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Selected health issues related to high altitude trekking

Abstract. The aim of the paper was to investigate health aspects of high altitude trekking such as preparation for the physical exertion during trekking at high altitude, the impact of mountaineering on the daily life before and after the expedition, the effect of high-mountain conditions on health and well-being. It was found that in the pre-departure period trekkers commonly train to ensure that they are physically fit for the expedition. They train alone or under the supervision of a trainer. Self-prepared workouts may turn out to be insufficient due to the lack of appropriate training plans. The most challenging aspects of high altitude trekking for the body include carrying too heavy equipment, dealing with illegibly marked routes, wearing inappropriate clothing, having an unbalanced diet, not having enough water, which can lead to dehydration and infections. Misconduct by other people poses a risk. The specific type of effort involved in mountaineering requires balanced nutrition in terms of both micro- and macro-elements. To find the right combination, one has to either experiment or seek advice from a dietitian. However, relatively few people consult a nutrition coach. Among sanitary problems, the most serious one is inappropriate human waste disposal, the resulting lack of drinkable water. Some of the observed problems result from insufficient regulations regarding the conduct in the mountains and from trekkers' lack of awareness regarding good practices in such extreme conditions.

Keywords: mountaineering, high altitude trekking, mountains

JEL Codes: I120, Z200, Z320

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1. Introduction

High altitude areas, i.e. those reaching at least 1,500 m above sea level according to Polish encyclopaedic dictionaries (Kiełkowska & Kiełkowski, 2003) or at least 2,400 m (8,000 ft) according to The National Geographic Society Encyclopedia[1], are used for alpine climbing and trekking. Their characteristics vary greatly, depending on season and many other geographical determinants, which affect the conditions for human activity. There are three altitude zones characterized by lowered amounts of oxygen in the atmosphere: high altitude (1,500-3,500 m), very high altitude (3,500-5,500 m) and extreme altitude (above 5,500 m); the zone above 8,000 m is regarded as a death zone, where the oxygen pressure is too low to sustain the human body for longer stays. Alpine climbing can be defined as an activity of going up and down a mountain, where the movement is so difficult that requires the use of hands and usually the climbing equipment; trekking is the activity of walking long distances[2]. Trekking routes can reach considerable altitudes, for example to the summit of Mount Kilimanjaro (5,895 m) or Mount Toubkal (4,167 m) in Africa or to Trans-Himalayan peaks, such as Stok Kangri (6,153 m). Commercial operators even offer trips to Aconcagua in the Andes, the highest mountain in the Americas (6,959 m). In addition, long distance wilderness trails, such as the Pacific Crest Trail (4,270 km) are becoming increasingly popular with individual wilderness travelers. There is a big group of tourists who wish to take part in guided group treks e.g. along the Transcaucasian Trail or want to experience wilderness in remote mountain areas of Alaska or Siberia.

1.1. Psychophysical preparation

High altitude activities require appropriate preparation and skills of navigating the terrain and using specialist equipment. They provide an opportunity to interact with the natural environment and endure considerable inconveniences while struggling with adverse natural conditions and one's own weakness. Mountaineering trips take place in highly stimulating environment, which has a strong impact on the way the human body functions. Thanks to reading and training, tourists are aware of numerous health threats that exist in the mountains (Piotrowska et al., 2014). It is important that the pre-trip preparation stage of high altitude activities should not be limited to physical and organisational preparation or experiencing the "imagined trip" but should involve practising the skills of com-

[1] https://www.nationalgeographic.org/encyclopedia/altitude/
[2] https://dictionary.cambridge.org/dictionary/english/trekking

posure and self-control as well as the ability to focus on a specific goal (Żoczek, Bilewicz-Stebel, & Stebel, 2017).

It is important that the setting out for a trip to the high mountains is preceded by a multi-week training in conditions simulating lower oxygen concentration. The lack of appropriate technical facilities at one's place of residence prevents the possibility of normobaric[3] hypoxia training. Besides, workouts in a hypoxic chamber are expensive. It is difficult for inhabitants of low-laying areas to get regular training opportunities under natural conditions of hypobaric[4] hypoxia, especially given the lack of places in Poland that are located at appropriate altitudes and made available for training. Workouts under conditions of hypobaric hypoxia at the altitude between 1,600 and 2,500 m are part of exercise regimens of professional athletes, but such training is not sufficient for people who want to take up activity in very high or extreme altitudes.

There is an interest in mind-body techniques like yoga and meditation as preventive non-pharmacological interventions in the treatment of hypoxic pathologies (Anand et al., 2020). Yogic practices have been proved to be effective for bettering health and performance at high altitudes (Himashree, Mohan, & Singh, 2016).

1.2. Health hazards due to the nature of activity in high mountains

Numerous illnesses are reported during mountain trips (including those resulting from lack of acclimatisation or heart failure, exhaustion or hypothermia) and foot problems (blisters, frostnip, frostbite, trench foot) (Faulhaber et al., 2020; Gatterer et al., 2019). Polish mountaineers, who had made treks or climbed mainly the Tatras and the Alps, reported several negative effects of being in high mountains: symptoms of altitude sickness, sunburn, breathing problems, mechanical injuries, pharyngitis and bronchitis, eye problems, swelling, frostbite and hypothermia, occasionally symptoms of high-altitude cerebral edema (Piotrowska et al., 2014).

Topographic characteristics of high mountains require a specific style of movement. Mountain trekking involves frequent ascents and descents, sometimes with the use of an ice axe, which are associated with aerobic exercise when trekkers' endurance is put to the test. In contrast, climbing sections, which are examples of anaerobic exercise, mainly require strength and agility.

