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Suboptimal Nutritional Characteristics in Male and Female Soldiers Compared to Sports Nutrition Guidelines

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ABSTRACT The purpose of this study was to evaluate the nutrient intake of male and female Soldiers in the 101st Airborne Division (Air Assault) compared to sports nutrition standards for athletes, and to identify suboptimal eating characteristics that may impair physical performance and jeopardize military readiness. Male and female Soldiers from the 101st Airborne Division (Air Assault) completed a 24-hour dietary recall and nutrition history questionnaire before anthropometric and body composition measurements were taken. Compared to sports nutrition guidelines, Soldiers of the 101st under consume carbohydrates (males: 3.9 ± 2.0 vs. 5.0 g/kg, $p < 0.001$; females: 4.0 ± 2.1 vs. 5.0 g/kg, $p = 0.001$), male Soldiers eat too much fat (32.4% of kcal vs. <30% of kcal, $p = 0.000$) and saturated fat (males: 10.5 ± 3.9% of kcal vs. 10.0% of kcal, $p = 0.044$), and both males and females follow a meal pattern that may not optimize energy availability throughout the day. Eating too much fat and under fueling carbohydrate may negatively impact the adaptations to physical training and compromise overall health. Although Soldiers continue to participate in arduous training programs, future research should be aimed at determining the energy and macronutrient needs to fuel and recover from specific types of military training.

INTRODUCTION

It has been well established in athletic populations that the provision and timing of adequate macronutrients to fuel training greatly improves many aspects of physical performance including power output, muscle strength and endurance, mental alertness, and recovery from injury.[1–3] As such, several professional organizations have collaborated on evidence-based guidelines to help athletes use nutrition to optimally fuel the body and expedite and improve recovery.[3] Energy intake should be adequate to meet the energy requirements and goals of training and thus provides the basis from which the amounts of carbohydrate (CHO) (5–7 g per kg body weight per day [g/kg/d] for moderate intensity physical activity), protein (1.2–1.7 g/kg/d), and fat (20%–35% of kcal) are recommended.[3] Vitamins and minerals should be met via the diet in amounts that meet the Dietary Reference Intakes (DRIs).[1,3,4] The right proportion of macronutrients, consumption of nutrient-dense foods, and timing of foods and fluids play a vital role in optimizing the adaptation and recovery from daily hard physical training (PT).

By the nature of the job, military personnel engage in high volume daily PT. Army Regulation 40-25 establishes nutrition standards, the Military Dietary Reference Intakes (MDRIs), to guide feeding military personnel.[5] The MDRIs suggest "the general values for moderate levels of activity are appropriate for most personnel in garrison," thus the energy intake recommendations are 3,250 kcal/d (males) and 2,300 kcal/d (females).[5] Macronutrient recommendations are based on providing sufficient energy to meet energy demands of PT. The MDRI for protein is 0.8 to 1.5 g/kg/d for males and females, based on the DRIs[5] is adjusted upward during periods of "intense activity" and increasing metabolic demands.[5–7] The MDRI for CHO and fat has not yet been determined, thus military nutrition guides[8,9] refer to the sports nutrition guidelines for CHO and fat. For vitamins and minerals, the MDRIs are "identical to the DRIs, except when known differences in the military population requires adjustment of a particular nutrient."[5]

To maximize the adaptations of daily PT, Soldiers need to consume sufficient energy and CHO to support the demands of physical and tactical training. Insufficient macro- and micronutrient intake compromises the ability to recover from daily high-volume training and decreases the desired adaptive response to PT. Therefore, the primary aim of this study was to evaluate the nutrient intake of male and female 101st Soldiers compared to MDRI and sports nutrition guidelines, and to identify suboptimal eating characteristics that may impair physical performance and jeopardize military readiness. A secondary aim was to evaluate the differences in eating habits between male and female Soldiers. This study was a part of a larger collaborated project between the University of Pittsburgh and the 101st Airborne Division (Air Assault).[10,11]

METHODS

Subjects

A total of 439 101st Soldiers completed the nutrition history questionnaire and body composition testing, and 324 completed the 24-hour recall (Table I). Both enlisted and officers from all 7 brigades (4 combat, 2 aviation, and 1 sustainment/

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TABLE I. Subject Demographic Data

