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Obesity on the line! An analysis of high school linemen recruited to play for “Power Five” schools

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Abstract

Purpose: This article explored the changing body sizes of high school football linemen recruited to play for "Power 5" schools between 2003 and 2020 when factoring in the position group. This study also allowed for a cross-sectional analysis to explore body size differences within and between "Power 5" conferences. Methods: The dataset contained 7,428 linemen, and a cross-sectional design was used to examine position and conference affiliation related

to the differences in height, weight, and Body Mass Index over three time periods. Statistical analysis was conducted using nonparametric Kruskal-Wallis H tests and post-hoc analysis with Bonferroni correction for pairwise comparisons. Results: The results showed that while height did not significantly change, weight continued to increase, particularly among defensive tackles, offensive centers, and guards. Conclusions: In some “Power 5” conferences, the number of linemen recruits weighing more than 300 pounds had more than doubled over this period. This adds to the player obesity discussion and the systematic issues that allow linemen to continue to play at weight levels categorized as obese, with little apparent regard for the risk of injury or long-term health implications. Application in Sport: College football decision-makers will be able to use the results of this study to demonstrate a need for new health protocols and policies that reduce the number of obese and significantly overweight linemen.

Keywords: college football, BMI, health risk

INTRODUCTION

Research regarding football players and the measurements and proportions of their bodies (Anthropometrics) has been extensive in the exercise science literature. However, little research has focused specifically on linemen at a conference level and the potential systematic issues that could be created when schools try to keep up with their competition. Therefore, this study focused on investigating the changing physical parameters of high school linemen recruited to play for a school in an NCAA Division I – Football Bowl Subdivision (FBS) Autonomous Conference, commonly referred to as the “Power 5 Conferences.” The “Power 5” conferences include the Atlantic Coast Conference (ACC), the Big 12 Conference (Big 12), the Big Ten Conference (Big Ten), the Southeastern Conference (SEC), and the Pacific 12 Conference (Pac 12).

Exercise science studies show how football players’ bodies have changed over time. One of the earliest studies, by Wilmore and Haskell (47), examined the body composition and endurance of professional football players in the early 1970s, finding that only defensive linemen had lower endurance capacity. The researchers partially attributed the lower endurance to the high relative body fat in the defensive linemen. Additional studies that combined anthropometric measurements such as height, weight, Body Mass Index (BMI), or Body Fat Percentage (BF%) with performance measurements such as the 40-yard dash, Vertical Jump, One-Rep Max Bench Press, or the 3-Cone Drill have been utilized to assess football players at various levels including high school (7, 26, 32), at the college level (11, 19, 21, 31, 36, 37, 41, 42), and on players invited to the National Football League’s (NFL) Draft Combine (9, 12, 18, 39). One of the foundational questions in most of these studies has always focused on the current size of players.

Anzell and Potteiger (2) went as far back as 1942 to explore the changes in body composition of both college and professional football players and found significant increases in height and body composition in college linemen. BMI is obtained by using a person's weight and height to classify their body size into categories of Normal, Overweight, or Obese. The categories have been used for almost 200 years. The formula for Imperial BMI is BMI = (body weight (lbs.) x 703.1) / height $(in)^2$. Once a BMI score has been established, the National Institutes of Health's longstanding BMI guidelines can be used to classify an individual as Normal weight if they have a BMI of 18.5-24.9, Overweight if they have a BMI between 25-29.9, Class 1 Obese for those with a BMI of 30-34.9, Class 2 Obese for a BMI between 35-39.9, or Class 3 Obese for those with a BMI ≥ 40.

Only a few studies have examined body size changes in football players over several years or decades. At the high school level between 1963 and 1989, research showed that the BMI of All-American interior linemen increased by more than four points, reaching a BMI of 32.0 (Class 1 Obese), with their weight increasing from a mean of 213 pounds to 268 pounds (45). Elliott and Harmatz (8) studied the body composition of NCAA Division III football players between 1956 and 2014 and found that the average offensive linemen's weight increased from 192 pounds to 264 pounds during the 58-year period, resulting in 90% of the offensive linemen having BMI scores above 30.0 which would classify them as obese.