Numerous fatalities during mountaineering result from sudden events (falls, avalanches, lighting strikes during a storm, etc.). Touring in avalanche terrain is

[3] Equivalent to pressure at sea level.

[4] Characterized by less than normal pressure.

especially dangerous. Many avalanche accidents are the result of judgement errors, such as over-confidence, anti-authority and other human factors which contribute to fatalities. This is why proper, multifaceted avalanche education is required (Johnson et al., 2020).

In the Polish part of the Tatra Mts., which are practically accessible to everyone, the likelihood of crisis situations increases when tourists take on challenges that are out of their depth, when they are not fit enough or they have inappropriate equipment (lack of suitable clothes and trekking shoes, or crampons and an ice axe in winter), or when they are not familiar with the terrain and specific natural conditions, especially signs of sudden weather changes (Gawlas, 2020).

Energy expenditure during a hiking trip depends on atmospheric conditions and the type of terrain. In addition to exertion associated with covering a given distance, physical effort is also required to carry mountain gear (also an avalanche safety package in winter and crevasse rescue equipment needed in glacial environment) and camping equipment plus provisions. The total weight carried by an individual often exceeds 20 kg. The carrying of necessary equipment inhibits the motor control and accelerates fatigue. In the case of women, the situation can often be aggravated by what is known as female athlete triad (a combination of three conditions: disordered eating, amenorrhea[5], and osteoporosis) and pelvic floor dysfunction[6], all of which can decrease performance and increase the risk of injury (Orr et al., 2020).

As altitude increases, atmospheric pressure declines. When people breathe rarefied air the oxygen saturation in their blood falls, which in turn leads to hypoxia, as a result of inadequate oxygen supply at the tissue level, causes weakness by slowing down metabolic processes, increases the rate of muscle fatigue and slows down their regeneration (Korzeniewski, 2008). People who have been living in high mountain areas for generations show certain adaptations to high altitude conditions, such as higher counts of red blood cells (RBC) and haemoglobin (Hb), but have lower values of arterial oxygen saturation (SaO_2) and many of them show symptoms of lung disease and suffer from headaches and dizziness (Sulaiman et al., 2020).

Oxygen deficit which occurs during physical exercise triggers the enzymatic reactions of cellular respiration, causing an increase in the level of erythropoietin, which in turn increases the rate of red blood cell production in the bone marrow. As a result of acclimatisation, the body adjusts to atmospheric pressure at high altitudes but the process requires sufficient time and gradual ascent to higher altitudes. In the longer term, adaptations resulting from altitude acclimatisation improves endurance performance. Muscles use oxygen more effectively thanks to

[5] The absence of menstruation.

[6] Inability to correctly relax and coordinate your pelvic floor muscles.

higher capillary density and increased erythropoiesis[7]. However, intensive exertion above the altitude of 2,500 m can cause adverse physiological changes; more intensive physical performance is not possible owing to limited motor control and speed of movement. As altitude rises, it becomes increasingly difficult to maintain balance, which can lead to ataxia[8] (e.g. gait abnormality) (Zur, Fogelman, & Carmeli, 2016). Problems occur when the body is unable to adjust to high altitude conditions, which is often the result of inappropriate acclimatisation or its absence.

Inexperienced tourists are not always aware of the importance of acclimatisation and the fact that there are no very high mountains in Poland prevents them from testing their own responses to high altitude conditions. According to a 2012 survey of tourists, who undertook to climb the highest Polish summit Rysy, 42% of them did it during a one-day or a weekend stay in the Tatras, which means that they set out without any acclimatisation (Wlazło et al., 2015). The limited time of the trekking trip and the cost of accommodation prevent a longer period of acclimatisation, which would prolong the whole undertaking. The optimal rate of ascent (the altitude of the overnight stay) should not exceed 500 m a day at altitudes over 2,500 m. The risk of altitude sickness can be reduced by spending one extra day acclimatising at the level of 2,500 m before another ascent, and then once again at least one day after each 1,000 m of elevation (Prince, Thurman, & Huebner, 2021). Commercial operators deliberately reduce the time for acclimatization while ascending the summit potentially putting participants' health in danger in order to pay less in fees for activities in national parks. The symptoms can be minimised pharmacologically, which is the recommended option in emergency situations, e.g. during rescue operations (Toussaint et al., 2020).

Intensive physical exercise above 2,500 m in the conditions of oxygen deficit can cause a number of pathophysiological changes (Dempsey & Morgan, 2015; Ryn, 2015; Millet & Brocherie, 2020). The body's lack of adjustment to hypoxic conditions is manifested by symptoms of acute mountain sickness (AMS), which is caused by hypoxia of internal organs, which include headaches, mild cognitive impairment, dizziness and impaired motor coordination, insomnia, apathy, nausea, vomiting, lack of appetite, swelling of hands, feet, and face, and high blood pressure (Bärtsch & Swenson, 2013; Imray et al., 2011; Siminska et al., 2016). The deprivation of oxygen reaching the tissues impacts cognitive impairment, alertness and reasoning (Anand et al., 2020). Insomnia usually occurs as one of the first symptoms. Poor sleep quality at high altitudes can impair cognitive skills, cause lack of concentration and inferior performance during the day (Kong, 2019; Szymczak et al., 2009).

[7] The production of red blood cells, which is stimulated by the hormone erythropoietin.

[8] Lack of voluntary coordination of muscle movements.

