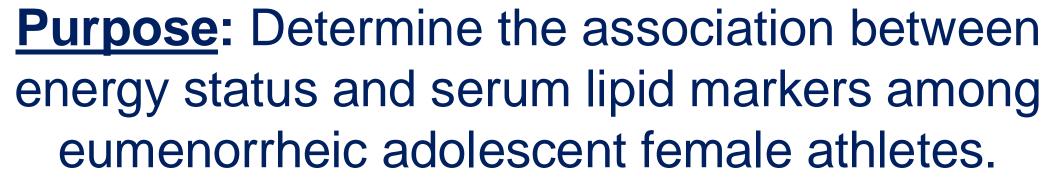
THE RELATIONSHIP OF ENERGY STATUS AND LIPID PROFILES AMONG **EUMENORRHEIC ADOLESCENT FEMALE ATHLETES**

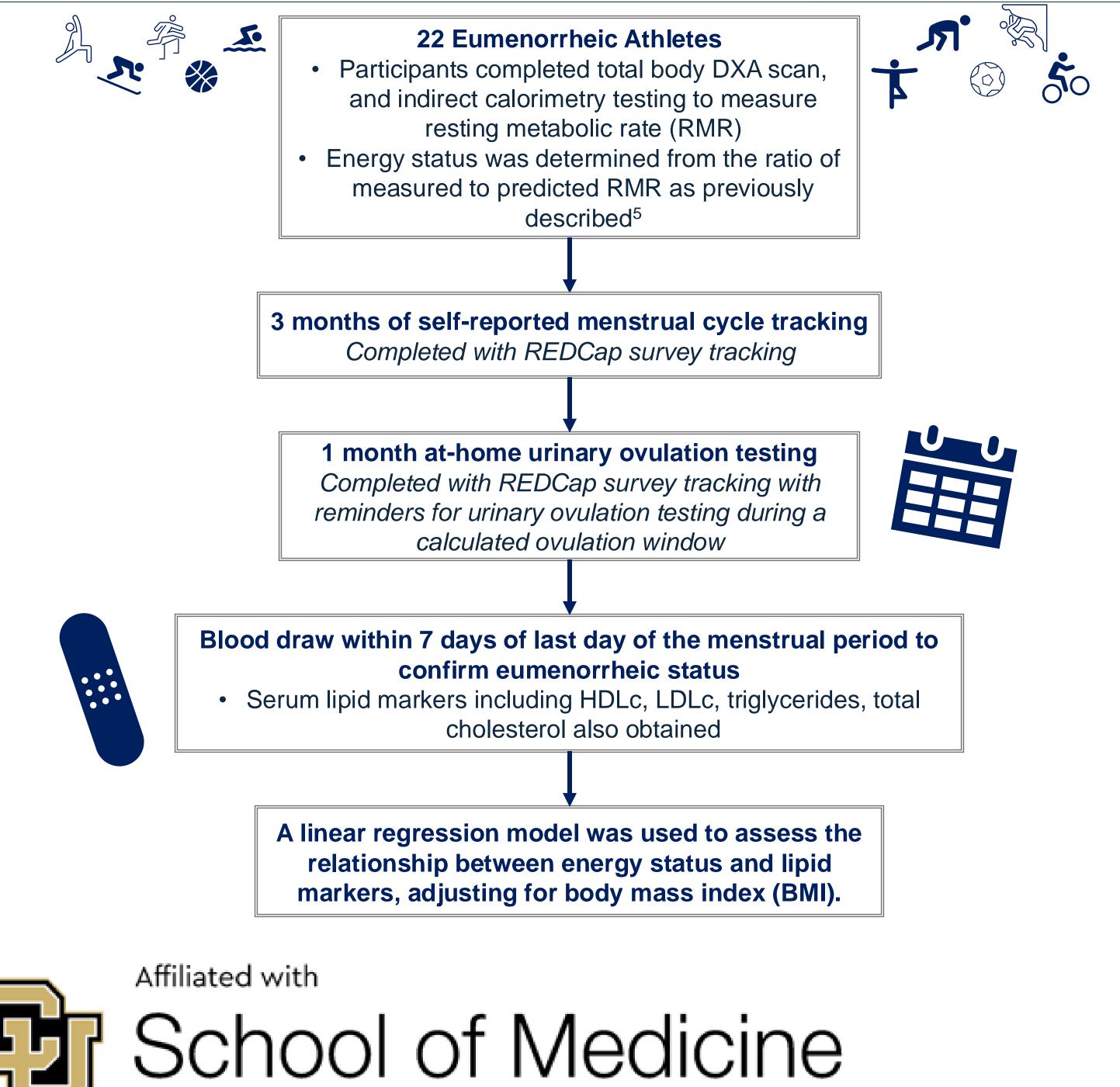
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Introduction

- 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}



Experimental Design and Methods



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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	

Acknowledgements

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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).

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- linear regression outcomes.

Conclusions

- athletes.



- 2020;142(25):e506-e532.
- 2021;51(5):843-861. doi:10.1007/s40279-021-01435-8
- doi:10.1123/ijsnem.2021-0257
- 10.1007/s00198-016-3887-x.



Results

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

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

> 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

Rickenlund A, Eriksson MJ, Schenck-Gustafsson K, Hirschberg AL. Amenorrhea in female athletes is associated with endothelial dysfunction and unfavorable lipid profile. J Clin Endocrinol Metab. Mar 2005;90(3):1354-9. doi:10.1210/jc.2004-

El Khoudary SR, Aggarwal B, Beckie TM, et al. Menopause Transition and Cardiovascular Disease Risk: Implications for Timing of Early Prevention: A Scientific Statement From the American Heart Association. Circulation. Dec 22

Elliott-Sale KJ, Minahan CL, de Jonge X, et al. Methodological Considerations for Studies in Sport and Exercise Science with Women as Participants: A Working Guide for Standards of Practice for Research on Women. Sports Med. May

Smith ES, McKay AKA, Ackerman KE, et al. Methodology Review: A Protocol to Audit the Representation of Female Athletes in Sports Science and Sports Medicine Research. Int J Sport Nutr Exerc Metab. Mar 1 2022;32(2):114-127.

Southmayd EA, Mallinson RJ, Williams NI, Mallinson DJ, De Souza MJ. Unique effects of energy versus estrogen deficiency on multiple components of bone strength in exercising women. Osteoporos Int. 2017 Apr;28(4):1365-1376. doi:

