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Article

Nourishing the Nation's Shield: Dietary Strategies for Indian Army's Climate Resilience

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ABSTRACT

The diverse topography of our motherland poses unique nutritional challenges for our army. From the frigid Himalayan heights to the arid deserts and the stifling coastal areas, the Indian army is constantly exposed to a wide range of climatic extremes. These adverse conditions, taxing physical activities and operational stressors often necessitate a deliberate dietary plan to optimize performance and wellness. This review zeros down on the crucial role of diet in enhancing the physical and cognitive capabilities of our soldiers. We delve deep into the specific nutritional requirements of them, considering the impact of stress, hydration, energy expenditure and micronutrient intake. Additionally, we highlight the challenges associated with military food services, including the need for food safety, shelf-life and palatability in field conditions. To enhance the operational readiness and overall well-being, our armed forces need to address these challenges by implementing effective diet plans which are the focal point of this work.

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Introduction

There are many different topographic features in India, from ice-covered Himalayas to being surrounded by the Arabian Sea, Indian Ocean, and Bay of Bengal, and from arid deserts to dense tropical forests. To protect our motherland against intruders, the Indian government has engaged many forces like the Indian army, air force, navy, and paramilitary units. In addition, India also faces internal security challenges or sometimes takes part in surgical strikes.

For decades, the Indian Army has been deployed throughout India, including high altitudes and deserts, to protect the nation. "High altitude" means above sea level. Low atmospheric pressure is observed generally at 8000 ft above sea level (An Altitude Tutorial, 2011; Cymerman, and Rock, 1994). The Siachen glacier, the highest

battlefield in the world, is located above 17,700 feet from sea level in the eastern Karakoram range in the Himalaya. Approximately 10,000 soldiers have been posted there. They are mainly present at 1800–23,000 feet above sea level. The temperature may go to - 55° C. Hypothermia, frost bite, chilblains are common problems for soldiers (https://www.jagranjosh.com/general-knowledge/what-is-the-siachen-glacier-dispute-1528291952-1). Moreover, they are vulnerable to other complications like acute mountain sickness, high altitude pulmonary oedema, snow blindness, and carbon monoxide poisoning (Jindal, 2009). Several parameters are responsible for having a cold injury at high altitudes. High-speed wind is another major threat to soldiers. Cold winds may cause a greater loss of heat from exposed skin, increasing the risk of frostbite. Heat loss also takes place from wet clothing. Clothes may get wet due to snow or rain. Physical conditions like dehydration results in fatigue more easily, and dehydrated soldiers are more susceptible to cold injury. Cold tolerance is also observed in people who are lean and over the age of 45. Frostbite can develop above 8000 feet above sea level due to a reduction in blood flow caused by low temperatures, altitude, stronger winds, and a lack of oxygen. In addition to cold temperatures, wind, and rain, a number of environmental stresses have been linked to cold weather. Sunburn and snow blindness are other problems associated with sunlight. Heat loss will be increased by sunburn during cold conditions. Low humidity is also accompanied by a cold climate. Low humidity is also responsible for drying of the lining of the nose, throat, and mouth, which may result in nosebleeds, sore throats, etc (Castellani, et al. 2001). Fresh drinking water may be unavailable during low temperatures as the river freezes. Hence, the arrangement of rations as well as obtaining drinking water and fuel for cooking are major challenges for the soldiers(https://theprint.in/defence/these-are-the-challenges-indian-army-will-face-in-ladakh-this-winter-besides-the-chinese/513327/). Oxidative stress is also associated with low temperatures in cold conditions. During cold conditions, heat generation is increased, resulting in the consumption of more oxygen and the production of reactive oxygen species (ROS). Oxidative stress leads to cellular oxidative damage (Blagojević 2011).

Indian soldiers are also posted on the desert, India-Pakistan border. In summer, scorching heat is a major challenge in the desert. Temperatures generally rise by up to 40 degrees. During May they often hit 50°C. Heat stress is a major problem associated with a hot environment. Dehydration may be one of the major problems in the hot environment.

Food can nourish our bodies by providing nutrients. Six major nutrients, namely proteins, carbohydrates, fats, vitamins, minerals, and water, are present in food. Each nutrient has definite functions like providing energy, supporting growth, and maintenance or repair of tissues (Srilakshmi, 2012). The amounts of various nutrients vary greatly between foods. On the basis of nutritive values, foods can be classified into several groups: Cereals and millets 2) Pulses, 3) Fats and oils, 4) Vegetables (including green leafy, root, and tuber vegetables). 5) Fruits and milk products 7) Animal-derived foods 8) Nuts and oilseeds 9) Sugar and starchy foods; 10) Spices (Swaminathan, 2011). Although all foods are functional because they supply nutrients, the concept of functional food is gaining attention nowadays. Functional foods are those foods which supply benefits beyond providing energy and basic requirements for growth. The risk of disease may be reduced or optimal health may be attended by the uptake of functional foods (Medeiros and Wildman, 2019).

