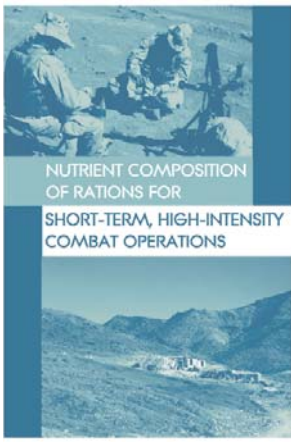
Nutrient Composition of Rations for Short-Term, High Intensity Combat Operations



The success of military operations depends largely on the physical and mental status of the individuals involved. An individual's physiological and nutritional status can markedly affect one's ability to maximize performance or effectiveness in short-term, high-stress, high-intensity assault missions. Maintaining appropriate nutrition during assault missions is a continuous challenge due to diminished appetites of individuals under stress.

Many less controllable and unpredictable factors, such as individual preferences and climate, reduce appetite. In fact, soldiers typically consume about half of the calories needed, leaving them in a state called "negative energy balance." The consequences of being in negative energy balance while under the strenuous circumstances of assault missions range from weight loss to fatigue and mental impairments. With the number of these types of missions increasing, the optimization of rations has become a high priority. Light-weight rations that contain all essential nutrients and food components are being developed with the idea of sustaining physical performance, postponing fatigue, and minimizing other adverse health consequences experienced while in these type of missions.

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To help in this effort, the Department of Defense asked the Institute of Medicine (IOM) to appoint a committee to guide the design of the nutritional composition of rations for assault missions. The report, titled *Nutrient Composition of Rations for Short-Term, High-Intensity Combat Operations*, reviews the unique circumstances of soldiers deployed in short-term, high-intensity missions. The report considers health concerns, food intake, energy expenditure, physical exercise and food technology issues to provide recommendations on the nutritional composition of daily rations for assault missions.

Although the focus of this report is on soldiers, the recommendations may be applicable to physically fit nonmilitary personnel under similar conditions of high-stress, intense physical activity, especially those experiencing negative energy balances for the repeated, short periods of time outlined here. This may include firefighters, peacekeepers, and other civilian emergency personnel.

To provide context for the recommendations, the committee formulated some basic assumptions about the characteristics of the soldiers' diets and health, the missions, and other issues, compiled through open sessions and available literature.

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Instead of maximizing the energy content within the size and volume limits of 3 pounds and 1.2 cubic feet, the committee recommends that a basic ration's energy content be approximately 2,400 kcal/day. In addition to the basic ration, the committee recommends provision of high-carbohydrate supplements for energy (400 kcal) in the form of gels, candy, or powder to add to fluids for individuals whose energy intake or need is higher than the one in the basic ration. The supplement could also be used at times when physical activity peaks and more energy is needed. While this level does not maximize energy density, this is the average daily energy intake that has frequently been reported for soldiers during training. Therefore, 100 % consumption of the ration would be more likely. To prevent significant amounts of individual micronutrients from being discarded, micronutrients should be distributed as evenly as possible throughout the food items in the ration.

Although soldiers would still be in a negative energy balance, little evidence exists to suggest that a periodic hypocaloric diet—if otherwise adequate in protein and other essential nutrients—is likely to be harmful, even if some weight loss occurs (< 10 percent of body weight). It is recommended that weight loss be measured after one month of use, and if weight loss is greater than 10 percent for a soldier, he should not be sent on assault missions until weight is regained to within 5 percent of initial weight. Also, the ration should not be substituted for Meals, Ready-to-Eat (MREs) or food services that provide a more appropriate diet for longer periods. Box 1 shows the general design of the recommended ration with the approximate energy and macronutrient content.