However, BMI is not capable of differentiating between body fat and lean, fat-free mass (muscle mass, for example) (20). Thus, the use of BMI on football players can be deceptive (25). Therefore, studies using BMI on an entire football population, regardless of playing position, can produce eye-catching results but might exaggerate the obesity rate for that population. For instance, the Journal of the American Medical Association (JAMA) published a research letter by Harp and Hecht (17) in which they applied the BMI formula to all National Football League (NFL) players that participated in the 2003-2004 season and found that 97% would have been classified as either overweight or obese. Thus, BMI is an imperfect indicator of healthy body parameters for many athletes, including most football players. However, it can be used to indicate potentially unhealthy physical parameters for the heaviest players, specifically those playing on the offensive and defensive lines. For instance, Allen and Vogel (1) found a strong relationship between BMI and BF% among a population of 504 veteran NFL players, particularly among the offensive linemen and the interior defensive linemen. Furthermore, many of the BF% measurement studies on football players that separated players into position groups either highlighted or at least acknowledged that the average linemen had elevated levels of BF% and that their weight was a cause for concern (16, 22-25, 27, 33, 40, 46).

The increased size of football linemen over time, regardless of BMI or BF% labels, still presents major health concerns, especially if players do not reduce excess weight after their playing days end (15). Selden and Helzberg (38) studied 3,850 professional football players and found that 28% of those in the obese group died before the age of 50, and 22% of these deaths were caused by cardiovascular disease. When Baron and Hein (3) studied NFL

retirees, the results showed that players with BMIs greater than 30 while they played had twice the risk of cardiovascular disease compared to players with lower BMIs, and the defensive linemen had a 42% higher mortality rate when compared to the United States population. In their study of NFL linemen's hearts, Croft and Belanger (5) discovered that linemen had a 52% greater risk of cardiovascular mortality compared to the general population and a 3.7-fold greater risk of death from heart disease when compared to other position players.

Research has also been conducted on the major health concerns of heavier football players at the college level. Linemen at the college level, in general, appear to be at greater risk for hypertension. One study found that 80% of linemen fell into the borderline hypertensive category when compared to only 40% of linebackers and 30% of all other players on one team (34). Similarly, Buell and Calland (4) studied college linemen from all three NCAA divisions and discovered that these players showed signs that indicated they should be screened for metabolic syndrome (a clustering of symptoms associated with abdominal adiposity, which is correlated with high blood pressure, insulin resistance, and impaired glucose metabolism, among others major health problems). In addition to the concerns of long-term health issues, heavier players are at greater risk of injury to their lower extremities. Gribble and Terada (14), for example, studied 606 football players from high school and college and their findings showed that players with higher BMI scores had significantly more lateral ankle sprains (a 2-fold increase) than players in the lower BMI group. Gómez and Ross (13) also found that heavier high school linemen had a significantly greater likelihood of lower extremity injuries. Furthermore, Tyler and Mchugh (44) studied high school athletes and observed that the risk of noncontact ankle sprains increased not only due to weight, but also if a player had suffered a previous ankle injury. The overweight players with a prior ankle sprain were 19 times more likely to suffer a subsequent sprain than the normal-weighted players without a prior sprain.

Football requires a variety of body types on both the offensive and defensive sides of the ball, with most positions "mirroring" the body size of their counterpart on the other side of the line (24). For instance, Kraemer and Torine (24) found that linebackers had similar body measurements as tight ends and running backs, and this "Mirror Effect" could also be seen between offensive and defensive linemen. Unfortunately, research focusing on player positions differed in the way linemen have been grouped and analyzed, with most studies either placing offensive and defensive linemen together as a single group (i.e., linemen) or separating the offensive line and the defensive line into two separate groups. There have only been a few studies that separated interior defensive linemen (defensive tackles and defensive ends) into different groups (1, 8, 12, 26, 48).

