EXAMINING PATHWAYS TO LOW ENERGY AVAILABILITY IN HIGH SCHOOL ATHLETES

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Introduction

- Female participation in high school athletics has significantly increased since the passing of the Title IX act in 1972, allowing female participation in sports.
- An increase in participation, increases the pressure these athletes face to perform their best.
- Added pressure can result in pressure to or an obsession with achieving the perfect sports physique, especially in sports that emphasize leanness, putting them at risk for serious health problems, such as the Female Athlete Triad.
- The Female Athlete Triad ("Triad") encompasses low energy availability (EA) with or without disordered eating (DE), menstrual irregularity (MI), and low bone mineral density (BMD).
- The primary driver of the Triad is low EA which can lead to endocrine changes causing both MI and low BMD.
- Low EA can either be through intentional or inadvertent pathways.
- Intentional pathways include DE or a clinical eating disorder (ED) which leads to purposeful calorie restriction or over exercise.
- Inadvertent pathways to low EA include lack of nutrition and sport-related fueling knowledge, food insecurity, lack of cooking skills, or lack of time.
- It is becoming more apparent in recent research that inadvertent pathways to low EA may be more a major cause.

Purpose

The purpose of this study was to conduct a secondary analysis of an existing merged data set among a sample of female high school athletes in order to identify those with low EA, presented by physiological indicators of low EA including functional hypothalamic amenorrhea and/or underweight status, and identify whether the pathways to low EA is intentional or inadvertent. Factors related to sport-type (leanness vs. non-leanness), DE behaviors and clinical indicators of low EA in the sample were also evaluated.
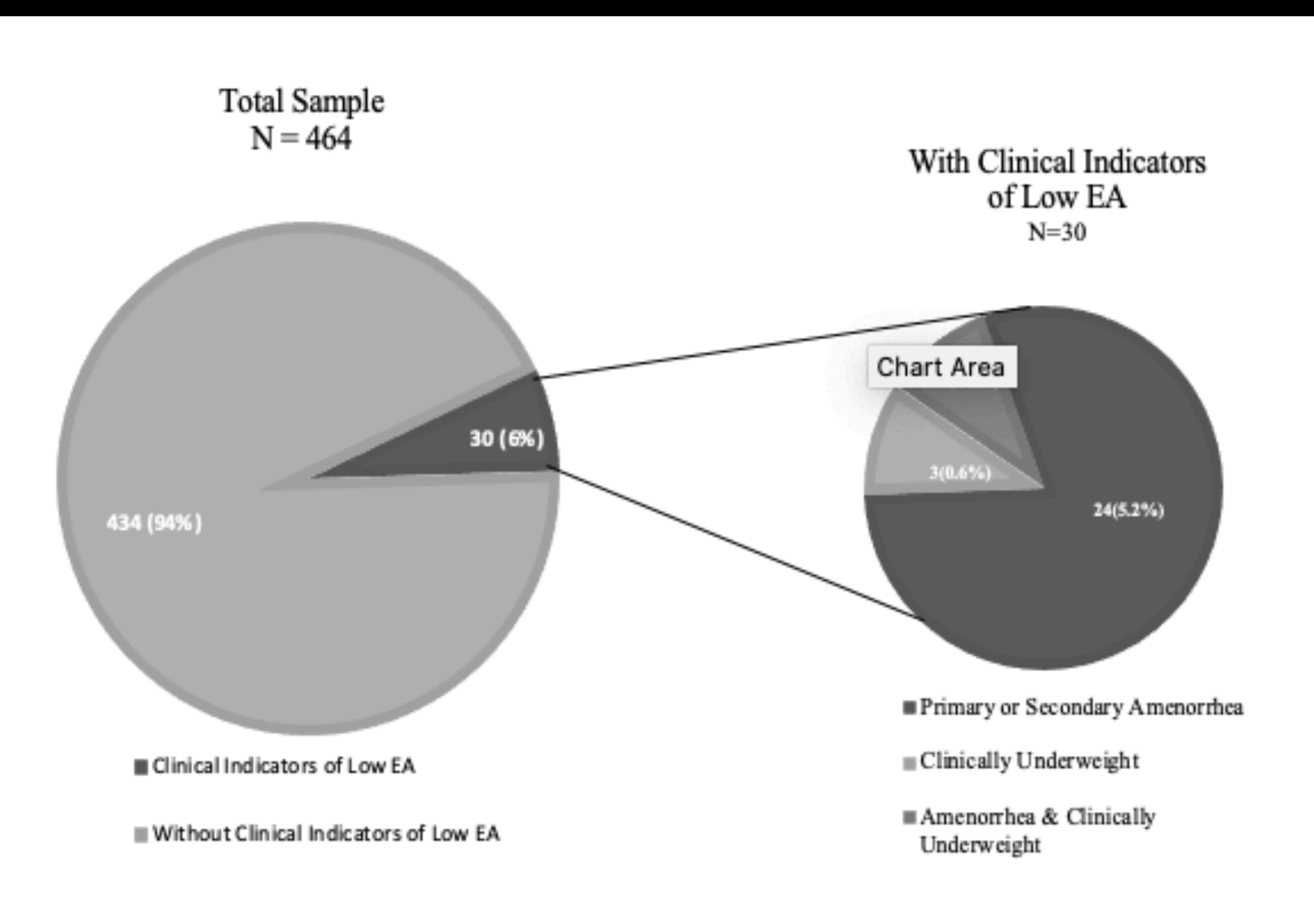
Methods