The fitness of soldiers plays a pivotal role in their performance under every condition. Good dietary habits as well as exercise are powerful combinations to make you fit. Exercise also needs energy, powered by ATP. ATP is produced when carbohydrates, fats, and proteins are broken down. These can be obtained either from endogenous sources like glycogen and fat or from exogenous dietary sources. Energy-providing foods include carbohydrates and fats, along with proteins. Foods also provide free radical scavenging activity. The generation of free radicals is associated with metabolism.
This present review mainly focuses on the diet plans for our soldiers under various conditions. In addition, it emphasizes the importance of convenient food for soldiers, such as ready-to-eat and ready-to-cook foods. This article also explains the use of foods to facilitate wound healing,
stress management, and the advantages of various antioxidant foods. The concept of a personalized diet is also elaborated.

Dietary strategies fortroopsat highaltitudesandhot conditions

In 400 BC Hippocrates told physicians that, “Leave your drug chemist’s pot, if you can heal your patients with food.” Hence, it is clear how important food is in one’s life. Food is composed of nutrients and non-nutrients. Nutrients is again classified as macronutrient and micronutrients. Macronutrients are generally required in larger amounts whereas small quantity for micronutrients. Macronutrients include carbohydrates, proteins, fats. Vitamin and minerals are the major micronutrients. Hence, nutrient requirement is defined

as minimum amount of absorbed nutrients which is essential to maintain the body's normal physiological functions (Srilakshmi, 2012). Meal planning is necessary for providing a balanced diet. A balanced diet contains nutrients with proper amounts to meet the nutrient requirement of a person for maintaining good health (Ross, 2010; Swaminathan, 2011).

The requirement of water for soldiers mainly depends on the environment, physical activity and body size. Hydrated body is always essential whether soldier is at a high altitude or hot conditions. In dry and cold conditions, water can be lost from lungs as cold air contains less moisture. An increased breathing rate would be observed at high altitudes, due to more frequent oxygen intake. Cold induced-diuresis also contributes water loss in cold condition. These may cause water loss. In a hot environment, daily fluid requirement of a soldier increases as sweating increases and temperature of air increases. Light, vapor permeable clothing is preferred for reduction of sweat rate in hot environment during day time. Sometimes, a soldier requires water 4-6 Lit/day in temperate condition and 8-10 Lit/day in extreme heat environment for heavy work or long hours of moderate work. Intensity of physical activity and duration are also responsible for sweat loss of a soldier. So, the water consumption should be high enough to prevent dehydration. Soldiers can follow some strategies to stay hydrated in extreme conditions. Meal should not be skipped. To keep soldiers from getting dehydrated, they should drink enough water. Soldiers should be offered different drinks -may be with flavour. Obviously, in cold environment, hot drinks are preferrable whereas in hot environment, cold drinks are better. Frequent intake of small quantities of fluid must be encouraged, than seldom intake of large quantities of fluid (Montain and Ely,https://medcoeckapwstorprd01.blob.core.usgovcloudapi.net/pfw-images/borden/mil-quantitative-physiology/QPchapter07.pdf).
At high altitudes, metabolism is dependent on physical exercise, diet, and a hypoxic-hypobaric environment. Changes in metabolism also occur at high altitudes. Increased basal metabolic rate, more glucose dependency, accumulation of lactate, reduced availability of oxygen in peripheral tissues, etc. aremorecommonlyobservedina coldenvironment.