	Male (n = 372) Mean ± SD	Female (n = 67) Mean ± SD
Age, years	28.2 ± 6.7	27.3 ± 5.8
Height, cm	176.8 ± 9.9	164.1 ± 7.6
Weight, kg	83.6 ± 12.3	65.1 ± 9.9
Service, years	7.0 ± 5.7	5.9 ± 4.2
BMI kg/m^2	26.7 ± 3.5	24.1 ± 3.1
% Body Fat	20.4 ± 7.3	27.2 ± 5.7

other) participated in the study. All Soldiers at Fort Campbell participated in mandated daily PT lasting 60 to 90 minutes Monday to Friday while in garrison. Subjects were recruited as part of an ongoing research project from April 2007 to July 2011.[10,11] The institutional review boards of the University of Pittsburgh and Dwight D. Eisenhower Army Medical Center provided human subjects protections approval before the commencement of study.

Nutrition History Questionnaire and 24-Hour Food Recall

After completion of informed consent, Soldiers reported to the laboratory to fill out the nutrition history questionnaire and 24-hour dietary recall. The nutrition history questionnaire was modified from the Screening Form for Collegiate Athletes[12] to address specific dietary habits of military personnel (meals eaten in the dining facility, local restaurants; food/fluid intake before/during/after PT). Trained laboratory personnel used a detailed 24-hour food recall to assess dietary intake Monday through Friday throughout the 4-year study. Subjects were asked to report all food and beverage consumption from the previous day, with the assistance of food models, measuring utensils, and tableware to illustrate portion size. Macro- and micronutrient distribution was analyzed using nutrient processing software (Food Processor SQL, 10.7.0, ESHA Research; Salem, Oregon). Diets were assessed and compared to gender and age-based DRIs,[4] MDRIs,[5] and evidence-based sports nutrition recommendations.[1–3] To assess the adequacy of micronutrient intake in male and female Soldiers, both MDRIs[5] and the estimated average requirement (EAR) were used,[4] if there was no established EAR value, adequate intake (AI) was used. EAR is the average daily nutrient intake to meet the requirements of half of the healthy individuals in the group and is often used to estimate population micronutrient intake.[4] Micronutrient supplements were omitted from dietary analysis so that nutrient intake would be representative of food sources.

Estimated energy expenditure was calculated using the Cunningham Equation[13,14] (500 + 22 (fat-free mass in kilogram) multiplied by an activity factor for moderate physical activity level of 1.5[2,3] resulting in 2,925 kcal/d and 2,320 kcal/d for males and females, respectively. The MDRI for energy intake during routine moderate activity in garrison is 3,250 kcal/d for 19 to 30 years male and 2,250 kcal/d for females.[5] Recommended intakes of both CHO and protein in g/kg body weight/day are based on 60 to 90 min/d of PT with the goal of improving physical adaptations to both endurance and strength characteristics.

Body Composition and Anthropometrics

After completion of the nutrition history questionnaire and 24-hour diet recall, standing height was measured using a balance beam scale with a height rod (Seca North America, East Hanover, Maryland). The BodPod Body Composition System (Life Measurement Instruments, Concord, California) was used to measure body weight, percent body fat, and fat-free mass. Intrasubject reliability within our laboratory has demonstrated an intraclass correlation coefficient of 0.98 and standard error of measurement of 0.47% body fat. The subject wore spandex shorts, sports bra (female subjects), and a spandex swim cap. The subject sat inside the device until two body volumes were measured within 150 mL. Body fat percent was calculated using predicted lung volume and an appropriate densitometry equation.[15]

STATISTICAL ANALYSIS

Descriptive statistics (means ± standard deviations [SD]) were calculated and data were tested for normality. Independent samples t tests were used to compare continuous variables between groups. One-sample t tests were used to compare continuous variables to benchmark values. Pearson correlation coefficients were calculated to measure correlations between pairs of continuous variables. If data were not normally distributed, the corresponding nonparametric tests were conducted. χ^2 tests were used to compare proportions between groups.

For continuous variables, in most cases, the results of the nonparametric tests agreed with the results of the corresponding parametric test, with respect to statistical significance of results. Results from the parametric test were presented in this article. In case the results did not agree and the data were not normally distributed, results from the corresponding nonparametric tests were presented (marked with an asterisk [*]). Statistical significance was set a priori at $p < 0.05$ (two-sided). Statistical analysis was conducted using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp, Armonk, New York).

RESULTS

A total of 439 101st Soldiers (males n = 372; females n = 67) completed the nutrition history questionnaire, of these, 324 Soldiers completed a 24-hour dietary recall (males n = 269; females n = 55).

