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# Body Composition of Female Collegiate Track and Field Athletes

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# Body Composition of Female Collegiate Track and Field Athletes

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## Abstract

The aim of this study is to see if there is a correlation between an athlete's body compostion and the demands of their different track and field events. Track and field is arugably the most diverse when it comes to body types in a single sport, with distance runners tending to be leaner and smaller and throwers more muscular and larger. However, most data collected is not female specfic. Thirty-one female track and field athletes were asked to take part in a series of physical measurements, which included recording their height, weight, percent body fat, and muscle mass. They were also asked to fill out a questionaire about their events, including person best and latest performance. This data was then used to compare muscle mass and percent fat across the event groups (distance, multis, sprints, jumps, throws) in which there was a linear relationship between the two with the exception of the multi event group. Percent muscle and percent fat were also looked at in terms of performance, in which there was no relationship. Finally, events were grouped by edurance and explosive athletes in which the edurance athletes were leaner, but the explosive athletes had more muscle mass. Across the board, there were many indicators that each event had specfic body composition characteristics, but that these characteristics were not a definiate indicator of performance.

## Acknowledgments

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## Introduction

Body composition of athletes has always been a topic of interest for sports medicine researchers. There are morphological and physiological characteristics that lead to a successful career in a given sport. Anecdotally, most players in the NBA are well over six-feet tall, most swimmers have broad shoulders, most football lineman are massive, and most long-distance runners are small and lean. This is largely due to the demands of the sport and the training. For example, there is evidence that runners decrease in size the further their running event is, while a swimmer's mass remains pretty constant across all distances (Gagnon et al., 2018). This could be attributed to the buoyancy of water. There is also been evidence in football players that there is a linear relationship of lean mass and fat mass seen across positions (Melvin et al., 2014). Linebackers, who value size and strength, tend have the highest lean and fat mass values in football, while wide receivers, who must be agile to beat defenders, typically have the lowest. Due to research like this, there has been a growing belief that an athlete has to look a certain way or weigh a certain amount to succeed in their sport.

Running and track and field has come under fire for this in the last year after runner Mary Cain spoke out against Nike's Oregon Project and world-renowned coach, Alberto Salazar. As one of the best runners in the country, she joined the team out of high school. The moment she started running for them, Salazar and his all-male coaching staff insisted that she lose weight to run faster (Cain, 2019). She experienced amenorrhea, started cutting, and had suicidal thoughts, not to mention her performance suffered. Unfortunately, many male coaches, especially in running, think that training female athletes is the same as training male athletes. However, the bodies of male and female athletes are drastically different, and therefore have to be trained different. Healthy percent fat values for fit/athletic females ranges from 14-24%, while in men it is 6-17%, a difference largely due to reproductive needs (Casey, 2013).  If a running coach wants their runners to be leaner so that they move less weight, they are still going to want them to take in enough food to remain healthy and reduce their risk for injury. The point here is that the percent fat where both these ideals are met is going to differ from person to person, and it certainly differs between male and female athletes.

The problem is that much of the research done on body composition has either been solely on male athletes or a combination of both sexes without evaluation of females as a separate group. For example, a study found that track and field throwers have a percent fat value of 23.6 ± 7.8%, but this number was found without differentiation between the sexes (Hirsch et al., 2016). This is likely the reason for the large standard deviation.

In this study, the focus was on female collegiate athletes and their body compositions. Track and field provides a range of body types, including light, lean runners and large, muscular throwers. The goal was not only to determine the differences that develop due to different training programs but to also note the similarities between them as athletes.

## Methods

**Subjects:** Thirty-one female NCAA Division I athletes from the University at Albany's track and field team participated in the study (Mean ± SD; Age = 19.8 ± 1.2yrs., Years of track participation = 8.3 ± 3.0yrs., Height = 1.66 ± 0.07m, Weight = 67.4 ± 16.3kg.). In 2019-2020, the season that this study was conducted, the team won the indoor America East Conference championship for the eighth-straight year. That same week, they were also ranked the second-best team in the Northeast region by the U.S. Track & Field and Cross-Country Coaches Association behind Harvard. All athletes were over the age of 18 and signed an informed consent approved by the university's Institutional Review Board for the protection of human subjects (*n*=30). For analysis, they were divided into five different groups: 100m-400m sprint/hurdles (sprints), 800m+ (distance), high jump/long jump (jumps), shot put/weight throw/hammer throw/discus (throws), pentathlon/heptathlon/pole vault (multis) (Table 1). These groupings were based on training groups (i.e. why pole vault was classified as multis) and demands of the event (i.e. why high jump and long jump were grouped together). Distance and throws athletes, the groups with highest number of participants (*n*=11, *n*=8 respectively) as well as the greatest difference when it comes to demands of the event, were also ranked based on performance. In the jumps group, which had a small sample size, subject FA30 was thrown out as an outlier. The average percent muscle mass for the jumps was 71.5±0.3% and the average percent fat was 24.7±0.2%. FA30 had a percent muscle mass of 35.3% and percent fat of 17.6%. This was 120.7 standard deviations and 35.5 standard deviations away from both averages respectively. In such a small sample size, this kind of deviation would greatly skew the data.

