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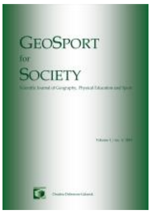

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Study on the possibilities of objectization of the organization's response to altitude variations

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Abstract: Currently, mainly due to the lack of subjects willing to be researched in extreme conditions, but also the lack of working conditions, specialized knowledge, information, publications in the field are quite few, most of them being from American literature, the USA. being one of the countries with a tradition in mountaineering, nature offering enough possibilities for practicing this sport. For this reason, I tried to contribute to the completion of current knowledge in this field. Due to the increase in the number of people going to altitude, it is necessary that the specialists who can offer advice or treatment be as well trained as possible, preventing the occurrence of seasickness as much as possible altitude: acute mountain sickness – AMR, high-altitude pulmonary edema – EPMA and high-altitude cerebral edema – ECMA, which are caused by reduced blood oxygen levels. Prevention can be done with specific drugs (Dexamethasone, Ibuprofen) and by descending to a lower altitude. These diseases are very rare below 2.500 m, and from 3.000 m up, they occur in 75% of those who are not acclimatized, they can appear even after 24 - 48 hours, the descent having an important role in their involution, the return can last between 2 – 5 days.

Keywords: mountaineering, altitude, acclimatization, acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE)

Introduction

According to Platonov (2015), we learn that the 19th Olympics in Mexico City – 2.240 m – was the moment when sports specialists focused on the preparation of athletes and competitions at altitude. Initially, only acclimatization was the problem that the researchers focused on, as it was the condition that most influenced the functional capacity of the athletes, the endurance of the efforts and the activity of the important functional systems of the body.

The study started from the premise that this study can be important both for climbers in particular, and in the training process of athletes at altitude, where the human body accumulates energy and increases the capacity for effort, by increasing the number of red blood cells.

Also, due to the increasing influx of tourists and climbers in the higher areas of the globe, I believe that a study on the accommodation and preparation of the body for altitude is necessary and beneficial for them, most of them coming from low altitude areas.

Prince and Huebner (2022) show that, due to the increase in the number of people going to altitude, is necessary that the specialists who can offer advice or treatment be as well trained as possible (Drăgan, 1977) preventing the occurrence of seasickness as much as possible altitude: acute mountain sickness – AMR, high-altitude pulmonary edema – EPMA and high-altitude cerebral edema – ECMA, which are caused by reduced blood oxygen levels. Prevention can be done with specific drugs (Dexamethasone, Ibuprofen) and by descending to a lower altitude. These diseases are very rare below 2.500 m, and from 3.000 m up, they occur in 75% of those who are not acclimatized, they can appear even after 24 - 48 hours, the descent having an important role in their involution, the return can last between 2 – 5 days (Prince and Huebner, 2022).

Platonov (2015) believes that the experiments related to the influence of training at altitude on the human body, but also in conditions of artificial hypoxia created in barochambers, demonstrate the need for this kind of training not only to increase the efficiency of competitive activity in conditions of medium altitude, but also its efficiency in increasing the possibilities of the functional systems of the athletes' body and the results in floor competitions. Thus, the attention of specialists turned to the active search for methods of using training at medium and high altitude, to increase the efficiency of the sports training process, especially for sports branches related to the manifestation of resistance.

Friedmann-Bette (2008) shows that not all specialists have agreed on the optimal altitude at which training is appropriate, most specialists, as well as the experience of athletes, are related to the altitude from 1.700 – 2.200 m. The high altitude training at 2.500 – is also significant 3,000 m. Training done at 1.000 – 1.500 m is not approved in increasing the efficiency of training preparation. Most specialists consider the altitude of 2.000–2.500 m as optimal in the training process of athletes. According to West et al. (2013), Aristotle himself (384 – 322 BC) when he climbed Mount Olympus – 2.917 m in Greece, claimed that in order to stay alive, he had to use wet sponges with the help of which it was possible to breathe in that rarefied air, and the first article related to mountain sickness was written in 1590 by Joseph de Aosta, a priest who traveled to high altitude in Peru and experienced altitude sickness, even vomiting.

According to Platonov (2015), the conditions of the mountain climate are much different from those on the plains, due to changes in humidity and temperature, through the decrease in atmospheric pressure and the partial pressure of oxygen in the atmosphere, through the high degree of ionization of the air and through increased solar radiation. Specialists classify altitude zones differently, leading to important contradictions for the definition of altitude, but the major condition is hypoxia, the factor that acts radically on the human body, in addition to natural factors. But lately, thanks to training analyzes and the physiological reactions of athletes, specialists in the field of high-performance sports have established the following classification:

- Low altitude conditions - between 800 – 1.000 m. In these conditions, at moderate efforts and at rest, hypoxia does not have a major influence on physiological functions. Major changes can be seen with high efforts;
- Medium altitude conditions - between 1.000 – 1.500 m. In this area, moderate efforts may cause functional changes, even if the body at rest does not feel the negative influence of hypoxia;
- High altitude conditions–over 2.500 m. At this altitude, in a state of rest, the body undergoes functional changes, due to hypoxia.