Meal Frequency

Soldiers consumed 3.3 ± 1.0 meals per day, including meals eaten in the dining facility, at home, or another eating establishment, with no significant differences between males 3.2 ± 1.0

and females 3.4 ± 1.1 meals/d; $p = 0.279$. Eating frequency (EF), defined as the addition of meals and snacks, was also similar between males and females (4.8 ± 1.4 vs. 5.0 ± 1.4 EF/day; $p = 0.472$). When Soldiers were categorized into low eating frequency (LEF ≤ 6 meals + snacks per day) and high eating frequency (HEF ≥ 6 meals + snacks per day), Soldiers in the HEF had significantly less body fat than the LEF (19.8 ± 7.3% vs. 22.6 ± 6.9%; $p = 0.013$). After further stratifying by gender, both male and female Soldiers in the HEF had significantly lower body fat percentages compared to the LEF (Males: 18.8 ± 7.4 vs. 21.6 ± 6.4 %; $p = 0.019$; females: 25.3 ± 3.7 vs. 30.4 ± 5.1%; $p = 0.016$).

Evaluation of 24-hour Food Recall

Energy

Analysis of the 24-hour recall data revealed a self-reported mean energy intake per day of 2,574 ± 974 kcal (males) and 1,920 ± 956 kcal (females), representing 88% of males and 83% of females estimated total energy expenditure respectively. Significantly more male vs. female Soldiers (23% vs. 9%; $p = 0.035$) reported energy intakes that fell between 90% and 110% of their estimated energy requirements.

Macronutrients

Self-reported CHO intake is presented in Table II. Seventy-eight percent of Soldiers in both male and female groups consumed less than 5 g/kg/d, the minimum amount of CHO necessary to fuel the 60 to 90 minutes of moderate intensity training in garrison. For CHO intake within the recommended range of 5 to 7 g/kg/d, only 15% of males and 13% of females met this goal with no significant differences between genders ($p = 0.896$). When compared to sports nutrition guidelines, both male ($p = 0.000$) and female ($p = 0.001$) Soldiers significantly under-consumed CHO (<5 g/kg/d) to support 60 to 90 minutes PT per day.

The self-reported mean protein intake of 1.4 g/kg/d (males) and 1.3 g/kg/d (females) in garrison meets the MDRI for protein[5,6] and is within the recommended range for athletes (Table II).[3,16] Comparing genders, 14% of males and 24% of females reported consuming less than the DRI/MDRI of 0.8 g protein/kg/d ($p = 0.118$) and 40% males and 54% females ($p = 0.078$) consumed less than 1.2 g/kg/d, the minimum amount of protein recommended for athletes to optimize adaptations from daily PT. Thirty-six percent of male and 31% female Soldiers exceeded the MDRI protein recommendation ($p = 0.532$).

When expressed as a percentage of total calories, significantly more males (62%; $p = 0.037$) consumed greater than 30% of their calories from fat than females (46%) (Table II). Fat as a percentage of total calories was positively correlated with total energy intake in male (Spearman correlation coefficient = 0.112; $p = 0.067$*) and female Soldiers (Pearson correlation coefficient = 0.306; $p = 0.023$). When subjects were divided into lower fat (LF < 30% kcal from fat) and higher fat (HF ≥ 30% of kcal from fat) groups, male subjects in the HF group consumed significantly less CHO (3.6 ± 1.9 vs. 4.3 ± 2.1 g/kg/d; $p = 0.006$) and significantly more saturated fat as a percentage of total kcal (12.5 ± 3.2% vs. 7.5 ± 2.9%; $p = 0.000$). Females in the HF group did not differ in the amount of CHO consumed (4.0 ± 2.2 vs. 4.0 ± 2.1; $p = 0.960$), but percentage of total kilocalories from saturated fat was significantly higher (11.1 ± 3.0 vs. 7.0 ± 2.4; $p = 0.000$).

