MILITARY MEDICINE, 00, 0/0:1, 2018

Dietary Intake in Relation to Military Dietary Reference Values During Army Basic Combat Training; a Multi-center, Cross-sectional Study

Laura J. Lutz, MS, RD; Erin Gaffney-Stomberg, PhD, RD; J. Philip Karl, PhD, RD; Julie M. Hughes, PhD; Katelyn I. Guerriere, MS; James P. McClung, PhD

ABSTRACT Introduction: The military dietary reference intakes (MDRIs), outlined in Army Regulation 40-25, OPNAVINST 10110.1/MCO10110.49, AFI 44–141, establish standards intended to meet the nutrient requirements of Warfighters. Therefore, the purpose of this study was to comprehensively compare the revised MDRIs, published in 2017, with estimated dietary intakes in U.S. military personnel. Materials and Methods: During this cross-sectional study, Block food frequency questionnaires were administered at the end of the 9-week basic combat training course to estimate dietary intake during basic combat training in male (n = 307) and female (n = 280) recruits. The cut-point method was used to determine nutrient adequacy in comparison to the MDRIs. This study was approved by the Institutional Review Board of the U.S. Army Research Institute of Environmental Medicine. Results: Recruits consumed an adequate amount of vitamins A, C and K, as well as the B-vitamins, and phosphorus, selenium, zinc, and protein and carbohydrate as a percentage of total calories when compared with MDRI standards. Vitamin D was the short-fall nutrient affecting the greatest number of participants, as 55 and 70% of males and females, respectively, consumed less than 33% of the MDRI. In addition, less than 50% of males met the MDRI for linoleic and α-linolenic acid, fiber, vitamin E, magnesium, and potassium, and less than 50% of females met the MDRI for α-linolenic acid, fiber, vitamin E, calcium, iron, magnesium, and potassium. In contrast, fat and sodium were over-consumed by both males (78 and 87%, respectively) and females (73 and 72%, respectively). Conclusion: The main findings of this study were that vitamins D and E, magnesium, potassium, α-linolenic acid, and fiber were under consumed by male and female recruits while males also did not consume adequate linoleic acid and females did not consume adequate calcium and iron. Future prospective research studies are needed to determine possible health and performance impacts that may be associated with suboptimal intake of these nutrients.

INTRODUCTION

Achieving and maintaining adequate nutritional status effect military performance during training and operations. For example, iron deficiency anemia has been linked to diminished two-mile run time in female recruits during U.S. Army basic combat training (BCT).[1] Further, vitamin D and calcium supplementation have been linked to protective effects on bone health during BCT, resulting in decreased stress fracture risk,[2] improvements in measures of bone strength in the tibia,[3] and mitigating changes in biomarkers associated with decrements in bone health.[3] Cognitive performance has also been linked to dietary intake and nutritional status, as iron supplementation during BCT attenuated declines in iron status during training and was linked to improvements in vigor, a component of the profile of mood states questionnaire.[1]

The military dietary reference intakes (MDRIs), outlined in Army Regulation 40–25, OPNAVINST 10110.1/MCO10110.49, AFI 44-14,[4] establish standards intended to meet the nutrient requirements of Warfighters. The MDRIs were adapted from the sex- and age-specific recommended daily allowances (RDA), which are the nutrient standards intended to meet the needs of 97–98% of healthy Americans over the age of two and published by the Institute of Medicine (IOM).[5] The IOM also publishes estimated average requirements (EARs) for some nutrients, which represent dietary intakes that meet the needs of 50% of the population in order to prevent overt signs of deficiency. The MDRI nutrient standards have been adjusted from the RDAs when scientific evidence indicates that Warfighters have unique nutrient requirements as compared with the civilian U.S. population, however the MDRIs do not include a military-specific EAR equivalent. To comply with the MDRI standards, the food choices offered in a military dining facility (DFAC) are required to meet the MDRIs when averaged over a 5- to 10-day period.[4] However, the food items that service members choose to consume ultimately determine whether nutrient intake requirements are met.

United States Army Research Institute of Environmental Medicine, 10 General Greene Avenue, Natick, MA 01760.

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Army or the Department of Defense. Any citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement of approval of the products or services of these organizations.