The onset of acute mountain sickness depends on individual susceptibility and is more likely in the absence of appropriate altitude acclimatisation. Factors such as sex, age, body mass index, smoking or alcohol intake have been found to have a negligible impact on the likelihood of developing AMS symptoms by people engaged in mountaineering activity (Schneider et al., 2002; Żebrowska et al., 2019). Symptoms can be alleviated by using medications such as dexamethasone (causing psychotic side effects) or acetazolamide, but because of its diuretic effect, it is unsafe in high-altitude conditions, where it may be difficult to ensure proper hydration.

In extreme cases, acute mountain sickness can lead to high altitude pulmonary edema (HAPE) and high-altitude cerebral edema (HACE) (Janus & Piechocki, 2016; Mills et al., 2016; Zubieta-Calleja & Zubieta-DeUrioste, 2021). HAPE is a rare but potentially life-threatening condition, which develops 1-4 days after reaching altitudes above 2,500 m. It is accompanied by shortness of breath, dry cough, a cough that produces frothy sputum tinged with blood, bluish-grey tongue, lips or fingernails, loss of consciousness owing to hypoxia. Treatment should include administration of oxygen (if it is available), nifedipine and an immediate descent to a lower altitude (Imray et al., 2011). HAPE is the most frequent cause of death in tourists staying at high altitudes (Korzeniewski et al., 2015).

High-altitude cerebral edema occurs much less frequently and its symptoms develop later (Janus & Piechocki, 2016; Siminska et al., 2016). These include severe headaches, impaired coordination, vomiting, altered mental states, drowsiness, vision problems (Korzeniewski, 2008; Ryn, 2015). HACE requires urgent administration of oxygen and dexamethasone or acetazolamide as well as immediate descent (Imray et al., 2011).

Another threat is posed by intensive ultraviolet radiation from sunlight, which is exacerbated by the fact that 80% of UVA and UVB rays are reflected from the snow cover. Exposure to intensive UV radiation without eye protection can cause conjunctivitis[9] and keratitis[10], commonly known as snow blindness. It is also associated with the risk of sunburn (Adhikary & Ueno, 2020; Krzeszowiak, Michalak, & Pawlas, 2014).

Strong wind blowing at high altitudes causes the disappearance of protective lipid barrier in the outermost layer of the epidermis, increasing its susceptibility to frostbite. Low air humidity increases water evaporation from the skin, which also makes it more sensitive. Strong wind, which lowers apparent temperature, causes hypothermia, either local, such as hypothermia of the limbs, or general.

[9] Inflammation of the outermost layer of the white part of the eye and the inner surface of the eyelid.

[10] Inflammation of the cornea.

The heat balance of the human body depends on ambient temperature, humidity, wind, clothing insulation, physical activity and proper functioning of physiological mechanisms. Exposure to cold stimulates a number of reactions in the body, which are meant to decrease the rate of heat loss as a result of convection and help to maintain constant internal temperature. The process consists in generating heat through involuntary contractions of skeletal muscles (shivering thermogenesis) and voluntary behavioural reactions, especially motor activity. Shivering increases heat production but results in higher energy expenditure. The low blood sugar level and fatigue limit the body's ability to generate heat through shivering thermogenesis. As a result of thermoregulation, the transfer of heat to the limbs affected by hypothermia is restricted, which helps the body to retain heat but leads to the further lowering of skin and limb temperature, which can cause frostbite. Individual tolerance to limb hypothermia varies. Tests of climbers' toes and fingers conducted before expeditions make it possible to identify persons who are more prone to frostbite (Gorjanc, 2019). However, the probability of surgical amputation after frostbite is strongly related to altitude (Carceller et al., 2019).

Low ambient temperature has a negative effect on human motor performance. A decline in muscle temperature, and, consequently, the force of muscle contraction, leads to lower movement precision, prolongs reaction times and makes it more difficult to maintain balance. Moreover, automatic survival functions are also disrupted. Lower sensitivity to stimuli can constitute a serious danger (Marszałek, 2009).

The declining effectiveness of thermoregulation lead to hypothermia, when the body temperature falls below 35°C, which leads to dysfunctions of the circulatory and respiratory system, impaired functioning of the liver and kidneys and electrolyte imbalance and loss of consciousness (Krzeszowiak, Michalak & Pawlas, 2014). When the body temperature falls below 25°C and the heart and the brain are affected by extreme hypothermia, there is a high probability of death.

Data from the highest mountains in the world indicate that hypothermia is one of the most common causes of death for mountain climbers, only preceded by injuries and high-altitude diseases (Procter, Brugger & Burtscher, 2018). The body has a limited possibility of adapting to low temperatures, which is why climbers wear insulated clothes which protect them against heat loss (Rodway, 2012). There are various ways of supplying the body with extra heat, such as clothing with temperature sensors, which control electric heating (Al Rasyid et al., 2020).

Mountaineering activity is characterised by high energy expenditure, causing a considerable loss of body mass, not only of fat but also lean muscle tissue (catabolism) (Ryn, 2015; Sitko et al., 2019). Caloric demand increases, while appetite declines as a result of changes in the sense of taste and smell. Acute

mountain sickness is accompanied by nausea and vomiting, and a change of diet including untypical meals, low level of hygiene and poor water quality can cause diarrhoea. All of these factors increase the probability of energy deficiency in the body (Broadhurst & Smith, 2008). Body mass loss is compensated after the end of the trip or during days of resting (Szymczak, 2009).

