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MRE Nutrition and Performance Among Male Armed Services Personnel in Hot Climates

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INTRODUCTION:

There are approximately over 300 cases of exertional heat stroke and over 2,000 cases of other heat related illnesses per year across all active duty military branches.[1] Heat illness is caused by environmental conditions, work intensity, hydration status, and nutrition status. Excessive amounts of heat can degrade mental and physical performance, which have the potential to cause heat casualties.[2] Heat illness can be prevented with proper nutrition, hydration, and climate awareness.[1,2] Although the main nutritional concern in hot environments is maintaining the body's hydration status, the focus of this literature review is on the specific military food rations "Meal, Ready-to-Eat" (MRE). MREs are the main rations consumed by the U.S. military to feed personnel during deployment. Prolonged exposure to environmental heat extremes may affect hydration and energy needs for military personnel through significant losses of several minerals in profuse sweating.[3] Hot environments tend to decrease food intake in order to reduce thermic effect and maintain body temperature in unacclimated personnel.[4] MREs can efficiently support military performance in moderate environments, but this may differ in operations in fields with extreme temperatures.[5,6] Inadequate nutrition in regards to over-exertion of physical activity in extreme climates can depress immune function; elongate recovery from illness and injury, and compromise physical performance.[3] Thus, military nutritionists focus on identifying optimal nutrition content in MREs so that personnels' performances will not be comprised due to intense physical activity and climate extremes.[5]

MAIN POINTS:

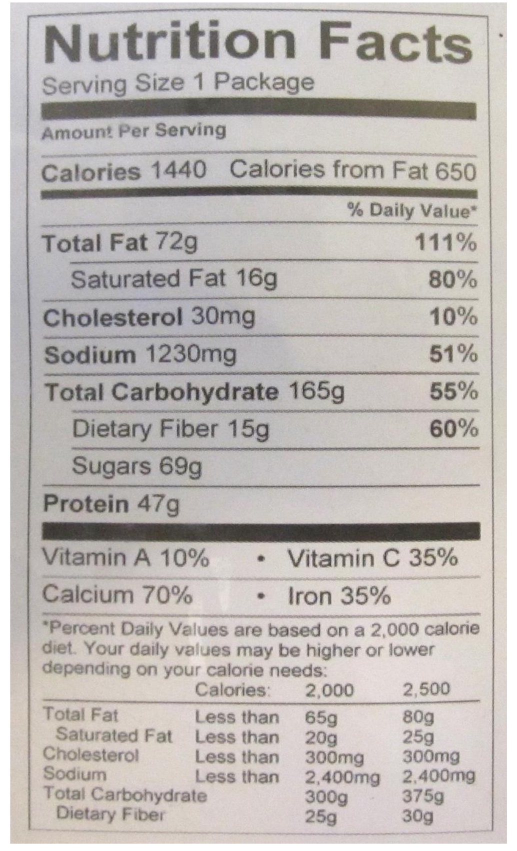
- Personnel typically engage in 16+ hours of vigorous physical activity per day in field operations[3,7]
- Recommended that personnel consume between 4,000-5,000 kcal/day due to increased exposure to stressors in the field[3]
- According to Military Dietary Reference Intakes, MRES exceed daily nutritional requirements contingent on at least parts of each component consumed[8]
- Energy requirements can increase 2.5-10% in temperatures between 86°F and 104°F[3]
  - Average temperature in Iraqi War theater is above 104°F and often exceeds 118°F[9]
- MREs not designed for long-term consumption in hotter climates[8]

METHODS:

- Richmond et al. [10] calculated energy expenditure (EE) and total body water by using doubly labeled water technique
  - MREs weighed with average calorie content to determine energy intake (EI)
- Friedl et al. [5] measured strength and maximal aerobic capacity to estimate energy deficits and performance
- Lieberman et al. [11] designed computerized vigilance task on computer to mimic mental operational stressors
- Costill et al. [12] used thigh musculature biopsies to determine glycogen storage levels in carbohydrate-poor diets (40% of total calories) and high-carbohydrate diets (70% of total calories) after intense physical activity

Soldiers have increased nutrient and energy requirements that exceed 125% of Military Dietary Reference Intakes for energy due to the long duration and high intensity level of field missions[13]

"…MREs are luck of the draw when it comes to macromolecules, vitamins, minerals, etc. because you could get everything you need by trading different items with different people, or you could not get nearly enough, and be detrimental to getting the mission done as a result, because you are tired, or your food wasn't cooked enough so your stomach is having problems, or really for any number of reasons."[14]
- A1C Petersen, U.S. Air Force, currently stationed in Okinawa, Japan



