International Journal of EXERCISE SCIENCE

Original Research

More than Body Composition: A Darwinian Theory of Somatotype Applied to a DII Track and Field Outdoor Season

WHITLEY J. STONE‡1, MATTHEW J. GARVER‡2, AMANDA WAKEMAN‡2, DANILO V. TOLUSSO‡1, HANNAH NELSON†3, JOSIE HAIR*2, and ERIC J. NEHLSEN†2

[1]School of Kinesiology, Recreation, and Sport, Western Kentucky University, Bowling Green, KY, USA; [2]School of Nutrition, Kinesiology, and Health, University of Central Missouri, Warrensburg, MO, USA; [3]Department of Health, Exercise Science, and Recreation Management, University of Mississippi, Oxford, MS, USA

*Denotes undergraduate student author, †Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 17(4): 1-12, 2024. This study presents somatotype data on a team sport with chronic and diverse sporting demands. The aims were to (1) characterize a somatotype profile for Division II (DII) track and field athletes (n=54) by sex, class, and events; (2) determine if somatotype changed across the season; (3) determine if changes differed based on class or sex; and, (4) assess potential differences in somatotype between sexes. Methods: Anthropometrics (height, weight, body composition, somatotype) were evaluated after a competitive indoor season and immediately before the outdoor conference championships (41 days). Body measurements were assessed using a bioelectrical impedance analysis device, skinfold assessment, boney breadths, and limb girths. Descriptive statistics are provided as well as results from two-way ANOVAs which evaluate differences in actual and change scores across sex and class. Results: Our DII track and field athletes were primarily endomorphic (scores displayed as ENDO, MESO, ECTO, respectively). Males were found to be primarily ENDO-MESO somatotypes (4.7, 4.1, 3.0), while females were dominantly ENDO (7.7, 2.9, 2.9). Upperclass were more ENDO-MESO balanced compared with lowerclass (5.8, 3.8, 2.8 vs 6.0, 3.5, 3.0). When investigated based on sex, class level, and event, the groups were similar. There was no meaningful change to ECTO scores across the season for males or females. Female athletes improved ENDO scores (-0.89%) and males and females improved MESO scores (14.29% and 5.29%, respectively), indicating adaptations can be accomplished despite the chronic demands of a competitive season. Conclusion: Our research offers practitioners information about the potential changes they may expect across a competitive track and field season.

KEY WORDS: Body shape, sport recruiting, endomorph, mesomorph, ectomorph

INTRODUCTION

The history of athletic competition is marked by the pronounced effort of athletes to perfect their skill and body. As sport has become progressively more lucrative and competitive, athletes, coaches, and trainers have sought mechanisms to fine-tune performance and bring personal achievement. Some athletes may seek or be steered toward engaging in events they are morphologically attuned to even more so than events they enjoy, because of their anthropometric or physical preparedness for success. This approach to sport success is Darwinian in nature (17), and embodies the idea that sport benefits athletes who were born to compete at an elite level, particularly in specific events based on the body's genetically-driven figure. While this is far from a 'rule' that one must be genetically designed to perform at an elite level, it certainly does not hinder those who were born with body attributes that benefit performance.

The composition of body shapes varies greatly across team sports (e.g., softball, American football). Nonetheless, there is a natural and growing trend of homogeneity of physical build for many sports teams (e.g., think broadly of taller volleyball or basketball athletes vs. differently shaped American football athletes); the same is true of specialized competitions such as track (e.g., sprinter vs. endurance runner) and field events (e.g., thrower vs. jumper). As one example, a research team found the strongest predictor of performance in the Ironman Switzerland competition was related to body shape, or somatotype (12). Researchers of sport have attempted to characterize the ideal body shape (i.e., a template) as it relates to success in each sport or position in order to improve recruitment and the physical development of participants. Body composition assessments, and height-to-weight and strength-to-mass ratios have been used in these attempts to find the ideal predictor for performance (1,7,9,18).

Originally described as a three-dimensional model by Carter and Heath (5) somatotyping has been conceptualized to be a taxonomy (7) that holistically considers boney breadths, height, mass, muscle girths, and body fat. Somatotyping may be a modality for assessing an athlete as a whole, based on the holistic interpretation of both innate and modifiable physical features at a single time. Using equations provided in the Heath-Carter manual (4), an athlete is described as endomorph, mesomorph, ectomorph, or a combination of the three. Endomorph (ENDO) is "more fat mass," mesomorph (MESO) is "more lean body mass," and ectomorph (ECTO) is "taller and leaner."

