THE RELATIONSHIP OF ENERGY STATUS AND LIPID PROFILES AMONG EUMENORRHEIC ADOLESCENT FEMALE ATHLETES

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Introduction

- The Relative Energy Deficiency in Sport (REDs) model proposes cardiovascular health impairments secondary to low energy availability (LEA).
- Female athletes with amenorrhea, often related to LEA, can **demonstrate endothelial dysfunction and dyslipidemia.**[1]
- Whether energy availability in adolescent female athletes, independent of amenorrhea, is associated with lipid profiles is unknown.
- It is important to understand cardiovascular disease (CVD) risk, as CVD is the number one leading cause of death in women in the US.[2]
- There is also a need to **standardize methodology used to classify menstrual status in female athlete research**, demonstrated by a lack of consistency in prior studies examining CVD risk and menstrual dysfunction.[3,4]

Purpose: Determine the association between energy status and serum lipid markers among eumenorrheic adolescent female athletes.

Experimental Design and Methods

22 Eumenorrheic Athletes
- Participants completed total body DXA scan, and indirect calorimetry testing to measure resting metabolic rate (RMR)
- Energy status was determined from the ratio of measured to predicted RMR as previously described[5]

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3 months of self-reported menstrual cycle tracking
Completed with REDCap survey tracking

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1 month at-home urinary ovulation testing
Completed with REDCap survey tracking with reminders for urinary ovulation testing during a calculated ovulation window

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Blood draw within 7 days of last day of the menstrual period to confirm eumenorrheic status
- Serum lipid markers including HDLc, LDLc, triglycerides, total cholesterol also obtained

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A linear regression model was used to assess the relationship between energy status and lipid markers, adjusting for body mass index (BMI).

Table 1: *Participant characteristics. Data are presented as mean (SD) for continuous variables and number within group (corresponding %) for categorical variables.*

Demographics		
Age (years)		15.6 (1.3)
Height (cm)		163.7 (6.2)
Weight (kg)		55.6 (8.8)
BMI		21.2 (3.4)
Race	White	18 (82%)
	More than one race	4 (18%)
Ethnicity: Hispanic or Latino		5 (23%)
Primary sport	Soccer	11 (53%)
	Basketball	1 (5%)
	Cross country	2 (10%)
	Track & field	2 (20%)
	Swimming	1 (5%)
	Dance	3 (14%)
	Horseback riding	1 (5%)
Anovulatory		5 (23%)
Energy status		1.13 (0.11)
Lipid profiles		
HDLc		51 (9.9)
LDLc		90 (29.9)
Triglycerides		82 (35.7
Total cholesterol		143 (28.7)

Table 2: *Linear regression outcomes evaluating the association between energy status and blood lipid markers, after adjusting for the independent effect of BMI.*

Variable	β coefficient	95% Confidence Interval	P value
Outcome: HDLc			
Energy status	-7.14	-57.5, 43.2	0.77
BMI	0.75	-0.85, 2.35	0.34
Outcome: LDLc			
Energy status	9.09	-136.8, 154.9	0.90
BMI	2.29	-1.75, 7.53	0.21
Outcome: Triglycerides			
Energy status	95.4	-84.3, 275.0	0.28
BMI	-0.72	-6.43, 4.99	0.79
Outcome: Total cholesterol			
Energy status	19.7	-111.7, 151.0	0.76
BMI	3.58	-0.60, 7.76	0.09

Results

- We enrolled and assessed 22 adolescent eumenorrheic female athletes, 5 (23%) of which were classified as anovulatory. The average BMI was 21.2±3.4, and a majority (53%) reported soccer as their primary sport (***Table 1).***
- All 22 eumenorrheic female athletes successfully completed the menstrual status classification assessment.
- After adjusting for BMI, energy status was not significantly associated with HDLc (p=0.77), LDLc (p=0.90), triglycerides (p=0.28), or total cholesterol (p=0.76), ***Table 2*** shows these linear regression outcomes.

Conclusions

- **Energy status in eumenorrheic athletes was not significantly associated with lipid markers**, suggesting that energy status, independent of menstrual status, is not associated with lipid profiles.
- Consequently, this work reinforces the importance of specifically **comparing lipid profiles of adolescent eumenorrheic and amenorrheic female athletes** to better understand the role that menstrual dysfunction may play in CVD risk.
- Enhanced understanding of the negative cardiovascular implications of REDs is **key for early prevention of CVD in adolescent female athletes.**

This understanding will ensure that physicians can provide comprehensive care to **keep female athletes on the trails, in the game, and out of the hospital.**

References

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