doi: 10.1093/milmed/usy153

Several studies have used various techniques to estimate dietary intake in military personnel in order to compare nutrient intakes to recommendations. Food frequency questionnaires (FFQs) are widely used as they can be administered at one time to provide average intake data over a defined period of time, generally 6–12 months. Using the Block FFQ, the dietary intake of Soldiers during a 9- and 12-month deployment was assessed and compared to the IOM DRIs in two separate studies.[6,7] During the 9-month deployment study, intakes of several nutrients including energy, protein, total fat, carbohydrates, calcium, phosphorous, sodium, potassium, and vitamins C, D, and K were assessed.[7] The 12-month deployment study assessed energy, protein, total fat, carbohydrates, calcium, magnesium, sodium, phosphorus, and vitamins K and D in 12 males and 7 females. In both studies, the authors reported that the most prominent short-fall nutrient was vitamin D both before and during deployment. Additionally, dietary intake in Israeli male and female recruits was assessed using FFQ derived nutrient estimates in comparison with the MDRIs before, during, and at the end of Israeli Army BCT.[8] Similar to other reports, data from this study also indicated that recruits did not consume adequate vitamin D, and females consumed an inadequate amount of calcium.[8] Lastly, the dietary intake of West Point cadets was assessed using a prospective 7-day food diary (n = 118M and 86F) and compared with the military RDA in 1996.[9] The West Point study documented that females consuming 0–1 meals in the military dining facility (Cadet Mess) had the highest incidence of inadequate intake of B6, folate, vitamin A, magnesium, and zinc when compared with those who consumed two or more meals in the dining facility.[9] Such research is critical in efforts to identify short-fall nutrients which may affect Warfighter health and performance. This information also provides the basis for targeted nutrition education and/or changes in military DFAC food choices in order to encourage the consumption of foods rich in such nutrients.

BCT is the initial training course that civilian recruits participate in after entry into military service. It consists of several weeks of military and didactic training. The training is demanding and requires optimal cognitive and physical performance. Prior studies indicate that BCT results in perturbations in biomarkers of nutrition status, to include decrements in iron status.[10] Recruits have access only to foods provided in the DFAC during BCT, resulting in a controlled nutrition environment. No study has comprehensively evaluated dietary intake in relation to MDRI values in U.S. military personnel. The purpose of this study was to assess the nutrient intake of recruits during Army BCT using a FFQ, and to compare the estimated daily nutrient intakes to the MDRIs.

METHODS

This research was approved by the Institutional Review Board of the U.S. Army Research Institute of Environmental Medicine (USARIEM), and investigators adhered to U.S. Army regulation 70–25 and the U.S. Army Medical Research and Material Command Regulation 70–25 regarding the participation of volunteers in research. Assessing dietary intake was a secondary outcome embedded within a series of trials aimed at understanding the roles of nutrient intake on health and performance.[3,11–13]

Study Location and Participants

A total of 890 (498M, 390F, 2 not reported) Army recruits were enrolled at the beginning of BCT after a verbal study brief and written informed consent. Multiple study iterations were conducted and participants enrolled as follows: (1) February–April 2010 at Fort Jackson, SC (n = 223, 132M, 91F); (2) June–August 2012 at Fort Sill, OK (n = 245, 158M, 85F); (3) February–April 2013 at Fort Sill, OK (n = 247,158M, 89F); (4) June–August 2015 at Fort Jackson, SC (n = 175, 50M, 125F). Participants were excluded from the analysis if they did not complete experimental testing at the end of BCT due to separation from their unit or voluntary withdrawal from the study (n = 224, 136M, 86F, 2 not reported), or if they reported implausible energy intakes (males <800 or >5,000 kcal/d, n = 55; females <300 or >4,500 kcal/d, n = 24) on their FFQ.[11] In the end, a total of 587 recruits (307M and 280F) were included in the statistical analysis. The demographic characteristics of the participants were self-reported on a paper survey at the beginning of BCT during reception. Race and ethnicity were self-reported and assessed according to the National Institutes of Health classification to describe the population of interest.[14]

Dietary Intake

Dietary intake was assessed at the end of BCT, prior to graduation, using the 3-month 2005 Block FFQ.[15] Participants were instructed to complete the FFQ by estimating the amount of foods consumed during the 9-week BCT period only. The FFQ was completed with Registered Dietitians present to answer any relevant questions. The Block FFQ has been validated for use in the general U.S. population[16,17] and has been utilized to assess dietary intake in military personnel in several published studies.[6,7,18–20] The FFQ food list was developed using National Health and Nutrition Examination Survey (NHANES) 1999–2002 dietary recall data and queried participants as to how often (ranging from never to every day) they consumed items from the list of approximately 110 foods, and on average how much (with 2–4 food appropriate options) they consumed of these items. To aid in portion size estimation, pictures of various portion sizes were provided. In addition to the food list, the FFQ asks what kinds of foods were usually consumed (i.e., low fat vs. regular fat foods, and low carbohydrate vs. regular carbohydrate foods). Questionnaires were analyzed and nutrient values determined by Nutrition Quest (Berkeley, CA, USA) using the U.S. Department of Agriculture Food and Nutrient Database for Dietary Studies version 1.0. Although the MDRIs provide values for iodine and fluoride,

TABLE I. Demographic and Anthropometric Characteristics[a]

	Male (n = 307)	Female (n = 280)
	Mean ± SD	
Age (year)	21 ± 4	22 ± 5
	n (%)	
Location, year		
Fort Jackson, year 2010	103 (34)	81 (29)
Fort Sill, year 2012	55 (18)	24 (9)
Fort Sill, year 2013	103 (34)	64 (23)
Fort Jackson, year 2015	46 (15)	111 (40)
Ethnicity		
White/Caucasian	178 (58)	154 (55)
Black/African American	46 (15)	81 (29)
Native American/Alaskan Native	3 (1)	3 (1)
Asian	11 (4)	8 (3)
Native Hawaiian/Pacific Islander	1 (<1)	4 (1)
Other	23 (8)	10 (4)
Race		
Hispanic/Latino	44 (14)	51 (18)

[a]Missing values: ethnicity and race 45 males, 20 females.

these nutrients are not assessed using the Block FFQ and therefore were not included in the analysis.