Using somatotyping, researchers have categorized (in generic ways) the body shape's impact on sport performance. As examples, increasing mesomorphic shape improves sprint performance, endomorphic shape negatively affects vertical jump, and those with mesomorph or ectomorph predisposition have the greatest aerobic capacities (7). Data like these are valuable for streamlining recruitment procedures for sport coaches who are particularly interested in identifying athletes for events with specific physical requirements. It has been suggested that somatotyping athletes places an emphasis on quality of body tissue relative to inherent shape, which could be more valuable than a focus on body fat analysis alone (11).

It is clear that genetics play a role in a person's somatotype distribution (19), but there is also ample evidence demonstrating that certain aspects of body shape can be modified with appropriate physical training (22). Athletes, tactical coaches, or strength and conditioning specialists may advantageously dedicate their efforts (i.e., teachings or workouts) to help modify an individuals' body composition during the off season; for example, professionals may steer training toward maintaining physical gains while reducing exercise volume to reach peak performance for important competitions.

There are many difficulties in both maintaining and peaking performance across long seasons of competition. For the college-athlete specifically, there is a need to balance travel, academics, nutritional needs, and the demands of sport training and competition. One investigation found that collegiate American football players saw small, but statistically significant improvements in MESO scores (5.3 to 5.4) and reductions in ENDO ratings (2.5 to 2.3) across their 13 week season (2). Elite female college swimmers experienced reductions in body weight, absolute and relative body fat, and calf circumference while increasing overall lean body mass (i.e., a shift away from ENDO toward MESO) from the start to the end of their five month competitive season (15). Unlike many sports, competitive college track and field athletes have two major competitive seasons, spanning most of the year. Recovery from indoor season occurs in temporal proximity to preparation for outdoor events, the two often overlapping or separated by a short interim (1-2 weeks). This schedule is physically demanding and requires that all athletes, but particularly aspiring champions, peak in performance at multiple times throughout the year.

Tactical and strength and conditioning coaches may benefit from knowing average somatotype of varying track and field events, whether somatotype is influenced by the competitive season, and if class status or sex appears to influence these outcomes. A recent article has called to attention the 'new frontiers' of body composition in sport (13), including ideas related to regional body composition measurements (i.e., somatotype ideology) opposed to simple body fat assessments.

Based on the aforementioned considerations, this study purposed to present somatotype data on a team sport with enduring and diverse sporting demands. The aims were to (1) characterize a somatotype profile for Division II (DII) track and field athletes (n=54) by sex, class, and events; (2) determine if somatotype changed across the season; (3) determine if changes differed based on class or sex; and (4) assess if there was a potential differences in somatotype between sexes. To accomplish these aims, we evaluated anthropometrics of a DII track and field team after a competitive indoor season (more specifically, just before the start of the outdoor competitive season) and immediately before the conference championships (i.e., the end of conference competition)--a span of 41 days.

METHODS

Participants

A convenience sample of athletes were recruited from the university's track and field team. Eligibility included being 18 years of age or older, being free from musculoskeletal injury that interfered with training or competition and being active in preparation for the university's track and field team. Prior to data collection, athletes reviewed the IRB-approved written informed consent and were given the opportunity to ask questions before agreeing to participate, as denoted by signing and dating. All research procedures followed the ethical standards established by the leaders in the field of Exercise Science (16) and the Declaration of Helsinki. Athletes were instructed to arrive to the Human Performance Laboratory between 7:00-9:00am in a fasted, rested, and euhydrated state on two occasions. The first session ("pre") marked the start of the outdoor season (February) and the second session ("post") was just prior to the conference championships (April).