Micronutrient Intake

Tables III and IV contain the mean and SD for vitamins and minerals, and percentage of Soldiers who fell below either the EAR/AI or MDRI. Greater than 50% of males and females failed to meet the EAR/AI and MDRI for Vitamins A, C, D, E, K, and folate. For minerals, more than 50% of Soldiers (males and females) failed to meet the EAR and MDRI for calcium, iodine, magnesium, and zinc. In addition, more than 50% of Soldiers did not meet the MDRI for iron (females 62%), phosphorus (females 62%), selenium (females 54%), potassium (females 84%, males 90%), and sodium (females 64%, males 61%). There were significant gender differences in the number of male and female Soldiers who failed to meet the EAR or AI for thiamin (females 62% vs. males 43%; $p = 0.021$), folate (females 80% vs. males 62%; $p = 0.021$),

TABLE II. Eating Frequency, Energy and Macronutrient Intake

	Total ($n = 324$)	Male ($n = 269$) Mean ± SD	Female ($n = 55$) Mean ± SD	P Value for Gender Comparison
Meals per Day	3.3 ± 1.0	3.2 ± 1.0	3.4 ± 1.1	0.279
Eating Frequency	4.8 ± 1.4	4.8 ± 1.4	5.0 ± 1.4	0.472
Energy Intake (kcal)	2463 ± 1000	2574 ± 974	1920 ± 956	0.000
CHO (g/kg body weight/d)	3.9 ± 2.0	3.9 ± 2.0	4.0 ± 2.1	0.810
CHO (g/d)	304 ± 143	315 ± 145	252 ± 124	0.003
Protein (g/kg body weight/d)	1.4 ± 0.7	1.4 ± 0.7	1.3 ± 0.8	0.302
Protein (g/d)	110.6 ± 55.7	116.2 ± 55.8	83.5 ± 47.4	0.000
Fat (g/kg body weight/d)	1.1 ± 0.7	1.2 ± 0.7	1.0 ± 0.7	0.165
Fat (g/d)	89.2 ± 51.8	94.1 ± 52.0	64.8 ±43.7	0.000
Fat (% of kcal)	31.9 ± 9.5	32.4 ± 9.6	29.1 ± 8.6	0.018
Saturated Fat (% of kcal)	10.2 ± 3.9	10.5 ± 3.9	8.8 ± 3.3	0.005

TABLE III. Vitamin Intake Reported as Percentage of Soldiers Below EAR, AI, and MDRI

	Females			Males			
Micronutrients (Units)	Intake M (SD)	% Below EAR/AI^	% Below MDRI	Intake M (SD)	% Below EAR/AI^	% Below MDRI	Gender Comparison (p values)
Vitamin A (ug)	355 (342)	74	88	387 (443)	80	91	0.440
Vitamin C (mg)	85 (109)	58	62	82 (90)	60	68	0.925
Vitamin D (ug)	91 (116)	95	85	118 (147)	95	78	1.000
Vitamin E (mg)	7.5 (14.5)	88	88	5.7 (8.9)	89	91	0.984
Vitamin K (ug)	50 (124)	92^	84	46 (127)	93^	88	0.763
Thiamin (mg)	1.0 (0.9)	62	70	1.5 (1.6)	43	51	0.021
Riboflavin (mg)	1.5 (1.2)	34	48	2.0 (1.9)	35	45	1.000
Niacin (mg)	22 (18)	36	42	25 (22)	32	40	0.741
Vitamin B_6 (mg)	1.8 (1.5)	40	46	2.5 (4.9)	36	45	0.700
Folate (ug)	241 (214)	80	86	330 (333)	62	74	0.021
Vitamin B_{12} (ug)	3.9 (4.0)	40	44	7.2 (22.4)	35	39	0.595
Pant Acid (mg)	3.6 (3.2)	74^	N/A	4.3 (4.1)	74^	N/A	1.000

^Adequate intake.

TABLE IV. Mineral Intake Reported as Percentage of Soldiers Below EAR, AI, and MDRI

	Females			Males			
Micronutrients (Units)	Intake M (SD)	% Below EAR/AI^	% Below MDRI	Intake M (SD)	% Below EAR/AI^	% Below MDRI	Gender Comparison (p Values)
Calcium (mg)	680 (650)	70	86	893 (619)	52	65	0.028
Iodine (ug)	45 (54)	89	91	74 (85)	73	84	0.087
Iron (mg)	13 (7)	28	62	17 (11)	7	24	0
Magnesium (mg)	169 (126)	82	90	209 (172)	87	92	0.436
Phosphorus (mg)	784 (764)	44	62	1007 (657)	29	36	0.061
Selenium (ug)	70 (60)	48	54	85 (71)	33	39	0.059
Zinc (mg)	7.4 (6.2)	54	82	9.5 (8.3)	62	81	0.409
Potassium (mg)	1685 (1073)	98^	84	1850 (1095)	98^	90	1
Sodium (g)	3.1 (2.1)	14^	64	4.2 (2.0)	3^	61	0.003
Chloride (mg)	548 (852)	93^		886 (1232)	87^		0.427

^Adequate intake.

calcium (females 70% vs. males 52%; p = 0.028), iron (females 28% vs. males 7%; $p < 0.001$), and sodium (females 14% vs. males 3%; p = 0.003).