According to Saltin (1985), in the case of people not adapted to altitude conditions, the heart rate at rest and during exertion can increase even at 1.000 m, the compensatory reactions of the body are very clear in the case of exertion, confirmation coming from the analysis of the dynamics of lactate growth from blood. Efforts at 1.500 m lead to an increase in lactate concentration by 30%, compared to data from the plateau, it follows that at 3.000 – 3.500 m, it can reach 170 – 240%. If the supply of oxygen to the body suddenly decreases, determined by the decrease in the partial pressure of oxygen in the air, it can lead to a decrease in the results of training, as well as in competitions, requiring high demands on the aerobic energy supply system. The decrease in functional capacity is determined by its connection with the VO2 max level, manifesting itself obviously from an altitude of 1.500 – 2.000 m.

The main purpose of this study is to verify the methods and tools used to objectify the body's response to altitude variations. This study started from the idea that monitoring and studying climbers at various altitudes can lead to the development of training/preparation structures for those who travel at high altitude–climbers, athletes, workers and tourists.

The objectives of this preliminary study are: objectivization of the body's response to altitude variations; checking the accuracy of measurements according to altitude; the evolution of the physiological changes of climbers or tourists at altitude variations; the choice and establishment of investigation methods usable for the objectification of changes of a physiological nature at altitude variations.

We assume that, by objectifying the body's response to altitude variations, it is possible to improve the body's adaptation level to effort in extreme conditions, obtaining concrete elements in the knowledge of the body's physiological response to demands related to altitude variations.

Methodology

In order to verify the methods of objectifying the body's response to altitude variations, the study part was organized as follows: functional check of the pulse oximeter Heal Force Prince - 100A, device used by the Sibiu County Ambulance Service, through measurements at various altitudes and time; assessment of the climbers regarding their physical, mental and health status using the LLS - Lake Louise Score questionnaire (Table 1).

Table 1. LLS self-assessment questionnaire for AMR-acute mountain sickness

1. Headache	0–No pain 1–Mild pain 2–Moderate pain 3–Severe pain, incapacitation
2. Gastrointestinal symptoms	0–No symptoms 1–Poor appetite or nausea 2–Moderate nausea or vomiting 3–Severe nausea or vomiting, incapacity
3. Fatigue and/or weakness	0–No fatigue or weakness 1–Mild fatigue/weakness 2–Moderate fatigue/weakness 3–Severe fatigue/weakness, incapacity
4. Dizziness/Confusion	0–No dizziness 1–Slight dizziness 2–Moderate dizziness 3–Severe dizziness, incapacity
5. Sleep disorders	0–Slept as usual 1–He didn't sleep as usual 2–Waking up often, insufficient sleep 3–He didn't sleep at all

The conditions for conducting the study were those specific to the mountain area, from summer with temperatures between 10 - 25°C to winter in extreme conditions, with wind of 80 km/h and temperatures of -20°C.

The present study was carried out in the Alps (France), Mont Blanc area.

The experiment included a total number of seven Romanian climbers, marked with "S" in the table, aged between 37 and 49 years, 5 men and 2 women, of which 1 was a smoker, most of them being at high altitude for the first time, with physical condition and good health.

According to the therapeutic effect, balneo and meteorology specialists distinguish:

- the temperate climate - which includes the plain and hilly climate-up to an altitude of 500 m;

- the subalpine climate between 500 - 1.000 m and the forest, lowland climate;

- the exciting climate-which includes the alpine and high-altitude climate (Drăgan, 1977).

Virgil (2005) say that "the test is a test strictly defined in the conditions of application and research, which allows the location of an object in relation to a well-defined collective from a biological and social point of view" and is used when there is a need to evaluate and measure the characteristics of certain human actions and activities.

Results

Previously, in the experimental study, the body's adaptation to effort during the training process was tested by evaluating the effort capacity using the Harvard test (ladder test). These subjects from the preliminary study conducted in Mont Blanc (France) at 1.030 m and 3.823 m altitude (Table 2 and Table 3) had measurements of weight–using a Zelner Typ 34Z012 scale, height, heart rate (HR) and blood oxygen concentration (SaO2) using the Heal Force Prince-100A pulse oximeter (Figure 1 and Figure 2).