Extreme environmental conditions, including stays at high altitudes and exposure to cold, are associated with greater energy expenditure, changing the body's metabolism and accelerate the loss of muscle mass and whole-body dehydration (Ryn, 2015). Nutritional guidelines must therefore be adjusted to make sure that depleted energy stores are sufficiently replenished and prevent deficits of iron (as a result of increased production of red blood cells), carbohydrates, protein and water. Tourists should follow nutritional guidelines regarding the proportion of microelements, should replenish them regularly and ensure adequate hydration (Kechijan, 2011). Average daily energy requirement ranges between 6,000 and 7,000 kcal, which cannot be ensured for technical reasons and would not be good for the body. For this reason, the recommended caloric content of meals is about 4,000 kcal. The most appropriate diet for people staying at high altitudes should be rich in carbohydrates, which quickly replenish the energy deficit (about 65% of daily energy requirement). Increased consumption of carbohydrates at high altitudes improves performance of the unacclimated but has no effect on the acclimated (Bradbury et al., 2020). Another important diet component for a physically active person is protein, which is necessary for the process of tissue regeneration. The percentage of fat in the macronutrient ratio should not be increased, since fat burning at high altitudes is not complete and increases blood lactate concentration, and consequently, deteriorates physical performance. During the high altitude trips the most appropriate form of food are freeze-dried meals, which are prepared for consumption by reintroducing water. Another form of supplementing nutrients are carbohydrate gels, which are quickly absorbed by the body. Tourists participating in mountaineering trips should also stay properly hydrated (drinking 3-4 litres daily) and replenish electrolytes.

Limited access to food, lack of appetite caused by hormonal changes (the satiety hormone – leptin), poor digestion and inappropriate diet are all factors that result in a negative energy balance, homeostatic imbalance, loss of lean muscle mass and inferior performance.

Mountaineers resort to various dietary supplements used by professional athletes. Consumption of nitrate-containing products (NO_3^-) in the form of beetroot juice increases endurance performance (McMahon, Leveritt & Pavey, 2017), but does not bring expected results in the conditions of hypoxia and can even lead to impaired performance (Rossetti et al., 2017).

They also use caffeine and theobromine[11], vitamin D and other supplements, such as bromelain[12] and curcumin (Roa, 2019).

During a hiking trip, clean drinking water is not always available. Water can be disinfected by adding chlorine, iodine, by using UV light or by filtration (Backer, Derlet, & Hill, 2019). Local inhabitants use intake points supplied with water from mountain springs, which is often contaminated with animal waste. In addition to *Escherichia coli* bacteria found in the gastrointestinal tract, cattle (domestic yak and dzo[13] in the Himalayas) carry other bacteria, such as salmonella, as well as viruses and protozoan parasites. In areas with a high volume of visitors it is necessary to remove human excrement to prevent the transfer of pathogens to potable water. Most tourists prefer to buy water, delivered in PET bottles. Trekkers who do not purify water on their own but buy it in plastic containers, leave behind large quantities of empty bottles, polluting the environment with plastic waste. The use of ecological solutions (such as biodegradable personal hygiene products, solar cells) by Polish backpackers is still relatively rare, mainly owing to prohibitive costs (Jabłońska, 2015).

Commercial operators are involved in garbage management because they want to leave a given place unspoiled knowing they will return with other groups. But in some regions of the world the situation is still bad. Inappropriate waste disposal and utilisation, numerous cases of negligence and violations of natural protection regulations are factors that put a strain on vulnerable mountain ecosystems (Apollo, 2016).

Mountain trips have traditionally been a male-dominated activity, so many of the problems discussed above have been analysed in the literature with respect to the male body. While the participation of women in strenuous hikes and climbs is still not equally common, it is necessary to analyse specific problems associated with how the female body functions during intensive outdoor activities in view of the psychophysiological differences between the sexes. Women tend to hide their experience of period cramps and all activities related to menstrual hygiene and inform other team members only when the pain prevents them from maintaining the hiking pace set by the team (Dykzeul, 2016).

Mountaineering trips also affect tourists' mental state. Participants often experience anxiety and stress caused by the fear of falling off, sudden weather changes, equipment defects, injuries, illness, fear for one's life and concerns about other team members. An insufficient amount of sleep and sleep disorders can impair the ability to think logically and critically and to make decisions, in some cases

[11] A bitter alkaloid of the cacao plant.

[12] An enzyme extract derived from the stems of pineapples.

[13] A hybrid between the yak and domestic cattle.

they can lead to acrophobia (fear of heights) or trigger previously unknown reactions, such as qualitative alterations or distortions of the sense of smell (dysosmia) (Banasiewicz, Przybył, & Holdys, 2014).

2. The study

2.1. Research aim and interview questions

The purpose of the study was to investigate the impact of physiological and health aspects of the wellbeing of tourists that go trekking in high mountains. Opinions obtained from this group of tourists can provide arguments in favour of introducing innovative solutions, reducing environmental impacts, increasing awareness regarding safety and hygiene and the importance of pre-trip preparation. A similar study conducted in 2011 was based on data collected using a questionnaire survey (Piotrowska et al., 2014).

The purpose of the study was to answer the following research questions:

In what way do the high altitude trekkers prepare for the physical exercise that awaits them in the mountains?

How do they perceive the specific nature of activity in high altitude conditions?

What kind of health problems do they have to cope with during mountaineering?

2.2. Research method and data

The use of individual in-depth interviews enabled the authors to elicit observations, opinions and feelings of the respondents. The sample was purposive and included people with a specific kind of experience. The authors used informal contacts, as well as snowball sampling, where already selected respondents recruit future subjects from among their acquaintances, which decreases the probability of refusal to participate in the study. Direct or online video interviews were carried out in April and May 2019.