Protocol

Following the Heath-Carter manual (4), technicians collected the anthropometric data (height, mass, skinfolds, girths, and breadths) required to calculate somatotype scores. Stature (via Seca stadiometer, Seca®, Chino, CA) and mass (via electronic Befour PS 7700 scale; Befour®, Saukville, WI) were recorded and used as input values for body mass index calculations as well as body fat percent analysis (InBody 570, InBody®, Arlington, MA). Skinfolds were collected on the triceps, subscapular, supraspinale, and medial calf locations following anatomical landmarks described by the Heath and Carter Manual (4). Skinfolds were taken by grasping the subcutaneous layer of fat with the thumb and pointer finger and Harpendin calipers were placed one centimeter below the fingers. With the arm in a relaxed anatomical position, the trained technician completed the tricep skinfold halfway between the acromion and olecranon processes of the right arm. The subscapular fold was taken on a diagonal line below the base of the right scapula. A downward, medial fold was created on the right anterior axillary border superior to the superior iliac spine for the supraspinale site. For the right calf, a vertical fold was created on the medial side of the leg at the maximal girth of the calf. Bony breadths were measured at the humerus and femur with girths assessed on a tensed bicep and relaxed calf. Heath-Carter somatotype calculations were used to gather composite ectomorphy (ECTO), mesomorphy (MESO), and endomorphy (ENDO) scores (syntax for SPSS is coded below), and HWR is height-to-weight ratio$^{1/3}$.

```
ECTO =
        IF HWR = 0 (0-38.25), THEN ECTO = 0.1
        IF HWR = 1 (38.26-40.74), THEN ECTO = (0.463 * HWR) - 17.63
        IF HWR = 2 (40.75 - highest), THEN ECTO = (0.732 * HWR) - 28.58

HWR = Height_cms / (Weight_kgs * 0.3333)

MESO= (0.858 * HumerusBreadthAvg) + (0.601 * FemurBreadthAvg) + (0.188 * CorrectedArm)
+ (0.161 * CorrectedCalf) - (Height_cms * 0.131) + 4.5.

ENDO = -0.7182+(0.1451*ENDO Equation)-(0.00068*ENDO Equation * 2) + (0.0000014 * ENDO
Equation * 3)
ENDO Equation=(TricepAvg + SubscapAvg + SupraAvg) * (170.8/ Weight)
```

It is important to note that assessments were completed by the same, trained technicians at the pre- and post-tests, and boney breadths were assessed by a licensed physical therapist. This was intended to support reliability and internal validity. Participants were split into classes according to their age at baseline, with the underclass being 18-19 years old and upperclass being 20 years old or older. In total, 54 DII track and field athletes volunteered to be tested. Table 1 provides descriptive statistics gathered at baseline.

Table 1. Absolute Demographic Data for Division II Track and Field Team at Baseline (N = 54).

	Age	Height	Weight	Body Fat	ENDO	MESO	ECTO
Males (n=33)	20.0 ± 1.2	181.8 ± 5.8	76.1 ± 6.4	8.9 ± 3.2	4.8 ± 0.8	4.2 ± 0.8	2.7 ± 1.0
Females (n=21)	19.9 ± 1.2	170.7 ± 6.1	63.6 ± 6.1	18.6 ± 4.1	7.8 ± 1.1	2.8 ± 1.3	2.8 ± 1.1
Team Performance							
	Immediately Prior to Study			During Study			
	All-Conference	National Qualifiers	All-Americans	All-Conference	National Qualifiers	All-Americans	National Champion
Number	68	22	8	60	8	4	1

Note: Data are presented as mean + SD; age in years; height in centimeters; weight in kilograms; body fat in percent; ENDO = endomorph; MESO = mesomorph; ECTO = ectomorph; all somatotype scores were calculated following the Heath-Carter manual.

Statistical analysis

Change scores were calculated for somatotype by subtracting pre-season somatotype scores (ENDO, MESO, ECTO) from post-season scores. Two-way ANOVAs evaluated differences in change scores (ΔENDO, ΔMESO, ΔECTO) across sex assigned at birth and class (underclass and upperclass). Levene's test and visual inspection of QQ plots were checked to assess the assumptions of homogeneity of variance and normality of residuals. Assumptions of homogeneity of variance and normality were verified for all analyses. All data were analyzed in SPSS (Version 27.0, IBM Corp., NY, USA). Data are presented as means and standard deviations unless otherwise noted. Statistical significance was set at $p < .05$.

RESULTS

Data for seven participants were excluded from the evaluation of change across the season due to an injury sustained during the season (i.e., they did not complete both pre- and post-testing). Table 2 provides a somatotype profile for track and field by sex, class, and selected events in order to satisfy the primary aim of this investigation.