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BOX 1. General design of the recommended ration

Basic Ration:	
Protein	100–120 g (400–480 kcal; 17–20% kcal)
Carbohydrate	350 g (1,400 kcal; 58% kcal)
Fat	58–67 g (520–600 kcal; 22–25% kcal)
Water	105 g (assuming an average of 17% moisture)
Total weight (kcal)	613–642 g (2,400 kcal)
Carbohydrate (and Electrolyte) Supplement:	
Carbohydrate	100 g (400 kcal)
Water	17 g (assuming an average of 17% moisture)
Sodium	up to 12 g (based on palatability)
Potassium	up to 3.3–4.7 g (based on palatability)
Total Weight (kcal)	117 g (400 kcal)
Salt Tablets (available through medical personnel):	
Sodium	up to 12 g
Potassium	up to 4.7 g
Total Weight	8.7–16.7 g
Packaging:	181 g
Total Weight	**0.95 kg**
Total Energy Content	**2,800 kcal**

NOTE: This ration is intended for use over 3- to 7-day missions for up to a month. Prolonged and continuous use of these rations as a sole source of sustenance may lead to substantial weight loss. Constraints: weight of 1.36 kg and volume of 0.12 cubic feet.

The macronutrient distribution of the ration was designed as follows:

- **High protein content to minimize muscle loss.** To minimize potential consequences of a hypocaloric diet, spare muscle protein loss, and adequately provide for synthesis of serum proteins, the ration should contain 100-120g of high quality protein. In addition, this level of protein will likely maintain the immune and cognitive functions requiring protein or amino acids.

- **High carbohydrate content as energy source.** There is strong evidence that suggest that supplementing the diet with carbohydrate throughout periods of continuous physical exercise and stress not only increases energy intake but also optimizes physical performance. The committee recommends that the carbohydrate in the basic ration be 350g to optimize physical performance. An additional 100g of carbohydrate should be available as a supplement. Therefore, the overall recommendation is for 450g.

- **Enough fat to provide palatability.** Among the macronutrients, protein and carbohydrate in adequate levels were considered the priority; the remainder of the macronutrients (up to the energy level of 2,400 kcal) should be provided as fat. Thus, the ration should provide 58–67g of fat (22–25 percent of energy intake) to be distributed across a variety of foods. Fat added to the ration should have a balanced mix of saturated, polyunsaturated, and monounsaturated fatty acids with palatability and stability the prime determinants of the specific mixture.

The committee used the Dietary Reference Intakes established by the IOM, the most authoritative, up-to-date standards available, for active young men as the starting point for nutrient content in formulating the assault ration. Further adjustments were then made to meet the unique needs of soldiers involved in assault conditions; for example, data about sweat losses and utilization under high energy expenditure and stress were considered.

To provide food developers some flexibility, a range of levels was recommended for most micronutrients. In most cases, the ranges are based on the Recommended Dietary Allowance or Adequate Intake and the 95th percentile of intake of the U.S. population. When the 95th percentile dietary intake was higher than the Tolerable Upper Level, then the Tolerable Upper Level was used as the upper limit of the recommended range.

Although the ration was designed using the best available data, the majority of this data was derived from studies in which the environment or the subjects were substantially different from the ones for which this ration is targeted. Further work needs to be conducted to confirm that this ration provides optimal performance and maintains health or to have the opportunity of improving the ration by making necessary adjustments.

Additional data in the following areas of investigation should prove particularly beneficial to future development and refinement of an optimal ration: (1) additional knowledge regarding the unique nutrient requirements during combat operations; (2) deeper understanding of food preferences under high-stress situations; (3) additional information on the actual use of the ration in the field; and (4) methods to identify individuals at greater risk of excess electrolyte loss and kidney stone formation.

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FOR MORE INFORMATION...

Copies of *Nutrient Composition of Rations for Short-Term, High-Intensity Combat Operations* are available from the National Academies Press, 500 Fifth Street, N.W., Lockbox 285, Washington, DC 20055; (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area); Internet, http://www.nap.edu. The full text of this report is available at http://www.nap.edu.

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