1. Data was collected from two different cohorts between 2006 and 2008.
2. Female athletes ages 13-15 from 12 different Southern California High Schools were asked to participate if they experienced menarche previous to data collection, or if not they must have been ages 15-18, as well as not taking any known medication to affect bone mass.
3. Participants (N=464) completed a series of surveys including demographic information, sports participation, a menstrual status and history questionnaire, the EDE-Q, and a small subset of participants (N=209) received a DXA scan for bone mass and body composition.
4. Low EA, underweight status, MI, DE, BMD and sport type were analyzed.
- Low EA: MI (primary or secondary amenorrhea) and/or clinical underweight status (BMI <5% using CDC BMI for Age guidelines for 2-20 y.o.).
- DE: >3 on any of the EDE-Q subscales or global scale, and/or signs of a pathologic DE behavior (binging with loss of control of intake, induced vomiting, use of laxatives or diuretics) for more than 2 days in the past 28 days.
- BMD: Z-score (lumbar spine or total body) <-1 standard deviations (SD).
- Leanness sports were identified as cross country, gymnastics, swimming/diving, and track.
- Non-leanness sports were tennis, volleyball, field hockey, basketball, softball, lacrosse and track field events.
5. Data was analyzed using IBM SPSS version 27 at an alpha level of 0.05 for independent T-tests, chi-square tests, ANCOVA and frequency computations.

Demographic and Variable Correlations

	Leanness Sport Athletes (n=230)	Non-Leanness Sport Athletes (n=244)	P-Value	Total (n=464)
Ethnicity			<0.001*	
Asian	6(2.6)	0(0)		6(1.3)
African American	29(12.6)	30(12.9)		60(12.9)
Caucasian	153(66.5)	152(65.2)		305(65.7)
Hispanic	35(15.2)	51(21.9)		86(18.5)
Other	7(3.0)	0(0)		7(1.5)
Age (years)[a]	15.7 ± 1.2	15.7 ± 1.1	0.83	15.7 ± 1.2
Anthropometric[a]				
Height (cm)	164.6 ± 6.6	166.4 ± 7.9	0.01*	165.5 ± 7.4
Weight (kg)	57.2 ± 7.8	62.3 ± 10.4	<0.001*	59.8 ± 9.5
Body Mass Index[a]	21.1 ± 2.7	22.5 ± 3.4	<0.001*	21.8 ± 3.1
BMI Z-score[a]	0.14 ± 0.76	0.46 ± 0.76	<0.001*	0.30 ± 0.77
BMI Percentile[a]	55.3 ± 23.6	64.2 ± 23.4	<0.001*	59.8 ± 23.9
BMI-for-age <5%[b]	6(2.6)	0(0)	0.01*	6(1.3)
Menstrual[a]				
Age of Menarche[1]	12.6 ± 1.2	12.4 ± 1.2	0.09	12.5 ± 1.2
Number of Menses	10.2 ± 3.1	10.9 ± 2.3	.052	10.5 ± 2.9
Amenorrhea[b]	22(9.6)	5(2.1)	<0.001*	27(5.8)
Disordered Eating (4)[b]	31(13.5)	37(15.9)	0.47	68(14.7)
Disordered Eating (3)[b]	65(28.3)	84(36.1)	0.07	149(32.2)
Low EA[b]	25(10.9)	5(2.1)	<0.001*	30(6.5)
Bone[a]				
Lumbar Spine Z-Score[2]	-.39 ± 1.30	.42 ± 1.16	<0.001*	-0.21 ± 1.30
Total Body Z-Score[2]	.30 ± .97	.88 ± 1.02	<0.001*	0.43 ± 1.01