Interviews were conducted with 15 respondents (9 men and 6 women), who had practised high mountain trekking in the last two years. All of them were able-bodied persons, aged between 20 and 40 and living in Poland, mostly in cities with populations over 500,000.

We did not want to classify respondents into specific categories such as professional/amateur, sport/recreation, self-organized/commercial etc. or limit the study only to high altitude trips. Some of the participants took up the challenge in manifold world's mountain areas, other trekked only inside Europe, so they

may neither stayed for a long time far from the civilization nor climbed too high to suffer seriously from altitude sickness.

2.3. Results

The interviews were conducted with various representatives of the Polish mountaineering community. The respondents did not constitute a homogeneous group. They have had different mountaineering experience, in terms of the number of years they have been active, the number of visited mountain ranges and altitudes they have reached as well as other details of their trekking experiences. Fragments of responses were grouped according to topics formulated in the research questions.

2.3.1. Psychophysical preparation

Psychophysical preparation before treks was regarded by the respondents as an important element of the whole undertaking. Undoubtedly it is common practice to prepare for future challenges by training to improve physical fitness. The reported time of preparation ranges from 3 to 6 months. The preparation consists in improving athletic performance during regular training sessions. It includes a component of mental preparation and mind-body techniques. Workouts are planned individually or more seldom in cooperation with professional trainers, still the help of professional mentors or use of personalised training plans are not widespread. The interviewees prefer to carry out workouts alone or in a small team of friends.

Training sessions can take place outdoors, preferably in environments that resemble conditions during the trip (jogging in lower mountains) and indoors (swimming pool, climbing wall, workout gym) but some respondents use any other opportunities, such as walking up the stairs:

> *Preparation is obligatory. Although I'm generally an active person, I crank up the intensity of trainings four months before the expedition* (Jakub).

> *Depends on the expedition, but in my case it usually starts five to six months earlier. I'm not a fan of gym workouts, so I do everything on my own or arrange occasional consultations to check if I'm going in the right direction* (Irena).

> *Pre-trip preparations start more or less three months before the expedition and I work with a trainer, who creates my mountaineering fitness plan, mainly consisting of cardio exercise. In everyday life I mainly work out in the gym, practice at the climbing wall and go jogging* (Robert).

Sometimes I fill my 70-litre backpack with books, water bottles, making sure it weighs at least 20 kg and go to a nearby gravel pit. It's super exhausting, especially when your feet get buried in the sand, but it works (Adam).

I do practice more on the climbing wall, go to the swimming pool and try to do sessions of running up and down the stairs. In my opinion it's the closest you can get to the type of activity you do in the mountains (Marek).

Respondents' preparation programmes included aerobic exercise and power training.

Preparation is obligatory, especially before trips with less trekking and more climbing. Physical efficiency is essential, because you get tired very quickly. Strong arms and legs are important because they support the body's weight for a few, sometimes several hours a day (Maryla).

I focus on aerobic exercise, do a lot of jogging and keep increasing the distance, I do ascent runs with a load on my shoulders, I try to take weekend trips to lower mountains, where I go jogging (Irena).

The respondents observed that pre-trip workouts require persistence and must be done systematically, which requires appropriate motivation. Some of them reported making an effort to prepare their bodies for the physical exercise awaiting them in the mountains.

For me the preparations are the worst because I hate jogging and it is the best way to improve your endurance before going to high mountains. Sometimes when I'm running I shout out the names of summits which I'm planning to climb. After workouts I feel good but forcing myself to get out and run each day is a fight against myself, and effects cannot be seen overnight (Aga).

When it comes to mental preparation, I try to focus on my goal as much as possible. I use visualisation techniques, I imagine myself standing at the summit and this feeling of satisfaction; this is what motivates me the most and what helps me endure the time of preparation and training, which I don't always feel like doing… (Robert).

The respondents had developed a habit of carrying out workouts – they kept exercising both before the expedition and afterwards:

This works before and after the trip. You need to prepare beforehand, which is obvious, there is no other way and you have to train. Interestingly, many people start exercising regularly after the trip, because they miss the physical effort on a daily basis. It turns out exercise is addictive, in the positive sense, of course (Marzena).

According to the respondents, acclimatisation, which helps tourists to avoid symptoms of altitude sickness to the extent that they are able to continue their trip, is an indispensable stage of a stay in high mountains. But before setting off to the mountains no one took advantage of either low-oxygen conditions in the form of workouts in a hypoxic chamber or spending nights in a hypoxic tent prior to the ascent in order to lessen possible symptoms of acute mountain sickness. Nobody mentioned the importance of learning the mountaineering breathing techniques.

2.3.2. Specific nature of trekking in high mountains

According to the surveyed mountaineers, the significant impact of environmental conditions on the body is a big challenge during the high altitude trekking. High mountains topography and harsh climate demand not only physical fitness and high energy expenditure but also know-how and team work.

Carrying luggage

The necessity of carrying luggage was regarded as an important inconvenience, particularly by female respondents, who seem to be less well adapted to carrying heavy loads:

> *I find it extremely uncomfortable to carry a heavy backpack. I feel like the load weighs me down and I can't move freely and my shoulders are crushed. From my observations, men tend to suffer from this inconvenience much less frequently, perhaps it's to do with the anatomy* (Dorota).

> *The load on your back, especially at the start of the trip, virtually presses you to the ground. Sometimes, when you start trekking at 2,000 metres, where it's 25 degrees Celsius in the sun, and you keep walking weighed down with all the gear like a Christmas tree, ready for freezing weather 2,000 metres higher, and you're drowning in your own sweat* (Marek).