Statistical Analyses

Male and female participants were analyzed separately due to the sex-specific MDRIs (AR 40–25). Nutrient intake estimates are presented as median (25, 75%) as they were not normally distributed when assessed using the Kolmogorov–Smirnov test. Participants were categorized into one of four groups for each micronutrient (except sodium) (those meeting <33, 33–66, 67–100, >100% of the MDRI or EAR) by dividing their estimated nutrient intake by the MDRI or EAR, respectively, and multiplying the quotient by 100. To split participants into those who ate below, at, and above the MDRIs for percent of calories from macronutrients, participants were divided into three categories as follows: (1) protein <10, 10–35, >35% total daily calories, (2) carbohydrate <50, 50–55, >55% total daily calories, and (3) fat <25, 25–30, >30% total daily calories. Participants were broken

TABLE II. Estimated Daily Nutrient Intakes in Comparison with Current Dietary Reference Intakes

	Male (n = 307)				Female (n = 280)			
	MDRI[a]	RDA[b]	EAR[c]	Estimated Intake[d] Median (25, 75%)	MDRI	RDA	EAR	Estimated Intake Median (25, 75%)
Protein (% kcal)	10–35		N/A	15 (14, 17)	10–35		N/A	15 (13, 17)
Carbohydrate (% kcal)	50–55	45–65	N/A	51 (47, 57)	50–55	45–65	N/A	53 (49, 57)
Fat (% kcal)	25–30	20–35	N/A	35 (31, 38)	25–30	20–35	N/A	34 (30, 37)
Linoleic acid (g/d)[e]	17		N/A	15 (11, 21)	12		N/A	13 (9, 17)
α-Linolenic acid (g/d)[e]	1.6		N/A	1.3 (0.9, 1.9)	1.1		N/A	1.1 (0.8, 1.5)
Fiber (g/d)[e]	34	38	N/A	20 (15, 26)	28	25	N/A	17 (13, 23)
Vitamin A (μg RAE/d)	900		625	906 (653, 1179)	700		500	754 (568, 1024)
Vitamin D (IU/d)	600		400	182 (117, 303)	600		400	136 (73, 244)
Vitamin E (mg/d)	15		12	8 (6, 11)	15		12	7 (5, 10)
Vitamin K (μg/d)[5]	120		N/A	171 (91, 273)	90		N/A	152 (89, 232)
Thiamin (mg/d)	1.2		1.0	1.9 (1.4, 2.5)	1.1		0.9	1.5 (1.1, 2.0)
Riboflavin (mg/d)	1.3		1.1	2.6 (1.9, 3.3)	1.1		0.9	2.0 (1.5, 2.6)
Niacin (mg NE/d)	16		12	24 (19, 32)	14		11	20 (15, 27)
Vitamin B_6 (mg/d)	1.3		1.1	2.3 (1.7, 3.1)	1.3		1.1	1.9 (1.4, 2.5)
Vitamin B_{12} (μg/day)	2.4		2.0	5.8 (4.2, 8.3)	2.4		2.0	4.3 (3.2, 6.1)
Folate (μg DFE/d)	400		320	639 (479, 915)	400		320	519 (381, 668)
Vitamin C (mg/d)	90		75	126 (87, 182)	75		60	119 (78, 168)
Calcium (mg/d)	1000		800	1,043 (741, 1383)	1000		800	748 (569, 1094)
Iron (mg/d)	8		6	17 (13, 23)	18		8.1	14 (11, 18)
Magnesium (mg/d)	420	400	330	338 (256, 414)	320	310	255	282 (212, 371)
Phosphorus (mg/d)	700		580	1,584 (1,187, 1,992)	700		580	1,267 (938, 1661)
Potassium (mg/d)[e]	4700		N/A	2,887 (2,265, 3,630)	4700		N/A	2,400 (1,897, 3,162)
Selenium (μg/d)	55		45	114 (84, 150)	55		45	92 (72, 124)
Sodium (mg/d)[e]	<2,300	1,500	N/A	3,590 (2,703, 4,782)	<2300	1500	N/A	2,918 (2,194, 3,674)
Zinc (mg/d)	11.0		9.4	11.7 (9.0, 15.5)	8.0		6.8	9.2 (7.2, 12.4)

[a]MDRI, Headquarters Departments of the Army, the Navy, and the Air Force Washington, DC. Army regulation 40–25, Nutrition and menu standards for human performance optimization. January 3, 2017.
[b]RDA, recommended daily allowances for males and females ages 19–30. Institute of Medicine. Dietary Reference Intakes Tables. http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx. Accessed 6 September 2017.
[c]EAR, estimated average intakes for males and females ages 19–30. Institute of Medicine. Dietary Reference Intakes Tables. http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx. Accessed 6 September 2017.
[d]Nutrient intakes were estimated using a full-length, 3-month 2005 Block food frequency questionnaire.
[e]Adequate intake in place of RDA value.

into two categories for sodium, those who met and those who exceeded the MDRI. All analyses were performed using the Statistical Package for Social Sciences (Chicago, IL, USA, version 24). Inadequate nutrient consumption was defined using the cut-point method as consumption less than the MDRI or EAR, respectively.