High energy expenditure is also observed among soldiers engaged at high altitudes (Hill et al.2011). Metabolism of carbohydrates requires a lower amount of oxygen to generate ATP.Hence, a high carbohydrate-rich diet is essential at high altitudes where cold stress and shivering take place (Febbraio, 2000). A carbohydrate rich meal can be a remedy of acute mountain sickness (AMS) (Khodaee et al. 2016). Hence, carbohydrates play a crucial role in metabolic heat generation in cold environments compared to fat. As we know, protein also plays a very important role in body building. The thermic effect of protein shows higher thancarbohydrates and fats. This could be one of the most important benefits of protein consumption in cold environments, because protein consumption keeps them warm for about 5–6 hours. It may be helpful to eat protein at night to prevent cold-induced waking (Marriott, 1996). Generally, "non-shivering thermogenesis" consumes about 30 % of the protein energy. Less fat use is preferable at high altitude because fat produces less energy per unit of oxygen utilization compared to carbohydrates (Hill et al. 2011). A diet richin fat may cause problems because the metabolism of fat needs higher amounts of oxygen (Babusha et al. 2008). But fat is required to meet the normal body's needs. The diet ofsoldiers at high altitude may comprise of 60 % carbohydrates, fat (22 % – 25 %), and 12 % – 15 % protein. A high-strength activity needs 1.2 - 1.5 gm/kg body weight (Hill et al. 2011). A positivebalance was found to be associated with an intake of dietary nitrogen of 12 g/day. Therequirement of vitamins at high altitude is the same as at sea level. A high level ofantioxidants such as vitamin E, C, A, or selenium, copper, or zinc may be required to reduce lipid peroxidation (Selvamurthy, 2003).

Exercise in a hot environment is thought to enhance the catabolism of proteins and cellulardamages. Intake of proteins with antioxidant vitamins should be enhanced. Improved workcapacity and performance have been observed after uptake of carbohydrates during prolonged moderate-intensity exercise or intermittent high-intensity exercise (Singh, 2005). Enhanced energy expenditure is observed in hot environments due to increased sweat gland activities.

There is no evidence of taking up more fat-soluble vitamins in a hot environment. Vitamin C may have a role in reducing the heat stress. Some reports suggest that increased vitamin C may be able to reduce heat stress during acclimatization. In a hot environment, loss of sodium, potassium, and chloride is observed as sweat increases. A beverage containing electrolytes like sodium, potassium, and chloride should be provided. Physical performance may be hampered due to iron deficiencies. Supplementation with iron may be optional in this regard (Marriott, 1993).

Hence, the menu for soldiers should be well-balanced. It

should be enriched with carbohydrates for getting energy as well as protein for maintaining the body, and vegetables and fruits for getting other nutrients like vitamins and minerals. The menus for breakfast, lunch, and dinner for our soldiers generally consists of roti, vegetables, dal, rice, etc. Kheer is served at dinner sometimes. It is estimated that, average energy expenditure of Indian army is around 2900 - 4500 kcal (Singh, 2012).

Convenience foods for Indian army

Convenience foods are prepared foods that are ready to consume. They are mainly heterogenous groups of products that vary in composition and method of preparation and processing. Hence, they are named as ready-to-eat, ready-to-cook, etc. Convenience foods offer various advantages in different conditions. Most convenience foods have a longer shelf life due to the addition of preservatives or fried products. They can be easily carried. Their storage is also very convenient. Sometimes, soldiers have to take shelter in inaccessible places for a long time. At that point, these types of foods meet their needs. Most of all, they are time-savers (Srinivasan, 2016).

Some fried and shelf-stable foods serve as the most common convenience foods in India.

They may mainly be used as snacks in a soldier's food chart because of their high shelf life. Namkeen paras and Shakar paras are made up of wheat, dough, ghee, salt, or sugar. The moisture content may vary from 2–5%. It may be stable for one year if packed properly with aluminum foilor polyethylene. Sev, ganthiya, and boondiare prepared from Bengal gramme flour. They may be salted and spiced. Dried products like chips and wafers may be stable for months. Depending on the nature of the frying oil, fried products may be stable for 1–4months. Murmura or muri may be consumed with roasted Bengal gram, shredded vegetablesand spices. Traditional sweets like chikkies, gajak, laddu, shoanpapdi, shoan halwa are made up of roasted wheat flour or Bengal gramme with jaggery. Roasted ground nuts make it more stable. Bakery products like biscuits, cakes, bread, and buns can be consumed. These are mainly ready-to-eat foods. That can be consumed without heating or thawing. Cooking is not required. In addition to ready-to-eat foods, soldiers can eat precooked, dehydrated foods whenever they need them. This type of ready-to-cook food requires cooking and frying before consumption. Precooked dehydrated foods like instant pulao, rice, noodles, khichdi, upma mixes, and masala oats can be kept with them for their ration. Depending on the ingredients and dehydration method, the foods can be cooked in 5–15 minutes (Khatkar,2007). It takes less time to cook than normal cooking. Sometimes soldiers have to be present in some battlefields where they are unable to cook properly. At that place, ready-to-cook foods are indispensable to them. They also carry canned foods like rasagulla, gulab jamun, etc.