Low EA vs. Without Low EA

	Low EA (N=30)	Without Low EA (N=434)	P-Value
Age (years)[a]	15.9 ± 1.1	15.7 ± 1.2	0.39
Anthropometric[a]			
Height (cm)	164.6 ± 7.3	165.6 ± 7.4	0.48
Weight (kg)	53.5 ± 8.1	60.2 ± 9.5	<0.001*
Body Mass Index[a]	19.7 ± 2.7	22.0 ± 3.1	<0.001*
BMI Z-score[a]	-0.41 ± 1.03	0.35 ± 0.73	<0.001*
BMI Percentile[a]	40.6 ± 27.2	61.2 ± 23.1	<0.001*
Menstrual[a]			
Age of Menarche[1]	13.2 ± 1.3	12.5 ± 1.2	<0.001*
Number of Menses[2]	5.8 ± 3.4	11.1 ± 2.3	<0.001*
Disordered Eating (4)[b]	3(10.0)	66(15.2)	0.44
Disordered Eating (3)[b]	6(20.0)	144(33.2)	0.14
EDE-Q Subscale Scores[a]			
Weight Concern	1.04 ± 1.34	1.65 ± 1.44	0.03*
Shape Concern	1.36 ± 1.39	2.03 ± 1.50	0.03*
Eating Concern	0.46 ± 0.79	0.71 ± 0.88	0.13
Dietary Restraint	0.74 ± 1.04	1.12 ± 1.29	0.76
Global Score	0.90 ± 1.02	1.37 ± 1.15	0.75
Bone[a]			
Lumbar Spine Z-Score[2]	-1.30 ± 1.38	-.07 ± 1.21	<0.001*
Total Body Z-Score[2]	-.30 ± .98	.53 ± .97	<0.001*

Clinical Indicators of Low EA

Total Sample N = 464

With Clinical Indicators of Low EA N=30

- Clinical Indicators of Low EA
- Without Clinical Indicators of Low EA
- Primary or Secondary Amenorrhea
- Clinically Underweight
- Amenorrhea & Clinically Underweight

Pathways to Low EA

BMD

BMD Z-Scores p=.003

	Low EA & DE (N=3)	Low EA w/ No DE (N=22)	DE w/ No Low EA (N=23)	No Low EA or DE (N=161)
Lumbar Spine	-1.57	-0.93	-0.12	-0.10
Total Body	-0.63	0.04	0.36	0.51

p=.016

Discussion/Conclusion

- The majority of female high school athletes with clinical indicators of low EA exhibited inadvertent undereating (presented through absence of DE) as opposed to intentional dietary restriction in this particular sample.
- Athletes with low EA without DE were also found to have significantly different BMD Z-scores than athletes without low EA and without DE.
- This study indicates the need for more research on the pathways to low EA in high school female athletes, focusing on the intentional DE pathway as well as limiting the barriers to inadvertent under-eating, increasing energy intake and decreasing the prevalence of the Triad among adolescent female athletes.
- Limitations: self-reporting, bias, over- and/or underreporting; subset of the sample that received the DXA scan; convenience sampling; criteria for identifying low EA in the sample was tailored for this study and its sample directly.