Nutrition facts for the Southwestern Style Chicken with Black Beans and Rice MRE. An Operational MRE contains 91g protein, 494g carbohydrate, and no more than 35% fat from total kilocalories per meal.[3]

RESULTS:

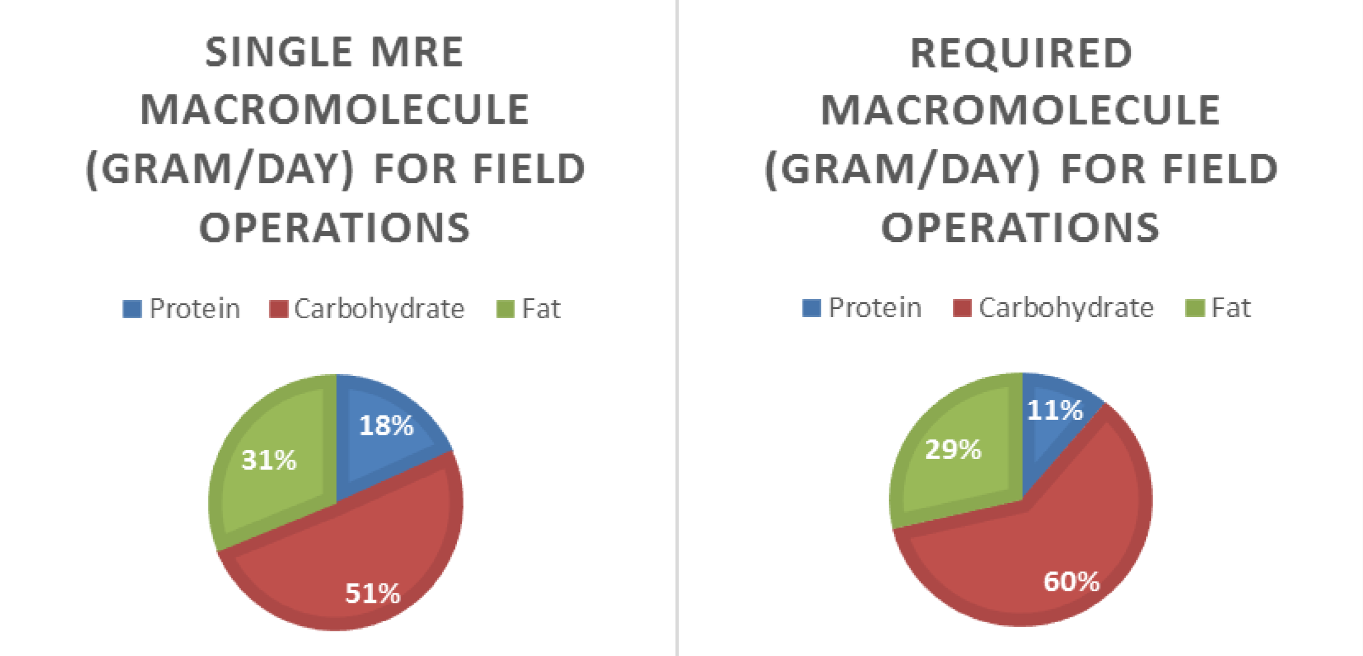


Figure 1: Suggested Macromolecule Intake by U.S. Department of Defense recommends 50-55% of total calories from foods and beverages to be sources from carbohydrates; between 63g and 119g of protein per day for men, and 30% or less of total calories from fat in a 3,567 calorie diet.[3] For military operations, there is a 9% increase in carbohydrates, 7% decrease in protein, and a 2% decrease in fat intake required. There is a larger focus on carbohydrate consumption during field operations because it is the primary fuel source of the CNS and used for the high intensity physical demand of combat.

- 50% less glycogen in thigh musculature stores 4-5 days post-field activity[12]
  - 3,700 kcal/day at 580 grams of carbohydrates
  - Suggests 30-40% decrease in endurance if expected to continue high intensity loads over prolonged period
- Target detection times decreased over 3-hour period with cognitive impairments after 60 minutes in temperatures over 95°F[11]