The data from these studies revealed a clear difference in the size of these two positions, with defensive ends having body types that are closer in physical parameters to linebackers and tight ends (28). Tucker and Vogel (43) even acknowledged that in their study defensive tackles were found to be comparable to offensive linemen, while defensive ends had much

lower BMIs, but they grouped them together (defensive line) because previous literature had grouped them that way. This conclusion raises questions about previous findings from studies that placed the defensive line into one single homogenous group, as this grouping might have caused defensive ends to mask greater weight and health issues of the defensive tackles.

Therefore, the primary purposes of this study were to (a) investigate body size changes of linemen recruited to play in the “Power 5” when factoring in position group, (b) to perform a cross-sectional analysis to explore body size differences within and between “Power 5” conferences, and (c) to extend the research on a specific athletic population (linemen) whose physical parameter requirements tend to lead to higher risks of injury and long term health consequences.

The following research questions framed the current study:

RQ 1 – Have the physical parameters of height (HT), weight (WT), or Body Mass Index (BMI) changed over time for high school linemen recruited to play for a “Power 5” school when grouped by specific positions?

RQ 2 – Have the physical parameters of HT, WT, or BMI changed over time within conferences for high school linemen recruited to play for a “Power 5” school when grouped by positions and stratified by time periods?

RQ 3 – Have the physical parameters of HT, WT, or BMI changed over time between conferences for high school linemen recruited to play for a “Power 5” school when grouped by positions and time periods?

METHODS

Subjects

Subjects for this study included high school football linemen who were recruited to play for a “Power 5” school between the years 2003 and 2020. The specific position the linemen were recruited to play was utilized to differentiate the players into position groups which included defensive ends (DEs), defensive tackles (DTs), offensive centers/guards (OCGs), and offensive tackles (OTs).

Data Collection

Archival recruiting data derived from ‘247 Sports’ was aggregated and made available on a publicly available website (collegefootballdata.com). ‘247 Sports’ is a well-established high school recruiting website with data going as far back as 1999 (32). The overall dataset contained over 25,000 players listed as Division I recruits between 2003 and 2020. Extracting the linemen yielded a large dataset (n = 7,428) for this study. Between 2003 and

2020, conference affiliation for some schools currently in the “Power 5” has changed. Therefore, each player was coded with the conference his school was in for the year he was recruited to the team.

Procedures

A cross-sectional design was used to examine position groups and conference affiliation for differences in height (HT), weight (WT), and Body Mass Index (BMI). The HT and WT listed for each lineman were used to calculate their (BMI) using the Imperial BMI formula. Linemen were placed into one of three time periods to allow for comparisons over time. Time periods were utilized because a college football team does not recruit an entirely new team each year, and the dataset contained 18 years of data; therefore, the researchers created three equal time periods of six years each to aid in the analysis. Independent variables included conference (ACC, Big 10, Big 12, SEC, and the Pac 12), position (DE, DT, OCG, OT), and time periods (P1 (2003-2008), P2 (2009-2014), and P3 (2015-2020). Dependent variables included HT, WT, and BMI. All statistical analyses were performed using SPSS version 28.0 (IBM SPSS, IBM Corp., Armonk, NY, USA), and an alpha of $p \leq 0.05$ was considered significant for all analyses. Exploratory analyses were conducted to establish whether the data met parametric assumptions, to assess data normality and homogeneity, Kolmogorov-Smirnov and Levene’s tests were applied to all three dependent variables’ distributions. All three dependent variables of height (HT), weight (WT), and Body Mass Index (BMI) had slightly skewed distributions, and homogeneity assumption of variances were rejected when categorized by position group (DE, DT, OCG, OT), conference (ACC, Big 10, Big 12, SEC, Pac 12) and stratified by time periods (P1, P2, and P3). Therefore, statistical analysis was completed using the nonparametric Kruskal-Wallis *H* test and post-hoc analysis with Bonferroni correction for pairwise comparisons.

RESULTS

Descriptive Statistics

Overall, the dataset included 7,428 linemen with 2,305 players listed as DE (31.04%), 1,458 listed as DT (19.63%), 1,681 in the combined position category of OCG (OC/OG; 22.63%) and 1,983 players listed as OT (26.70%). The ACC conference accounted for 1,567 of the linemen (21.10%), the Big 12 had 1,295 (17.43%), the Big Ten had 1,525 (20.53%), the Pac 12 had 1,327 (17.86%), and the SEC was represented by 1,714 linemen (23.07%).With the data’s nonparametric distributions, the descriptive statistics included medians and were calculated for all three measurements of HT, WT, and BMI.