Data in Table 2 excludes the seven participants who did not complete both pre- and post-testing; data for three participants' primary event were not coded–they deemed multiple events to be primary–they are not included. Figure 1 offers a visual depiction of somatotype profile for five main event groupings, based on similar metabolic demands. Data are collapsed across sexes and class status.

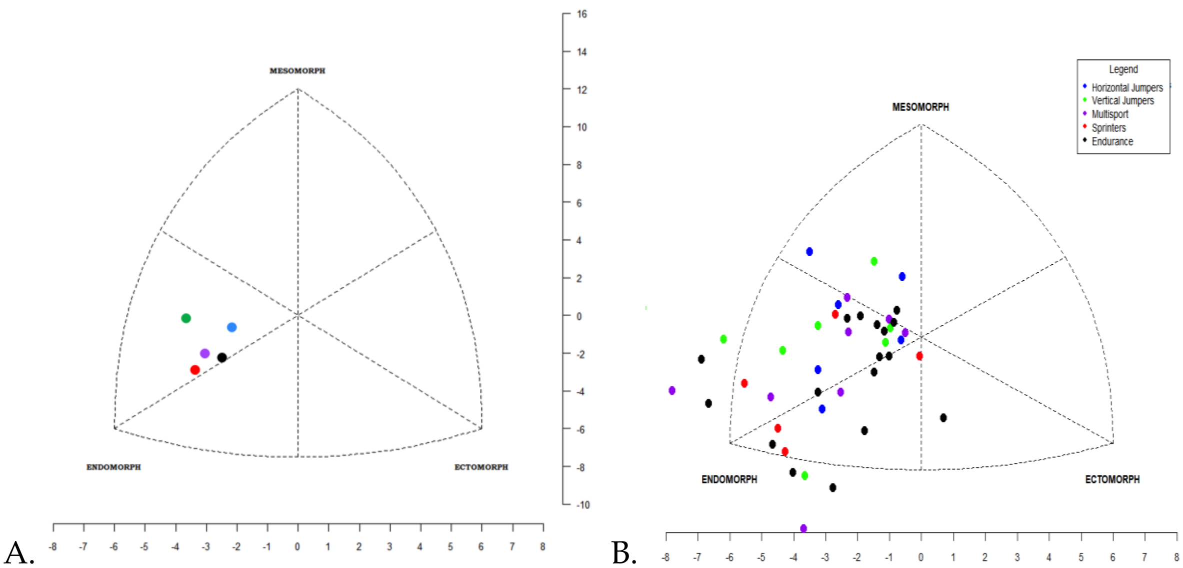

Figure 1. Baseline somatotype based on athletes' primary event. Data points calculated using the following equations: X axis = Ecto – Endo. Y axis = 2(meso) – (endo + ecto) (6). A: Averages for each event; B: Individual data points based on event. Red = sprinters (100m, 100m or 110m Hurdles, 200m); Black = endurance sprinters (400m & 800m); Purple = multi sport (decathlon & heptathlon); Green = vertical jumpers (pole vault, high jump); Blue = horizontal jumpers (long jump, triple jump).

The sample size was not large enough to allow for inferential statistics to evaluate if somatotype change across the season differed between males and females within similar events. A two-way ANOVA was implemented to evaluate if somatotype changed across a season while considering sex and class, not considering events. The evaluation revealed no main effects for sex ($F_{1,43}$ = 0.21, p = 0.646) or class ($F_{1,43}$ = 0.13, p = 0.721) on ΔECTO from pre- to post-season. However, a significant interaction was observed where female, underclass-members demonstrated an increase in ΔENDO while female, upper class-members saw a decrease in ΔENDO ($F_{1,43}$=6.58, p = .014, n_p^2 = 0.133). Table 3 presents change scores considering sex and class.

There was a significant main effect for sex on ΔENDO where females saw a greater decrease in their ENDO scores than males from pre- to post-season ($F_{1,43}$=4.47, p = .04, n_p^2 = 0.094; Figure 2 depicts change scores between sexes without consideration of class). No significant main effect for class ($F_{1,43}$ = 1.73, p = 0.195) or interaction effect of class and sex ($F_{1,43}$ = 1.65, p=0.206) were observed. There were no observed main effects of sex ($F_{1,42}$ = 0.55, p = 0.461) or class ($F_{1,42}$ = 0.601, p = 0.443) for ΔMESO from pre- to post-season. Additionally, there was no interaction effect ($F_{1,42}$ = 1.086, p = 0.303; see Table 3).

