Nutrition At High Altitude-Approach That Nutrients Can Help

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INTRODUCTION

The regions that are higher from the mean of the sea level are defined as high altitude. At high altitude usually 2400 meter (8000 ft) above sea level the atmospheric pressure becomes low as compared to sea level[1, 2]. Humans can survive in almost each and every environmental condition. Human body is able to adapt and acclimatized at high altitude. The air pressure becomes reduced as the person goes towards high altitude. As the altitude increases a person starts facing problems viz; hypoxia, extreme cold, solar radiation, physical and physiological stress[3]. All these problems contributes to the acute mountain sickness (AMS) which further leads to high altitude pulmonary edema (HAPE) and high altitude cerebral edema (HACE)[4]. As the time passes at high altitude a person is shifted from acute to chronic mounting sickness (CMS) which further turn into polycythemia[5] and hypoxemia[6].

Due to decrease in atmospheric oxygen at high altitude, breathing rate and sleep pattern will be affected[7]. Not only the respiratory response will be affect at altitude but also the heart rate will also be increased to fulfill the oxygen demand at high altitude. In addition, the efficiency of the digestive system will also be reduced[8].

The elite player's training programs are designed at high altitude for endurance performance and this is very common practice among them. A strategically periodized intervention is generally designed for their endurance preparation [9,10,11,12]. The main purpose of the athlete to travel for high altitude training is to increase their red blood cells (erythropoietin driven)[13]. Apart from the increase in red blood cells, increase in buffering capacity as well as the genetic responses of hypoxia inducible factor 1- alpha (HIF) is non hematological altitude adaptations of high altitude training[14].

However, the athletes tolerate a number of challenges imposed by the environment at high altitude that includes: heat, humidity, cold and other altitude pose conditions[15].

The inability of an athlete to maintain body strength, power, speed, endurance, fatigue, impaired cognitive skills during the training at high altitude is basically due to environment induce hyperthermia [16] and hypothermia. The consequences includes: frostbite [17, 18, 19,] exercise induced asthma, bronchial hyper responsiveness[20, 21, 22], inflammation [23] and dehydration [24] among the sports population. These effects pose severe challenges on cardiovascular, thermoregulatory, metabolic, neural and cognitive functions of an athlete[25-30].

The number of factors viz.; current health status, fitness level, easy to acclimatize, certain physical and physiological parameters, nutrition and hydration status and rate of sweat loss of an athlete play an important factor to ensure the capacity of an athlete to adequately adopt these challenges imposed by the environment.

A well planned nutritional strategy plays an important role in combating these adverse altitude challenges during training. For an athlete, a carbohydrate rich diet is found to be helpful as it enhances the metabolism of glucose. The requirement of vitamins such as, vitamin A, E and C as well as some minerals especially, iron, zinc, selenium, copper and magnesium are also prove to be beneficial while training at high altitude[31].

HYDRATION -AT HIGH ALTITUDE

Water, next to oxygen, is an essential substance required by the body. At high altitude an athlete becomes more prone to dehydration or hypo hydration[32]. There is an increase in water losses from lungs due to cold and dry air as the cold air carries less moisture than warm one. In addition, there is an increased urinary loss of water termed as cold induced diuresis (CID) because of cold effect and also the body mechanism to avoid respiratory alkalosis with the help of renal system through bicarbonate excretion [33]. Heart rate may be increases and the cardiac output decreases. At high altitude (2500-5300m) oxygen saturation falls below 90%, at this level attitude illness is more common and the bodily system needs to acclimatize. An increased breathing rate will also be the cause of water loss to compensate by taking more oxygen more frequently[34]. Sweating may also be the reason of water loss at high altitude as hot and humid climate will make a person to sweat more to adjust the bodily temperature. Dehydration increases the risk of fatigue, impaired judgment, and apathy of hypoxia. It's advisable to stay hydrated before travelling to high altitude as well as intake adequate amount of water in the form of fresh fruits and vegetables, plain water/sports drink/ salted water with lemon and honey or sugar at high altitude[35, 36].

MACRONUTRIENTS- AT HIGH ALTITUDE

At high altitude, calorie intake is reduced that results a loss of body weight and alterations in body composition. Intake may be decreased due to anorexia, food aversion, physical discomfort because of cold, nausea and other gastrointestinal problems at high altitude. The loss in the body mass will further result into depletion in body fat percent and muscle mass as well[37, 38, 39]. Increased rate of energy expenditure during this time is also associated with negative energy balance[40, 41, 42].

Carbohydrate

At high altitude the main fuel to provide energy is carbohydrate [43] as it requires less oxygen 8-10% (approx.) for metabolism compared to fat & protein. Carbohydrates are also needed for muscle glycogen storage for energy and prevent muscle to be used as a source of energy (protein sparing) hence, reducing muscle wasting at altitude. Acute mountain sickness (AMS); headache, anorexia, nausea, vomiting, dizziness, central fatigue, weakness, insomnia, are very common problems at high altitude. A high carbohydrate diet can reduce the onset of AMS and improve the physical performance of an athlete [44]. It is advisable to take carbohydrate rich and frequent meal while travelling at high altitude.