> *The backpack loaded with all the gear really takes its toll on you, especially if you're a woman, because in some cases it's a third of your own weight, so it's a big strain on the body and the back* (Irena).

Transportation and accomodation

The respondents pointed out that the whole experience can be made more convenient by the presence of transportation services and accommodation facilities. They are available in regions with a well-developed tourist infrastructure, while in poorly developed regions one can rely on road transportation services provided by local inhabitants and higher up they hire professional porters or use other means of transport (e.g. sleighs).

The weight of backpacks is certainly a strain on the body and doesn't make things easy. But it all depends on how much money you have for the gear and the facilities. I have seen this, especially in Switzerland, when climbers from Western Europe, who slept in the shelter, would set out carrying only small backpacks and were really surprised to see a group of Poles with huge rucksacks, tents and foam pads (Adam).

People who don't use hotels are at a double disadvantage because not only do they not rest in such comfortable conditions but they also have to carry the stuff that enables them to have somewhere to sleep and something to eat. You must be ready to spend several days in a tent and apart from the weight of the climbing gear, you have to add the weight of food and clothes, and then you end up with a load of 30 kg (Maryla).

When I was climbing Grossglockner, just the gear and the sleeping bag, apart from food and a few sets of clothes, weighed several kilograms. Fortunately, some shelters offer an option of leaving your luggage in lockers, after paying a fee (Stefan).

It depends on your budget and on the specific location. In some mountains you can save yourself the effort of carrying the tent and food by going up in a cable car; in the Caucasus you can travel some part of the way having your luggage carried by horses, and in the Himalayas you can use the help of Sherpa porters (Zuzanna).

In Alaska, instead of carrying heavy rucksacks, we used pulk sleds to haul all the gear between bases. It certainly different, but it's hard to say if it made things easier. The harness would cut into your body and each step felt like pulling an elephant, and during a blizzard, the sleds would overturn in fresh snow and would have to be put upright non-stop (Jan).

Terrain conditions

Terrain conditions can be treacherous, which requires extreme caution and the right climbing technique. The use of specialist equipment involves additional effort:

You don't always walk on snow and ice, where crampons and the ice axe provide good traction. Sometimes ice is so brittle and the terrain slopes so much that everything slides down from under your feet and you lose traction and can fall over a precipice (Dawid).

Soft, freshly fallen powder snow slows everything down and, besides, walking in crampons is hard in itself. In some places, one moment you walk on snow, a moment later on a rocky section, and then on snow again, and there's no time to keep changing clothes and taking off your gear, so you keep your crampons on all the time (Stefan).

Another problem was the difficulty of finding the right way owing to the badly marked route:

> *Not all routes are clearly marked; sometimes the route is marked with red symbols painted on the rock or with piles of stones and different teams choose different route variants which they consider best, which is why some trodden paths lead to nowhere and you have to turn back. Usually, you set off before dawn. Then you walk with headlamps, which is an additional difficulty* (Marek).

Physical fitness is also affected by the form of overnight accommodation – the type of terrain used for camping, distance to a water source, possibility of spending the night at a shelter:

> *It makes a big difference where you set up camp, because some shelters have a ban on camping within a certain radius and you have to look for a place located further away, which means an additional distance that needs to be covered during the final ascent. Sometimes you have to shovel tons of snow just to uncover the ground for the tent* (Maryla).

Atmospheric conditions

Changeable weather conditions require a number of adaptations to ensure comfort on the way. The problem consists in choosing the right clothes to avoid thermal discomfort:

> *It is not always easy to make sure that your clothes are suitable for a given temperature, because there are different stages during climbing and different kinds of exertion. There is a stage of climbing up a vertical face, when you don't feel cold because all your muscles are working and it's hot. But right before the climb you sometimes have stand still in a queue for half an hour, and then your body quickly loses heat, especially when standing in the wind and in the shade. A descent with belaying usually takes longer than the ascent, because the body is already tired and you feel even colder* (Marek).

The interviewed mountain trekkers also mentioned atmospheric phenomena that can be dangerous:

> *The weather in the Alps is not always good. Two years ago, during a climbing trip, my team and I were caught in a thunderstorm. We had to go down as soon as possible. What happened was that a lightning struck right next to us and one of the guys lost consciousness; fortunately, the others ended up with just a couple of bruises* (Dawid).

> *Sometimes, especially in exposed sections, strong wind can knock you off your feet. These are really extreme conditions* (Dawid).

2.3.3. Health and hygiene hazards

The study identifies efforts undertaken by high altitude trekkers to prevent health hazards or work against them. The surveyed trekkers gave many examples of how natural conditions in high mountain areas affected their well-being.

Altitude

In high mountain areas one may suffer from various symptoms of altitude sickness, such as insomnia, eating disorders, shortness of breath and decreased performance:

> *High altitude and altitude sickness take their toll on you. Your body functions in a completely different way at altitudes of a few thousand metres. Even if you don't vomit, your strength is still affected. Your movements are slower, less precise, your grip is weak. Each step is an effort. It is hard to imagine for people who feel pretty strong when exercising in lowland areas* (Jan).

> *Above 3,000 metres everything annoys me at night, even the moon which keeps me awake. You lie and stare at the roof of the tent, additionally stressed out by the realisation that the less I sleep, the worse I'm going to feel during the climb. But you can't fall asleep – it's a vicious circle* (Marek).