The descriptive statistics were presented by each position group, categorized by conference, and stratified by time periods to provide an overview of body parameter changes of linemen between 2003 and 2020. Rushin (35) used the 300-pound threshold for NFL linemen as a

benchmark in 1995. Therefore, an initial frequency count of the dataset was performed to see what percentage of players at each position had traversed the 300-pound threshold.

Table 1 provides the overall percentages of 300-pound high school linemen for each position, as well as the conference breakdown. Altogether, interior linemen (DTs and OCGs) showed consistent growth in the percentage of recruits coming into college weighing more than 300 lbs. When examined by conference, the percentage of DTs weighing greater than 300 lbs. from the SEC more than doubled to 49%, and OCGs from the SEC eclipsed the 50% mark in Period 3. The data also provides evidence that DEs are substantially different from the other linemen, with a drastically smaller number of them weighing 300 lbs. or more.

Table 1

Percentage of linemen that weighed 300 lbs. or more when grouped by position, conference, and stratified over time periods

POS	Time Period	N	Overall %	ACC	Big 12	Big Ten	Pac 12	SEC
DE	P1 (2003-2008)	626	0.64%	0.00%	0.00%	0.88%	0.95%	1.41%
	P2 (2009-2014)	794	0.25%	0.00%	0.00%	0.00%	0.00%	1.02%
	P3 (2015-2020)	886	0.34%	0.50%	0.00%	0.00%	0.00%	1.05%
DT	P1 (2003-2008)	420	20.24%	29.33%	21.35%	14.46%	12.99%	22.92%
	P2 (2009-2014)	494	23.28%	26.73%	8.43%	21.57%	19.28%	34.40%
	P3 (2015-2020)	544	31.62%	23.88%	31.88%	15.45%	34.88%	48.97%
OCG	P1 (2003-2008)	551	27.40%	20.56%	30.00%	25.29%	25.71%	33.61%
	P2 (2009-2014)	558	32.80%	23.68%	41.18%	23.36%	29.06%	45.93%
	P3 (2015-2020)	572	39.69%	34.71%	39.77%	33.60%	35.09%	54.84%
OT	P1 (2003-2008)	522	33.14%	38.39%	30.77%	33.03%	16.25%	43.27%
	P2 (2009-2014)	645	24.65%	25.18%	21.49%	22.83%	23.58%	29.63%
	P3 (2015-2020)	816	30.39%	27.27%	24.79%	23.53%	23.45%	47.98%

Table 2 provides the medians for DEs by conference over time. The data shows that this position group stayed relatively consistent in HT, WT, and BMI over the three time periods. This was the only position group that did not see any significant body size changes over time. Tables 3 to 5 provide the medians for the other three position groups, and while median HT remained relatively consistent, there were significant changes in median WT and BMI between time periods. With the Big 12, Pac 12, and SEC DTs median BMI scores over 36 points (Obesity Class II classification) in Period 3.

Table 2

Anthropometric Medians by Time Period and Conference for Defensive Ends (DE)

	Time Period	ACC	Big 12	Big Ten	Pac 12	SEC
Height (inches)	P1	76.00	76.00	76.00	76.00	76.00
	P2	76.00	76.00	76.00	76.00	76.00
	P3	76.00	76.00	76.00	76.00	76.00
Weight (lbs.)	P1	240.00	238.00	240.00	240.00	241.50
	P2	238.00	235.00	240.00	240.00	240.00
	P3	240.00	240.00	240.00	240.00	243.00
BMI	P1	29.40	29.10	29.00	29.00	29.70
	P2	29.00	28.90	29.00	29.30	29.70
	P3	28.90	29.20	29.00	29.20	29.40
N	2306	489	441	460	402	514

Table 3

Anthropometric Medians by Time Period and Conference for Defensive Tackles (DT)

