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Longitudinal Body Composition Changes in NCAA Division I College Football Players

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Abstract

Many athletes seek to optimize body composition to fit the physical demands of their sport. American football requires a unique combination of size, speed, and power. The purpose of the current study was to evaluate longitudinal changes in body composition in Division I collegiate football players. For 57 players (Mean ± SD; Age=19.5 ± 0.9 yrs; Height=186.9 ± 5.7 cm; Weight=107.7 ± 19.1 kg), body composition was assessed via dual-energy x-ray absorptiometry in the off-season (March-Pre), end of off-season (May), mid-July (Pre-Season), and the following March (March-Post). Outcome variables included weight, body fat percentage (BF%), fat mass (FM), lean mass (LM), android (AND) and gynoid (GYN) fat, bone mineral content (BMC), and bone density (BMD). For a subset of athletes (n=13 out of 57), changes over a 4-year playing career were evaluated with measurements taken every March. Throughout a single year, favorable changes were observed for BF% (Δ=−1.3 ± 2.5%), LM (Δ=2.8 ± 2.8 kg), GYN (Δ=−1.5 ± 3.0%), BMC (Δ=0.06 ± 0.14 kg), and BMD (Δ=0.015 ± 0.027g·cm^{-2}; all $p<0.05$). Across four years, weight increased significantly (Δ=6.6 ± 4.1kg), and favorable changes were observed for LM (Δ=4.3 ± 3.0 kg), BMC (Δ=0.18 ± 0.17 kg), and BMD (Δ=0.033 ± 0.039 g·cm^{-2}; all $p<0.05$). Similar patterns in body composition changes were observed for linemen and non-linemen. Results indicate that well-trained collegiate football players at high levels of competition can achieve favorable changes in body composition, even late in the career, which may confer benefits for performance and injury prevention.

Keywords

Dual-energy x-ray absorptiometry; American football; Lean body mass; Body fat percentage; Bone density; Regional adiposity

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Introduction

Athletes commonly seek to optimize body composition to meet the physical demands of their sport. American football requires a unique combination of size, strength, speed, and power, and the physical demands of the sport vary widely between position groups (11). Previous research has shown that various indices of body size and composition correlate with outcomes in football-related performance tests evaluating speed, strength, and power (27), which may translate to in-game performance (29, 35). Accordingly, increases in body mass or height are associated with greater career earnings in professional football players (29) and higher rating scores in high school recruits (10). Similarly, fat-free mass is correlated with various indices of strength, power, and competition level in Australian football players (4). Nearly all position groups prioritize the accretion of lean mass, based on the established links between lean body mass, strength, and power development (4, 27, 32). Lean mass accretion is an even higher priority for athletes in positions that specifically emphasize size and strength, such as linemen, tight ends, and linebackers. Body fat percentage is also an important performance correlate, with evidence showing higher body fat to adversely influence measured of speed and endurance (8), along with sport-specific tasks like peak and average velocity of the drive block in offensive linemen (17). As such, body composition testing provides valuable performance-related information for practitioners working within American football.

Given the relationship between body composition and performance, collegiate and professional football teams devote large amounts of time and resources to strength and conditioning programs aimed at enhancing physical performance and body composition. This trend is reflected in recent research indicating significantly larger strength and conditioning facilities and coaching staff sizes in universities with football programs, in comparison to schools without football programs (19). As the emphasis on strength and conditioning has grown in recent decades, an increase in the size, strength, and speed of American football players has been observed (3, 11, 28, 29, 31). While most studies evaluating body composition in football players have been cross-sectional in nature (7, 9, 16, 20, 23, 25, 28), longitudinal designs are needed to determine the relative magnitude by which body composition can be changed over a single year or a full career of American football participation. Longitudinal designs may also help to determine if current strength and conditioning practices are sufficient to mitigate the potential cumulative effects of muscle damage on body composition in college football players, as has been suggested previously (21, 22). In studies evaluating short-term interventions spanning the competitive season or off-season training, Hoffman and colleagues (12, 14, 15) have documented improvements in strength and power outcomes. However, body composition was only assessed in one of these studies (12), with results indicating that body composition did not change significantly from pre-season to post-season testing. Smith et al. (33) found improvements in strength and power outcomes throughout an offseason utilizing a variety of resistance training programs prioritizing hypertrophy, strength, or power, despite no significant changes in body mass. Conversely, studies investigating longer time periods have documented significant body composition changes in football players (13, 18, 34). Studies spanning 4–5 years in length have consistently shown significant increases in lean mass with no change or reductions in body fat percentage (BF%) (13, 18, 34). Longitudinally, previous studies have indicated that the most pronounced body composition changes occurred between the first two years of the playing career (18, 34). These findings conflict with other research showing the largest improvements between the final two years (13). More research is needed to evaluate the magnitude of body composition changes in collegiate football players, and to identify the time course of these changes.