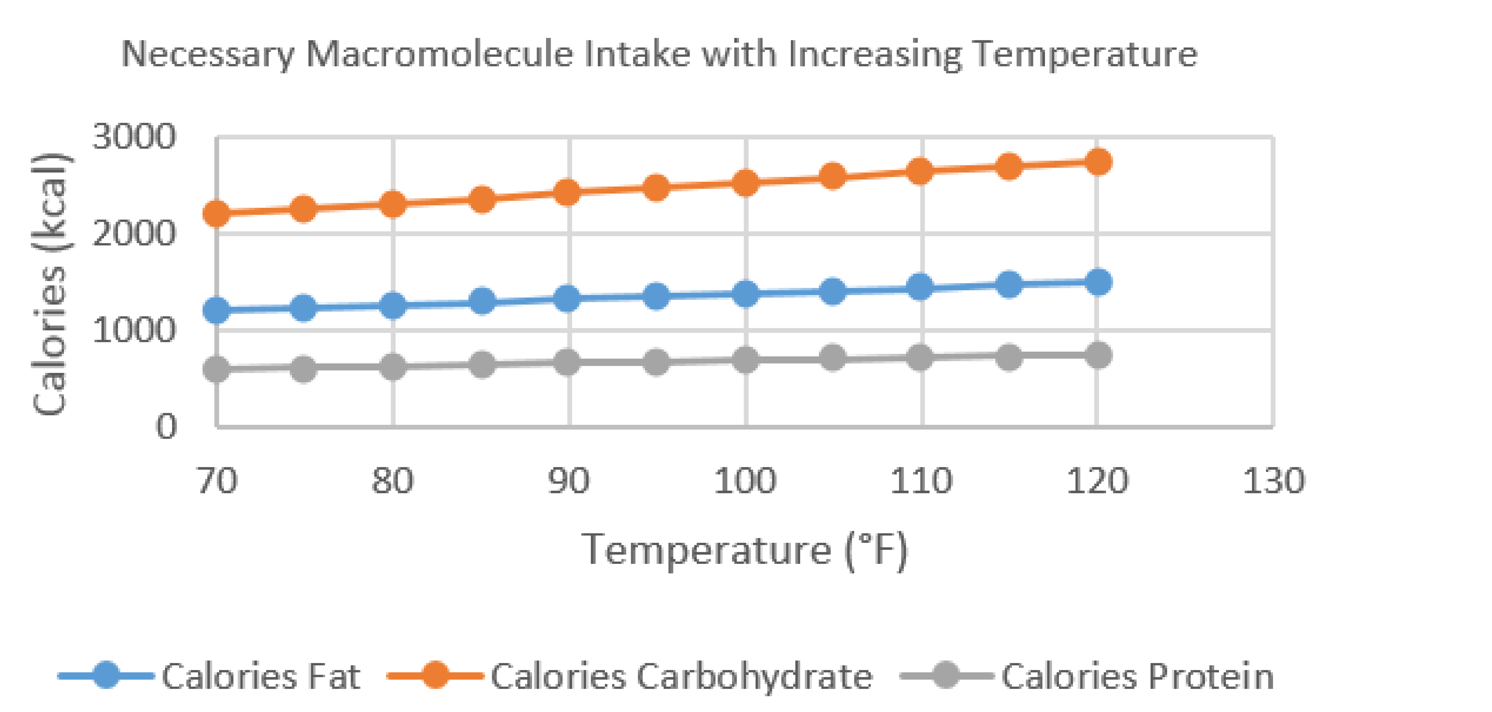


Figure 2: As temperature increases, the required amount of calories needed to support the level of physical activity in military personnel also increases. For temperatures over 95°F, an increase in macromolecule consumption increases by 2.5%, which can cause an additional 1,500 to 2,000 calorie intake.[11,15]

Richmond and colleagues[10] observed that soldiers were in a negative energy balance throughout 8-week course. The Army regulations of 3,299 kcal/day were provided, but soldiers were in a theoretical 1,388 kcal/day energy deficit. Soldiers would have had to consume an extra 1,331 kcal/day in addition to the MRE in order to maintain energy balance during training after the second week.

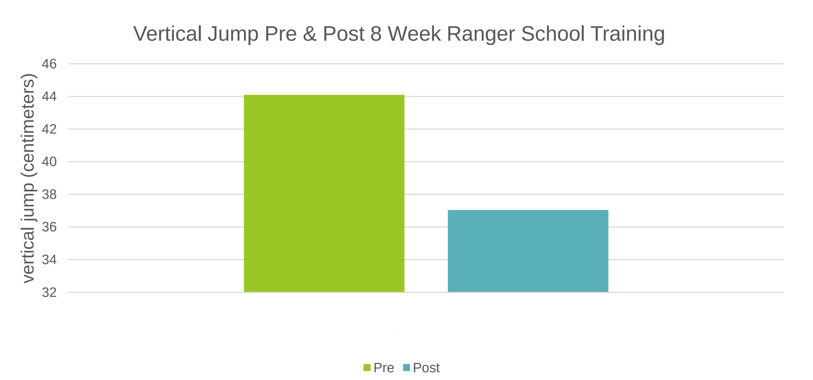


Figure 3: A total mass loss of 15.6% over an 8 week Ranger Course contributed to a 16% decline in vertical jump height. Pre-course, the average height was 44.10 cm and 37.04 cm post-course.[16]