	Time Period	ACC	Big 12	Big Ten	Pac 12	SEC
Height (inches)	P1	75.00	75.00	75.00	75.00	75.00
	P2	75.00	75.00	75.00	75.00	75.00
	P3	75.00	75.00	75.00	75.00	75.00
Weight (lbs.)	P1	285.00	280.00	280.00	280.00	285.00
	P2	285.00	280.00	280.00	280.00	287.00
	P3	285.00	290.00	281.50	287.00	298.00
BMI	P1	35.30	34.70	35.00	35.00	35.80
	P2	36.20	35.00	35.00	35.60	36.20
	P3	35.60	36.60	35.10	36.50	36.60
N	1458	331	246	254	294	333

Table 4

Anthropometric Medians by Time Period and Conference for Offensive Centers and Guards (OCG)

	Time Period	ACC	Big 12	Big Ten	Pac 12	SEC
Height (inches)	P1	76.00	76.00	76.00	76.00	76.00
	P2	76.00	76.00	76.00	76.00	76.00
	P3	76.00	76.00	76.00	76.00	76.00
Weight (lbs.)	P1	285.00	290.00	280.00	285.00	288.50
	P2	285.00	290.00	285.00	290.00	295.00
	P3	290.00	295.00	288.00	289.50	300.50
BMI	P1	34.40	35.40	34.40	34.80	35.60
	P2	35.00	35.60	34.70	35.30	36.40
	P3	35.60	35.90	35.00	35.30	37.10
N	1681	370	283	368	288	372

Table 5

Anthropometric Medians by Time Period and Conference for Offensive Tackles (OT)

	Time Period	ACC	Big 12	Big Ten	Pac 12	SEC
Height (inches)	P1	78.00	78.00	78.00	78.00	78.00
	P2	78.00	78.00	78.00	77.00	77.00
	P3	78.00	77.00	78.00	77.50	77.50
Weight (lbs.)	P1	290.00	285.00	285.00	280.00	290.50
	P2	280.00	280.00	280.00	280.00	288.00
	P3	285.00	285.00	283.00	280.00	296.50
BMI	P1	33.50	33.50	32.90	32.40	34.10
	P2	32.80	32.70	32.40	32.60	33.50
	P3	33.50	33.50	33.20	32.80	34.70
N	1983	377	325	443	343	495

Empirical Findings

The first research question sought to determine if the physical parameters of this highly recruited group of linemen had changed over time. To give more insights into specific differences, Table 6 displays the differences in medians that were found to be significant from the analysis. Using the Kruskal-Wallis *H* (KW) test, HT of linemen showed that only one

position, OT (*median (mdn)*= 78 in.), was found to be significantly different over the three time periods ($H(2)=8.536$, $p = 0.014$). For the other three positions, HT changes were not statistically significant. Post hoc pairwise tests indicated significant differences for OTs between time periods' P2-P3′ ($p \leq 0.011$), with the difference in median decreasing by half an inch.

The KW test on WT changes over time found significant differences between time periods for DTs ($H(2)=30.823$, $p \leq 0.001$), OCGs ($H(2)=40.505$, $p \leq 0.001$), and OTs ($H(2)=13.080$, $p \leq 0.001$). Pairwise testing indicated that the largest difference in median for DTs was between 'P1-P3' (9.00 lbs., $p \leq 0.000$). Post hoc tests for OCGs showed the largest difference in median between 'P1-P3' (8.50 lbs., $p \leq 0.000$), while OTs as a group saw their median WT decrease between 'P1-P2' (4.00 lbs., $p \leq 0.041$), and then increase between 'P2-P3' (4.00 lbs., $p \leq 0.001$). The KW test for BMI changes over time also found significant differences between time periods for DTs ($H(2)=26.439$, $p \leq 0.001$), OCGs ($H(2)=32.234$, $p \leq 0.001$), and OTs ($H(2)=17.271$, $p \leq 0.001$). Pairwise tests indicated that all changes were less than one BMI point. However, the median DTs and OCGs were nearing the 36-point threshold by Period 3, and that moves a person from Obese Class I classification to Obesity Class II.

