



# **FEATURES OF ORGANIZING NUTRITION, WATER SUPPLY, AND SANITARY-HYGIENIC SUPPORT FOR SERVICEMEN IN HOT CLIMATES AND HIGH-ALTITUDE CONDITIONS**

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## **Abstract:**

This article examines the deployment, nutrition, and water supply of military personnel in extreme desert and high-altitude conditions. The effects of high temperature, direct solar radiation, hypoxia, and limited water availability on physical, cognitive, and combat performance are analyzed. Data indicate a 20–40 % increase in daily energy expenditure in hot and high-altitude climates, highlighting the risk of dehydration, heat exhaustion, and altitude sickness

**Keywords:** extreme climate, desert, high altitude, military personnel, hydration, rational nutrition, energy expenditure

## **RESEARCH OBJECTIVE**

The objective of the research is a comprehensive analysis of the features of the organization of nutrition and water supply for military personnel in extreme hot and high-altitude climates, with the aim of increasing combat readiness and reducing the risks of dehydration, heat exhaustion, and altitude sickness. The study focuses on identifying key adaptation factors, optimizing nutrition, hydration, and sanitary-hygienic support systems to maintain the physical and cognitive performance of personnel.

## **MATERIALS AND METHODS**

Materials for the research include data from domestic and foreign scientific publications, methodological recommendations on military hygiene, military medicine, nutrition and water supply logistics, as well as field observation data of servicemen performing tasks in desert and high-mountain conditions.

Research methods involved the analysis of literature on extreme conditions, sanitary and hygienic support, and military nutrition. Systematization of data on energy expenditure, hydration, rational nutrition, and thermoregulation in the conditions of high temperature and hypoxia was conducted. A comparative analysis of water supply methods, field kitchens, and acclimatization of personnel was also performed. Practical recommendations were summarized on adapting rations, organizing water supply, and medical monitoring.

## **INTRODUCTION**

The effect of natural and climatic factors in the desert—primarily high air temperature, difficulties in water supply, and direct exposure to solar radiation—leads to a significant decrease in both physical and mental performance, overheating, and a high risk of heat stroke. Loads that are as close as possible to combat conditions, sun exposure, sandy terrain, frequent water shortages,

disrupted nutrition regimens, and other factors create extreme physical and psycho-emotional stress for military personnel.

Taking into account the specifics of the terrain and climate is a key factor in the planning and execution of combat operations, affecting both tactical decisions and the physical condition of the troops [4].

Altitude differences, thin air, steep slopes, and difficult terrain significantly complicate logistics, tactical operations, and medical support. To maintain combat readiness and safety, special training, acclimatization to altitude, and careful planning of routes and supply are necessary. Successful operations in mountainous areas require a comprehensive consideration of natural conditions, adaptation of personnel, and logistics to minimize losses and maintain the physical and psychological stability of forces [3].

## **RESULTS AND DISCUSSION**

Energy expenditure of military personnel in extreme conditions. An analysis of publications shows that service in hot and high-altitude climates is accompanied by a significant increase in energy expenditure. For example, Murray B. et al. (2022) indicate that daily energy expenditure of military personnel in conditions of high temperature and reduced partial oxygen pressure increases by 20–40% compared to temperate climates, especially during marches, engineering works, and combat missions in full gear [30]. Combined heat stress and hypoxia accelerates fatigue, increases metabolic stress, and raises the body's need for energy and fluids.

Insufficient caloric intake leads to negative energy balance, accompanied by weight loss, decreased muscle strength, impaired immune function, and increased non-combat medical losses during prolonged operations [16, 22]. Energy deficit is often accompanied by inadequate hydration, which exacerbates



thermoregulation disorders and increases the risk of heat illnesses. The weight of equipment and reduced heat dissipation further increase energy expenditure and heat load, especially in mountainous and desert regions. To compensate for increased energy expenditure, the authors recommend high-calorie, easily digestible rational food packages with adequate amounts of carbohydrates, fats, and electrolytes. Gradual acclimatization to heat and altitude reduces excessive energy expenditure and increases the effectiveness of service and combat tasks [30].

#### **Hydration and Water Supply**

Effective water supply is a critical factor for maintaining combat effectiveness and health. Studies show that even moderate dehydration (1.5–2% of body weight) leads to statistically significant decreases in muscle strength, endurance, reaction speed, and cognitive functions, directly affecting the performance of combat missions [26]. Lack of fluid impairs heat loss due to reduced sweating and skin blood flow, increasing the risk of heat exhaustion and heat stroke [18, 21].