Body Composition

Mean body mass index (BMI) was 26.7 ± 3.5 kg/m^2 (males) and 24.1 ± 3.1 kg/m^2 (females). Mean body fat percentage was 20.4 ± 7.3% (males) and 27.2 ± 5.7% (females). There were no significant differences (p = 0.493) in the proportion of males (26%) and females (21%) who exceeded the Army Body Composition Program (ABCP) standards for both BMI and body fat.[17] Male and female Soldiers were divided into 2 groups: those who met the ABCP standards (MABCP) and those who did not (NMABCP) and compared on various dietary factors. Both male and female Soldiers in the NMABCP group consumed significantly less CHO (3.0 ± 1.6 vs. 4.2 ± 2.0; p = 0.000 males and 2.5 ± 1.1 vs. 4.5 ± 2.1; p = 0.004 females) and protein (1.2 ± 0.6 vs. 1.5 ± 0.7; p = 0.004 males and 0.9 ± 0.5 vs. 1.4 ± 0.8; p = 0.028 *females), and male Soldiers (NMABCP) consumed significantly more saturated fat as a percentage of total calories (12 ± 4 vs. 10 ± 4%; p = 0.014).

DISCUSSION

This study compared the nutritional habits and diets of male and female 101st Soldiers during military training in garrison to the sports nutrition guidelines developed for competitive athletes, DRIs/EARs, and MRDIs. Suboptimal nutrition characteristics were identified that may impair training adaptations and compromise physical performance. When compared to the dietary recommendations for competitive athletes, 101st Soldiers under consumed CHO, ate too much fat (particularly saturated fat), and followed a meal pattern that may not optimize energy availability throughout the day. Protein intake met sports nutrition and MRDI guidelines.

Meal Frequency

Optimal fueling for PT requires spreading calories throughout the day and avoiding long periods without eating.[18] Soldiers reported consuming an average of 3.3 meals per day with the majority of Soldiers (80%) eating three or more meals per day. Soldiers' reported meal frequency is consistent with the average daily meal frequency of 3.47 for American adults reported in the 1997 to 1998 Nationwide Food Consumption Survey.[19]

However, the average total daily meal frequencies reported in athletic populations was higher at 4.8 ± 0.8 times per day.[20,21] Our survey data are consistent with these findings as Soldiers reported an average of 4.8 total eating episodes a day. Evidence in the athletic population suggests increased meal frequency may aid in decreasing fat mass although maintaining lean body mass.[18] Our results appear to be consistent with these findings as Soldiers in the HEF group had a significantly lower body fat percentage than those in the LEF group. After stratifying by gender, males in the HEF group had lower percent of calories from saturated fat in addition to higher intakes of magnesium and fiber. In contrast, female Soldiers displayed significantly higher intakes of total calories and potassium in the HEF group compared to the LEF group. The association between increased eating frequency and improved diet quality appears more apparent in male vs. female Soldiers. Overall, Soldiers who were more frequent eaters tended to be leaner, and male Soldiers in this group have a slightly higher diet quality than less frequent eaters.

Energy Intake

Our results revealed a mean daily energy intake of 2,574 kcal/d for males and 1,920 kcal/d for females, which was lower than predicted energy requirements for athletes (males 2,925 kcal/d and females 2,320 kcal/d) and the MDRI (19–30 years male 3,250 kcal/d) and females 2,250 kcal/d) in garrison.[5] In comparison to other military populations training in garrison, the mean daily energy intake for males Soldiers was substantially lower than that reported for SEAL trainees (3,886 ± 73 kcal/d), Finnish Conscripts (3,401 ± 3,111 kcal/d), Rangers (2,961 ± 239 kcal/d), and Special Forces (SF) Soldiers (average daily intake 3,204 kcal), and comparable to Fighter Pilots (2,657 ± 168 kcal).[22–26] Although this would suggest that the 101st Soldiers are energy deficient, it is more likely that Soldiers have underreported their dietary intake. Further, the anthropometric data collected were not suggestive of Soldiers being below weight standards; in fact approximately 25% of Soldiers exceeded the ABCP.

