DIETARY INTAKE AND DIET QUALITY ACROSS A COMPETITIVE SEASON IN FEMALE AND MALE CROSS COUNTRY STUDENT-ATHLETES FROM A SINGLE ACC INSTITUTION

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Link to video presentation

Abstract: Nutrition is essential for the health and performance of athletes, especially in collegiate cross country where high energy intakes are required to match high training volumes. Due to the demands of the sport, cross country athletes often suffer from energy deficiency due to insufficient dietary energy intake, which can negatively impact health and performance. The purpose of this study was to characterize dietary intake and diet quality across a competitive cross country season in female and male student-athletes from a single ACC institution. The primary findings were that 64% of females and 36% of males were in energy deficit (i.e. dietary caloric intake is below total daily energy expenditure), and a majority of student-athletes did not meet sport-specific recommendations for carbohydrate intake. Moreover, diet quality did not meet Federal guidelines, but diet quality in females was better than the average American. Finally, diet quality was greater in food provided by university dining halls and the athletic department compared other sources.

Brief Overview of Study Design

Human subjects research was approved by the Institutional Review Board of the study investigators (IRB 00000263). Student-athletes were recruited from the Women's and Men's Cross Country Teams from a single ACC institution in August of 2019. Thirty-one student-athletes consented (15 females and 16 males). Throughout the study, one female was excluded due to departure from the team, and two males were excluded due to musculoskeletal injuries sustained in training. Following consent, student-athletes completed a Demographic Questionnaire (DQ) that included questions on menstrual cycle regularity for females. During the non-championship competitive season, student-athletes completed two 24-hr dietary recalls (DRs) of all food and drink consumed during a 24-hr period. Student-athletes completed 3 additional DRs during the championship competitive season, which included the ACC, NCAA Regional, and NCAA National Championships. Training logs were collected across the entire season and average total daily energy expenditure (TDEE) was determined using the Compendium of Physical Activities over a 10-d period including and preceding days of DRs. At each study visit, anthropometrics were measured.

Results & Discussion

***Student-athlete characteristics*.** 14 females and 14 males (n=28 total) completed all aspects of the study, except two males did not complete the championship season DRs. Data are presented as mean ± SD and statistical significance was set to $P<0.05$. Student-athletes were of college age (20.4 ± 1.3 y) with a class distribution of 6 freshmen (21%), 7 sophomores (25%), 10 juniors (36%), and 5 seniors or graduate students (18%). BMI was lower in females (18.3 ± 1.6 kg/m^2) than males (20.6 ± 1.7, P-main<0.01), and 7 females were classified as underweight (BMI < 18.5 kg/m^2). Neither BMI nor body weight (BW) changed over the course of the season (BMI P-main=0.53, BW P-main=0.46). VO_2max was lower in females (62.5 ± 4.2, mL/kg BW/min) than males (69.8 ± 5.6, P<0.01); however, both indicate a high level of fitness. Average weekly running mileage across the season was lower in females (46.2 ± 7.0 mi/wk) than males (66.6 ± 9.8, P<0.01) and is reflective of training differences due to competition race distance (females: 5000m and 6000m, males: 8000m and 10000m).

Energy intake, expenditure, and balance. Across the entire season, average energy intake (EI) from DRs was lower in females (2253 ± 389 kcal/d) than males (2772 ± 558, P-main=0.02). EI did not differ between the non-championship and championship seasons (P-main=0.43). Average TDEE calculated from training logs across the entire season was lower in females (2218 ± 681 kcal/d) than males (2767 ± 1072, P-main<0.01), and TDEE decreased in both sexes from the non-championship season (2576 ± 400 kcal/d) to the championship season (2259

± 172, P-main<0.01). Sex differences in TDEE reflect greater training volumes in males, and time differences reflect a tapering of training volume during the championship season to enable peak performance. On average, across the entire season females were in energy deficiency (-121 ± 311 kcal/d) and males were near energy balance (37 ± 621 kcal/d, P-main=0.23). The majority of females (64%) and 5 males (36%) were in energy deficiency across the entire competitive season (mean balance in those with energy deficiency: -439 ± 280 kcal/d). Notably, all females with an energy deficiency >100 kcal/d reported menstrual cycle dysfunction in the form of amenorrhea (no menses) or oligomenorrhea (irregular menses).

Adherence to Federal and Sport-Specific Guidelines: Macronutrients. Adherence to the Recommended Daily Allowances (RDAs) established by the U.S. Government and to endurance sport-specific recommendations set by the American College of Sports Medicine (ACSM) was assessed. Nearly all (93-100%) student-athletes adhered to the RDAs for carbohydrate (130 g/d) and protein (0.8 g/kg BW/d) across timepoints; however, the ACSM recommends that endurance athletes increase their carbohydrate intakes above 6 g/kg BW/d to meet the energy needs of training. Across timepoints, few student-athletes (8-29%) meet2246 this threshold, with the exception of females during the championship season (57%). We conclude that carbohydrate intakes below ACSM recommendations are the key contributor to energy deficiency. For endurance athletes, the ACSM recommends protein intakes above 1.2 g/kg BW/d to support muscular adaptation to training. The majority of student-athletes (69-100%) met these guidelines across timepoints. The ACSM recommends that athletes at risk of energy deficiency consume greater than 2.0 g/kg bodyweight/d. Notably, mean protein intake across the entire season meets this threshold in both sexes, indicating that these student-athletes may not suffer the full consequences of energy deficiency. Finally, no RDA exists for fat, but the U.S. Government provides an Acceptable Macronutrient Distribution Range (AMDR) of 20-35% of total kcal/d from fat. The majority of student-athletes consumed >35% kcal/d of fat. Collectively, these findings suggest student-athletes consumed an excessive proportion of energy from fat; however, fat intake may decrease if ACSM recommendations for carbohydrate intake are met.

