2021, Volume 4 (Issue 1): 3 OPEN ACCESS

# The Effects of a Baseball Season on Various Body Composition Measurements in NCAA Division I Baseball Players

*Original Research*

Jordan R. Marthens[1], Sofia R. Sanchez Porush[1], Selena A. Sharpless[1], Mary K. Oates[2], Andrew A. Schaffner[3], Angelos K. Sikalidis[1], Scott K. Reaves [1]

[1]*Sports Nutrition Research Team, Nutrition Program, College of Agriculture, Food and Environmental Sciences, California Polytechnic State University, San Luis Obispo, CA/United States*
[2]*Global Asset Lead Medical Director-EVENITY of Amgen, Thousand Oaks, California/United States*
[3]*Statistics Department, College of Science and Mathematics, California Polytechnic State University, San Luis Obispo, CA/United States*

**Abstract**

**Purpose**: The purpose of our study was to evaluate the body composition fluctuation pattern, in baseball players thus generating insights that may contribute to optimization of the diet/training regimes for maximal performance and optimal health.

**Methods**: Dual energy x-ray absorptiometry (DXA) scans performed at the start and end of five different seasons (2015-2019) were analyzed and compared. Groups were stratified to examine differences in players' positions (Pitchers vs. Position Players) and first-year status effects (Freshman/Transfer vs. Sophomore/Junior/Seniors).

**Results**: Body weight and lean body mass, significantly decreased from the beginning to end of season for the overall team ($p \leq 0.05$). Position Players exhibited a statistically significant decline in body weight, body fat percentage, and fat mass ($p \leq 0.05$) during the season while pitchers did not demonstrate significant changes in these measures. First-year players exhibited a statistically significant increase in visceral adipose tissue (VAT) mass over the season while Sophomore/Junior/Seniors demonstrated a significant decrease in body weight and fat mass ($p \leq 0.05$).

**Conclusion**: Baseball players' body composition changes over the season, therefore, the study results may be helpful for collegiate baseball programs, and potentially athletes in similar sports, to improve the performance, development, and health of young student athletes.

***Key Words***: body composition, baseball, VAT

Corresponding author: Scott K. Reaves, sreaves@calpoly.edu

## Introduction

Success of baseball athletes can be evaluated through physical performance measures (i.e., speed, grip-strength, vertical jump etc.) and in-game statistics (i.e. homeruns, runs-batted in, earned run average)[2,6,8,22]. While strength and conditioning programs are typically utilized aiming to support the athlete regarding performance and training demands, other relevant important determinants such as nutrition and body composition (BC) have not been extensively studied or effectively used in baseball. On the contrary, in other sports such as football, hockey, and soccer there has been significantly more extensive examination of the relationship between BC and performance, while a limited body of research has been conducted with baseball players[12]. In terms of BC aspects, knowledge of the amount and respective distribution of various tissue types can be important to athletic performance as well as optimal physical health and development. In this context, detailed sport-specific analyses enable athletes and coaches to better understand the needs and define goals in terms of optimal BC for maximum performance potential for their respective sport[21].

Lean body mass (LBM) and body fat percentage (BF%) are commonly the focus of BC research for optimization of athlete performance[7,19]. LBM is of particular interest in high-performance athletes as it impacts physical performance output directly, since increases in LBM enable the athlete to generate more force and produce more strength, while also contribute to speed, swiftness, and agility[1,13]. Excess fat mass (FM) can limit endurance, balance, coordination, and movement/maneuverability capacity, however some sports require athletes to be larger, thus benefitting from higher FM and BF%[13,14]. For example, football and baseball players typically have higher BF% compared to track & field or soccer athletes due to the difference in sport demands[4]. Furthermore, visceral adipose tissue (VAT) is an indicative BC measurement, however very few studies have specifically evaluated VAT in athletes. VAT is most commonly studied in obese populations, as increasing amounts may be associated with increased risk of cardio-metabolic syndrome[3]. Previous studies have evaluated VAT in collegiate and professional football players while very few have reported VAT in baseball players[3]. BC analyses in addition to VAT measurements, allow coaches and trainers greater insight regarding the implementation of sport- and position-specific training programs to optimize health and athletic performance, while decreasing injury risk in collegiate baseball players[3]. Further studies examining sport-specific VAT are needed to increase knowledge of reference values for specific athletic populations (i.e., female sports vs. male sports; baseball vs. track vs. basketball).