The Defense Food Research Laboratory (DFRL), Mysore, developed this type of convenience food for the Indian army. They are mainly focused on the production of shelf-stable foods under different climatic conditions. It is stable for up to 6-12 months(https://www.drdo.gov.in/sites/default/files/technology-focusdocument/TF_Oct_2017_WEB.pdf). Ready-to-eat foods are produced by retort pouch processing technology. It includes plain rice, vegetable pulav, potato peas curry, chicken curry, egg curry, paneer peas curry, chicken pulav, vegetable noodles, rajam curry, dal curry, and plain rice. Other ready-to-eat foods include chicken biscuits, flax cookies, preserved and flavouredchapathies, short-term preserved chapathies, high energy bars, nutri food bars, omega 3 bars, sweet and sour tasty bars, protein-rich mutton bars etc. Ready to cook products include instant cooking rice, instant suji halwa mix, instant upma mixes, millet dosa mix, millet kheer mix, Ragi cookie mix, millet halwa mix, etc. Readyto drinkis also available.

They are aloe vera juice, tender coconut water, vegetable juice, etc. (https://www.aecengg.com/post/processed-food-for-armed-forces-developed-by-drdo). Among them, energy foods include chicken biscuits, flax cookies, flax munch, cocoa delight bar, omega-3 rich bar, sweet and sour bar, high energy bar, nutri food bar, composite tasty bar, flax oat tasty bar, ergogenic bar. Besides these, DRDO also generates hightechnology-based preserved fruits and vegetables, minimally processed vegetables, etc (https://www.drdo.gov.in/survival-ration). Protein-rich egg biscuits can be available in three flavours: vanilla, pineapple, and orange. Around 475 kcal is obtained from 100 gm of thesebiscuits. These nutritious and tasty biscuits are really well accepted by the armed forces(https://www.drdo.gov.in/sites/default/files/technology-focus-documrnt/TF_Oct_2017_WEB.pdf).

Foodswhichcanprotect our soldiers from coldinjuries

Hypothermic soldiers should be hydrated and fuelled as

soon as possible. Carbohydrates are the best option for mild hypothermic soldiers to provide instant energy and a heat surge, followed by proteins. Hot liquids and chocolates are also another option to get carbohydrates, proteins, fats, and calories. To meet the needs, proper health drinks with balanced carbohydrates, proteins, and fats are required. Caffeine, tobacco, and nicotine should not be consumed in these situations because it may cause dehydration or aggravate the injury. A diluted mixture of warm water with sugar can be given every 15 minutes to severe hypothermic soldiers (Nagpal and Sharma, 2004). Water is another essential factor to prevent dehydration even in cold conditions. Overheating due to excess clothing results in sweating. Sweating may be responsible for water loss from the body, even in cold weather. Sweat evaporates rapidly in cold, dry conditions (Castellani, 2001).

Foods used to facilitate wound healing

Getting wounds is common in soldiers' life. Wound healing is a complex phenomenon comprised of cell migration, cell proliferation, and the deposition of extra cellular matrix.Nutrients also have a major role in wound healing. Some of the foods may have antioxidant properties.

Micronutrients play a critical role in wound healing. Dietary supplementation with the amino acid arginine accelerates wound healing by deposition of collagen (Seifter, 1978). The recommended dose for arginine supplementation in wounded patients having good protein intake is 4.5 gm/day (Leigh, 2012). Glutamine is also helpful in wound healing by protecting against inflammations and infections. Glutamine also regulates superoxide generation, apoptosis of leukocytes, and antigen processing (Wischmeyer, 2002; Ardawi, 1988). Proline and its derivative hydroxyproline, a main component of collagen, should be supplied adequately for collagen deposition in wound healing. Another micronutrient has a significant role in wound healing; repair of normal wound and epithelial tissue development requires vitamin A (Keleidari, 2014). Vitamin C is responsible for collagen synthesis, angiogenesis, cell migration, and transformation. Zinc facilitates wound healing by promoting DNAreplication in epithelial tissues and fibroblasts (Barchitta et al. 2019).

Fruits as antioxidants protect ROS

Reactive oxygen species (ROS) are produced from oxidative phosphorylation in aerobic metabolism. It can also be generated from other sources in our bodies. ROS includes free radicals having unpaired electrons and non-radical forms. They are oxidising agents and cause cellular damage by inducing oxidative stress. Oxidative stress is involved in various diseases like cancer, cardiovascular disease, and inflammatory conditions. The main function of the antioxidant system is to protect the cells by neutralizing free radicals. Although the body contains antioxidant enzymes, foods are rich sources of antioxidants. Hence, intake of a good number of foods containing antioxidants, should be included in the diet of Indian soldiers to boost their immune systems and prevent various diseases.