Table 2. Measurements of climbing subjects (male) registered in Mont Blanc (France)

No. years	Weight (kg)	Height (kg)	HR (b/min)		SaO_2 (%)	
			1.030 m	3.823 m	1.030 m	3.823 m
S1–46	81	192	63	97	85	99
S2–49	80	171	86	103	90	99
S3–43	62	174	70	100	85	99
S4–43–F	63	170	71	103	93	99
S5–42	81	185	60	103	87	99
M	**73.40**	**178.40**	**70**	**101.20**	**88**	**99**
S	**9.96**	**9.66**	**10.07**	**2.68**	**3.46**	**0**
CV %	**13.58**	**5.41**	**14.39**	**2.65**	**3.94**	**0**

F–smoking subject
M–arithmetic mean
S–standard deviation
CV%–coefficient of variability

Figure 1. Average values of weight, height, FC and SaO2 parameters of climbing subjects (male)

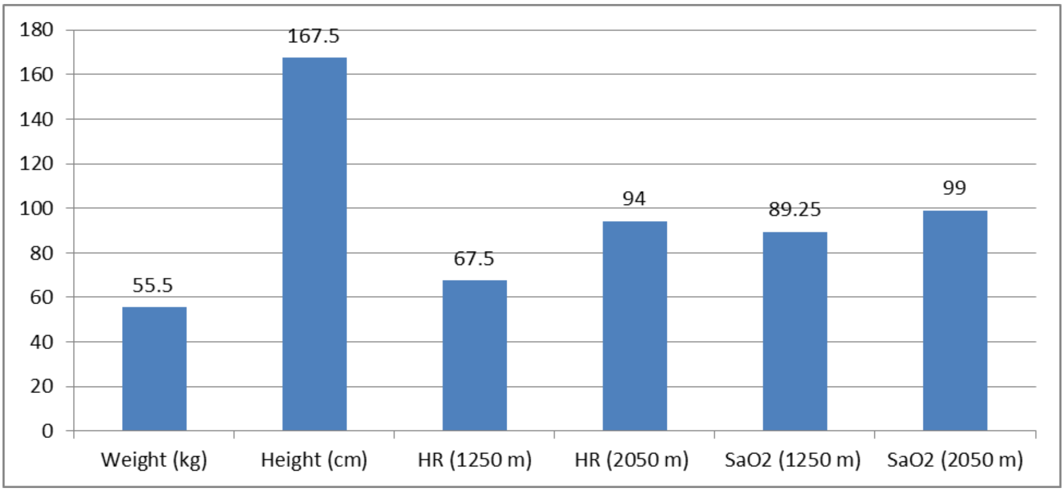

Table 3. Measurements of climbing subjects (female) registered in Mont Blanc (France)

No. years	Weight (kg)	Height (kg)	HR(b/min)		SaO_2(%)	
			1.030 m	3.823 m	1.030 m	3.823 m
S6–39	48	167.5	70	95	90.5	99
S7–37	63	167	65	93	88	99
Average	**55.50**	**167.,50**	**67.50**	**94**	**89.25**	**99**

It is noted that the youngest female participant was 37 years old, and the oldest male participant was 49 years old. It should be noted that all participants reached the Mont Blanc Peak–4.810 m after considerable efforts at high altitude and in special weather conditions: wind of 80 km/h and temperatures of -20°C. As preparation for this high-altitude expedition, they all participated in a training tour in the Bâlea Lac area, where they encountered similar mountain conditions.

A 43-year-old male participant recorded the best parameters (99%–SaO2 and HR of 70 bpm) at 375 m (Geneva) when returning to departure altitude due to the condition of returning the body to the altitude where it reacted best, being used to it.

During the acclimatization stage for the ascent of Mont Blanc peak–4.810 m, the incidence of RAM–acute mountain sickness at the altitude of 3.823 m was 47% mild cases, 33% moderate cases and 20% were severe cases, which required medication or rest.

The incidence of mild symptoms was lower than in the case of moderate or severe symptoms.

At the altitude of 3.823 m the worst symptoms were those of vomiting, fatigue and insomnia, but they were not so serious as to require withdrawal from the mountain.