RESULTS

Participants included in the analysis were mostly White or Caucasian and non-Hispanic or Latino (Table I). Males had a mean age of 21 years, and the largest proportion were recruited from Fort Jackson in 2010 and Fort Sill in 2013, while females were predominately recruited from Fort Jackson in 2015 and had a mean age of 22 years. On average, males consumed an adequate amount of vitamins A, C, and K, as well as the B-vitamins, and calcium, iron, phosphorus, selenium, zinc, and protein and carbohydrate as a percentage of total calories. Conversely, males consumed an inadequate amount of linoleic and α-linolenic acid, fiber, vitamins D and E, magnesium, and potassium, while they consumed excess sodium and fat as a percentage of total calories when compared to MDRI standards (Table II). Females consumed adequate linoleic and α-linolenic acid, vitamins

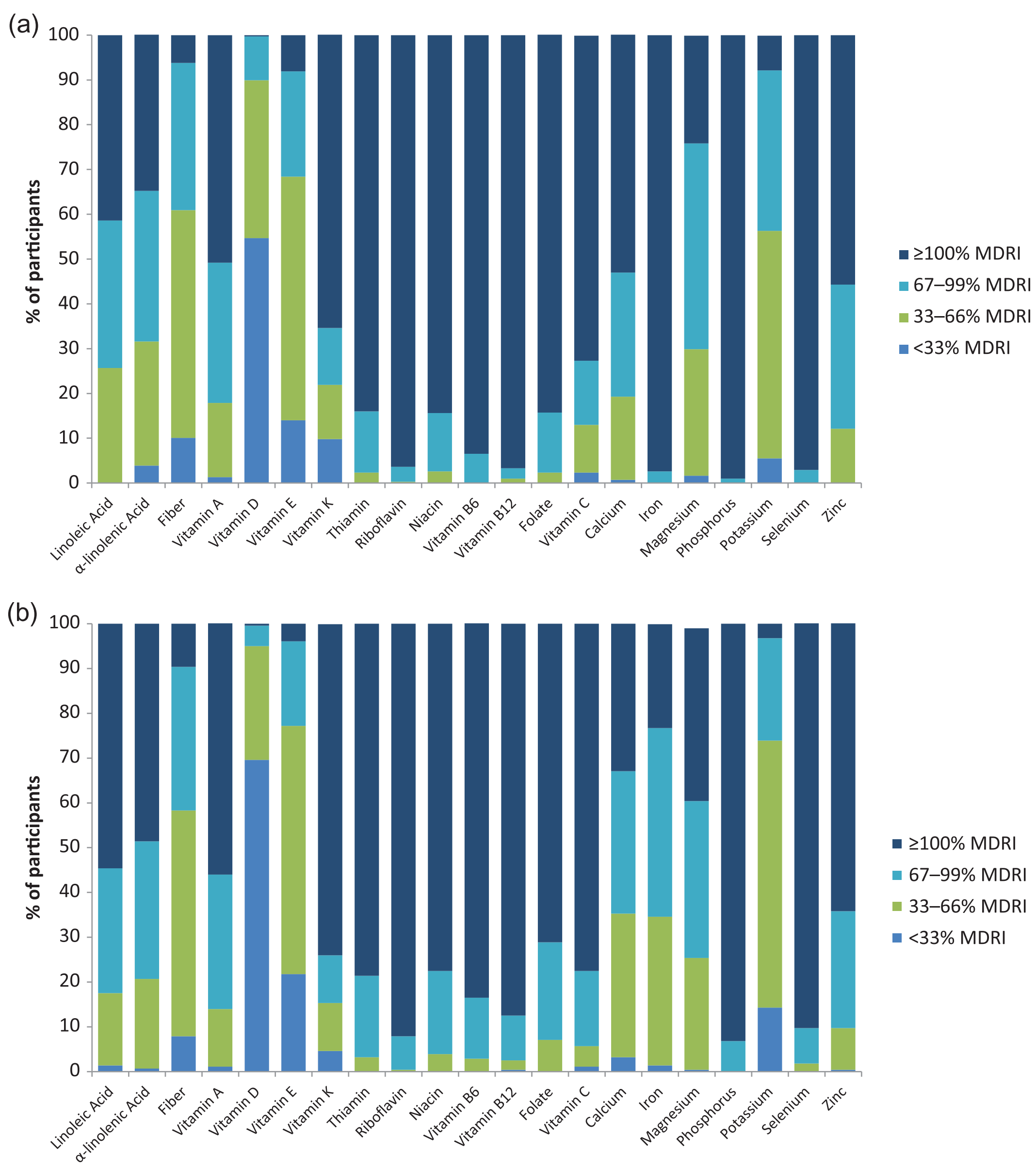

FIGURE 1. Percent of participants meeting the MDRI for micronutrients. (a) Males and (b) females. n = 887 (307M and 280F); MDRI; ≥100% MDRI, participants who met or exceeded the MDRI on average daily; 67–99% MDRI, participants who consumed between 67 and 99% of the MDRI on average daily; 33–66% MDRI, participants who consumed between 33 and 66% of the MDRI on average daily; <33% MDRI, participants who consumed less than 33% of the MDRI on average daily. Headquarters Departments of the Army, the Navy, and the Air Force Washington, DC. Army regulation 40–25, Nutrition and menu standards for human performance optimization. January 3, 2017.

A, C, and K, as well as the B-vitamins, and phosphorus, selenium, zinc, and protein and carbohydrate as a percentage of total calories. Alternatively, females consumed an inadequate amount of fiber, vitamins D and E, magnesium and potassium, and similar to males, excess sodium and fat as a percentage of total calories when compared with MDRI standards. In addition, females also consumed an inadequate amount of calcium and iron when compared to the MDRIs, whereas, on average, intake of these micronutrients was adequate in males. When comparing estimated nutrient intakes to the EARs, both males and females consumed an inadequate amount of vitamins D and E, while only females consumed an inadequate amount of calcium.