Table 6

The Anthropometric median differences of the Pairwise post hoc tests that were found to be significantly different between time periods of all linemen by position

	POS	Time Periods (A-B)	Median (A)	Median (B)	Median Difference	*p*-value
Height (inches)	OT	1-3	78	77.5	- 0.5 inches	0.011
Weight (lbs.)	DT	1-3	280.00	289.00	9.00 lbs.	0.000
	DT	2-3	283.50	289.00	5.50 lbs.	0.000
	OCG	1-2	285.00	290.00	5.00 lbs.	0.015
	OCG	1-3	285.00	293.50	8.50 lbs.	0.000
	OCG	2-3	290.00	293.50	3.50 lbs.	0.001
	OT	1-2	285.00	281.00	- 4.00 lbs.	0.041
	OT	2-3	281.00	285.00	4.00 lbs.	0.001
BMI	DT	1-3	34.99	35.93	0.94 BMI points	0.000
	DT	2-3	35.55	35.93	0.38 BMI points	0.010
	OCG	1-3	35.05	35.89	0.84 BMI points	0.000
	OCG	2-3	35.30	35.89	0.59 BMI points	0.003
	OT	2-3	32.86	33.51	0.65 BMI points	0.000

Note: The Kruskal-Wallis *H* test with Bonferroni corrections was used, and significance was set at the .05 level.

To answer the second research question, whether there were differences over time within each “Power 5” conference, the prior statistical analysis was extended from the four position groups stratified by three time periods to a 4x3x5 analysis of the dataset to include the five conference affiliations. Additional Kruskal-Wallis *H* tests and pairwise post hoc analyses with Bonferroni correction were used for the analysis as the subdivided dataset continued to show non-normal distributions. In the prior analysis, OTs as a group were the only position that showed a significant difference in HT between time periods. When subdivided by conference affiliation, DTs from the SEC between ‘P1-P3’ ($p \leq 0.015$) and OTs from the Big Ten ‘P1-P3’ ($p \leq 0.046$) were the only pairs found to show significant differences in the pairwise post hoc test. Twelve pairs from the post hoc test on WT changes were found to be significantly different when conference affiliation was added to the analysis, and those results are displayed in Table 7. There was one significant change between ‘P1-P2’, four significant changes between ‘P2-P3’, and seven significant changes in WT between ‘P1-P3.’ No significant pairs were found when analyzing WT changes for DEs or OTs. All significant pairs in WT changes were found at the DT and OCG positions. The largest median WT change occurred in the SEC between ‘P1-P3’, with the median SEC DT increasing 13 lbs. from 285 to 298 lbs. by Period 3.

Table 7

The change in medians between time periods categorized by position and conference were found to be significantly different for Weight (WT(in lbs))

POS	Conference	Time Periods			Median Difference	*p*-value
		P1 to P2				
OCG	SEC	288.50	295.00		6.50 lbs.	0.031
			P2 to P3			
DT	Big 12		280.00	290.00	10.00 lbs.	0.000
DT	SEC		287.00	298.00	11.00 lbs.	0.004
OCG	SEC		295.00	300.50	5.50 lbs.	0.015
OT	SEC		288.00	296.50	8.50 lbs.	0.000
		P1 to P3				
DT	Big 12	280.00		290.00	10.00 lbs.	0.005
DT	Pac 12	280.00		287.00	7.00 lbs.	0.017
DT	SEC	285.00		298.00	13.00 lbs.	0.000
OCG	ACC	285.00		290.00	5.00 lbs.	0.018
OCG	Big 12	290.00		295.00	5.00 lbs.	0.019
OCG	Big Ten	280.00		288.00	8.00 lbs.	0.028
OCG	SEC	288.50		300.50	12.00 lbs.	0.000

Note: The Kruskal-Wallis test with Bonferroni corrections was used with a significance level set at $p < 0.05$

The Kruskal-Wallis *H* test exploring differences over time in BMI indicated significant differences between eight subgroups when conference affiliation was included in the analysis. Table 8 displays the pairwise results. Of those eight subgroups, three had significant increases in BMI medians between P2 and P3, while the other five significant increases happened between P1 and P3. The largest increase in median for BMI points was found in Big 12 DTs between 'P1-P3', with their median increasing by 2.92 points. Four of the five significant BMI increases between 'P1-P3' saw DTs from the Big 12, Pac 12, and SEC as well as OCGs from the SEC, cross over the 36-point threshold from Obese Class I classification to Obesity Class II.