Acknowledgements

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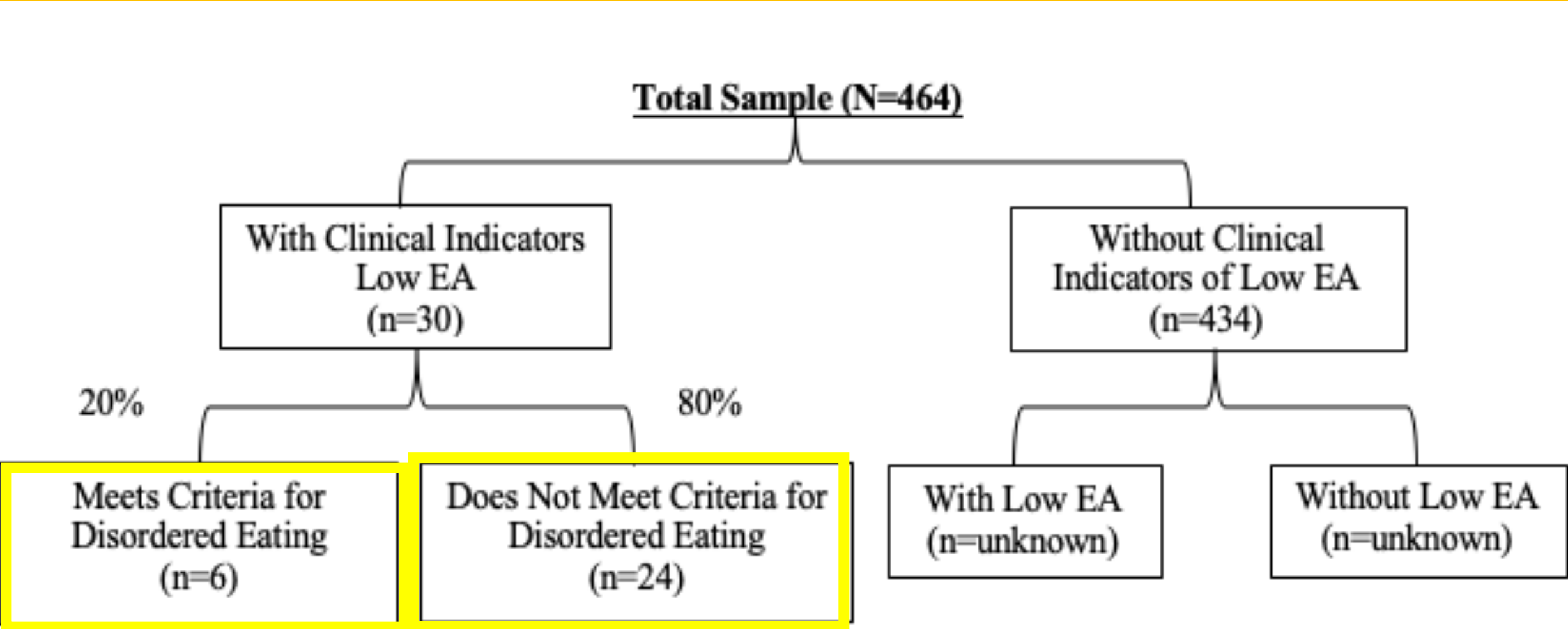Thralls, K. J., Nichols, J. F., Barrack, M. T., Kern, M., & Rauh, M. J. (2016). Body mass-related predictors of the female athlete triad among adolescent athletes. International Journal of Sport Nutrition and Exercise