In previous research in football players, skinfold caliper measurements and air displacement plethysmography have frequently been used to estimate body composition due to convenience and accessibility (13, 18, 27, 34). Dual-energy x-ray absorptiometry (DEXA) is a comparatively valid and reliable method of body composition estimation (1) that reduces the likelihood of operator error. In addition to measuring bone density, DEXA also allows for the estimation of android and gynoid fat, which may be valuable information to gather based upon increased risk of medical conditions related to obesity and metabolic syndrome in football players post-career (2, 6, 26). Recent studies have used DEXA to perform cross-sectional evaluations of body composition in both collegiate (25) and professional (7, 9) football players, but authors of the current study are unaware of research utilizing DEXA in longitudinal football studies. The purpose of the current study was to track longitudinal body composition over a single year and a 4-year career using DEXA in Division I collegiate football players.

Methods

Experimental Approach to the Problem

The current study assessed body composition in NCAA Division I American football players via DEXA. For 57 athletes, body composition was tracked longitudinally over the course of one calendar year, with measurements taken in the off-season (March-Pre), the end of the off-season in late May (May), mid-July (Pre-Season), and the following March (March-Post). For a smaller subset of athletes (n=13), annual measurements were taken in March of each year over a 4-year period to track changes over the course of a collegiate career. For practical reasons, measurements taken in late February were included in “March” time points, and measurements taken in early June were included in the “May” time point.

Subjects

Male NCAA Division I football players (n=57) participated in the current study (Mean ± SD; Age = 19.5 ± 0.9 yrs, Height = 186.9 ± 5.7 cm, Weight = 107.7 ± 19.1 kg). All procedures were approved by the University’s Institutional Review Board and all participants signed an approved informed consent document prior to participation. Changes across a single year were assessed in a sample of 57 subjects, which consisted of 3 quarterbacks (QB), 9 wide receivers (WR), 5 running backs (RB), 2 tight ends (TE), 11 offensive linemen (OL), 9 defensive linemen (DL), 7 linebackers (LB), 8 defensive backs (DB), and 3 special teams athletes (SP). Changes across a 4-year career were assessed in a subset of 13 subjects, which consisted of 3 WR, 1 RB, 3 OL, 2 DL, 2 LB, 1 DB, and 1 SP. Due to marked body composition differences, data are presented for the full team, and for sub-groups of linemen (OL and DL) and non-linemen (all other positions). Athletes were recruited from all across the United States, with the majority of enrolled athletes coming from high schools in Texas, Missouri, and Oklahoma.

Procedures

Dual Energy X-Ray Absorptiometry (DEXA)—All body composition assessments were performed via DEXA (Hologic Inc., Bedford, MA, USA), using the default software (Apex Software, Version 3.3). Participants were instructed to abstain from eating and exercising for at least 2 hours prior to each visit. Height and weight were measured upon arrival to the laboratory, and participants were asked to remove their shoes and any metal, hard plastic, or other items that could potentially interfere with the DEXA scan. Participants laid supine in the center of the scanning table with their arms at their sides and palms facing down. If the participants' shoulders were too wide to fit in the area of the scan, thumbs were tucked under their buttocks to capture the full scan. All scans were performed by a trained DEXA technician, who entered the age, height, weight, sex, and ethnicity of each subject prior to each scan. Body composition was measured using the device's default software, with outcomes including lean mass (LM), fat mass (FM), body fat percentage (BF%), bone mineral content (BMC), bone mineral density (BMD), android fat (AND), and gynoid fat (GYN). Test-retest reliability using this method for BF% has previously been reported from our lab with an intraclass correlation coefficient (ICC) of 0.964, and standard error of measure (SEM) of 1.279%.