Plants are a rich source of antioxidants. They produce antioxidants like water soluble ascorbate, glutathione, phenol, and lipid soluble tocopherol and carotenoids (Dumanović et al. 2021). Invitro, polyphenols are more effective antioxidants than Vitamin C or E. Polyphenols can be found in vegetables, fruits, cereals, tea, coffee, and wine. Berries, tomatoes, nuts, olives, olive oil, soy, flaxseed oil are rich sources of different types of polyphenols, including flavonoids, lycopene, resveratrol, anthocyanins, etc. Among fruits, berries, including blackberry and raspberry, are a very good source of antioxidants. Fruits contain a significantly better quantity and quality of phenols than vegetables. Apple, red grape, strawberry, banana, peach, pear, pineapple, orange, and lemon are enriched in phenol contents.

Beverages like cocoa, coffee, black tea, and green tea contain polyphenols (Mohamed, 2015). Carotenoids are present in yellow fruits (mangoes, papayas, pumpkins, and carrots).

Nutrients for stress management:

Stress is closely associated with everyone’s life. It is obviously applicable to soldiers as well. They have stress on daily basis. They have professional stress like being injured or killed, witnessing death or witnessing death of a unit member, attempted attack on one’s camp. Additionally, they have to face other issues like being away from family, acclimating to extreme weather or other environmental changes (Maglione, 2021). Stress may be acute or chronic. Headache, tiredness, body aches, reduced sleep, and a loss of appetite are common forms of acute stress (Ryali, 2011). A little stress is often required for better performance, until it tells upon health. Stress management therefore, is essential for soldiers. Nutrients of the foods play a crucial role in it. Serotonin, a neurotransmitter, plays vital roles in modulating mood, cognition etc. A depressive mood can be found due to

depletion of serotonin precursor, tryptophan. Several foods are rich sources of tryptophan, precursor of serotonin. Salmon which has high content of tryptophan should be incorporated in soldier's diet if possible. It also contains higher amounts of omega 3 fatty acid sand vitamin D. Vegetarian diet may include seeds and nuts instead of salmon. Seeds and nuts are excellent sources of proteins. Turkey, poultry, eggs, milk and cheese are also good sources of protein. Soymilk and tofu are good options for vegetarians to get tryptophan. Among fruits, pineapple has a high content of tryptophan (https://www.purerecoveryca.com/foods-to-boost-serotonin-mental-health-mood/). Omega 3 fatty acids are also required for improved moods and cognitions (Giles,2015). Marine fishes like mackerel, tuna, sardine are rich in omega 3 fatty acids. If possible, these types of marine fishes may be included in soldier's diet. Flaxseed, canola, and walnut oil are enriched in alpha linolenic acid (ALA). Dietary ALA can be converted into omega 3 fatty acids. Walnut also contains omega3 fatty acids (Singh, 2016).

As vitamin C can reduce a stress hormone, cortisol, citrus fruits like orange, and grape are essential to reduce stress. Soldiers should take orange juice frequently. Magnesium is also very helpful in reducing the stress level. Spinach is a good source of magnesium. It also contains vitamin C. Hence, palak-paneer may be a healthy option. Chocolate is another stress-busting food. Because cocoa beans contain magnesium, potassium, zinc, flavonoids (polyphenol). Chocolate also contains high amount of tryptophan, precursor of serotonin. Chocolates or hot chocolate soups can be a potent stress reliever. Caffeine, present in coffee is known to enhance the secretion of serotonin. Caffeine also decreases fatigue, gives an alertness which is essential for our soldiers. L-theanine, present in green tea, helps in reducing anxiety. Coffee and green tea should be included in soldiers' diet. Banana which is good sources of carbohydrate, potassium, iron, vitamin B_6 and vitamin C helps to maintain blood sugar level. Egg also contains tryptophan, vitamin B_{12}, B_2, B_5 and vitamin D. So, it becomes a perfect stress-busting food (Singh, 2016).

Conclusion

Indian armed forces form the back bone of our country. They protect our country by sacrificing their own lives. Healthy food is essential for everyone and soldiers are no exceptions. It allows them to work efficiently in diverse battlefields. They may have to endure a long period of time in a variety of climate conditions. Sometimes they don't get the enough time to cook.

Personalized diet and food supplements can have a major impact on their physical performance. Genetic backgrounds and the interplay of nutrients are the key factors of metabolism. As this review depicts, diet has a substantial impact on maintaining health. Healthy people definitely perform optimally. Hence, to achieve optimal performance, an individual's diet should be very carefully chosen. Thus, the principles of nutrigenomics, which are directly related to personalized diet, are of immense importance for optimal performance.

Conflict of Interest

There is no conflict of interest.

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