Table 2. Baseline Somatotype Profile for Division II Track and Field Athletes Participating in Events (n=47).

	Height (cm)	Weight (kg)	Body Fat (%)	FFM (kg)	ENDO	MESO	ECTO
Sex							
Males (n = 28)	182.8 ± 5.1	76.4 ± 6.6	8.2 ± 2.3	70.5 ± 6.0	4.7 ± 0.7	4.1 ± 0.8	3.0 ± 0.7
Females (n = 19)	170.4 ± 6.3	62.9 ± 6.1	18.3 ± 4.3	51.6 ± 4.6	7.7 ± 1.1	2.9 ± 1.3	2.9 ± 1.1
Class							
Underclass (n = 16)	176.3 ± 8.6	70.0 ± 8.9	12.7 ± 6.1	61.7 ± 10.6	5.8 ± 1.5	3.8 ± 0.8	2.8 ± 0.8
Upperclass (n = 31)	178.5 ± 8.2	71.4 ± 9.4	12.2 ± 6.0	63.5 ± 11.1	6.0 ± 1.9	3.5 ± 1.3	3.0 ± 0.9
Event (n = 44)							
100m (n = 4)	168.0 ± 7.6	61.3 ± 7.9	14.0 ± 6.2	53.3 ± 10.0	6.9 ± 1.2	3.3 ± 0.9	2.7 ± 0.8
200m (n = 1)	181.3 ± 0.0	68.3 ± 0.0	7.1± 0.0	64.0	4.0 ± 0.0	3.4 ± 0.0	3.9 ± 0.0
400m (n = 11)	176.2 ± 9.6	67.1 ± 9.1	11.4 ± 5.7	60.2 ± 11.5	5.7 ± 1.7	3.2 ± 1.0	3.2 ± 0.7
800m (n = 4)	177.8 ± 11.4	70.9 ± 10.1	10.7 ± 8.2	64.2 ± 13.6	5.5 ± 2.2	3.8 ± 0.4	2.9± 0.8
100/110m Hurdle (n = 2)	178.6 ± 7.7	68.5 ± 12.4	14.6 ± 7.2	59.3 ± 15.5	5.4 ± 1.7	2.4± 2.0	3.5 ± 0.6
High Jump (n = 3)	178.4 ± 2.4	68.7 ±7.4	11.9 ± 6.1	61.2 ± 10.3	6.0 ± 1.6	3.4 ± 1.4	3.4 ± 0.7
Long Jump (n = 4)	182.0 ± 3.2	73.7 ±5.1	10.4 ± 1.8	66.5 ± 5.3	5.6 ± 1.0	3.9 ± 0.7	3.2 ± 0.6
Triple Jump (n = 2)	182.3 ± 0.0	81.4 ± 7.8	7.2 ± 0.0	76.1 ± 7.3	4.3 ± 1.1	5.3 ± 0.5	2.2 ± 1.0
Pole Vault (n = 5)	173.5 ± 10.8	72.2 ± 8.9	14.8 ± 7.4	62.1 ± 11.6	6.4 ± 2.4	4.8 ± 0.8	2.1 ± 1.0
Heptathlon (n = 3)	175.6 ± 3.7	68.4 ± 8.1	18.1 ± 3.2	56.5 ± 4.6	8.3 ± 1.0	2.8 ± 1.4	2.9 ± 1.6
Decathlon (n = 5)	184.34 ± 3.3	77.6 ± 4.7	8.5 ± 2.4	71.5 ± 5.8	4.8 ± 0.8	4.0 ± 0.6	3.1 ± 0.5

Note: Data are presented as mean + SD; cm=centimeters; kg=kilograms; FFM=fat free mass; ENDO=endomorph; MESO=mesomorph; ECTO=ectomorph; m=meters.

Table 3. Somatotype Profiles (as Percent Change) for Athletes Who Completed Both Pre- and Post-Testing.