Training—Throughout all time points, subjects participated in a periodized training program designed and supervised by a professional strength and conditioning coach. The program changed each of the four years as athletes progressed, as part of a long-term development model. All programs prioritized three primary exercises (squat, bench press, and hang clean), with additional accessory and sport-specific exercises incorporated as necessary in each program. During the spring semester the team trained in a 3 $d \cdot wk^{-1}$, total body routine. During the summer semester the team trained in a 4 $d \cdot wk^{-1}$ split, with upper body exercises completed on Monday and Thursday, and lower body exercises completed on Tuesday and Friday. During the competitive season, athletes completed resistance training 3 $d \cdot wk^{-1}$. Between the first week of January and first week of August, athletes had a total of 8 weeks off from supervised training; during these weeks, athletes were provided with workout guidelines to be completed at their own volition. Each year, training camp began in the first week of August.

While the primary exercises remained the same (squat, bench press, and hang clean), the way exercises were programmed varied year to year. All first-year athletes completed a high-volume, moderate intensity program to facilitate learning the movements. During this time they used autoregulatory progressive resistance exercise (APRE) (24) with loads primarily corresponding to an estimated 10-repetition maximum (10RM; APRE 10) and 6RM (APRE 6). As previously describe by Mann et al. (24), loads were adjusted based on performance feedback from each individual athlete, with the number of repetitions successfully performed influencing the load selected for subsequent sets, and the starting load for the following week. Second-year athletes predominantly utilized the APRE 6 during their training sessions. Similarly, loads were consistently adjusted based on individual performance feedback, thereby progressing the training load over time.

Third-year athletes utilized a higher intensity, lower volume form of training with each training day predominantly focused on one of the primary exercises. Over the course of a mesocycle, working sets progressively shifted from sets of 5, to sets of 3, and eventually included sets of 1, as loads progressively increased from 75% to 95% of 1RM. In comparisons to the programs utilized in year 1 and year 2, this program notably featured higher loads but fewer repetitions for each set performed. Fourth-year athletes utilized a modified form of concurrent periodization, focusing on one dynamic effort and one maximal effort session per week for the upper body, and one dynamic effort and one maximal effort session per week for the lower body. Dynamic efforts generally involved using submaximal loads lifted with the intent of moving the load as rapidly as possible, thereby prioritizing power development. Maximal efforts involved using loads as heavy as possible to complete a given number of repetitions, generally ranging from 1–5 repetitions, thereby facilitating maximal strength development. During the spring semester, this was done by utilizing a modified tier system to complete the four sessions over three days. During the summer semester, this was done in the traditional 4-day split.

Nutrition—Throughout the career, all athletes had access to a number of nutrition services provided to support their performance and development. All athletes had access to the services of a certified sports nutritionist, which included educational information and individualized nutrition counseling as needed. Athletes also had access to a dining area that provided dinner and snacks within the guidelines established and enforced by the NCAA. Additionally, athletes had access to NCAA-approved items including nutrition bars, generally offered prior to workouts, and recovery shakes, which were typically offered following workouts.

Statistical Analyses

For longitudinal changes within one year, parametric tests were used for all analyses based on sufficiently large sample size (n=57). Changes were evaluated using repeated measures analyses of variances (ANOVAs), with a Greenhouse-Geisser correction applied for any violations of the sphericity assumption. In the event of a significant omnibus ANOVA, post hoc comparisons were completed using pairwise t-tests with a Benjamini-Hochberg p-value correction to control for false discovery rate with multiple comparisons. For changes across a career, a Shapiro-Wilk test was used to assess the normality of each dependent variable. Normally distributed variables were analyzed using the parametric tests described above. Due to small sample size (n=13), longitudinal changes in non-normal variables were analyzed using a series of Friedman tests. In the event of a significant Friedman test, post hoc comparisons were made using Conover's test with a Benjamini-Hochberg p-value correction. Statistical analyses were performed using R software (Version 3.2.2, R Foundation for Statistical Computing, Vienna, Austria), with statistical significance set *a priori* at $\alpha = 0.05$.

Results

Changes across one year (n = 57)

Significant increases between time points were observed for LM, BMC, and BMD (all $p < 0.05$). Lean mass increased from May to Pre-Season, with a more pronounced change from Pre-Season to March-Post. Both BMC and BMD increased incrementally over time, with March-Post values significantly greater than March-Pre. Significant reductions were observed for BF%, FM, AND, and GYN (all $p < 0.05$). Body fat percentage increased slightly from March-Pre to May, before significantly dropping at the Pre-season and March-Post time points. Changes in FM, AND, and GYN mirrored this time course, with slight increases from March-Pre to May, followed by reductions at the Pre-Season and March-Post time points. No significant changes were observed for weight ($p > 0.05$). Values for the full sample are listed in Table 1; values for individuals classified as linemen or non-linemen are also listed to allow for comparison, as these groups are likely to have large baseline differences and potentially divergent goals for body composition changes.