**Procedure:** Participants came into an anthropology lab at the University at Albany for one ten-minute session. It started with a questionnaire asking for their age, years of track participation, year of college, the event(s) they participate in, and their personal best and last performance in each reported event. Their height was then measured using a portable stadiometer (SECA, Chino, CA). They were then asked to step barefoot onto a Tanita Iron Man body composition scale set to the athletic mode, grab the handles, and stand with their arms relaxed by their sides. The scale sent an indetectable electrical current through their body to determine values for weight, hydration, total percent fat and total muscle mass as well percent fat and muscle mass values for each arm, each leg, and the torso. After the collection of this data, the particpant was asked for three skin fold measurments at four different sites: biceps, triceps, lower shoulder, and at the hip. Each time, the skin was gently pinched and the thickness of this pinch was measured to the nearest milimeter using skinfold calipers. From the skin fold measurement, it was possible to calculate values for body density (females 17-19 = 1.1549 – (0.0678 x log of sum of average skin folds); females 20-29 = 1.1599 – (0.0717 x log of sum of average skin folds) and percent fat (Body Fat Percentage (%) = (495 / body density) – 450) (Durnin & Womeersley, 1974).

An ANOVA analysis was run to determine if there was a difference in weight, body fat, and muscle mass between the different athletic groupings, controlling for height in all cases and weight for muscle and fat mass analysis. Given the small sample size, for this analysis athletes were placed into one of two groups: endurance (distance) or explosive (sprints, throws, jumps, and multis).

## Results

**Event Body Composition:** Using the data collected from the body composition scale, averages and standard deviations were found in each even group for both total muscle mass and percent fat. For throwers, those values were 56.7±4.5kg and 31.4±5.7% respectively (Table 1). For distance, it was 42.3±5.0kg and 18.7±4.2%, sprints were 44.0±4.1kg and 20.0±2.7%, jumps were 50.0±4.1kg and 24.7±0.2%, and for the multis, the averages were 50.8±6.5kg and 21.5±2.5% (Table 1).

**Table 1.** Average body composition values with standard deviations across event groups. Throws have the highest numbers across all categories, while distance have the smallest.

| Event | n | Height (m) | Weight (kg) | % Fat | Total MM (kg) | % MM | Avg. MM Arms (kg) | Avg. MM Legs (kg) | Avg. MM Torso (kg) |
|---|---|---|---|---|---|---|---|---|---|
| **Multi** | 4 | 1.69±0.09 | 68.2±8.0 | 21.5±2.5 | 50.8±6.5 | 74.5±2.4 | 2.7±0.4 | 8.9±0.9 | 28.1±3.8 |
| **Jumps** | 3 | 1.76±0.06 | 69.9±5.5 | 24.7±0.2 | 50.0±4.1 | 71.5±0.3 | 2.5±0.3 | 8.6±0.5 | 27.8±2.4 |
| **Distance** | 11 | 1.64±0.04 | 54.8±7.3 | 18.7±4.2 | 42.3±5.0 | 77.5±3.8 | 2.1±0.4 | 7.3±0.7 | 23.6±2.9 |
| **Throws** | 8 | 1.68±0.05 | 87.9±12.4 | 31.4±5.7 | 56.7±4.5 | 65.2±5.4 | 3.4±0.5 | 10.0±1.0 | 29.8±2.1 |
| **Sprints** | 4 | 1.62±0.05 | 58.0±4.9 | 20.0±2.7 | 44.0±4.1 | 75.9±2.6 | 2.3±0.3 | 7.5±0.6 | 24.6±2.3 |

These points were graphed along with the average for total muscle mass across groups (48.3kg) and the average for percent fat across all groups (22.9%). With all groups, the coefficient of determination for this relationship was $R^2$ = 0.8488 (Figure 1). However, it was obvious that the multis were an outlier. The coefficient of determination for muscle mass and percent fat without the multis was $R^2$ = 0.9904 (Figure 1). The average slope for this relationship is 0.4921.