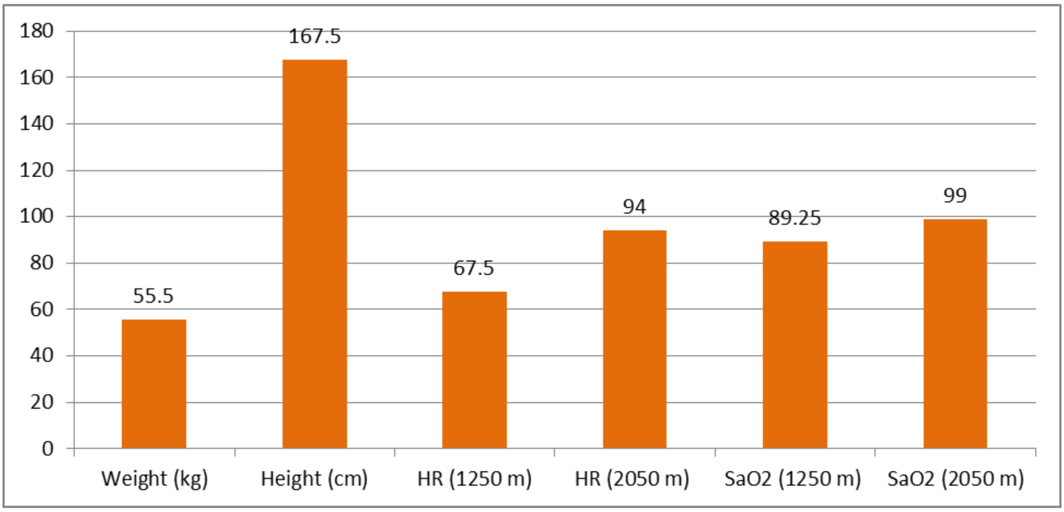

Figure 2. Average values of weight, height, FC and SaO2 parameters of climbing subjects (female)

The above measurements were taken as follows:

- weight and height at the beginning of the ascent;
- pulse and SaO2 were measured both at the beginning of the ascent and during it.

It was found that there is no general rule according to which a correct and effective acclimatization can be carried out, this adaptation to altitude variations depends on the physical and mental state of the subject, the environment, the weather conditions, the geographical area in which it is carried out the ascent, smoking or non-smoking status and previous altitude experience of the climbers.

Discussions

It was found that a 37 - year - old female subject (according to table no. 3), who was also the youngest person in the group, had the best adaptation to effort through the Harvard test.

It is noted that the youngest female participant was 37 years old, and the oldest male participant was 49 years old. It should be noted that all participants reached the Mont Blanc Peak – 4.810 m after considerable efforts at high altitude and in special weather conditions: wind of 80 km/h and temperatures of -20°C. As preparation for this high-altitude expedition, they all participated in a training tour in the Bâlea Lac area, where they encountered similar mountain conditions.

A 43 - year - old male participant recorded the best parameters (99% – SaO2 and HR of 70 bpm) at 375 m (Geneva) when returning to the starting altitude due to the condition of returning the body to the altitude where it reacted best, being used to it.

Walls (2018) shows that one of the most significant physiological changes that occurs during acclimatization is the increase in immediate ventilation. Within minutes of exposure to high altitude, peripheral chemoreceptors in the carotid bodies sense the hypoxemia resulting from the decrease in the partial pressure of oxygen in the alveoli (PaO2) and signal the medullary respiratory control center to increase ventilation, which causes a decrease in the partial pressure of dioxide of carbon in the alveoli (PaCO2).

Aebi (2020) shows the implications of CVR (cerebrovascular reactivity) in hypobaric normoxia/hypoxia are of interest to both aviation and high altitude dwellers/climbers or workers as they may be exposed to the hypobaric environment with supplemental oxygen.

According to Harris (2008), the principles of high-altitude symptoms result from exposure to low-oxygen situations caused by low atmospheric pressure. Brain and lung syndromes are the primary clinical manifestations of high altitude sickness (HAS).

Burtscher (2022) argues that modern acclimatization training strategies do not require actual high-altitude environments, but only controlled indoor or laboratory conditions, with instruments that can mimic aspects of such environments to prepare the body for high-altitude exposures.

Conclusions

The conclusions of the study highlighted that during the acclimatization stage for the ascent of the Mont Blanc peak–4.810 m, the incidence of RAM–acute mountain sickness at the altitude of 3.823 m was 47% mild cases, 33% moderate cases and 20% were severe cases, which required medication or rest. The incidence of mild symptoms was lower than in the case of moderate or severe symptoms.

At the altitude of 3.823 m the worst symptoms were those of vomiting, fatigue and insomnia, but they were not so serious as to require withdrawal from the mountain.

Other conclusion showed that there is no general rule according to which a correct and effective acclimatization can be carried out, this adaptation to altitude variations depends on the physical and mental state of the subject, the environment, the weather conditions, the geographical area in which it is carried out the ascent, smoking or non-smoking status and previous altitude experience of the climbers.

Acclimatization, an important element in reducing the occurrence of RAM-acute mountain sickness, is mandatory from above 3.000 m, being recommended in mountain ascents, assuming an average ascent of 300 m per day difference in level.

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