Changes across a career (n = 13)

Weight and AND were non-normal ($p < 0.05$). Weight increased from year 1 to 2 (106.0 ± 19.9 to 109.3 ± 20.2 kg; $p < 0.05$) and 2 to 3 (109.3 ± 20.2 kg to 112.2 ± 23.0 kg; $p < 0.05$), but not from 3 to 4 (112.2 ± 23.0 to 112.6 ± 21.1 kg; $p > 0.05$; Figure 1). Weight gain over the full career was slightly greater in linemen than non-linemen (Δ=8.5 ± 5.4 and Δ=5.4 ± 2.7 kg, respectively). Omnibus ANOVAs indicated significant time effects for FM and BF %, but no pairwise comparisons were significantly different for either variable (all $p > 0.05$). Lean mass increased significantly, with LM at year 4 (83.7 ± 8.2 kg) significantly greater than years 1, 2, and 3 (79.4 ± 7.4, 80.6 ± 7.1, and 80.6 ± 7.8 kg, respectively; all $p < 0.05$; Figure 2). Lean mass changes over the full career were larger in linemen than non-linemen (Δ=6.2 ± 3.2 and Δ=3.1 ± 2.4 kg, respectively). Individual changes for weight and LM are presented in Figures 1 and 2. Android fat did not change significantly over the full career ($p < 0.05$). The omnibus test suggested a significant time effect for GYN ($p < 0.05$), but no pairwise comparisons were significantly different (all $p > 0.05$). For all measures of adiposity (BF%, FM, AND, GYN), small and non-significant increases were observed in both linemen and non-linemen sub-groups. Bone mineral content increased significantly, with BMC at year 1 (4.55 ± 0.55 kg) lower than years 2, 3, and 4 (4.65 ± 0.56, 4.73 ± 0.62, and 4.74 ± 0.54 kg, respectively; all $p < 0.05$). For BMC, the magnitude of change was greater in non-linemen compared to linemen (Δ=0.22 ± 0.18 and Δ=0.13 ± 0.15 kg, respectively). Bone mineral density increased significantly; BMD at year 4 (1.543 ± 0.080 $g \cdot cm^{-2}$) was greater than at year 1 (1.510 ± 0.105 $g \cdot cm^{-2}$; $p < 0.05$) and 3 (1.527 ± 0.076 $g \cdot cm^{-2}$; $p < 0.05$). Non-linemen experienced a slightly greater increase in BMD compared to linemen (Δ=0.036 ± 0.04 and Δ=0.028 ± 0.05 $g \cdot cm^{-2}$, respectively).

Discussion

In the current study, favorable changes in body composition were observed over one calendar year in Division I collegiate football players. Although weight did not change significantly, BF% was significantly reduced with a concomitant increase in LM from off-season (March-Pre) to March of the following year (Table 1). Gynoid fat was significantly reduced over the course of the year, and a nonsignificant drop was also observed in android fat, while BMC and BMD both improved to a significant degree (Table 1). Favorable body composition changes were also observed over the course of a 4-year career. Weight increased significantly (Δ = 6.6 ± 4.1 kg), while modest increases in FM, BF%, AND, and GYN were not statistically significant. Lean mass increased significantly (Δ = 4.3 ± 3.0 kg), with a particularly large increase observed between years 3 and 4 (Δ = 3.1 ± 2.5 kg). Finally, both BMC and BMD improved significantly over the course of a playing career. When comparing linemen to non-linemen, body composition changes were similar, with modest differences observed in the magnitude of changes. Taken together, results of the current study indicate that Division I collegiate football players experience favorable changes in body composition over a single calendar year and a 4-year playing career.