Table 8

The change in medians between time periods categorized by position and conference was found to be significantly different for Body Mass Index (BMI)

POS	Conference	Time Periods		Median Difference	*p*-value
		P2 to P3			
DT	Big 12	34.99	36.59	1.60 pts.	0.002
OCG	SEC	36.40	37.12	0.72 pts	0.014
OT	SEC	33.51	34.66	1.15 pts	0.000
		P1 to P3			
DT	Big 12	33.66	36.59	2.93 pts.	0.002
DT	Pac 12	34.99	36.48	1.49 pts.	0.011
DT	SEC	35.83	36.62	0.79 pts.	0.020
OCG	ACC	34.39	35.62	1.23 pts.	0.003
OCG	SEC	35.62	37.12	1.5 pts.	0.000

Note: The Kruskal-Wallis test with Bonferroni corrections was used with a significance level set at $p < 0.05$

To answer research question three, whether there were differences between "Power 5" conferences, the analysis was adjusted to test for differences between conferences when grouped by position for each period. Using Kruskal-Wallis *H* tests, 37 pairs were found to be significant in post hoc tests at the $p \leq 0.05$ threshold. For ease of readership, the significant pairs for periods, positions, and conferences are presented with differences in median and post hoc p-values and compiled for WT (Table 9) and BMI (Table 10). There were only four significant HT differences between conferences with two for DEs in period 2 and two for DTs in Period 3. However, there were 17 significant WT differences between conferences, one in Period 1, five in Period 2, and 11 in Period 3. Sixteen of the 17 significant differences showed the SEC outweighing the other four Power 5 conferences with the biggest difference in Period 3 with SEC DTs median weight 16.5 lbs. more than the Big Ten and the SEC OCGs

median weight 16.5 lbs. more than both the ACC and Pac 12 OCGs. The significant differences in median for BMI is similar to the WT results, with the SEC having significantly higher BMI points in 15 of the 16 significant pairs.

Table 9

The significantly different pairwise results between conferences when categorized by period and position for Weight (WT(in lbs))

Time Period	POS	Conferences			Median Difference	*p*-value
P1	OT	Pac 12	<	SEC	10.50 lbs.	0.024
P2	DE	Big 12	<	SEC	5.00 lbs.	0.037
	DT	Big 12	<	SEC	7.00 lbs.	0.008
	OCG	ACC	<	SEC	0.00 lbs.	0.003
	OCG	Pac 12	<	SEC	5.00 lbs.	0.001
	OCG	Big Ten	<	SEC	10.00 lbs.	0.000
P3	DT	Big Ten	<	Big 12	8.50 lbs.	0.034
	DT	ACC	<	SEC	13.00 lbs.	0.000
	DT	Big Ten	<	SEC	16.50 lbs.	0.000
	OCG	Big Ten	<	SEC	5.50 lbs.	0.042
	OCG	ACC	<	SEC	10.50 lbs.	0.000
	OCG	Pac 12	<	SEC	11.00 lbs.	0.000
	OCG	Big 12	<	SEC	12.50 lbs.	0.000
	OT	Big Ten	<	SEC	11.50 lbs.	0.000
	OT	Big 12	<	SEC	13.50 lbs.	0.000
	OT	ACC	<	SEC	16.50 lbs.	0.000
	OT	Pac 12	<	SEC	16.50 lbs.	0.000

Note: The Kruskal-Wallis *H* test with Bonferroni corrections was used with a significance level set at $p < 0.05$

Table 10

The significantly different pairwise results between conferences when categorized by period and position for BMI