> *At 6,000 metres digestive disorders are quite normal and nobody is surprised by occasional vomiting, lack of appetite or diarrhoea. Sometimes it's one of these things, sometime just a slight ringing in your ears. There are no rules: on one occasion you get stomach problems, another times everything is alright, and yet another time you suffer from a shortness of breath. All tasks in the camp are done like in films – in slow motion* (Kamil).

> *Altitude sickness also affects your mental state. You're walking and at some point your thinking just switches off, your lose awareness of where you are. It's dangerous because you don't even realise it* (Tadek).

One respondent stressed the importance of assistance from others team members during altitude sickness:

> *In my case, altitude sickness occurs at about 4,000 metres, I have breathing problems and I feel tightness in my chest. This is when support from the rest of the team is essential, mutual support and motivation. You have to force yourself to eat and drink, although you don't feel like it, because you need to supply your body with energy* (Irena).

Frost

Surveyed trekkers are aware of the dangers of hypothermia, especially in the limbs while roaming the high mountains:

For me, wind is the worst. It's not cold temperature itself but wind that removes body heat. Strong wind chills you to the bone. Snow and small pieces of ice cut your cheeks and each exposed patch of skin, immediately causing frostbite (Jan).

The temperature is so low that even in the right clothes, you can expect frostbite. You can't ignore the fact one of frozen fingers or toes is changing colour, because it may be a symptom of frostbite. Which means the end of the trip for you in the best case, or amputation in the worst (Kamil).

Ultraviolet radiation

Lack of adequate protection against the sun or lack of knowledge about the impact of strong UV radiation can result in sunburn or eye damage:

Sunshine in the mountains is treacherous and you half-measures won't do; beginners often apply sunscreen only once and think it's enough and next day they wake up with second degree sunburns (Dorota).

You have to watch out for the sun, because once I hadn't taken glacier goggles but normal UV 400 sunglasses and blood vessels in my eyes were all broken, my eyes bloody red. After a day of walking over a glacier with unprotected skin, without sunscreen, you get sunburnt for sure (Robert).

Injury

Trekkers are conscious that physical activity in the mountains is naturally associated with the risk of injury:

Fortunately, I have never had a serious injury but my friends haven't been so lucky. A slip can end in a sprained or broken ankle, a collision with another climber can result in a dislocated shoulder. Such things happen (Jan).

Inappropriate behaviour on the part of others can be dangerous, and in some cases can even lead to death. There were also comments about the danger connected with inattention or recklessness on the part of other tourists:

Once I witnessed how a guy wanted to take a shortcut and pass on the side, he knocked down a few loose stones, which caused more stones to fall and a women standing below was hit by one of them in the face (Marek).

Nutrition

Proper nutrition in high altitude conditions is particularly important, but also causes some difficulties. For the respondents, freeze-dried meals and snacks are staple food during expeditions. The specific type of physical effort requires a balanced diet, which the interviewees found difficult to maintain in practice. Because of altitude sickness, which is sometimes manifested by a lack of appetite,

it is difficult to supply the body with the right amount of nutrients required during intensive physical exercise:

> *Food mainly consists of snacks, sweets, dry pepperoni sausages, everything that is easy to eat. You can take whatever you like best, because freeze-dried meals don't taste good and sometimes it's hard to eat anything* (Zuzanna).

> *Food in the mountains is lousy. Freeze-dried food is bland, has really no taste, you have to wait ages before you can eat it, and when the pulp is finally ready, you don't feel like eating at all because of altitude sickness and the very thought of it makes you dizzy* (Robert).

> *When you leave the camp in the middle of the night, you need to force yourself to eat breakfast, which you don't feel like doing, but you've got no choice because there'll be just sweets and gels on the way* (Aga).

Finding a balanced diet combination requires the help of a dietitian, but no one of the interviewees sought the advice of a nutrition advisor.

Drinking water

Finding potable water is another problem, especially when the camp site is not conveniently located and there are no clear rules of waste disposal. Littering and contamination of the surrounding area with faeces make it impossible to obtain drinking water by melting snow.

> *If there is snow, there's no problem with water, but in places without snow, where the camp site is set up on rocks or gravel, you have to look elsewhere and it takes time. Fetching water from far away is inconvenient, takes time and energy, which is why people often end up dehydrated* (Maryla).

> *When it comes to water, to get a litre of water from snow, you need about an hour to melt it, and not every snow is suitable for this. In some places there are people responsible for removing faeces in an appropriate way and heavy fines are imposed for violating the rules of hygiene. But this is rare, and in most cases camping sites are a right mess, so you need to watch out. Because getting water takes so much time, cooking takes longer because freeze-dried food needs to be hydrated, so most of the time during days of acclimatisation and rest are spent cooking* (Jan).

As regards sanitation issues, the major problem, as seen by the interviewees, is the lack of utilisation of human waste in order to protect sources of potable water against contamination with faeces.

> *Sometimes, you can't collect any fresh snow in the vicinity of organised camping sites because people leave their litter lying around or relieve themselves where it suits them and the ground is contaminated* (Maryla).

*Water can be taken from mountain springs in some places and if that's not possible, you can melt snow. But you need to be careful because people relieve themselves practically everywhere and there have been situations when they contaminated the spring with their faeces and the whole camp got infected (*Zuzanna).

Personal hygiene

The lack of water causes further discomfort associated with ensuring sufficient personal hygiene, especially for women during menstruation:

If the expedition is long, the question of hygiene becomes a nuisance. There is no possibility to wash the whole body, it's easy to get infected, so you need to make do with wet wipes. But in the long run it's neither pleasant nor effective (Maryla).