	Weight (kg)	ENDO	MESO	ECTO
Sex				
Males (n=28)	0.17+1.94%	2.88+5.99%	14.29+66.45%	-1.21+7.35%
Absolute	76.36 to 76.52			
Females (n = 19)	0.31+1.62%	-0.89+5.72%	5.29+8.04%	-0.86+7.00%
Absolute	62.93 to 63.13			
Class				
Under-class (n = 16)	0.55+1.50%	-0.16+5.90%	3.43+3.77%	-2.60+7.36
Absolute	69.95 to 70.43			
Upperclass (n = 31)	0.06+1.94%	2.14+6.17%	14.38+63.20%	-0.28+7.05%
Absolute	71.44 to 71.46			

Note: Data are presented as mean + SD; Weight was measured in kilograms, body fat in 'percent fat' and somatotype scores were calculated as described before. Percent change calculated by subtracting post scores from pre- scores and dividing the difference by post-scores. Final values were multiplied by '100' to express them as a percent.

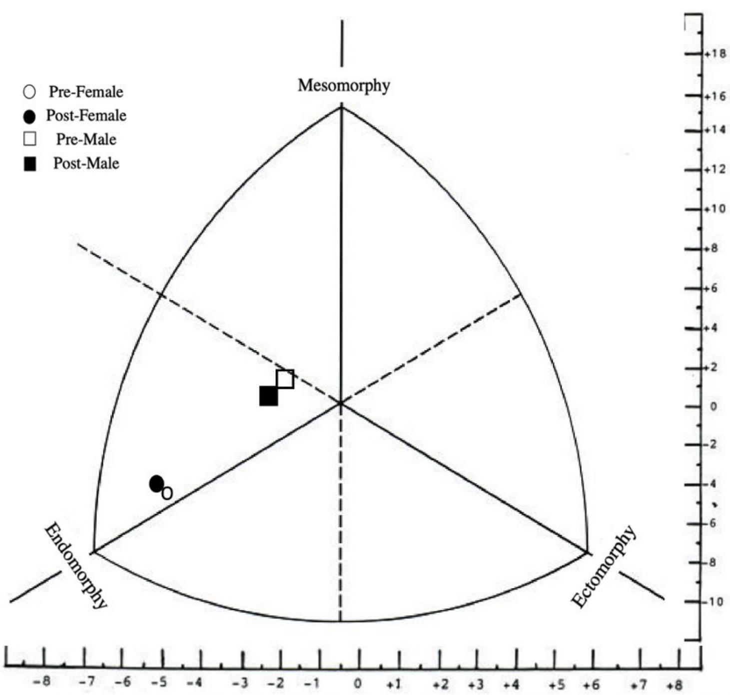

Figure 2. Somatotype for males and females (both pre- and post-testing) across the competitive season. Statistically, there was a greater decrease in female ENDO scores pre- to post-season compared to males. Males = squares; Females = O; pre data = black and filled; post data = open; data points calculated using the following equations: X axis = Ecto – Endo. Y axis = 2(meso) – (endo + ecto) (6).

DISCUSSION

Somatotyping assesses an athlete as a whole, accounting for innate and modifiable physical features at a single time. The present study measured the somatotype distribution of competitive DII track and field athletes and investigated the impact of class level and sex on these distributions. Because of the enduring schedule and very brief period between indoor and outdoor seasons, changes to somatotype distribution were also investigated from pre- to post-outdoor season to assess how the athletes may experience body composition changes. Identification of athletes' somatotype may be useful for determining a young athlete's predisposition for a specific sport or potentially serve as an associated thought in recruiting activities. If coaches better understood how an athlete's somatotype distribution can be modified, it may allow them to foresee how an athlete could slim into or grow into a distribution that positively impacts aspects of performance.

The findings of the current study indicate that our DII track and field athletes are primarily endomorphic. When separated by sex, males were found to be primarily ENDO-MESO somatotypes (4.7, 4.1, 3.0) while females were dominantly ENDO (7.7, 2.9, 2.9). Similarly, when examined by age, upperclass and lowerclass were both found to be endomorphic (5.8, 3.8, 2.8 vs 6.0, 3.5, 3.0). Interestingly, body shapes could be distinguished between events. Most athletes were found to be primarily ENDO except for the triple jump athletes (n=2) that were mesomorphic (4.3, 5.3, 2.2), whereas the 200m (n=1) and heptathlon (n=5) athletes that were central somatotypes (4.0, 3.4, 3.9 and 4.8, 4.0, 3.1). Admittedly, it is difficult to draw conclusions from these data because of the small sample sizes of each event (Table 2). This may be an area worth investigation in future research.