When comparing between nutrients, vitamin D was the short-fall nutrient affecting the greatest number of volunteers, as 55 and 70% of males and females, respectively, consumed less than 33% of the MDRI and only one male and one female met the MDRI (Fig. 1). In addition, less than 50% of males met the MDRI for linoleic and α-linolenic acid, fiber, vitamin E, magnesium, and potassium, and less than 50% of females met the MDRI for α-linolenic acid, fiber, vitamin E, calcium, iron, magnesium, and potassium. In contrast, fat and sodium were over-consumed by both males (78 and 87%, respectively) and females (73 and 72%, respectively; Fig. 2). Lastly, when nutrient intake was compared with the EAR, more than 50% of males and females did not meet the EAR for vitamins D and E, while additionally, 51% of females did not meet the EAR for calcium (Fig. 3).

DISCUSSION

The primary objective of this study was to assess nutrient intakes during Army BCT, and to compare the estimated daily nutrient intakes to the MDRIs. The major finding was that military recruits consumed a diet adequate in most nutrients to include vitamins A, C, and K, as well as the B-vitamins, and phosphorus, selenium, zinc, and protein and carbohydrate as a percentage of total calories. However, their dietary intake did not meet the MDRI for: linoleic and α-linolenic acid, fiber, vitamins D and E, magnesium and potassium for males, and fiber, vitamins D and E, iron, magnesium and potassium for females. In addition, both males and females consumed excess sodium and fat as a percentage of total calories when compared with the MDRIs. Lastly, when comparing intakes to the lower intake standards of the EARs, more than 50% of males and females consumed an inadequate amount of vitamins D and E and 49% of females consumed inadequate calcium. While use of the more conservative EAR resulted in identification of fewer short-fall nutrients as compared with the MDRI, the EAR is the intake level of a given nutrient that is expected to meet the needs of 50% of the average, non-military, population. Given the unique stressors sustained by military personnel, this cut off may not be appropriate for use in this population.