Despite the established importance of BC in relation to performance and health of athletes, there is a gap in research addressing the effects of training and competing on BC in baseball athletes. The aim of this study was to evaluate BC changes from the beginning to end of season for five different seasons in National Collegiate Athletic Association (NCAA) Division I (i.e., highest/most competitive collegiate division) baseball athletes. We hypothesized effects of the season would include significant decreases in body weight (BW), LBM and FM. This study appears to be the first, or one of very few, to compare BC measures (i.e., BW, LBM, FM, body fat percentage [BF%] and VAT) from the beginning to end of season for NCAA Division I (DI) collegiate baseball players.

## Methods

*Participants*

Over the 2015-2019 baseball seasons, approximately 91 different players were eligible to participate in BC measurements performed using dual energy x-ray absorptiometry (DXA). Out of the 91 possible players, 67 players (age [yrs] =19.8±1.28; height [in] =72.6±2.09, [cm] =184.40 ± 5.3; weight [lbs] = 192.8±16.75, [kg] = 87.64 ± 7.61) met the requirements to be included in the study (i.e., received DXA scan in Jan and June of the same season). Some players had repeated measures across multiple years (18 for 2 years, 7 for 3 years, and 2 for 4 years). Inclusion criteria allowed all baseball players during any of the 2015-2019 seasons to be a part of the study. Additional required criteria included: signed Consent Form for Sports Nutrition Projects and Release Form for DXA scan and received a DXA scan before and after the same season.

All participants were informed of the procedures, benefits, and risks of participating in the study and provided written informed consent prior to enrollment. All participating players were made aware that they could cease their participation at any time. The study was reviewed and approved by the Institutional Review Board for Human Subjects Research of California Polytechnic State University San Luis Obispo.

*Protocol*

BC measurements were performed using DXA on a Lunar iDXA™,[5]. All procedures were conducted according to GE Lunar specifications and analyzed with enCORE™ software and CoreScan™ (version 14.1; GE Healthcare). The same certified technician performed all scans throughout the study and calibrated the iDXA each day of testing using a phantom spine to verify proper function. The participants read, signed and submitted a University Waiver Release Form as well as fasted 10-12 hours prior to each scan. Participants wore light clothing and no shoes for height and weight measures and DXA scans. Heights and body weights were taken using a wall stadiometer and physicians scale in the laboratory. The same measurements and analyses were performed for five consecutive baseball seasons (2015-2019).

DXA has been established as a highly accurate BC measurement that provides numerous types of data including tissue fat percentage and region fat percentage[20]. The latter was used and defined in our study as "BF%"; it is important to note that region fat percentage, or "BF%", is the sum of FM divided by body mass (i.e. including bone mass). Furthermore, DXA measures LBM and defines the variable as the sum

of all soft tissue, whereas Fat-Free Mass (FFM) includes soft-tissue and bone. Terminology of "lean tissue" varies throughout BC studies and is referenced as "Lean Body Mass" and/or "Fat-Free Mass" however, these terms are not interchangeable. We chose to report LBM in our study rather than FFM.

*Statistical Analysis*

IBM SPSS (Version 26.0)[9] and JMP Pro (Version 15; SAS Institute)[10] were used for all calculations throughout the study. A mixed model was fitted with age, position, time, age*position, age*time, and position*time interactions with player and season nested in player as random effects. The season variable was used because some players played for multiple seasons. VAT mass was square-root transformed to meet the model conditions of normality. All tests set the level of significance at $\alpha$=0.05. To protect from inflated Type I errors (false-positives), joint factor (partial F-test) tests were used to examine in as few tests as possible which whole factors (age, position, time) are associated with each of the body measurements either as main-effects or interactions.

**Results**

Our results revealed a statistically significant mean difference of BW from beginning to end of season (effect over time) for the overall team when all players were grouped together (means and ANOVA p-values for all results are shown in Tables 1 and 2, respectively). However, there was a larger effect of time on position players (a statistically significant reduction), as compared to pitchers (no evidence of change), so the significance of the BW change for the entire team was driven by the decrease in BW change in position players. We examined the effects of age (FT vs. SJS) on BW change from beginning of season to end of season and found the change was significant for SJS players but not for FT players.

FM significantly decreased from beginning of season to end of season when all players were grouped together. However, the significance of the change was driven by the significant decrease in FM in position players as pitchers' mass slightly increased, albeit not statistically significantly. Older players (SJS) also showed a statistically significant reduction in FM over the season, whereas younger players (FT) showed a slight, non-significant increase.

There was a significant decrease in LBM from beginning of season to end of season when all players were grouped together. This seasonal change was consistent (not statistically different) across age (FT vs. SJS) and position (position players vs. pitchers) of players.

The BF% significantly decreased in position players from beginning of season to end of season, but not for pitchers who showed a slight non-significant increase in BF%.

VAT mass increased from the beginning to end of season and reached statistical significance when all players were grouped together. The effect on VAT increase was mostly driven by the increase in the younger (FT) players who showed a statistically significant increase. Older players (SJS) also showed an increase, but it was not statistically significant.

**Discussion**

Despite the recognized importance of BC in relation to athletic performance, there is a limited number of studies addressing the effects of nutrition, training and exercise performance on BC within collegiate baseball athletes. Research pertinent to collegiate athletes' BC has focused primarily on football, consequently there is a limited amount of data comparing the variety of NCAA sports[4]. For baseball specifically, research has examined performance measures and mechanics of the sport, with a very limited number of studies investigating contributing factors such as BC. Our study addresses this need by focusing on the effects of a baseball season on various aspects of BC.

The method used to address BC in our study aligns with previous research, utilizing whole-body measurements from the DXA scan to include: LBM, FM, BF% and VAT[15,16,18]. In our study, we found significant changes of BW and LBM for the team as a whole, as these values decreased from the beginning to end of season. Previous studies using DXA have not examined this specific part of the baseball season. In the off-season, BC changes of college baseball players assessed via DXA revealed significant favorable changes of increased LBM, decreased FM and %BF[23]. Other studies utilized air-displacement plethysmography to measure BC in the off-season in conjunction with a nutrition intervention

**Table 1.** Comparisons of Body Weight and Body Composition

| | | LSM ± SE | | N |
|---|---|---|---|---|
| | | **Beginning of Season** | **End of Season** | |
| **Body Weight lbs (kg)** | Pitchers | 195.52±2.92 (88.87±1.33) | 195.08±2.92 (88.67±1.33) | 52 |
| | Position Players | 190.88±2.57 (86.76±1.17) | 187.87±2.57 (85.40±1.17) | 53 |
| | FT | 190.40±2.09 (86.55±0.95) | 189.82±2.09 (86.28±0.95) | 42 |
| | SJS | 196.00±2.04 (89.09±0.93) | 193.13±2.04 (87.79±0.93) | 63 |
| | Team | 193.20±1.94 (87.82±0.88) | 191.47±1.94 (87.03±0.88) | 105 |
| **Fat Mass lbs (kg)** | Pitchers | 36.68±1.38 (16.67±0.63) | 37.09±1.38 (16.86±0.63) | 52 |
| | Position Players | 34.03±1.24 (15.47±0.56) | 32.50±1.24 (14.77±0.56) | 53 |
| | FT | 34.02±1.13 (15.46±0.51) | 34.32±1.13 (15.60±0.51) | 42 |
| | SJS | 36.69±1.05 (16.68±0.48) | 35.26±1.05 (16.03±0.48) | 63 |
| | Team | 35.35±0.93 (16.07±0.42) | 34.79±0.93 (15.81±0.42) | 105 |
| **LBM lbs (kg)** | Pitchers | 150.12±2.52 (68.24±1.15) | 149.39±2.52 (67.90±1.15) | 52 |
| | Position Players | 148.50±2.21 (67.50±1.00) | 147.48±2.21 (67.04±1.00) | 53 |
| | FT | 147.68±1.74 (67.13±0.79) | 146.90±1.74 (66.77±0.79) | 42 |
| | SJS | 150.94±1.72 (68.61±0.78) | 149.97±1.72 (68.17±0.78) | 63 |
| | Team | 149.31±1.68 (67.87±0.76) | 148.44±1.68 (67.47±0.76) | 105 |
| **Body Fat %** | Pitchers | 18.77±0.65 | 18.82±0.65 | 52 |
| | Position Players | 17.88±0.58 | 17.30±0.58 | 53 |
| | FT | 18.01±0.50 | 18.07±0.50 | 42 |
| | SJS | 18.63±0.48 | 18.06±0.48 | 63 |
| | Team | 18.32±0.44 | 18.06±0.44 | 105 |
| **VAT Mass (g)√** | Pitchers | 0.59±0.05 | 0.63±0.06 | 20 |
| | Position Players | 0.65±0.05 | 0.72±0.05 | 25 |
| | FT | 0.57±0.05 | 0.66±0.05 | 18 |
| | SJS | 0.67±0.04 | 0.68±0.04 | 27 |
| | Team | 0.62±0.04 | 0.67±0.04 | 45 |

Data presented as Least Squares Mean (LSM) ± Standard Error (SE) for lbs and kg values. Freshman/Transfer; SJS= Sophomores/Juniors/Seniors; LBM= Lean body mass; VAT= visceral adipose tissue. √=square root of VAT Mass values used to normalize data. N represents the number of scans.
*Note: Body Fat % is equal to fat mass divided by body mass calculated by DXA.*

**Table 2.** Mixed effects ANOVA p-values

| | **Body Weight** | **Fat** | **LBM** | **Body Fat%** | **VAT Mass√** |
|---|---|---|---|---|---|
| **Age** | 0.001* | 0.091 | 0.000* | 0.465 | 0.300 |
| **Age*Position** | 0.325 | 0.723 | 0.349 | 0.619 | 0.860 |
| **Age*Beginning/End of Season** | 0.029* | 0.060 | 0.812 | 0.078 | 0.071 |
| **Position** | 0.129 | 0.049* | 0.598 | 0.163 | 0.307 |
| **Position*Beginning/End of Season** | 0.012* | 0.031* | 0.719 | 0.069 | 0.385 |
| **Team Beginning/End of Season** | 0.001* | 0.216 | 0.035* | 0.144 | 0.013* |

Data presented as p-values. LBM= lean body mass. *Significant difference ($p<0.05$)

demonstrating that baseball athletes who received the nutrition intervention exhibited an increase of body weight with a decrease of %BF and FM[17]. These studies exemplified the off-season as an opportune time for significant increases in LBM across all playing positions. From our findings and the significant decrease of BW and LBM, it is understandable that the off-season is a favorable time for BC changes in order to offset any adverse changes produced during the on-season[23]. The demands of a baseball season

may produce suboptimal BC status, rendering it crucial to offset these less favorable changes during the off-season.

Baseball players may be divided into the categories of position players and pitchers as the roles and demands on these two types of players are quite distinct. Therefore, playing position is important to factor in when considering various aspects of BC. One of the few studies focusing on collegiate baseball BC found no significant differences among infielders, outfielders, and pitchers when using air-displacement plethysmography in the off-season[4]. We did not examine the statistical significance levels among the positions (infielders vs. outfielders vs. pitchers) similar to previous work, but our results demonstrated that Position Players (infielders and outfielders combined) exhibited less FM and lower BF% as compared to Pitchers.

Players were further divided into groups of their respective year of school due to evident differences between each year and concomitant age. To examine any First-year playing effects, freshmen and transfers were combined into one group while sophomores, juniors, and seniors as are older in age and well-adjusted to college level playing demands as well as their team's specific training, constituted a distinct single group. Stratifying by First-year status vs. SJS may be considered comparable to previous work differentiating levels of professional players. Total body mass (BM), especially LBM, increases with professional level of play from Rookie Ball to AAA to major league baseball (MLB)[8]. This phenomenon is consistent with the concept that strength is associated with greater performance, but these correlations also involve age. BM, LBM, and %BF all significantly increase with age until a later stage that is over a collegiate baseline player's age; MLB level players demonstrated significantly higher amounts of LBM and BM compared to the younger players in the Minor Leagues[11]. In our study, SJS, the eldest players of the groups, exhibited higher values in every BC variable measured at the beginning of the season, compared to First-years, validating the idea that BC change is correlated with age.

Further research within collegiate baseball is necessary due to the uniqueness of the sport and its respective playing positions. A stronger emphasis on BC, especially during the baseball season, is necessary to better understand the effects from the physical demand of the sport. Moreover, examining the differences between the playing positions and year of the athlete, can benefit the coaches, nutrition professionals, and strength and conditioning coaches' helping them to understand better and in more depth the players' individual needs for optimal performance and health. In addition, weightlifting and dietary intake are important factors contributing to BC changes, and should be taken into account. The participants train year round, however, during the athletic season their regimen is altered. Establishing differences between off-season lifting vs. intra season lifting would provide a better understanding of the physical demands and its effects on the body, in conjunction to dietary intake during these periods. Moving forward, attention on BC for all collegiate sports is needed. BC can be a significant factor in the athletes' health and performance, and warrants more attention and support within the NCAA population.

**Media-Friendly Summary**

Unfavorable BC changes were observed in baseball athletes during season that may be affecting training and performance during season. Therefore our findings are important for coaches and players to consider, as well as other collegiate baseball programs that postulate similar demands. Every NCAA sport endures specific demands during season, thus focusing on seasonal BC changes of the individual sports could potentially benefit athletic programs towards optimizing BC of athletes and subsequently performance and health. In this context, our findings described herein may be helpful for improving the performance, development and health of NCAA athletes.

**Acknowledgements**

Foremost, the authors would like to give special thanks to the Cal Poly Sports Nutrition Research Team for their contributions to the study. The authors would also like to thank the baseball players and coaches and the Athletics Department of California Polytechnic State University for their commitment in the multi-year research project. The authors declare no conflicts of interest.

**References**

1. Bilsborough JC, Greenway K, Opar D. et al. The accuracy and precision of DXA for assessing body composition in team sport athletes. *Journal of Sports Sciences*. 2014;32(19):1821-1828.

2. Crotin RL, Forsythe CM, Karakolis T, Bhan S. Physical size associations to offensive performance among major league leaders. *Journal of Strength and Conditioning Research*. 2014;28(9):2391-2396.
3. Czeck MA, Raymond-Pope CJ, Bosch TA, et al. Total and regional body composition of NCAA division i collegiate baseball athletes. *International Journal of Sports Medicine*. 2019;40(07):447-452.
4. Fields JB, Merrigan JJ, White JB, Jones MT. Body composition variables by sport and sport-position in elite collegiate athletes. *Journal of Strength and Conditioning Research*. 2018;32(11):3153-3159.
5. GE Healthcare. Lunar iDXA. General Electric Company. 2017;JB48997XX.
6. Grasberger K, Bean R, Doernte L, et al. Examination of body composition and performance metrics of division i collegiate baseball players. Poster session presented for University Presentation Showcase: Undergraduate Poster Gallery. 2017.
7. Hinton BJ, Fan B, Ng BK, Shepherd JA. Dual energy x-ray absorptiometry body composition reference values of limbs and trunk from NHANES 1999-2004 with additional visualization methods. *PloS one*. 2017;12(3):e0174180.
8. Hoffman JR, Vazquez J, Pichardo N, Tenenbaum G. Anthropometric and performance comparisons in professional baseball players. *The Journal of Strength & Conditioning Research*. 2009;23(8): 2173-2178.
9. IBM Corp. IBM SPSS Statistics for Mac, Version 26.0. Armonk, NY: IBM Corp. 2019.
10. JMP®, Version 15. SAS Institute Inc., Cary, NC, 2020.
11. Mangine GT, Hoffman JR, Fragala MS, et al. Effect of age on anthropometric and physical performance measures in professional baseball players. *The Journal of Strength & Conditioning Research.* 2013; 27(2):375-381.
12. Muth B. The relationship between body composition and baseball performance in division ii baseball players. Master's Thesis, East Stroudsburg University. 2013.
13. NSCA's Guide to Tests and Assessments. Sport Performance and Body Composition. National Strength and Conditioning Association (NSCA). https://www.nsca.com/education/articles/kinetic-select/sport-performance-and-body-composition/#. Published June 1, 2017. Accessed March 27, 2020.
14. Kyriazis T, Terzis G, Karampatsos G, Kavouras S, Georgiadis G. Body composition and performance in shot put athletes at preseason and at competition. Int J Sports Physiol Perform. 2010 Sep;5(3):417-21. doi: 10.1123/ijspp.5.3.417.
15. Oates MK, Oates DW. Body Composition of Collegiate Swimmers, Runners and Baseball Players Measured with iDXA. Poster session presented for ASBMR at Marian Osteoporosis Center. 2009;SU0021.
16. Pearson J, Wadhi T, Rauch JT, et al. The relationship between body composition with peak force and anaerobic power in collegiate baseball players. *Medicine And Science In Sports And Exercise.* 2019;51(6):913-913.
17. Rossi FE, Landreth A, Beam S, et al. The effects of a sports nutrition education intervention on nutritional status, sport nutrition knowledge, body composition, and performance during off season training in NCAA Division I baseball players. *Journal of sports science & medicine*. 2017;16(1):60.
18. Sanfilippo J, Krueger D, Heiderscheit B, Binkley, N. Dual-energy x-ray absorptiometry body composition in NCAA division i athletes: exploration of mass distribution. *Sports Health*. 2019;11(5):453–460.
19. Santos DA, Dawson JA, Matias CN, et al. Reference values for body composition and anthropometric measurements in athletes. *PloS one.* 2014;9(5):e97846.
20. Shepherd JA, Ng BK, Sommer MJ, Heymsfield SB. Body composition by DXA. *Bone.* 2017;104:101-105.
21. Silva AM. Structural and functional body components in athletic health and performance phenotypes. *European journal of clinical nutrition*. 2019;*73*(2):215-224.
22. Spaniol FJ. Baseball athletic test: a baseball-specific test battery. *Strength & Conditioning Journal*. 2009;*31*(2):26-29.
23. Sweet J. A comparison of body composition changes throughout the offseason for NCAA division i male baseball players. Doctoral dissertation, Southeast Missouri State University. 2018.