Metabolism, 26(1), 17-25. doi: 10.1123/ijsnem.2015-0072
Thomas, D. T., Erdman, K. A., & Burke, L. M. (2016). Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: nutrition and athletic performance. Journal of the Academy of Nutrition and Dietetics, 116(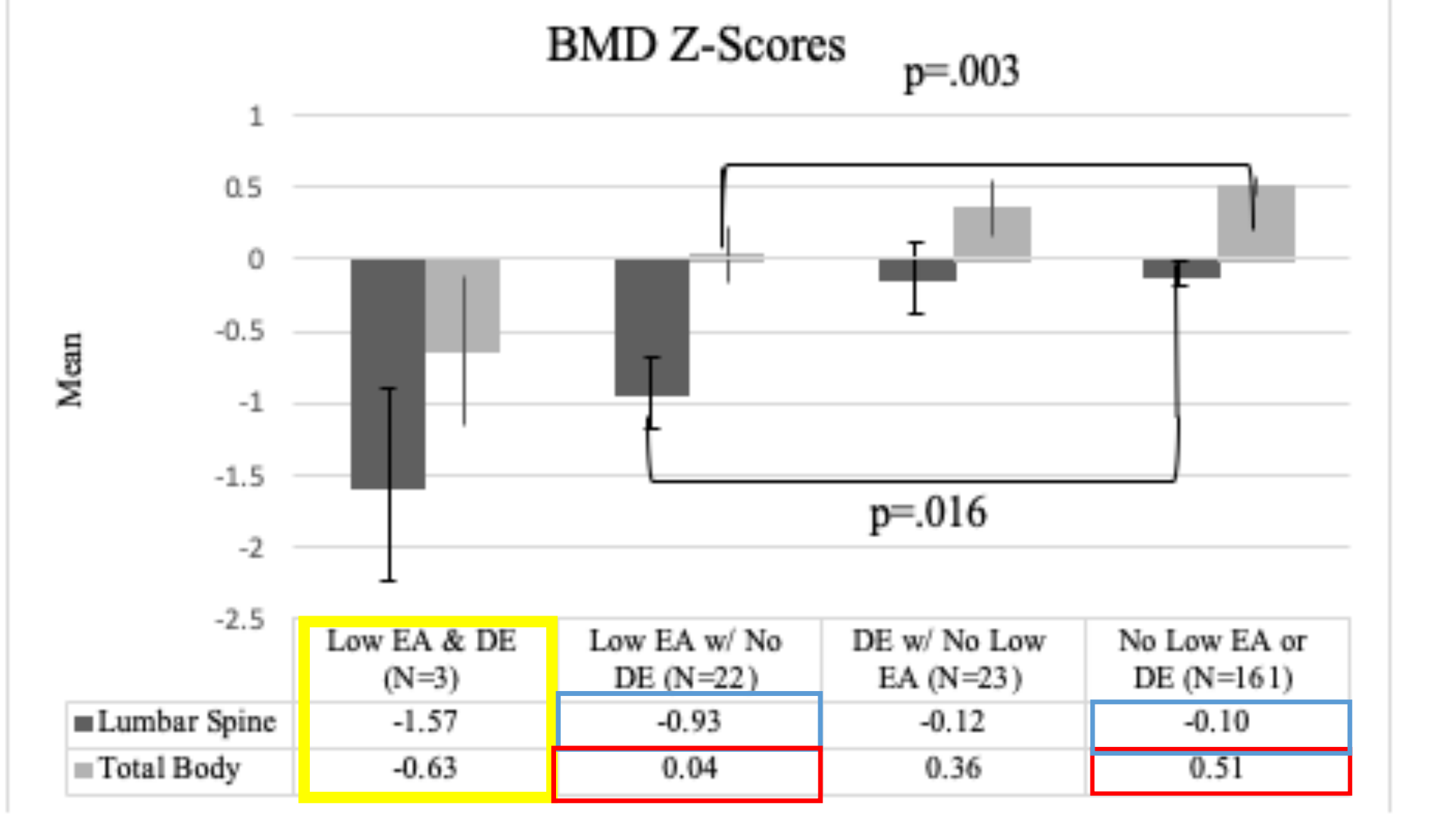3), 501–528. doi: 10.1016/j.jand.2015.12.006