

Introduction

Endurance and ultra-endurance athletes have been shown to have both poor knowledge of specific nutrition recommendations and poor nutritional intake, often failing to meet specific recommendations (Blennerhassett et al 2019). **Nutritional knowledge has been associated with nutrition intake in endurance athletes, resulting in an increased risk of low energy availability (LEA).** In particular, athletes have been deficient in the macronutrient carbohydrate (Beermann et al 2020), and this may be the main contributing factor to LEA (Stellingwerff et al 2021). LEA has been shown to be a robust and reliable marker of sub-optimal health and is used as a diagnostic to screen for RED-S (Loucks et al 2011). However, RED-S is also often misdiagnosed for overtraining syndrome in many athletes and reliable information is needed to predict and screen for LEA and reduce the risk of RED-S (Stellingwerff et al 2021).

Results

Carbohydrate knowledge and EA: Using Pearson product-moment correlation coefficient, no correlation was found across the whole group (n = 33) between carbohydrate knowledge quiz scores and energy availability (r= -.052, n=33). Two sub-groups were created based on an optimal EA group (n = 6) and a clinical EA group (n = 11) and an independent T-test was used to check compare groups. No correlation was found. Using the other independent variables, statistical significance was achieved when correlating EA with carbohydrate, fat and protein intake. **CEAC-Q Scores:** Score for the CEAC-Q were an average of 41.9 (n = 33). Females scored 37.6, with a lower score than males 46.2. Scores are presented in Table 3. **Nutrient intake and EA:** Overall energy intake, rather than specific macronutrients all correlated with energy availability. A significant, large, positive relationship exists between CHO (r=0.73, n=33, P<0.05), Protein (r=0.65, n=33, P<0.05) and Fat intake (r=0.73, n=33, P<0.05) and energy availability in non elite ultra-runners. **Energy availability:** n = 6 presented with optimal values of EA (f = 6; m = 0), = 16 presented with sub-clinical values of EA (f = 7; m = 9), and n = 11 (f = 4; m = 7) presented with clinical values of EA. EA scores are presented in Table 4.

Table 3 | Carbohydrate Quiz Score

n = 33	Females (n = 17)	Males (n = 16)
Score	37.6 (17.6)	46.2 (16.6)
Mean Average	41.9	

Data is presented as mean (SD). No significant correlation was found between carbohydrate knowledge (assessed by carbohydrate score) and energy availability.

Table 4 | Energy Availability

n = 33	Females (n = 17)	Males (n = 16)
EA >45	6	0
EA 30-45	7	9
EA <30	4	7

FFM = fat free mass EA = energy availability; optimal >45 Kcal/FFM, >35 Kcal/FFM medium, <35 Kcal/FFM at risk.

Findings and Summary

No association was found between ultra runners carbohydrate knowledge and energy availability. This finding does not support previous published research linking nutritional knowledge with energy availability. **CEAC-Q Scores of an average of 41.9 was lower than the 46 CEAC-Q score recorded for endurance athletes by Sampson et al (2021).** A novel finding was that 33% of participants presented with clinical values of LEA. Females had higher overall levels of EA and lower levels of clinic EA when compared to males. Male participants had a higher rate of sub-clinical and clinical values, placing them at a higher risk of RED-S. Once participant presented signs of overtraining syndrome. On analysis this participant also had exceptionally low values of EA. Stellingwerff et al (2021) suggest that RED-S is often misdiagnosed as overtraining syndrome. The results and data for this study support that position and provide strong evidence that ultra-runners are at an increased risk of RED-S.

Methods

Study Design and methods: To investigate the association between carbohydrate knowledge and energy availability in ultra runners, a 7-day descriptive correlation design study collected food and training logs to capture energy intake (EI) and EEE (exercise energy expenditure) data. The final stage of the study invited participants to complete the CEAC questionnaire online to collect scores testing carbohydrate knowledge. The study was granted ethical consent from UWTSD. The purpose and duration of the study was explained to all participants, along with detailed information of what was required from them and the opportunity to withdraw from the study at any time. Each participant completed a standard UWTSD consent form. Dietary and training data were collected at the end of 7 days, followed by a questionnaire. **Recruitment and Participants:** To be included in the study, participants had to be experienced ultra runners and to have completed at least 2 ultra marathons. In addition, usual weekly training outside of race, recovery or tapering weeks was expected to be over 40 miles per week, and currently training and racing. Contact was made with five professional ultra running coaches with good international reputations and participants were recruited from their athletes. 34 ultra-runners took part in the study and 33 completed (females: n=17; males: n=16) the study and were included in the final analysis. Participant characteristics can be found in Table 1. **Screening questionnaire and CEAC-Q:** Each participant completed a screening questionnaire to collect age, anthropometric, and weekly average training habits. On completion of the food diary and training log, an invite to complete the Carbohydrate for endurance athletes in competition questionnaire (CEAC-Q) (Sampson et al 2021) was issued to all participants. **Energy availability (EA):** Energy availability was estimated using the formula: EA = EI - EEE/FFM kg. Participants EI and EEE data was examined over the duration of the food and activity logs. Daily total of EA Kcal/FFM were calculated. Total energy availability for each athlete was provided as a mean average over the 7 days. Energy availability values estimated were 45 Kcal FFM/d - Optimal EA in females and 40 Kcal FFM/d in males. A sub-clinical EA of 30-45 Kcal FFM/d and a clinic value is <30 kcal/FFM/d. (Melin et al 2019). An EA of 30 Kcal/kg/FFM has a rough correlation to RMR (Loucks et al 2011), and has been associated with metabolic and endocrine perturbations, especially in female athletes, leading to a number of negative health and performance outcomes (Melin et al 2019). EI and macronutrients are presented in Table 2.

Table 1 | Participant Characteristics

n = 33	Females (n = 17)	Males (n = 16)
Age (y)	42 (5.4)	43 (6.8)
Height (m)	1.63 (.05)	1.81 (.7)
Weight (kg)	58 (4.0)	76 (5.2)
Body Fat %	27.8 (2.0)	18.3 (2.8)

Data is presented as mean (SD)

Table 2 | Energy Availability and Macronutrient Values

n = 33	Females (n = 17)	Males (n = 16)
EA (Kcal/FFM/Kg)	37.5 (12.2)	27.9 (8.3)
CHO (g/kg)	4.5 (1.6)	4.1 (1.3)
Protein (g/kg)	1.6 (0.4)	1.3 (.49)
Fat (g/kg)	1.7 (.53)	1.4 (.39)

Data is presented as mean (SD). FFM = fat free mass EA = energy availability.

References

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