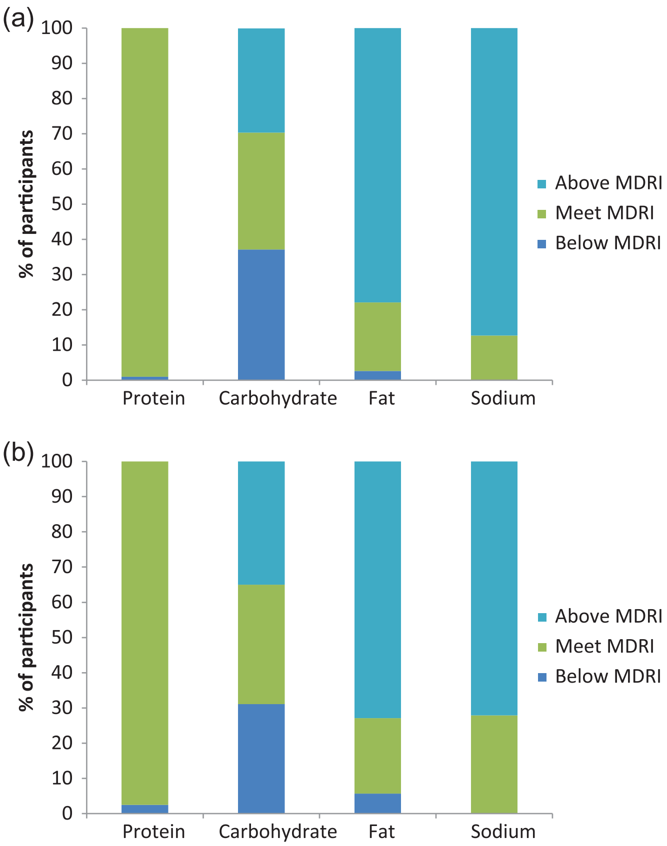

FIGURE 2. Percent of participants meeting the MDRI for macronutrients and sodium. (a) Males and (b) females. n = 887 (307M and 280F); MDRI; meeting protein MDRI equals 10–35% of calories from protein, meeting carbohydrate MDRI equals 50–55% of calories from carbohydrate, meeting fat MDRI equals 25–30% of calories from fat, and meeting sodium MDRI equals consuming less than 2300 mg daily. Headquarters Departments of the Army, the Navy, and the Air Force Washington, DC. Army regulation 40–25, Nutrition and menu standards for human performance optimization. January 3, 2017.

Analyses from NHANES provide data on nutrient intakes in the U.S. civilian population. These analyses indicate that under-consumption of fiber, vitamins D and E, calcium, iron, magnesium, and potassium and over-consumption of fat and sodium is prevalent throughout the American population. In this way, findings from the present study are similar to the age- and sex-specific nutrient consumption observed in the general civilian population.[21] However, in the 2013–2014 What We Eat in America NHANES data, linoleic and α-linolenic acid were consumed in adequate amounts in males and females, whereas the estimated intakes in the present study indicated that recruits may consume an inadequate amount of these fatty acids during BCT. This may be due to an under-reporting of total fat intake on the FFQ during BCT. Alternatively, the difference in fatty acid intake may be the product of food selections within the military DFAC. Male and female participants reported eating 86 and 69 g of fat per day, respectively, while the NHANES data reported males of the same age consumed between 98