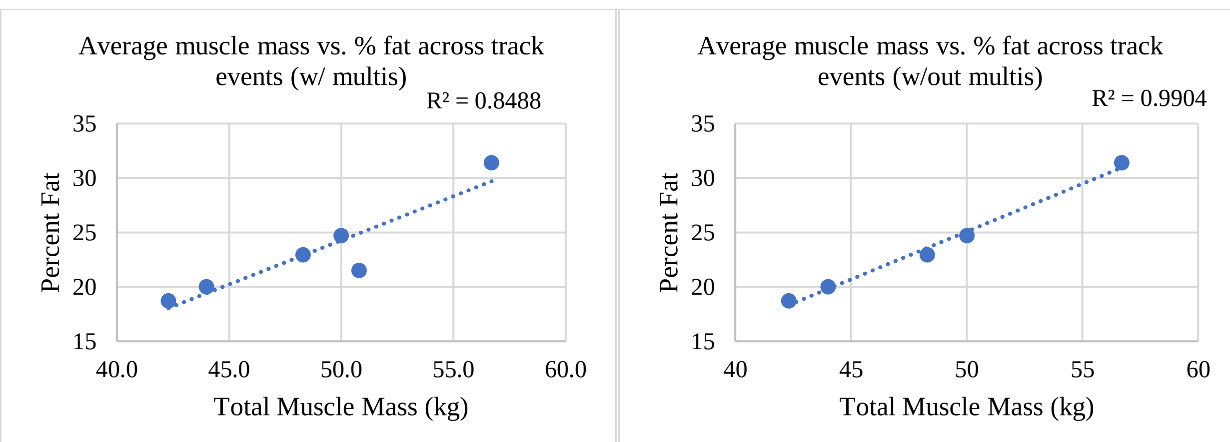


**Figure 1.** The multis appears to be an outlier when it comes to the comparison between muscle mass and percent fat. There is less of a correlation when they are included in the trendline between total muscle mass and percent fat.

Unsurprisingly, the throwers were the most massive, while the distance runners were the least massive. Throwers had and average weight of 87.9±12.4kg and distance runners 54.8±7.3kg (Table 1). Throwers also tended to have more muscle mass in their arms, on average 3.4kg compared to the 2.7kg found with the multis, the second most massive group. While the throwers had the most muscle mass in their torso, the variability for torso muscle mass as a whole was less. Both the multis and jumps were within one standard deviation of the throwers' average of 29.8kg. The runners were the leanest. Distance runners had an average percent fat of 18.7±4.2%, and sprinters had an average of 20.0±2.7% (Table 1). This also meant they had the highest percentage of muscle, though not the greatest amount of muscle. There also seems to be more bilaterally symmetry when it comes to muscle mass of the legs in these two event groups compared to the other event groups. The highest percent fat values were found in the legs.

In the comparison of endurance and explosive athletes, endurance athletes had significantly higher muscle percentage ($p$=0.002). Endurance athletes had 77.5±3.9% compared to the 70.4 ± 6.2% of explosive athletes. Explosive athletes also had significantly more muscle mass ($p$=0.001). They had 51.7±7.0kg compared to the 42.4±5.3 kg found in endurance athletes.

**Performance** Based on reported performances (both personal best and most recent performance), throws and distance athletes were ranked. Distance athletes were ranked from 1-11 (1 being the best athlete). As their ranking increased, the trend was that the percent muscle mass and percent fat did as well. However, the coefficient of determination for muscle mass was $R^2$ = 0.0271 and the coefficient of determination for percent fat was $R^2$ = 0.0126 (Figure 2).