Personal hygiene is a big discomfort for women during backpacking trips. I don't mean washing but just taking a pee. There are routes where you can walk for a few hours without coming across a single bush or rock you can hide behind and you need to squat in plain view, which is certainly not comfortable. Not to mention menstruation, which does happen. Once I was unlucky enough to get my period during the final ascent and I had no choice and did what I had to do along the way, on the last flat stretch of the ascent, next to a group of complete strangers. I don't have a trauma but I don't have fond memories of that situation (Katarzyna).

3. Conclusions and discussion

This sociologically focused study was undertaken to collect responses of active trekkers, who represent a heterogeneous population in terms of skills, commitment, performance and mountaineering achievements. They are aware of the problems they may face when trekking in high mountains.

There is a general conviction among high altitude trekkers that preparation for activity and survival in high altitudes is of paramount importance. However, none of the respondents mentioned practising any kind of hypoxic exercises (such as workouts with reduced oxygen or sleeping in an altitude tent, which simulates a higher altitude conditions). Although the help of sport psychologists is widely practiced in many disciplines of sport and a lot of progress has been made in research on the psychology of mountaineering, the support of a psychologist in the choice of a trip destination and during the pre-trip psychophysical preparation is not yet very common.

The most inconvenient factors that have an impact on mountaineers well-being include excessive load of the gear, poor route marking, forcing to walk back and trying another way, inappropriate clothing, lack of adequate protection against sun-

shine, unbalanced diet, shortage of water, causing dehydration and badly resolved sanitation issues. Therefore the health problems reported during mountaineering include various symptoms of the altitude sickness (shortness of breath, decreased performance, weakened mental state, poor sleep, digestive disorders), frostbite, sunburn, symptoms of dehydration caused by water scarcity and infections as a result of the lack of personal hygiene. Moreover various conflicts triggered by the incompetent behaviour and non-compliance with ethical norms may also affect psychophysical well-being.

These results are consistent with results of a 2011 survey of Polish mountaineers, who had experiences mainly from European mountains (Piotrowska et al., 2014). However, problems resulting from bad nutrition and the lack of water were not mentioned in their study.

The findings of the current study throw light also on minor disadvantages, which occur during mountains treks. There are health problems and aches, resulting not only from external mountaineering hazards but also from the lack of suitable nutrition and hydration, heavy weights carried etc. They are obstacles in practising this kind of physical activity for less resistant persons, especially for women, whose body is on average able to lift and carry lighter loads than men and who are more prone to suffer due to poor hygienic conditions.

One can note that sport medicine research on health issues of humans in high altitude areas used to be focused on specific conditions where extreme hazards occur. Therefore, most of the literature on health issues during mountaineering activities revolves around the major medical issues such as hypoxia and hypothermia, which are caused by severe high altitude conditions. However, because of a poor representation of women in high altitude activities, due to natural, social as well as economic factors, their health and wellbeing problems during strenuous high altitude exercise remain poorly recognized and should be examined by medical science.

Workouts led by professionals in preparation for high altitude stays should gain more popularity. Awareness programs should be addressed especially to amateur participants of tailor-made treks. Trips to remote areas and summit pushes are nowadays facilitated by commercial organisers. In this way participants who are not sufficiently fit may even die because of excessive exertion in high altitude conditions. Certainly, many negative aspects of high altitude trekking can be minimised by increasing the awareness of participants regarding good practices and decision-making in high risk situations. At the same time it is necessary to support the regulations concerning the sustainable use of high altitude areas and enforce international recommendations in order to keep the environment clean and alleviate negative effects of the nature-based physical activities.

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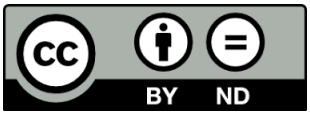
Wybrane aspekty zdrowotne trekkingów wysokogórskich

Streszczenie. Celem artykułu było rozpoznanie znaczenia aspektów zdrowotnych mających związek z aktywnością trekkingową na terenach wysokogórskich, obejmujących sposób fizycznego przygotowania się do trekkingów wysokogórskich, wpływu wypraw na życie codzienne przed- i powyjazdowe, a także wpływu warunków wysokogórskich na kondycję i samopoczucie. W okresie przedwyjazdowym powszechne są przygotowania mające na celu poprawę kondycji, na ogół w formie regularnych treningów biegowych, ustalanych samodzielnie lub pod okiem trenera. Podejmowany jest także trening mentalny. Samodzielne przygotowanie może okazać się niewystarczające ze względu na brak dobrych planów treningowych. Do najbardziej uciążliwych dla organizmu aspektów trekkingu wysokogórskiego należą: zbyt duże obciążenie, złe oznakowanie trasy, niewłaściwa odzież, niezrównoważona dieta, niedobór wody skutkujący odwodnieniem i infekcjami z powodu braku higieny osobistej. Niewłaściwe postępowanie innych osób również

stwarza zagrożenie. Zbilansowanie odżywiania wymaga eksperymentowania lub pomocy dietetyka, jednak konsultacje takie nie są powszechne. Spośród problemów sanitarnych najpoważniejszym jest sprawa utylizacji odchodów ludzkich, obecnych na całym terenie, powodujących zanieczyszczenie śniegu i źródeł wody oraz problemy z dostępnością wody pitnej. Słabe strony trekkingu wysokogórskiego wynikają z ograniczonych możliwości organizmu, ale też z braku świadomości w zakresie dobrych praktyk postępowania w ekstremalnych warunkach.

Słowa kluczowe: turystyka wysokogórska, trekking wysokogórski, góry



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