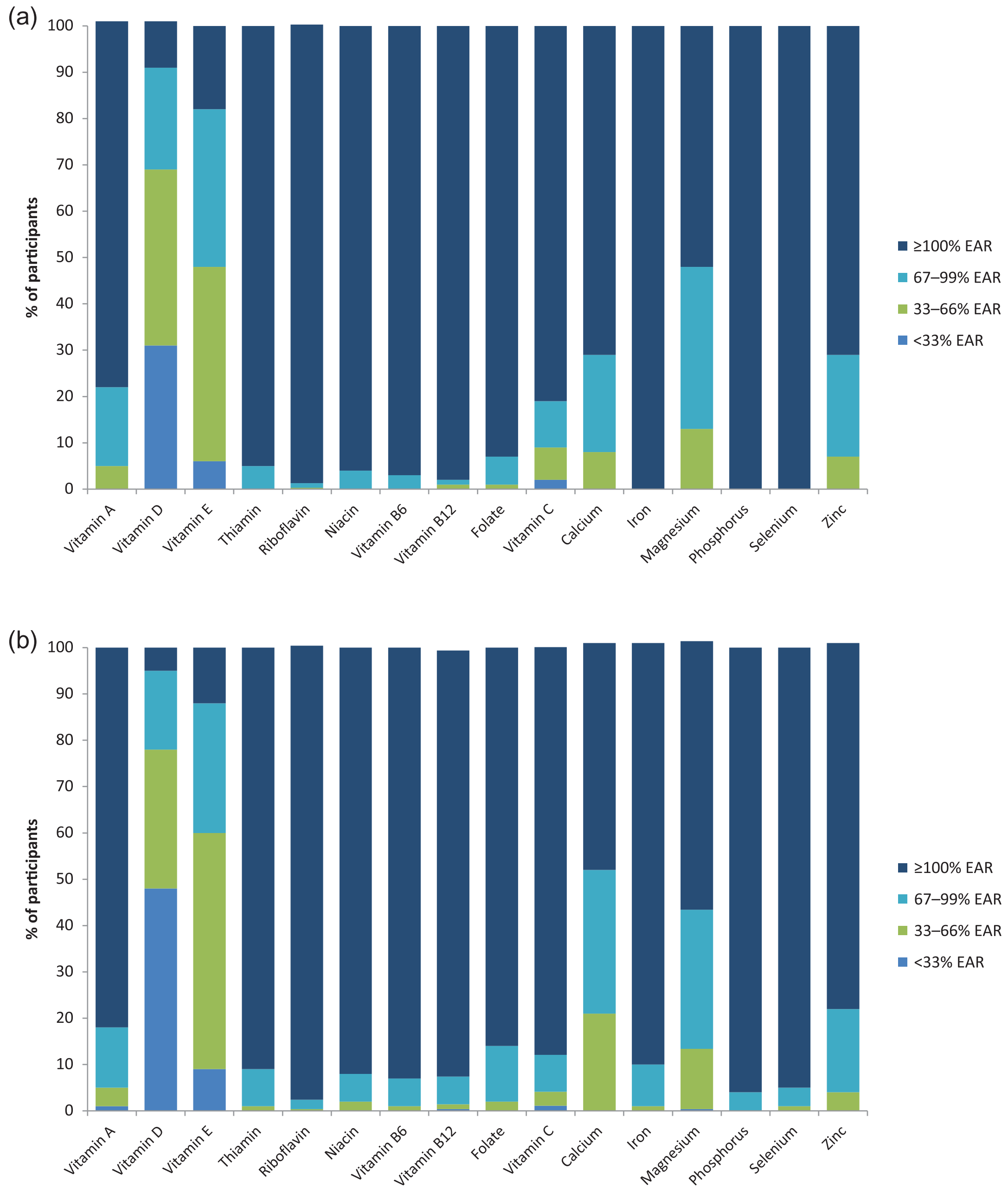

FIGURE 3. Percent of participants meeting the EAR for micronutrients. (a) Males and (b) females. n = 887 (307M and 280F); ≥100%EAR, participants who met or exceeded the EAR on average daily; 67–99% EAR, participants who consumed between 67 and 99% of the EAR on average daily; 33–66% EAR, participants who consumed between 33 and 66% of the EAR on average daily; <33% EAR, participants who consumed less than 33% of the EAR on average daily.

and 104 g of fat per day and females between 74 and 77 g of fat per day.[21] Thus, while a large proportion of recruits overconsumed total dietary fat, average total fat intake in this study was less than that reported for the general U.S. population.

The effects of inadequate iron, calcium, and vitamin D intake on the health and performance of military recruits during training have been well documented.[1,3,22] These findings underpinned changes in the BCT environment resulting in efforts to improve micronutrient consumption. However, the potential effects of diminished intake of linoleic and α-linolenic acid, fiber, vitamin E, magnesium, and potassium have not been well studied. Linoleic and α-linolenic acids are not synthesized by humans, and are therefore considered essential in the diet. They both function as precursors for eicosanoids and inadequate consumption of these fatty acids may result in dermatitis and poor growth.[23] Adequate fiber consumption has been associated with healthy laxation and regulation of blood lipids and glucose.[23] Vitamin E deficiency is rarely reported and it is thought that vitamin E consumption is often under-reported due to an under-reporting of fat intake.[24] Magnesium and potassium depletion is associated with muscle cramps,[25] affecting physical performance, and in addition, magnesium is involved in bone modeling and remodeling, potentially affecting bone health.[26]

Limitations of this study include the use of a FFQ to estimate and not directly measure dietary intake. Assessing energy intake using FFQs is difficult given that FFQs (1) rely on participant memory of estimated food consumption over time, (2) often result in under-reporting portions consumed, and (3) contain a finite list of foods.[27] However, the FFQ used in this study was previously demonstrated to correlate with blood biomarkers of nutrient intake such as alpha and beta carotene in other military training environments.[20] In addition, the dietary intake data were collected before the MDRIs used for comparison in this study were published, and during the time that new initiatives may have been implemented in the dining facilities. It is possible that a limited selection of foods rich in short-fall nutrients resulted in inadequate intake of those nutrients, such as vitamin D. Strengths of this study include the comprehensive nature of the analysis, with all but two nutrients (fluoride and iodine) with a MDRI value analyzed and averaged over the course of BCT. In addition, the robust study population included both males and females at more than one BCT location and was racially diverse.

If recruits followed the dietary recommendations set forth in the Dietary Guidelines for Americans, and outlined in the MDRIs, the gap in intakes of short-fall nutrients identified in this study and the excess intakes of sodium and fat, would be mitigated.[28] Foods rich in these short-fall nutrients include nuts, seeds and legumes, vegetable oils, fruits, vegetables, whole grains, dairy, and meat. Future prospective research studies are needed to determine if linoleic and α-linolenic acid, fiber, vitamin E, magnesium, and potassium are persistently under consumed during BCT, if there are demographic or cultural variables that may be associated with the under-consumption of these nutrients, as well as possible health and performance impacts that may be associated with suboptimal intake of these nutrients. This is particularly important to determine whether military-specific recommendations are needed. In the interim, nutrition education efforts in the BCT environment could focus on promoting foods rich in these short-fall nutrients as well as reducing sodium and total fat intake, and/or evaluate eating behaviors that may underlie recruits' dietary choices within the military dining facilities.

FUNDING

The authors have no conflicts of interest associated with this research, which was funded by the United States Medical Research and Material Command.

ACKNOWLEDGEMENTS

The authors would like to acknowledge and thank the Soldiers from Fort Jackson, SC and Fort Sill, OK who chose to participate in this research.