Lean mass changed throughout a single year, with significant increases observed between May and Pre-season, and between Pre-Season and March-Post. Training is often intensified in the months directly preceding the season, which explains significant LM increases at the Pre-Season time point. These results may help to explain why Binkley et al. (5) previously observed significant LM losses from pre- to post-season. The intensified training preceding the season is likely to optimize body composition in preparation for competition, but increases in sport-specific practices, drills, and meetings during the competitive season inherently require a reduced emphasis on resistance training. As such, periodized programs typically apply a “maintenance phase” during the competitive season, which involves increased training intensity and reduced volume in attempt to maintain off-season improvements (15). While the results of Binkley et al. (5) indicate that LM may be lost during the competitive season, Hoffman and colleagues (12) have not observed such a reduction, and have shown that strength can be maintained or even improved during the competitive season (12, 15). Based on the timeline of the current study, it is possible that LM dropped during the season, but rebounded above baseline between January and March. However, the results of the current study support previous work indicating a net gain in LM between pre-season and the following spring (5), suggesting that current strength and conditioning methods are effective in supporting longitudinal LM increases across a single year (34).

Over a 4-year career, LM increased by an average of 4.3 kg. This magnitude of change is similar to other 4–5 year longitudinal studies in college football players, in which increases of approximately 5–6 kg have been reported in the first four years (13, 18, 34). The largest change in the current study occurred between the final years of the career, which mirrors the results of Hoffman et al. (13) but contradicts others (18, 27, 34). For example, Miller et al. (27) found that strength outcomes increased most dramatically during the first 1–2 years of the collegiate football career in a Division I football team, although the time course of body composition changes were not described in detail. Stodden et al. (34) found that the largest increases in LM were observed between year 1 and 2 of the career (Δ = 3.6 kg), while changes from year 3 to 4 were minimal (Δ = 0.04 kg). Jacobson et al. (18) also found greater LM changes early in the career, with changes from year 1 to 2 (Δ = 6.0 kg for linemen, 6.5 for non-linemen), greater than changes from year 3 to 4 (Δ = 1.8 kg for linemen, −0.8 kg for non-linemen).

Discrepancies in the time course of LM improvements between the current study and previous literature may be related to baseline physical preparedness of recruits, competition level of each team, or the NFL draft prospects of each sample. The group sampled for career data in the current study was part of a freshman cohort that was ranked nationally as a top-25 recruiting class by a reputable recruiting network (*Rivals.com*). This may indicate a high level of physical preparedness prior to arrival, and therefore a lower likelihood of immediate and pronounced changes in body composition. For this cohort, the team reached a top-15 national ranking in NCAA Division I in years 3 and 4. It is therefore possible that expectations to compete for conference and even national titles may have influenced motivational factors pertaining to training. Of the 13 athletes with career data available, eight were listed as potential draft prospects by a reputable sports media company (*ESPN.com*) upon graduating (2 WR, 2 DL, 2 OL, 1 DB, 1 RB); five of these athletes received offers for NFL contracts (2 WR, 1 DL, 1 OL, 1 RB). As such, external motivation relating to competition for limited NFL roster spots may have influenced training practices late in the collegiate career, which would theoretically explain the observed increase in LM toward the end of the collegiate playing career. Within the current study, the discordant time course for LM changes could also be attributed to differences between training programs implemented, as the program varied from year to year. Such an explanation might indicate that the year 4 program, which incorporated a combination of maximal and dynamic effort emphasis, was particularly effective in increasing LM. Differences in the magnitude and time course of changes between studies could also relate to differences in nutrition practices, training program implementation, or measurement devices used for body composition estimation (13, 18, 34). While more research is needed to further investigate factors relating to the time course of LM adaptations, research collectively indicates that significant increases in LM are achieved across a playing career in college football players.

In the current study, increases in LM within one training year were not accompanied by significant weight increases. Fat mass was significantly reduced from May to Pre-Season and March-Post, and BF% reductions were observed across the year. Previous studies by Hoffman et al. (12, 14, 15) have examined weight changes from pre-season to post-season, observing no significant changes. Conversely, Stodden et al. (34) generally observed weight increases throughout the training year of approximately 1–3 kg, while Binkley et al. (5) found that weight dropped ($\Delta = -1.3$ kg) from pre- to post-season, then slightly increased ($\Delta = 0.6$ kg) from post-season to spring. While changes in total body mass appear to be somewhat variable but modest in magnitude, the current study supports previous data indicating that football players can increase LM within a single training year while simultaneously experiencing losses or minimal changes in FM (5, 34). Over the course of a career, the current study found a similar relationship in which weight and LM increased significantly, without significant increases in FM or BF%. These results mirror previous 4–5 year longitudinal studies (13, 18, 34), suggesting that college football players can substantially increase LM with minimal increases in FM when placed in a well-designed strength and conditioning program.