Adherance to Federal and Sport-Specific Guidelines: Select Micronutrients. The ACSM recommends sport-specific intakes for iron, calcium, and vitamin D. Low iron status is common in endurance athletes. From dietary sources alone, 50-57% of student-athletes met the RDA for iron and 86-100% met the ACSM guidelines; yet, across the competitive season 13 females (92%) and 10 males (71%) consumed iron supplements. Iron supplement consumption placed 11 females (79%) and 7 males (50%) over the U.S. Government's Upper Tolerable Intake Limit (UL), which is the maximum daily intake unlikely to cause adverse health effects. While endurance athletes are at an increased risk for iron deficiency, current evidence suggests this risk may be due to energy deficiency. Correcting energy deficiency may be a safer solution to prevent iron deficiency than aggressive supplementation given that dietary iron intakes were adequate. For athletes at risk of energy deficiency, the ACSM recommends increased intakes of calcium and vitamin D to mitigate the impacts of energy deficiency on bone health. Few student-athletes met the RDA (43%) and ACSM guidelines (4%) for calcium intake. No student-athletes met either guidelines for vitamin D intake; however, the vitamin D guidelines are for diet alone and do not account for vitamin D synthesized from the sun. The student-athletes in this study lived in a location with adequate sun exposure (below the 35th parallel) and performed the majority of their training outside, suggesting that vitamin D deficiency was unlikely.

Diet quality assessed by the 2015 Healthy Eating Index. The Healthy Eating Index is a metric of diet quality based on the Federally established Dietary Guidelines for Americans (DGAs). The most recent version was published in 2015 (HEI-2015), and evaluates diet quality by dietary adequacy of 9 food groups and moderacy of 4 food groups (**Table 1**). Across all timepoints, student-athletes did not meet the DGAs, and females consistently scored higher

in diet quality than males. Diet quality from foods provided by the dining halls and athletic department was of higher diet quality than foods from other sources. Diet quality did not differ substantially across timepoints. Specific components of the HEI-2015 reflect noncompliance to Federal and ACSM guidelines and provide specific food group targets to improve guideline adherance. For instance, HEI-2015 scores for carbohydrate food sources (fruits, vegetables, whole grains) and calcium food sources (dairy) are particularly low across sexes and timepoints. Additionally, whole grain diet quality is noticeably greater from school sources of food.

Table 1. HEI-2015 component and composite scores from school and non-school sources and across timepoints.

HEI-2015 components	Score to meet DGAs	Americans Adults	Entire season		Non-championship		Championship	
			School sources	Non-school sources	Females	Males	Females	Males
Total fruits	5	2.6	1.8	1.6	2.1	0.9	2.8	1.3
Whole fruits	5	3.8	2.4	2.1	2.5	1.2	3.4	1.7
Total vegetables	5	3.5	3.1	4.0	4.1	3.3	4.3	3.0
Greens & beans	5	3.4	3.4	3.9	3.3	2.3	3.7	2.7
Whole grains	10	2.7	6.9	4.6	6.6	4.5	6.9	3.5
Dairy	10	5.4	4.2	7.8	5.6	4.6	7.3	5.0
Total protein foods	5	5.0	4.7	4.8	4.7	4.7	4.8	4.5
Seafood & plant proteins	5	5.0	4.6	3.8	4.5	3.6	4.6	3.0
Fatty acids	10	4.5	6.5	3.9	6.1	5.8	5.6	4.5
Refined grains[1]	10	6.7	3.7	5.2	4.7	4.6	5.3	4.0
Sodium[1]	10	3.4	8.1	4.6	7.8	6.6	6.6	4.0
Added sugars[1]	10	6.8	3.5	6.4	3.8	5.7	4.3	8.1
Saturated fats[1]	10	5.4	8.5	5.2	7.0	6.3	6.5	5.9
COMPOSITE SCORES:	**100**	**58.2**	**58.9**	57.6	62.7	54.1	66.0	51.5

[1] evaluated on moderation instead of adequacy in the diet (i.e. a higher score indicates lower consumption)

Take Home Message and Future Directions

The current study found a high prevalence of energy deficiency in cross country student-athletes from a single ACC school. Energy deficiency in these student-athletes is likely due to carbohydrate intakes below sport-specific recommendations. Calcium and vitamin D consumption were also below guidelines, which may exacerbate the impacts of energy deficiency on bone health. Furthermore, despite consuming adequate amounts of iron from the diet, a high proportion of student-athletes consumed iron supplements which led to total intakes above thresholds that may lead to adverse impacts on health. Diet quality as measured by the HEI-2015 was greater in foods from school dining halls and athletic departments. To improve overall diet quality and adherence to guidelines, data from the current study suggest that ACC athletic departments should increase the availability of whole grains, fruits, vegetables, and dairy to cross country student-athletes. Although these data provide valuable insight into the dietary habits of cross country student-athletes, future studies should replicate these findings in a larger sample size.