample was divided into two groups and only after the aerobic capacity was adjusted for their age (as there was a large age span across the sample). It means that according to the criteria generally used for evaluation of population fitness, their aerobic capacity was categorized in one of the five categories from very poor to excellent. Without that adjustment of the fitness level for the age it appeared to be no correlation between maximal aerobic oxygen consumption achieved at treadmill test and the AMS which might explain some previous findings.

Altogether, we can conclude that the overall occurrence of the high-altitude sickness symptoms was not high apart from the expected tiredness which was reported relatively often. Also, we can conclude that the level of physical fitness seemed to be related to the lower chance of high-altitude sickness manifestation but it is not a guarantee to avoid it. Still an improvement in aerobic capacity before the ascent should still be considered.

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