Macronutrient Intake

Repeated high-intensity tasks often included in military training indicate a heavy reliance on CHO as an energy source. Suboptimal CHO intake could result in premature muscle glycogen depletion during training, decreased power output, and early onset fatigue. In addition, low CHO intake can lead to insufficient glycogen resynthesis after exercise, delaying recovery and compromising subsequent training sessions.[1,2] Zehnder et al[27] found that a habitual intake of 4.8 ± 1.8 g CHO/kg/d in elite soccer players did not completely restore muscle glycogen content in 24 hours. In this study, Soldiers reported a mean intake of 3.9 g CHO/kg/d, well below the recommended amount for general PT and adequate glycogen restoration. Even when nutrient intake was adjusted to meet estimated energy requirements, CHO intake was still below the minimum recommended amount of CHO for daily general PT for both males (4.3 ± 1.1 g/kg/d) and females (4.8 ± 1.2 g/kg/d). Nutrient intake was adjusted to meet the estimated energy requirements from the Cunningham Equation. Adjustment was conducted assuming that the proportions of each macronutrient (fat, protein, and CHO) would be constant between the reported and adjusted calories.

Our study findings are consistent with previous literature where lower CHO intake has been a prevalent problem in athletic[28,29] and military populations training in garrison, including Army Rangers at 306 g/d[23] and SF Soldiers at 387 g/d.[24] The mean daily CHO intake in our study was comparable to these findings 315 ± 145 g/d for males and 252 ± 124 g/d for females. Daily CHO intake was lower than the recommended CHO intake for the activity level of military personnel training in garrison 60 to 90 min/d.

Research has reported that lower CHO intake will decrease performance on military tasks.[29,30] Tharion and Moore[31] fed 15 male Soldiers either a 250 (low), 400 (normal), or 550 (high) grams CHO per day diet for a 4-day period. Subjects in the low CHO had a significant deterioration in shooting performance after completing a 4-hour treadmill march while carrying a 45-kg pack. DeBolt et al[26] concluded that a higher intake of CHO may be beneficial to Soldier performance as their training consists of endurance conditioning, high-intensity interval training, and long duration field training exercises; all of which utilize CHO as an energy substrate. There is a fair amount of evidence to support the benefit of a higher CHO diet (>5 g/kg/d) on performance and recovery in competitive athletes.[29,32,33] Only a few research studies have examined the impact of a high CHO diet on military performance.[31,34] However, these studies support the use of a higher CHO diet. Consequently, additional studies are needed to evaluate the optimal amount of CHO in the diet to fuel military training and enhance physical readiness.

Military training encompasses both strength and endurance activities to increase physical fitness and military readiness. Consuming protein at the higher end of the recommended range for endurance to strength trained athletes (1.2–1.7 g/kg/d) may help to optimize muscle mass gains, increase strength and power, and aid in muscle recovery.[3,16,35] Mean protein intake for both male (1.4 g/kg/d) and female (1.3 g/kg/d) Soldiers met the daily protein recommendations for athletes and MRDI for protein intake in garrison. When protein intake was adjusted to meet estimated energy requirements, mean adjusted intake was 1.6 ± 0.6 g/kg/d (males) and 1.5 ± 0.4 g/kg/d (females), which met sports nutrition protein and the MRDI for protein intake in females, but exceeded the MDRI for males.[5–7] Regardless, compared to other studies done on military personnel, 101st Soldiers self-reported mean protein intake was on the lower end of range (1.5–2.0 g/kg/d) reported in the literature.[22,25,26]

Eating higher amounts of protein (>2.0 g/kg/d) may compromise CHO intake and increase fat and saturated fat intake.[35,36] Although this relationship was not observed in male Soldiers, female subjects who reported a higher protein intake, consumed a significantly higher percentage of calories from saturated fat (11.6 ± 1.7 vs. 8.4 ± 3.3%, $p = 0.015$), and trended toward a higher daily fat consumption (33.9 ± 4.7 vs. 28.4 ± 8.9 %, $p = 0.119$). When energy balance is negative, however, consuming protein up to 2.0 g/kg/d may provide protection from loss of lean body mass.[16]