Trials NCT01617109 and NCT02375503, registered at clinicaltrials.gov

REFERENCES

1. McClung JP, Karl JP, Cable SJ, et al: Randomized, double-blind, placebo-controlled trial of iron supplementation in female soldiers during military training: effects on iron status, physical performance, and mood. Am J Clin Nutr 2009; 90: 124–31.
2. Lappe J, Cullen D, Haynatzki G, Recker R, Ahlf R, Thompson K: Calcium and vitamin D supplementation decreases incidence of stress fracture in female Navy recruits. J Bone Miner Res 2008; 23: 741–9.
3. Gaffney-Stomberg E, Lutz LJ, Rood JC, et al: Calcium and vitamin D supplementation maintains parathyroid hormone and improves bone density during initial military training: A randomized, double-blind, placebo-controlled trial. Bone. 2014; 68: 46–56.
4. Headquarters Departments of the Army, the Navy, and the Air Force Washington, DC. Army regulation 40–25, Nutrition and menu standards for human performance optimization. 3 January 2017.
5. Institute of Medicine. Dietary Reference Intakes Tables. Available at http://www.nationalacademies.org/hmd/Activities/Nutrition/SummaryDRIs/DRI-Tables.aspx; accessed September 6, 2017.
6. Carlson AR, Smith MA, McCarthy MS: Diet, physical activity, and bone density in Soldiers before and after deployment. US Army Med Dep J 2013; APR–JUN: 25–30.
7. Frank L, McCarthy MS: Telehealth coaching: Impact on dietary and physical activity contributions to bone health during a military deployment. Mil Med 2016; 181: 191–8.
8. Etzion-Daniel Y, Constantini N, Finestone AS, et al: Nutrition consumption of female combat recruits in army basic training. Med Sci Sports Exerc 2008; 40: S677–84.
9. Klicka MV, King N, Lavin PT, Askew EW: Assessment of dietary intakes of cadets at the US Military Academy at West Point. J Am Coll Nutr 1996; 15: 273–82.
10. McClung JP, Karl JP, Cable SJ, Williams KW, Young AJ, Lieberman HR: Longitudinal decrements in iron status during military training in female soldiers. Br J Nutr 2009; 104: 605–9.
11. Pasiakos SM, Karl JP, Lutz LJ, et al: Cardiometabolic risk in US Army Recruits and the effects of basic combat training. PLoS One 2012; 7: e31222.
12. Lutz LJ, Karl JP, Rood JC, et al: Vitamin D status, dietary intake, and bone turnover in female Soldiers during military training: a longitudinal study. J Int Soc Sports Nutr 2012; 9: 38.
13. Gaffney-Stomberg E, Lutz LJ, Shcherbina A, et al: Association between single gene polyporphisms and bone biomarkers and response to calcium and vitamin D supplementation in young adults undergoing military training. J Bone Miner Res 2017; 32: 498–507.
14. National Institute of Health: Policy of Reporting Race and Ehnicity Data: Subjects in Clinical Research. Bethesda, MD, National Institutes of Health, 2001.
15. NutritionQuest. Assessment and Analysis Services. Available at https://www.nutritionquest.com/assessment/list-of-questionnaires-and-screeners/; Accessed September 12, 2017.
16. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L: A data-based approach to diet questionnaire design and testing. Am J Epidemiol 1986; 124: 453–69.
17. Block G, Woods M, Potosky A, Clifford C: Validation of a self-administered diet history questionnaire using multiple diet records. J Clin Epidemiol 1990; 43: 1327–35.
18. Lutz LJ, Gaffney-Stomberg E, Scisco JL, et al: Assessment of dietary intake using the healthy eating index during military training. US. Army Med Dep J 2013; Oct–Dec: 91–7.

19. Lutz LJ, Gaffney-Stomberg E, Williams KW, et al: Adherence to the Dietary Guidelines for Americans is associated with psychological resilience in young adults: a cross-sectional study. J Acad Nutr Diet 2017; 117: 396–403.
20. Lutz LJ, Nakayama NT, Karl JP, McClung JP, Gaffney-Stomberg E. Serum and erythrocyte biomarkers of nutrient status correlate with short-term α-carotene, β-carotene, folate, and vegetable intakes estimated by food frequency questionnaire. J Am Coll Nutr. in Press.
21. United States Department of Agriculture: Nutrient Intakes from Food and Beverages: Mean Amounts Consumed per Individual, by Gender and Age, What We Eat in America, NHANES 2013–2014. Washington DC, United States Department of Agriculture Agricultural Research Service, 2016.
22. Karl JP, Leiberman HR, Cable SJ, Williams KW, Young AJ, McClung JP: Randomized, double-blind, placebo-controlled trial of an iron-fortified food product in female soldiers during military training: relations between iron status, serum hepcidin, and inflammation. Am J Clin Nutr 2010; 92: 93–100.
23. Institute of Medicine: DRI Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC, National Academy of Medicine, 2002.
24. Institute of Medicine: DRI Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids. Washington DC, National Academy of Medicine, 2000.
25. Institute of Medicine: DRI Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. Washington DC, National Academy of Medicine, 1997.
26. Palacious C, Wigertz K, Braun M, et al: Magnesium retention from metabolic-balance studies in female adolescents: impact of race, dietary salt, and calcium. Am J Clin Nutr 2013; 97: 1014–9.
27. Willet W: Nutritional Epidemiology. New York, New York, Oxford University Press, 1990.
28. Dietary Guidelines for Americans. Office of Disease Prevention and Health Promotion Website. Available at http://health.gov/DietaryGuidelines/. Published November 6, 2015. accessed September 20, 2017 .