Body fat percentage typically decreases over the course of a track and field season due to the stresses of training and competition (3,14,20). Stanforth et al. (20) documented a decrease in body fat from 18.5% in the preseason to 16.2% in the postseason in Division I (DI) female track athletes. The present study identified a similar trend in body fat percentage; the team experienced a 5.27% decrease in body fat percentage from pre- to post-season (Table 3). This reduction in fat mass was primarily contained to female athletes (△10.33%; 18.31% to 17.07%) as males realized a modest increase of 8.16% to 8.2%. When categorized by class, the under class athletes had a 7.25% decrease in body fat percentage while the upperclass athletes saw a 4.25% decrease. Authors hypothesize that class status may relate to years training with the sport coaches and strength and conditioning staff and thus explain, at least partially, why a larger change was seen in the underclass vs. the upperclass. A highschool athlete's competitive track and field season is generally only three to four months long in most states. A competitive collegiate season is almost ten months long with steady training over summers and holiday breaks as well. The sheer sport training volume for an athlete almost quadruples as they start their collegiate careers. The upperclass has effectively modified somatotype over the course of several years training at the collegiate level (i.e. they do not have as much fat to lose). Other researchers may utilize existing data or future investigation to add merit to this hypothesis.

The loss of fat occurred alongside an overall 0.23% average increase in body weight over the season (Table 3). These anthropometric changes are partially explanatory to the shifts in somatotype seen over the season. The most pronounced change was a 10.65% increase in team MESO scores (Table 3). It is reasonable to postulate that the increased MESO score was due to increased muscle mass (consider the decrease in body fat percentage yet small increase in weight throughout the season). When we consider these small changes that occurred, we must recognize a limitation. Even though the same, trained technician performed all body composition assessments, there is still error associated with the data. There are no data available on the technician's intrarater reliability, nor do we have interrater reliability for this technician.

Noteworthy distinctions in weight and body composition are evident when comparing the DII athletes in the present study against DI track and field athletes in prior research (8,10). The female DII athletes in the present study were heavier (62.93 ± 6.1 kg) than DI female athletes (58.2 ± 4.4 kg) (10). DII females (18.31 ± 4.26%, measured with BIA) also had more body fat than DI female athletes (12.9 ± 4.01%, measured with BodPod) (10). Although male athletes were similar in weight between divisions (DII: 76.4 ± 6.6 vs DI: 76.1 ± 11.8 kg), there were slight differences in the body fat percentage (DII: 8.2 ± 2.3%; DI males: 9.8 ± 5.1%) (10). The literature is lacking data relative to other DII athletes for comparison at this time; future investigations should consider adding to the body of knowledge to allow for such comparisons.
Previous reports specify that a primarily MESO somatotype is the most advantageous for sprinting performance while both MESO and ECTO are beneficial for aerobic capacity (7). Alternatively, ENDO seems to negatively impact jumping performance and does not seem to positively benefit either aerobic or anaerobic performance (7). Our present data reveals differences in somatotype distribution when comparing DII athletes to elite track and field males (successful performers at national level), where our DII athletes were more endomorphic in shape. Stanković et al (2018) found elite performers to be primarily MESO (3.3, 5.5, 3.0) while the male DII athletes in the present study were primarily ENDO-MESO distributions (4.7, 4.1, 3.0) (21). Is possible that our DII athletes' somatotype-bias toward endomorph undermined their abilities to perform at a DI level? The dominant ENDO somatotype distribution of the athletes in the present study may not be fundamentally advantageous to their performance. However, it may be argued that the DII athletes were still capable of adaptation toward more advantageous somatotypes. There was a slight change in the athletes throughout the season towards increased MESO values, which would suggest that the outdoor training season contributed positively to creating adaptations beneficial for performance.