Previous cross-sectional football studies have noted that compared to other common body composition devices, DEXA confers the additional benefits of allowing bone and regional fat analysis (7, 9). These features may be particularly important in football players, as they are at elevated risk for obesity-related health complications (2, 6, 26), and bone density is inherently important in such a high-impact contact sport. Findings of the current longitudinal study suggest favorable changes in BMC and BMD, with significant increases observed within a single year and across a full career. It is important to track changes in AND and GYN, as these regional indices of adiposity are more closely related to disease risk than whole-body indices of adiposity, such as body mass index (30). In the current study, there was a significant but modest reduction in GYN within a year, with no other significant changes observed across a year or a career. These outcomes appear to indicate that players were able to favorably increase LM while avoiding deleterious increases in total and regional indices of adiposity.

While the current study addresses multiple gaps in the current literature, its limitations must be noted. It would be preferable to include an additional session of data collection immediately following the competitive season, but these data are not available. Despite this limitation, the current study features time points spanning a full calendar year, which builds upon previous studies that exclusively evaluated the pre- and post-season time points. Although previous literature has established relationships between body composition and physical performance (4, 8, 27), the current study is limited by a lack of available performance data to evaluate. In addition, the sub-sample for 4-year data collection features a small sample size. This may limit the generalizability of changes observed over the career, but allows for the plotting of individual changes (Figure 1, Figure 2), which provides valuable information for the strength and conditioning practitioner that is not feasible with larger samples. Finally, goals pertaining to body composition changes can be highly specific to the individual athlete, and are often influenced by baseline body composition and position. While the current study cannot account for the specific goals and needs of each individual athlete, trends for the overall team have been assessed, and data are presented to demonstrate changes specific to linemen and non-linemen, along with individual changes for key variables (Figure 1, Figure 2).

In conclusion, the current study utilized DEXA to investigate longitudinal body composition changes in Division I college football players over one full year, and over a 4-year playing career. Overall, results indicate that college football players may achieve favorable increases in LM, BMC, and BMD without deleterious increases in total or regional FM. Increases in LM, BMC, and BMD may confer benefits related to performance and injury prevention, and can be obtained without unwanted fat gain that may have adverse effects on speed and long-term disease risk. In the future, researchers should seek to implement annual body composition testing programs to further our knowledge of longitudinal changes in collegiate football players.

Practical Applications

College football teams should implement strength and conditioning programs designed to optimize performance and body composition. Such programs are likely to have favorable effects on performance and injury risk, maintain strength during the competitive season, and facilitate improvements in LM, BMD, and BMC across a single season and across an entire playing career. Importantly, it would appear that appreciable improvements in body composition are possible late in the playing career, even in well-trained athletes at the highest levels of college football. When possible, strength and conditioning practitioners should work closely with nutrition practitioners to ensure that athletes are receiving adequate nutrition and consuming diets that closely match their body composition goals, thereby facilitating appropriate changes in LM, FM, and bone characteristics. Longitudinal testing of body composition may be valuable for tracking progress and evaluating training and nutrition practices in college football programs.