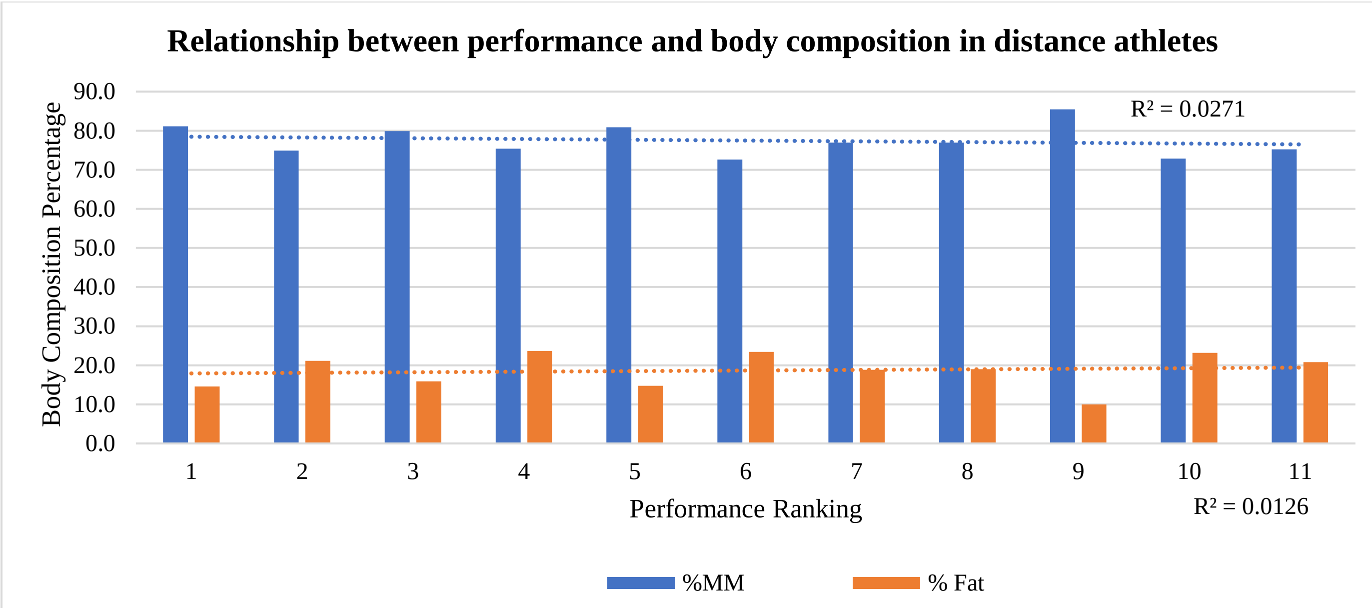


**Figure 2.** Percent muscle mass generally decreases and percent fat generally increase as the performance ranking increase with distance runners. However, there is not enough evidence to draw a correlation.

Throwers were ranked 1-8 (with 1 being the best). As their performance ranking increased, their percent muscle mass tended to decrease and percent fat tended to increase. However, again, the coefficients of determination for these two relationships were quite small ($R^2$ = 0.0255 and $R^2$ = 0.2054 respectively) (Figure 3).

