

Energy expenditure as the basis for determination of nutritional demand in soldiers

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Summary:

The study summarizes the history of studies to determine the nutritional demand in soldiers of different armies, both in Poland and worldwide. Standard energy values of food rations as used for planning and providing nutrition to soldiers over the last century were presented.

Key words: energy expenditure, food rations, military service .

Introduction

Good nutrition is one of the fundamental factors allowing soldiers to maintain high physical fitness and good mental condition. Such conditions may only be achieved by proper nutrition that covers all nutritional demands of the body.

The main principle of rational nutrition is that the food should deliver appropriate amount of energy to match the energy expenditure. In nutrition, the energy expenditure values are the measure of calorific demand of human body that may be covered only by the food intake. Thus, the knowledge of daily energy loss is the basis for determination of energy values of nutritional standards for populations homogenous in terms of gender, age, body weight and height, performing similar works and living in similar conditions.

The question of daily energy expenditure, energy value of food and, in consequence, the energy balance, are of particular importance in the

army. Knowledge of the physical burden associated with soldiers' training, type of military unit and the specificity of service should be an essential element in nutrition planning which has to cover the energy demand and provide the body with all required nutrients in appropriate quantities and ratios.

History of the studies of energy demand in soldiers

History of determination of nutritional demands and in particular the energy demand in soldiers dates back to the 19th century. Soldiers' nutrition was usually the subject of interest for military healthcare services, as it directly affected the soldier's health and the efficacy of their action. Hence, in 1863, responsibility for nutrition in the US Army was bestowed by law to the military healthcare service [1]. The regulations were verified in 1877 and have remained in force ever since, including appropriate amendments. According

to these regulations, Medical Corps officers are also responsible for soldiers' nutrition:

“The officers of the Medical Department of the Army shall unite with the officers of the line (under such rules and regulations as shall be prescribed by the Secretary of War) in superintending the cooking done by the enlisted men; and the Surgeon General shall promulgate to the officers of said Corps such regulations and instructions as may tend to insure the proper preparation of the ration of the soldier.” [2]

About 1870, first studies were conducted in Europe to measure the physiological load of soldiers burdened by the accouterment of different weight, training at different ambient temperatures. These and subsequent studies conducted in Europe and the US led to determination of energy expenditure of humans undertaking various forms of physical activity, e.g. marching, including the carried load. The above studies, albeit encumbered with large margin of error, showed that soldiers may be burdened with energy expenditure in the range of 5,000-6,000 kilocalories per day, depending on the accouterment weight and outside temperature [3]. However, determination of energetic and nutritional needs of soldiers was at that time based mainly on the average consumption of food. The food ration proposed at the end of World War I by the Quartermaster General of the US Army Medical Corps was based on the results of the studies on the quantities of standardized food consumed by the soldiers in 400 canteens in years 1917-1918.

The results of the studies allowed to determine the mean energy value of food consumed at the level of 3,633 kcal with the actual values falling within the range of 3000 to 4000 kcal [4,5]. Subsequent study of the energy demand in soldiers, based on calculations of the energy values of food rations were conducted in the US in 1941. The study covered a total of several hundred units of infantry, air force, armored troops, artillery, engineering troops, chemical troops, cavalry, quartermaster troops, logistic services troops, medical troops, military training centers and others. The mean daily energy value of food consumed by soldiers was 3,694, ranging from 3,132 to 4,135 kcal. The highest energy value was measured for food rations dispensed in autumn season (September-November — 3,960 kcal), while

the lowest energy value was measured for rations dispensed in spring season (March-May — 3,570 kcal) [6,7,8,].

The results did not differ significantly from these obtained in years 1917-1918. A study conducted in 1943 in 99 canteens of the US Army ground forces and encompassing 130,000 food rations showed that the mean energy value of a daily ration was 3,468 kcal, ranging from 2,774 to 4,644 kcal [9]. Finally, a study to determine the energy demand in all US Army troops was undertaken and completed in the spring of 1945 [10]. The mean energy value of the food rations consumed by soldiers was 3,744 kcal and ranged from 3,471 to 4,078 kcal. The mean energy value determined in the study was very similar to the values obtained for food rations in the studies conducted during both World War I (3,633 kcal), and World War II (3,694 kcal).

During the World War II, the energy value of food rations in the British Army was higher than that in the American food rations and amounted to 5,127 kcal in January 1942. Due to the overly high weight of the rations, the energy value was reduced to 4,562 kcal in May 1942 [11].

Results of subsequent studies served as basis for revisions of nutritional standards for the American society; changes in the nutritional recommendations for soldiers followed these revisions.

Studies of the energy expenditure of soldiers in Poland

Also in Poland, studies of energy expenditure of soldiers in active service were conducted as early as before World War II [12,13].

The nutritional tables for Polish soldiers, developed in early 1920s, determined the minimum nutritional demand of soldiers. However, the energy and nutritional value of rations actually used was insufficient, leading to hunger among soldiers. Therefore, the nutritional standard was revised and the energy value was established at 2,900 kcal and later at 3,800 kcal [14].