Although the DRIs specify a dietary fat intake range of 20% to 35% of total calories, consuming fat in the range of 20% to 30% may be more beneficial for individuals who are involved in daily hard PT and are trying to lower body fat. The mean percentage of calories from fat in Soldiers was 32 ± 10% (males) and 29 ± 9% (females). Males, not only consumed a higher percentage of fat from total calories, but significantly more males consumed greater than 30% of total calories from fat. Higher fat diets have been reported in other studies in male military populations including SEAL trainees 41%,[26] Rangers 38%,[23] and SF Soldiers 35%.[37] Whereas, studies examining fat intake in competitive athletes reveal lower fat intake in elite male and female Canadian athletes 27%,[20] combat athletes 27%,[38] and national-level triathletes 27%.[39] In male Soldiers who consumed greater than 30% total calories from fat, CHO (3.6 vs. 4.3 g/kg/day; $p = 0.006$) was significantly lower. Higher fat diets that replace CHO calories may limit the energy available to participate in long duration and/or high-intensity interval training activities, and negatively impact military readiness.

Micronutrient Intake

It is important for athletes to meet the recommended DRIs, and in some cases, when excessive losses of micronutrients occur because of sweating increased amounts of certain micronutrients may be recommended.[1,2] For Military personnel, the goal is to meet the MRDIs, which were adjusted from the DRIs to meet the unique demands of military PT.[5,40] In this study, a high proportion of Soldiers did not meet micronutrient EAR and MDRI goals. This may, in part, be explained by dietary underreporting. However, it may also point to diet quality and higher consumption of refined and processed foods, and lower consumption of nutrient-dense foods including fruits, vegetables, dairy, and whole grains. The 2005 Dietary Advisory Committee Report highlighted micronutrients in which the average intake by adults in the United States are consumed in amounts low enough to be of concern (<60% of recommended intake) and they include Vitamins A, C, E, K, folate; magnesium; and fiber.[41] Many of these identified "shortfall nutrients" were also the micronutrients that fell below DRI/MDRI standards in this study.

Body Composition

As the body weight/fat of military personnel continues to rise, it is important to identify the contributing dietary factors and impact it has on military training and combat readiness.[42] The results of this study indicate that 26% (male) and 21% (female) Soldiers failed to meet the maximal allowable body fat percentage and BMI specific to age and gender as stipulated in the Army Body Composition Program.[17] Even though the Army circumference equations were developed from hydrostatic weighing (HW) and body density calculations,[43] the actual circumference taping method is less accurate than either BodPod or HW in measuring body composition.[44] Unfortunately, neither BodPod nor HW is feasible to measure body fat in the field setting or force wide.

Previous research examining a subset of this study population found that male Soldiers with a body fat of ≤18% performed better on a majority of physiological and musculoskeletal tests compared to those with a body fat >18%.[45] Examining the dietary differences between Soldiers who met the ABCP and those who did not, both males and females who met the ABCP consumed significantly more CHO and protein relative to body weight. Surprisingly, there were no differences observed between groups for percent of calories from fat. Consequently, additional studies are needed to evaluate the optimal amount of CHO, protein, and fat in the diet to help Soldiers achieve a body composition that will improve physical performance and overall health.

LIMITATIONS

Accurate measurement of energy and nutrient intake is an acknowledged limitation of dietary assessment methods[46–48] with underreporting being a common problem,[49] resulting from inaccurate estimation of portion sizes, omission of foods and fluids, altering foods consumed, and poor memory.[50,51] Given the difference between self-reported energy intake and estimated energy expenditure in this study, it is likely that underreporting occurred. We studied a large number of men and women and also had to work within certain time constraints as to not interfere with the military training schedules. Therefore, a 24-hour recall was performed on each subject by trained laboratory staff with the assistance of measuring utensils and tableware to reduce error in estimating portion sizes. Despite these problems, strength of the 24-hour recall method is the ability to estimate nutrient intake and dietary patterns of groups.[26,50,52]

CONCLUSION

Compared to sports nutrition recommendations 101st Soldiers do not consume enough CHO, eat too much fat, particularly saturated fat, and follow a meal pattern that may not optimize energy availability throughout the training day. Compared to the MDRIs, Soldiers met dietary protein needs for in garrison routine PT. Findings from this study will help to identify dietary eating patterns that may lead to suboptimal adaptations and recovery from daily PT and compromise overall health. Although Soldiers continue to participate in garrison as well as arduous field training programs in preparation for battle, future research should be aimed at determining the optimal energy and macronutrient needs to fuel and recover as Soldiers progress through the training pipeline.

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