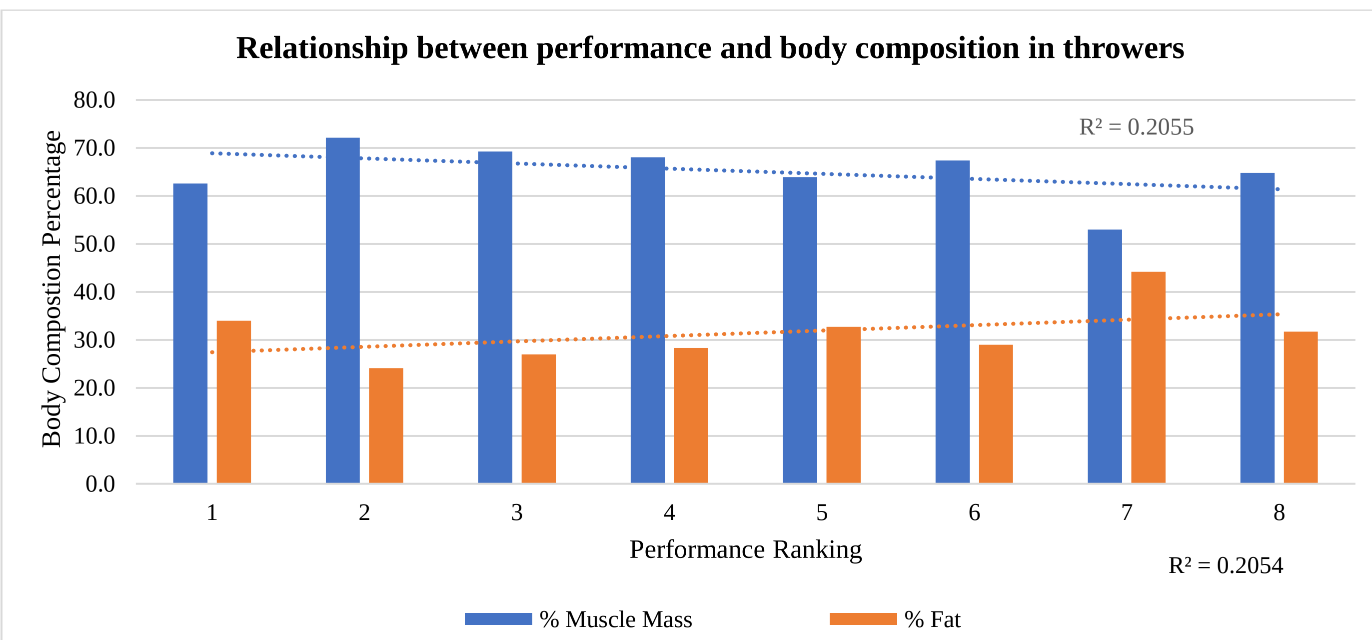


**Figure 3.** Percent muscle muss generally decreases, and percent fat generally increases as performance ranking increases in throwers. However, there is not enough evidence to draw a correlation.

**Discussion**

The measuring and analysis of body composition of female collegiate track and field athletes in this study suggested that each event has its own morphological and physiological characteristics. However, body composition did not factor into performance in a given event. The body composition trends were similar to the findings of other studies done on NCAA Division I track and field athletes, such as Hirsch et al. (2016). The throwers have the greatest muscle mass and percent fat. This make sense from a physics standpoint. If the aim is to generate as much power, you want to create as much kinetic energy as possible before you throw (Bartonietz, 1994). An increase in mass or velocity increases kinetic energy. The trick of throwing is transferring this kinetic energy into the throwing implement.  This is why the successful smaller throwers must to be quicker than their competitors. It should also be noted that though the correlation was far from strong when it came to performance and body composition in throwers, the percent fat decreases with increased performance ranking. This suggests that an increase in mass to increase performance is not about increasing body fat but increasing lean body mass.

On the other end of the spectrum are the runners. As Gagnon et al. (2018) proved, as you increase the running distance you are training for, you decrease your mass. This is true with the sprinter and distance groups, with distance being the less massive of the two. This could come back to the types of muscle fibers required to be successful in each run. Slow-twitch fibers or type I muscle fibers are smaller in diameters compared to fast-twitch or type II muscle fibers (Kenney et al., 2015). Distance would have more type I fibers than sprinters, suggesting that their muscle mass would be less if a cross section had the same number of muscle fibers as a sprinter. A sprinter also has more muscle mass in their arms compared to distance (2.3±0.3 kg. vs 2.1±0.4kg) (Table 1). This is because their upper body is used to balance their strides (Mann &

Sprague, 1983). They can energetically afford to have the increased weight in their upper body because they run for a much shorter time than distance runners.

This is furthered by the comparison of endurance and explosive athletes, which not only compared distance runners to the sprinters but also to other events utilizing these fast-twitch, type II muscle fibers. Though distance, endurance runners were significantly leaner, explosive athletes had significantly more muscle mass. If we directed this back to what we were talking about above, a point could be made about the different distribution of fiber-type that can be found in endurance vs. explosive athletes. Distance would be the group Mary Cain would find herself in. Despite what Coach Salazar believed, we did not find a great enough correlation between performance and percent fat or performance and muscle mass to come to the conclusion that either body composition variable contributes to an athlete's performance.

The multis appear to be an outlier in the relationship between muscle mass and percent fat. They had low fat percentages for the given muscle mass that they had. This could be due to the nature of the event they train for the. A multi event challenge an athlete across several disciplines. They have to be explosive in the jumps, massive and strong in the throws, while still lean enough to run hurdles and the 800m. However, them being an outlier could also be attributed to the small sample size, which is not large enough to draw a significant conclusion.

These trends beg the question if body composition is  a result of training or if individuals are drawn to certain events because of their genetically pre-disposed body type. At the University at Albany, the throwers are given one lifting program, the distance group another, while the multis, jumpers, and sprinters lift together. However, there is both diversity in the throws group and with the multis, jumpers, and sprinters. This suggests that while strength and conditioning is a vital component to building one's body composition for an event, it is likely the individual training done with coaches that plays more of a role in performance. Furthermore, this study reiterates the importance of having female-specific studies in the field of sports medicine, which can only help coaches better train their female athletes in a healthy and successful manner.

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