The history of studies of the energy expenditure of soldiers of the Polish Army dates back to 1925, when major dr. Gustaw Szulc determined the energy load of soldiers in military service.

Table 1: Changes in the nutrition standards in the US Army (1943–1985) [15].

Normative document	Standard*	Energy † (kcal)	Protein (g)	Fat (%kcal)	Calcium (mg)	Iron (mg)	Vit. A (IU)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vit. C (mg)
FNB RDA‡	1943	3.000	70	—	800	12	5.000	1.8	2.7	18	75
	1945	3.000	70	—	800	12	5.000	1.5	2.0	15	75
AR 40-25§	1947	3.600	100	—	700	—	5.000	1.6	2.2	16	50
	1949	3.600 ¶	100	—	700	—	5.000	1.6	2.2	16	50
		3.000#	100	—	700	—	5.000	1.6	2.2	16	50
Tri-Service Regulation**	1968	3.400	100	<40% †††	1.400	18	5.000	1.4	2.0	22	60
	1969	3.400	100	<40% †††	800	14	5.000	1.7	2.0	22	60
	1970	3.400	100	<40%	800	14	5.000	1.7	2.0	22	60
	1976	3.200	100	<40%	800	18	5.000	1.6	2.0	21	60
MRDAs AR 40-25**	1985	2,800-3,600	100	<35%	800-1,200	10-18	1,000 (µg RE)	1.6	1.9	21	60
MRDAs AR 40-25**	1985	Na (mg/1,000 kcal)	P (mg)		Mg (mg)		Zn (mg)	I (µg)	Vit. B6 (mg)	Folacin (µg)	Vit. B ₁₂ (µg)
		1,700 "goal"	800-1,200		350-400		15	150	2.2	400	3.0

* Male personnel: †—Moderate climate; ††—National Research Council (1941, 1945); § U.S. Department of the Army (1947, 1949); ¶—Physically active; # Sedentary-type service.

** U.S. Departments of the Army, the Navy, and the Air Force (1968, 1969, 1970, 1976, 1985);

††—< 40% supply; †††—< 45% per ration (1968); < 42% per ration (1969); < 40% per ration (1970).

These studies led to publication of first energy expenditure tables for soldiers performing various tasks during service-related military trainings. The value of the daily energy expenditure was determined at the level of 3,876 kcal which gave a slightly negative energy balance compared to the energy value of the food ration being 3,800 kcal [12]. During the first twenty years after World War II, food rations of Polish soldiers were based on data from the Soviet Army.

Studies on the daily energy expenditure of the soldiers of the Polish Army were taken up again in the late 1960s in the Military Institute of Hygiene and Epidemiology. The studies were initially of evaluative character, and the obtained results served as basis for revision of soldiers' food rations. More than ten years of studies were concluded by the collective study titled "Tabele wydatków energetycznych żołnierzy polskich różnych rodzajów wojsk i służb" [Energy

expenditure tables for Polish soldiers of different arms and services], published in 1982 and being the only publication of this type to date [16]. Data in tables allowed for easy calculation of the daily energy expenditures of soldiers as well as classify the respective workload.

In the last two decades of the 20th century, studies of daily energy expenditure encompassed most training procedures compulsory for soldiers in mandatory military service, soldiers in training centers and students of military academies. The studies were conducted by the Military Institute of Hygiene and Epidemiology, and the obtained results served as basis for revision of energy values being in force at that time. The values of the energy expenditure of soldiers during a typical training day depended on the type and character of the unit and fell in the range of 3,339.5-4,651.6 kcal (13.99-19.49 MJ) (Table II [14].

Table 2: Mean daily energy expenditure values for soldiers of different types of units of the Polish Army.

Unit type	Daily energy expenditure	
	Kcal	MJ
Ground troops	4270.5	17.89
Mechanized infantry	4274.0	17.89
Armored troops	4319.0	18.10
Mountain infantry	4062.5	17.02
Air cavalry	4100.0	17.18
Air cavalry—military range	4594.4	19.25
Representative Company	4550.3	19.06
Battleships at docks	4000.0	16.76
Battleships at sea	4200 – 4700	17.60–19.00.
Missile base ships	4507.1	18.88
Divers' training	4282.9	17.94
Students in military academies	3535.0	14.81
Students of the Military Medical Academy	3339.5	13.99
Students of the Military Medical Academy—military range	4121.3	17.27
Students of the Military University of Technology	3737.3	15.66
Pilots at training camps	4651.6	19.49

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Conclusion:

Currently, the service in the Polish Armed Forces is a professional service, and thus, the results of the studies on the energy expenditure resulting from military training, which served as basis for determination of the energy values of food rations used in soldiers' nutrition have lost some relevance. However, studies of the energy expenditure associated with military training are still being conducted in students of military schools and academies as well as in soldiers at service in some air force units and Polish Navy battleships, as well as during military range trainings. The results of these studies serve as a basis for determination and/or revision of the energy and nutritional values of the food rations used in the nutrition of soldiers in the Polish Army.

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