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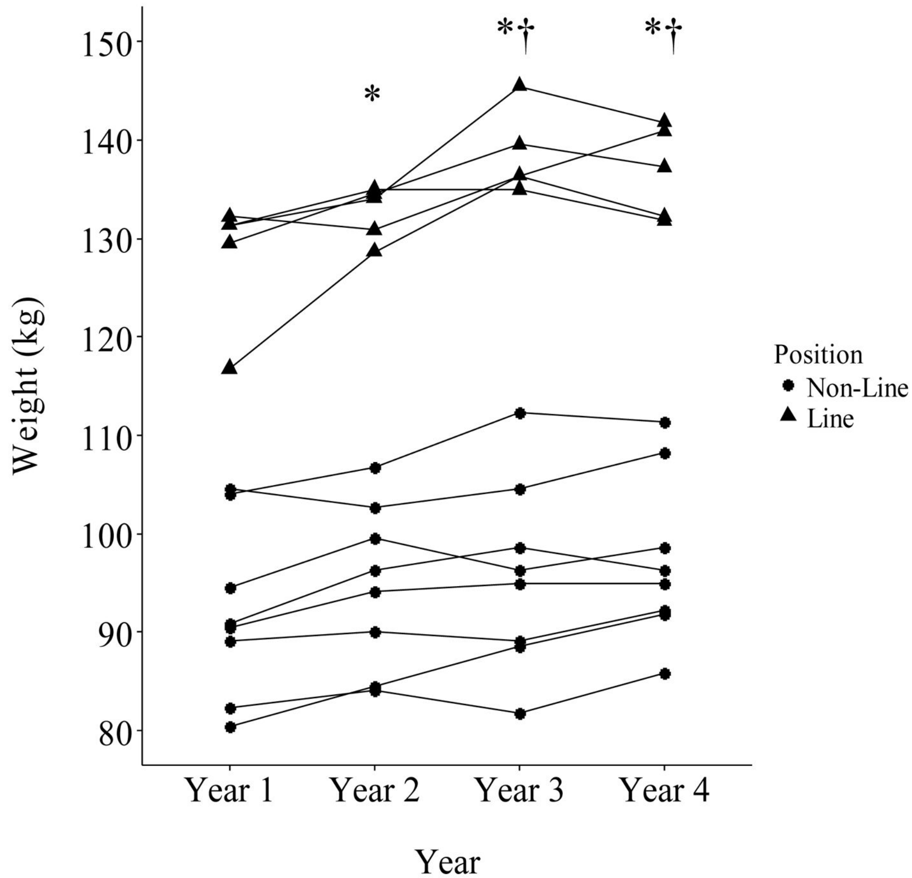

Figure 1.

Individual changes in weight across a career. *Significantly different than year 1 ($p < 0.05$); †Significantly different than year 2 ($p < 0.05$).

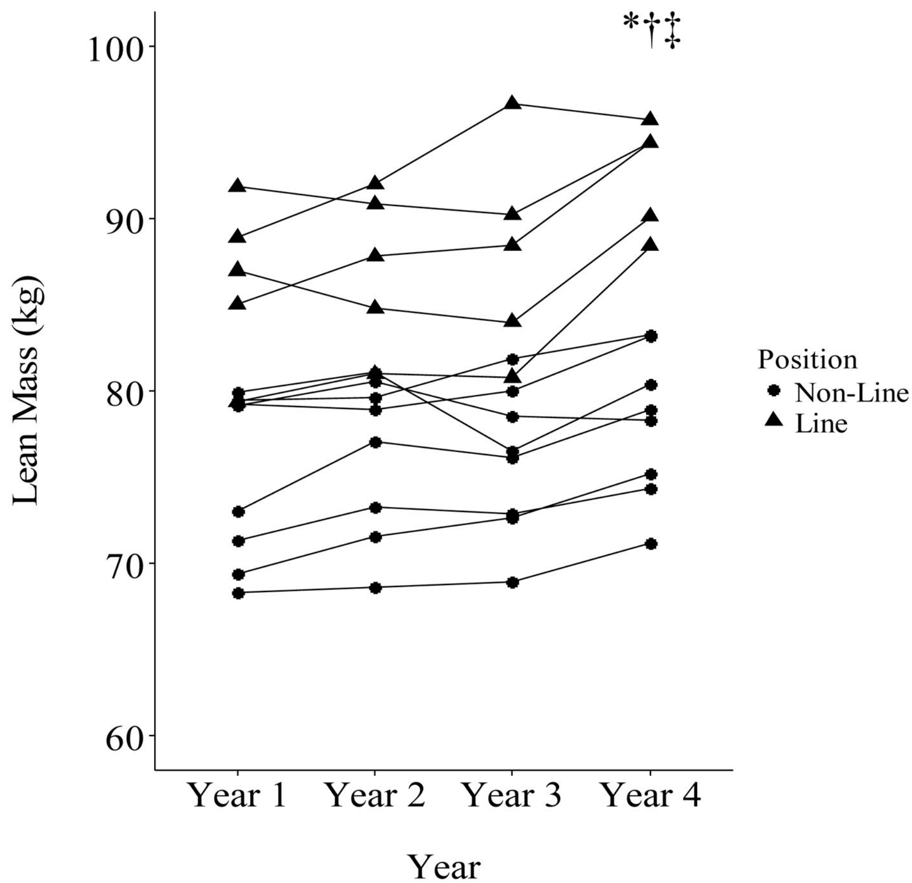

Figure 2.