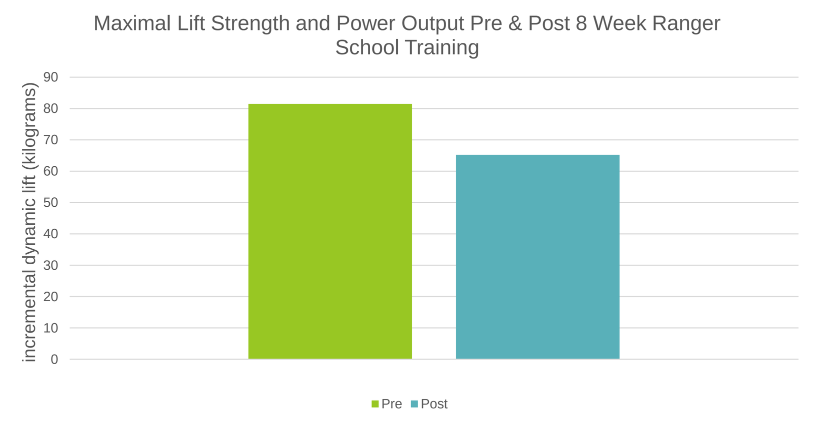


Figure 4: A total mass loss of 15.6% over an 8 week Ranger Course contributed to a 20% decrease in maximal lift strength and power output. Pre-course, the average incremental dynamic lift was 81.5 kg and 65.2 kg post-course.[16]

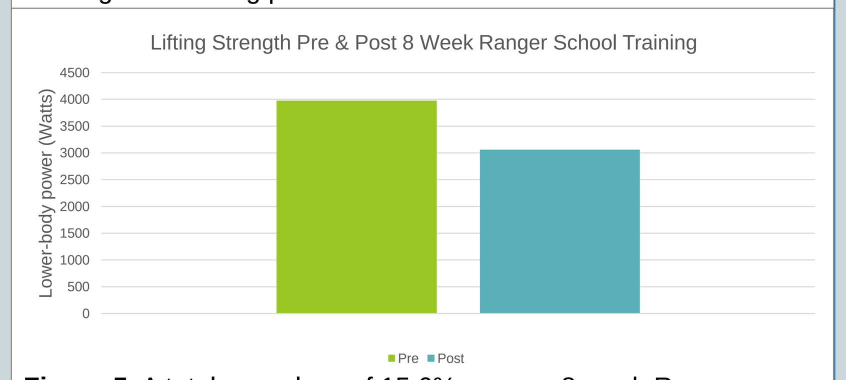


Figure 5: A total mass loss of 15.6% over an 8 week Ranger Course contributed to a 23% decrement in lifting strength. Pre-course, the average lower-body power produced was 3,972 W and 3,058 W post-course.[16]

DISCUSSION & CONCLUSION:

Adequate dietary intake of macromolecules help to facilitate skeletal muscle adaptations to aerobic training especially in military personnel. Research shows that maintaining carbohydrate availability in glycogen stores can sustain and enhance aerobic exercise performance by delaying the onset of muscle fatigue.[17] In increased heat temperatures, military cognitive and vigilance tasks performed during operational forces begin to become impaired above 90°F. Tasks of boring and repetitive nature are affected most by heat due to an overall blunting effect.[15] An operational MRE contains 51% carbohydrate, 31% fat, and 18% protein, which would suggest an emphasis on the high intensity, long duration workload, but not enough on the rebuilding of muscle tissues. Thirty out of every 100 male soldiers experience a musculoskeletal injury as a result of high running mileage and weekly exercise.[18] An adequate supply of macromolecules are used to repair all injuries to the body, but only if there is a reserve of 13% of total energy intake from protein.[6,18] A higher intake of carbohydrates in MREs may also be necessary to reduce the feeling of overall fatigue and perception of work intensity because muscular work is done with less effort if there is an adequate supply of glycogen available. Because protein is primarily used for the repair and rebuilding of tissues, a higher amount should be provided in operational MREs to decrease the likelihood of injury and stress fractures.[4]

TAKE HOME MESSAGE:

- *Acute shortages of carbohydrates with successive days of long, intense exercise in sustained operations may result in depletion of glycogen stores, decrease in performance & increased perception of work intensity*[6]
  - *Cause personnel to feel more fatigued sooner*
  - *Cause tasks to feel more difficult*
- *Consumption of 500g to 550g of carbohydrates is optimal for male soldiers to ensure speed of recovery of local muscle & overall fatigue*[6]
- *Most effective MRE for personnel would maintain body weight, provide adequate nutrients for prevention of nutrient deficiencies, provide adequate protein, and maximize carbohydrate intake*

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