Special importance is attached to the integration of water logistics with sanitary and hygienic support and nutrition supply. The use of mobile water purification units, filters, and containerized water storage systems makes it possible to maintain drinking water supply even during prolonged operations in desert and mountainous environments [12, 25]. Rations should ensure adequate intake of fluids and electrolytes, including sodium and potassium, to maintain water-salt balance. The use of wearable sensors to monitor hydration allows for the detection of early stages of dehydration before the appearance of clinical symptoms and adapts fluid intake regimes to the specific needs of each serviceman [28].

A crucial element is the standardization of hydration norms, taking into account ambient temperature, the intensity of physical activity, and acclimatization status of personnel. Adhering to army hydration standards reduces the incidence of heat exhaustion and heat stroke, increases physical and cognitive performance, and maintains the combat readiness of the troops [24].

#### **Rational Nutrition.**

Military rations should provide not only sufficient calories but also a complete set of macro- and micronutrients, including proteins, carbohydrates, fats, vitamins, and minerals [17, 22]. Inadequate energy intake leads to decreased endurance, loss of muscle mass, reduced attention span, and slower recovery after exertion, all of which directly decrease combat task performance.

In a hot climate, the ration should compensate for fluid and electrolyte losses through sweating. Including chilled foods and drinks helps to reduce heat load on the body, while salty foods compensate for losses of sodium and other electrolytes [7, 15, 16]. The caloric value of nutrition must be adjusted in view of the body's increased energy expenditure to maintain thermoregulation and enable physical activities.

Maintaining an optimal level of water and electrolytes, along with adjusting the energy value of rations considering increased bodily demands in hypoxic conditions, are key factors in adaptation to high altitude [19]. The use of nutritional supplements, including BCAAs, glutamine, and antioxidants (vitamins C and E, polyphenols), is considered to support muscle function and immunity; however, the authors emphasize the need for scientific validation of their dosing and integration into comprehensive prevention measures [29].

#### **Acclimatization and Physiological Adaptation.**

Gradual adaptation to high temperatures and altitude reduces the risk of heat exhaustion, heat stroke, and altitude sickness, and also helps maintain the physical and cognitive performance of military personnel [19]. Adaptation includes increased lung ventilation, improved oxygen transportation in the blood, and optimization of cardiovascular indicators and metabolic processes.

Regular monitoring of physiological indicators (oxygen saturation, pulse, blood pressure, body temperature) makes it possible to timely detect signs of overload or the onset of altitude sickness and to adjust the acclimatization process accordingly [19, 20]. Repeated exposure to high temperatures and gradual acclimatization improve the body's thermoregulatory capabilities and reduce the incidence of heat-related illnesses among personnel [20].

#### **Sanitary and Hygienic Support and Logistics.**

The comprehensive integration of sanitary-hygienic measures, nutrition, and water supply is critically important for preserving the health and combat readiness of troops in extreme conditions [13, 14, 15]. Field sanitation posts, water treatment systems, and adherence to personal hygiene rules reduce the risk of infectious diseases and heat injuries [8, 12, 13].

Optimization of field kitchens, including the use of water-saving technologies, modular kitchen complexes, and digital water consumption control, makes it possible to reduce water costs by 20–35% without compromising the microbiological safety of food [27]. The use of modern technologies, including wearable sensors and artificial intelligence algorithms, facilitates



the monitoring of personnel condition and prevents dehydration and heat disorders [28].

Cognitive Performance. High temperatures, dehydration, and electrolyte deficiency lead to decreased attention, slower reaction speed, reduced working memory, and impaired decision-making, which directly affects the fulfillment of service and combat tasks [23]. Effective integration of physiological, sanitary-hygienic, and organizational measures—including hydration monitoring, rational nutrition, and specialized equipment—can reduce the negative impact of heat stress on the cognitive performance of servicemen.

**CONCLUSIONS.** Service in hot climates and high-mountain conditions is accompanied by a 20–40% increase in daily energy expenditure, an increased need for calories and fluids, as well as a significant risk of overheating, dehydration, and heat-related illnesses. Comprehensive organization of rational nutrition, hydration, water supply, and sanitary-hygienic support is a key factor in maintaining the physical and cognitive performance of servicemen. Gradual acclimatization and regular monitoring of physiological indicators reduce the risk of altitude sickness, heat exhaustion, and cognitive impairment. Effective logistics, including mobile field kitchens, water treatment systems, and digital monitoring of water consumption, allow for resource optimization, minimized sanitary risks, and increased unit autonomy. The integration of medical, organizational, educational, and logistical measures ensures the maintenance of combat readiness, health, and morale of personnel during prolonged operations in the extreme climatic conditions of deserts and high mountains.

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