Individual changes in lean mass across a career. *Significantly different than year 1 ($p < 0.05$); †Significantly different than year 2 ($p < 0.05$); ‡Significantly different than year 3 ($p < 0.05$).

Table 1

Body composition changes across one year. Values are Mean ± SD.

Time	Weight (kg)	BF% (%)	Fat Mass (kg)	Lean Mass (kg)	Android (%)	Gynoid (%)	BMC (kg)	BMD ($g \cdot cm^{-2}$)
March-Pre	**107.7 ± 19.1**	**20.0 ± 8.4**	**22.5 ± 12.8**	**79.5 ± 7.1**	**25.9 ± 12.2**	**23.8 ± 8.5**	**4.74 ± 0.59**	**1.537 ± 0.09**
	L: 129.8 ±11.9	L: 29.3 ±5.4	L: 37.2 ± 9.1	L: 84.7 ±7.3	L: 39.6 ±7.6	L: 32.8 ±5.4	L: 5.18 ± 0.57	L: 1.545 ± 0.09
	NL:95.7 ± 8.5	NL: 14.9 ± 4.3	NL: 14.5 ± 5.0	NL: 76.7 ± 5.3	NL: 18.5 ± 6.2	NL: 19.0 ± 5.2	NL: 4.51 ± 0.45	NL: 1.533 ± 0.09
May	**107.3 ± 19.2**	**20.2 ± 8.2**	**23.0 ± 12.8**	**79.7 ± 7.4**	**26.5 ± 11.9**	**24.4 ± 8.3**	**4.77 ± 0.60**	**1.547 ± 0.10**
	L: 129.4 ± 12.4	L: 29.0 ± 5.4	L: 37.6 ±9.1	L: 85.5 ±7.1	L: 39.1 ±7.8	L: 32.5 ±6.0	L: 5.19 ±0.61	L: 1.569 ±0.12
	NL: 95.4 ± 8.7	NL: 15.5 ± 4.7	NL: 15.1 ± 5.6	NL: 76.6 ± 5.3	NL: 19.7 ± 7.3	NL: 20.0 ± 5.6	NL: 4.55 ± 0.46	NL: 1.534 ± 0.08
Pre-Season	**107.7 ± 18.7**	**19.3 ± 8.2** *†	**22.0 ± 12.5** †	**80.6 ± 7.5** *†	**25.3 ± 12.1** †	**23.1 ± 8.6** †	**4.76 ± 0.57**	**1.543 ± 0.09**
	L: 129.0 ±12.4	L: 28.0 ± 5.9	L: 35.9 ± 9.4	L: 85.8 ± 8.0	L: 38.4 ± 8.4	L: 31.3 ± 6.4	L: 5.12 ±0.57	L: 1.560 ±0.09
	NL: 96.2 ± 8.6	NL: 14.6 ± 4.7	NL: 14.5 ± 5.5	NL: 77.8 ± 5.6	NL: 18.2 ± 6.7	NL: 18.6 ± 6.0	NL: 4.56 ± 0.46	NL: 1.534 ± 0.08
March-Post	**108.1 ± 18.7**	**18.7 ± 8.2** *†‡	**21.6 ± 12.8** †	**82.3 ± 7.4** *†‡	**24.9 ± 12.1** †	**22.3 ± 8.3** *†	**4.80 ± 0.57** *	**1.552 ± 0.09** *‡
	L: 129.7 ±12.0	L: 27.7 ± 5.6	L: 36.3 ± 9.2	L: 88.0 ± 7.3	L: 38.4 ± 7.8	L: 31.3 ± 5.6	L: 5.20 ± 0.54	L: 1.566 ± 0.09
	NL: 96.4 ± 8.2	NL: 13.7 ± 4.1	NL: 13.6 ± 5.0	NL: 79.2 ± 5.3	NL: 17.6 ± 6.2	NL: 17.5 ± 4.7	NL: 4.58 ± 0.46	NL: 1.545 ± 0.09

Statistical tests performed on values for whole team (bold); L = values for linemen, NL = values for non-linemen. BF% = body fat percentage, BMC = bone mineral content, BMD = bone mineral density.

* Significantly different than March-Pre ($p < 0.05$);

† Significantly different than May ($p < 0.05$);

‡ Significantly different than Pre-Season ($p < 0.05$)