Fat

Fat is energy dense macro-nutrient but required more oxygen for metabolism than carbohydrates[45] hence, not suitable for high altitude as it worsens the symptom of acute mountain sickness (AMS). However, up to some extent fat intake is required to provide essential fatty acids and for fat soluble vitamins.

Protein

A negative nitrogen balance has been reported in high altitude and to achieve a positive nitrogen balance minimum intake of protein is required. Muscle wasting is very common at high altitude and it can be corrected by supplementation of branched chain amino acids; leucine, isoleucine and valine [46]. To retain fat free mass or to prevent muscle loss increase intake of protein mainly leucine is beneficial at high altitude [47, 31]. Therefore, protein is required to maintain desirable body weight and to build and repair tissues also[48, 49].

MICRONUTRIENTS- AT HIGH ALTITUDE

At high altitude there is a need of some vitamins and minerals only when natural food sources such as fruits and vegetables are not available. Though some of the minerals are especially required and need to monitor like Iron, Vitamin D, etc.

Vitamins & Minerals at Altitude

Natural antioxidants such as beta carotene, vitamin C, vitamin E selenium & zinc are required at high altitude as ultraviolet exposure becomes more prominent and anaerobic metabolism increases. Supplementation with antioxidants increases the ventilator threshold[32, 50, 51, 52]. Antioxidant dosage may play a protective role against lipid per oxidation caused by hypoxia [53, 54].

There is an increased requirement of erythropoisis [55]for adaptation of the body at high altitude which requires a strong nutritional strategy before travelling to high altitude to increases the intake of iron, folic acid, copper, zinc, manganese, vitamin A, vitamin C, E & B12 [56]in diet and in supplementation to prevent hypoxia (hypoxic anaemia). Erythrocytosis, an increased rate of red blood cell production, is one of the main physiologic adjustments to hypoxia.

Among the micronutrients, iron plays an important role for adaptation while training at altitude[57]. The body stores of iron must be sufficient before travelling to high altitude[58]. Hypoxic exposure increases iron requirements and utilization for erythropoiesis in athletes. Low iron reserve reduces the ability of an athlete to sustain and adapt in response to altitude changes. For this concern, the supplementation of iron must have start few months before traveling to high altitude for better iron reserves in the body[59].The supplement must be given based on test the reports or iron status in the body. A study suggests that, even though test parameters of iron are in good status but the supplementation with iron before and during at high altitude proves to give good result. Supplementation of iron along with vitamin C as well as diet rich in these nutrients (meat, poultry, chicken, lamb, salmon, shellfish, pork, green vegetables, goose berry, lemon, citrus fruits, etc) is helpful to store iron reserves.

GASTROINTESTINAL & HORMONAL RESPONSES- AT HIGH ALTITUDE

It has been studied that, at high altitude due to low oxygen concentration person feels more satiety and less hungry or anorexic. At high altitude, the heart rate increases to fulfill the need of oxygen demanded by the organs to acclimatize. Due to increased heart rate the digestive efficiency of food is reduced, as body suppresses the digestive system in favour of increasing its cardiopulmonary reserves. There is a decrease in the amount of blood flowing to digestive organs and increased blood flow to the brain, heart and lungs [31, 8]. In addition, there is a decrease in the core body temperature and reduces the motility of the gastrointestinal muscle which further leads to distension of colon and reduced Gastro Intestinal (GI) secretion.

At high altitude, there is an alteration of gut hormones such as leptin and cholecystokinin [60, 61] which suppress appetite as well as GI discomfort. Hypobaric hypoxic condition may cause reduction in the secretion of digestive enzymes & gastric motility which results in slow digestion of food, malabsorption and hence malnutrition. A person feels anorexic and vomiting sensation. It has been studied that, anaerobic bacteria population grows at high altitude regions [61, 62]. Helicobacter pylori are very common & popular bacteria present at high altitude may also be the cause to damage the pyloric lining of the stomach at higher altitude [61, 63].

The growth of the gut microbiota can be determines by the diet consumed. Dietary habits and the food group consumed is significantly impacts the composition of gut microbiota. It has been observed that, a diet rich in prebiotics with high fibre content, as in Vegetarian, Mediterranean and in Fermentable Oligosaccharide Disaccharie, Monosaccarides and Polyols (FODMAP) promotes the growth of healthy intestinal microbiota and hence reducing the consequences of inflammation and disease[64, 65]. The diet affects the internal atmosphere of the gut microbiota. Fermented food contains good amount of healthy microorganism as probiotics[66] .Some of the food items that contains probiotics like yogurt, fermented soy product, etc imparting the benefits to the intestinal mucosa and reducing the risk of inflammation and disease [67].

CONCLUSION

In all over the world the most of the populace are searching the entertainment, recreation and some sort of adventure at altitudes while some other population are involved in sports at altitude for the sake of performance. Sports population however, naturally increases their physiological demands for performance enhancement at high altitude. Whatever the population or the purpose is to be at high altitude, body demands some adaptations and acclimatization to survive there. This article suggests the need of some of the specific macro and micro nutrients that has to be supplied to combat the series of metabolic stress due to physiological responses at high altitude.

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