Our research offers sport coaches, strength and conditioning coaches, sports dieticians, athletes, and recruiters important thoughts to consider about their track and field athletes and the potential changes they may expect across a competitive season. We have offered notes about fruitful areas of investigation (e.g., studying the full academic year to include both indoor and outdoor seasons), and we urge others to consider these in future works.

REFERENCES

1. Bale P, Colley E, Mayhew JL, Piper FC, Ware JS. Anthropometric and somatotype variables related to strength in American football players. J Sports Med Phys Fit 34(4): 383–9, 1994.

2. Bolonchuk WW, Lukaski HC. Changes in somatotype and body composition of college football players over a season. J Sports Med Phys Fit 27(2): 247-52, 1987.

3. Carbuhn AF, Fernandez TE, Bragg AF, Green JS, Crouse SF. Sport and training influence bone and body composition in women collegiate athletes. J Strength Cond Res 24(7): 1710–7, 2010.

4. Carter JEL. The Heath-Carter anthropometric somatotype. Retrieved from: https://mdthinducollege.org/ebooks/statistics/Heath-CarterManual.pdf; 2002.

5. Carter JEL, Heath BH. Somatotyping: Development and applications. Cambridge: Cambridge University Press; 1990.

6. Carter JEL, Ross WD, Duquet W, Aubry SP. Advances in somatotype methodology and analysis. Am J Phys Anthropol 26(S1): 193–213, 1983.

7. Çinarli FS, Kafkas ME. The effect of somatotype characters on selected physical performance parameters. Phys Educ Stud 23(6): 279–87, 2019.

8. Dobrosielski DA, Leppert KM, Knuth ND, Wilder JN, Kovacs L, Lisman PJ. Body composition values of NCAA Division 1 female athletes derived from dual-energy X-ray absorptiometry. J Strength Cond Res 35(10): 2886–93, 2021.

9. Eiin WJ, Flyger N, Wilson N. Somatotypes of young Malaysian track and field athletes. Asian J Exerc Sports Sci 4(1): 1-7, 2007.

10. Fields JB, Merrigan JJ, White JB, Jones MT. Body composition variables by sport and sport-position in elite collegiate athletes. J Strength Cond Res 32(11): 3153–9, 2018.

11. Goe K. Women athletes allege body shaming within Oregon Ducks track and field program. Retrieved from: The Oregonian - oregonlive.com; 2021.

12. Kandel M, Baeyens JP, Clarys P. Somatotype, training, and performance in Ironman athletes. Eur J Sport Sci 14(4): 301–8, 2014.

13. Lukaski H, Raymond-Pope CJ. New frontiers of body composition in sport. Int J Sports Med 42(7): 588-601, 2021.

14. McNeal JR, Poole RC, Sands WA. Body composition trends in women collegiate track-and-field athletes across two consecutive competitive seasons. J Strength Cond Res 13(3): 214–8, 1999.

15. Meleski BW, Malina RM. Changes in body composition and physique of elite university-level female swimmers during a competitive season. J Sports Sci 3(1): 33–40, 1985.

16. Navalta JW, Stone WJ, Lyons TS. Ethical issues relating to scientific discovery in exercise science. 12(1): 1-8, 2019.

17. O'Connor H, Olds T, Maughan RJ. Physique and performance for track and field events. J Sports Sci 25(sup1): S49–60, 2007.

18. Ostojic SM, Mazic S, Dikic N. Profiling in basketball: Physical and physiological characteristics of elite players. J Strength Cond Res 20(4): 740-44, 2006

19. Silventoinen K, Maia J, Jelenkovic A, Pereira S, Gouveia É, Antunes A, et al. Genetics of somatotype and physical fitness in children and adolescents. Am J Hum Biol 33(3): e23470, 2021.

20. Stanforth PR, Crim BN, Stanforth D, Stults-Kolehmainen MA. Body composition changes among female NCAA Division 1 athletes across the competitive season and over a multiyear time frame. J Strength Cond Res 28(2): 300–7, 2014.

21. Stanković D, Pavlović R, Petkovic E, Raković A, Puletić M. The somatotypes and body composition of elite track and field athletes and swimmers. Int J Sports Sci 8(3): 67-77, 2018.

22. Tyhkorskyi O, Dzhym V, Galashko M, Dzhym E. Analysis of the morphological changes in beginning bodybuilders due to resistance training. J Phys Educ Sport 18(1): 382-86, 2018.