Time Period	POS	Conferences			Median Difference	*p*-value
P1	OCG	ACC	<	SEC	0.64 pts.	0.038
	OCG	Big Ten	<	SEC	1.25 pts.	0.037
	OT	Pac 12	<	SEC	1.69 pts.	0.034
P2	OCG	Pac 12	<	SEC	1.10 pts.	0.001
	OCG	ACC	<	SEC	1.42 pts.	0.003
	OCG	Big Ten	<	SEC	1.78 pts.	0.000
P3	DT	Big Ten	<	Big 12	0.24 pts.	0.020
	DT	Big Ten	<	SEC	0.40 pts.	0.000
	OCG	Big 12	<	SEC	1.26 pts.	0.012
	OCG	ACC	<	SEC	1.50 pts.	0.000
	OCG	Pac 12	<	SEC	1.82 pts.	0.000
	OCG	Big Ten	<	SEC	2.14 pts.	0.000
	OT	Big 12	<	SEC	1.15 pts.	0.000
	OT	ACC	<	SEC	1.21 pts.	0.000
	OT	Big Ten	<	SEC	1.46 pts.	0.000
	OT	Pac 12	<	SEC	1.82 pts.	0.000

Note: The Kruskal-Wallis *H* test with Bonferroni corrections was used with a significance level set at $p < 0.05$

DISCUSSION

The findings extend prior research that shows certain linemen positions continued to get heavier over time. As previously mentioned, the method of grouping DEs and DTs into a single classification (defensive linemen) was common in past research. In this study, the DEs median weight was more than 45 lbs. less than the other linemen position groups, and their median BMI (29.21) was four points lower than the next-lowest linemen group (OTs, 33.22). Thus, DEs have body types that are similar to those of linebackers and tight ends, and not other linemen position groups, and should be analyzed either separately or with positions that are more closely related in physical attribution.

Overall, the data revealed that the players defined as DTs and OCGs became significantly heavier and increased their BMI scores between Period 1 and Period 3, while OTs physical parameters fluctuated between the three time periods. However, when conference affiliation was considered, by Period 3, the SEC was significantly heavier in almost all linemen position groups compared to the other four conferences.

A large-scale dataset analysis using BMI, like this study, cannot claim with certainty that all linemen with BMI scores over 30 points are actually obese, but based on previous studies, there is a high likelihood that Body Fat Percentage (BF%) tests would show most of the

linemen would be classified as obese (4, 16, 22-25, 27, 28, 33, 40, 46).

A closer examination of the changing physical parameters required of high school linemen to be recruited to play for a “Power 5” school provides evidence of the increasing expectations that they need to be larger than ever. In some “Power 5” conferences, the median weight of the high school recruits is equal to the average size of NFL linemen from the 1990s. The results show that over half of the incoming freshmen recruits at the OCG position in the SEC (54.84%) and almost half of SEC DTs (48.97%) and OTs (47.98%) weighed more than 300 lbs. in the most recent six-year period (P3). According to Kraemer and Torine (24), the “Mirror Effect” might help explain the continued increase in the size of linemen. As coaches recruit larger linemen to keep up with their competition, a ‘linemen obesity arms race’ is created without regard for the increased risk of injury or the long-term health implications these players face.

With the medical issue of concussions and the link to Chronic Traumatic Encephalopathy (CTE) receiving considerable attention in recent years, football organizations have implemented new health policies at all levels. For example, the NCAA now has “Concussion Protocols” to help make sure that coaches and players are not putting the outcome of a game ahead of the brain health of an athlete (30). Unfortunately, there are no such overarching policies in place for obesity.

The existing literature addresses the unlikely chance of systemwide modifications to reduce the size of linemen during their playing careers. The discussions tend to focus on advocating for additional post-career support. For instance, Griffin (15) argued for post-career counseling that focused on providing proper eating habits and exercise programs to help reduce the risk of players developing future medical issues associated with obesity (metabolic syndrome, cardiovascular disease, or diabetes). Demirel (6) reported on the obesity issue in college football from the viewpoint of past players seeking help years later as their weight spiraled out of control. He argued that the NCAA and college athletic departments needed to do a better job of providing former players access to nutritionists, as they had during their playing days. However, if this only applies to players that graduate from a program, this would not help the large percentage of football players that don’t stay on the roster throughout their college careers (10). Unfortunately, there also appears to be little regard for the large number of high school players that increase their physical parameters to try to get noticed by college scouts, but fail to ascend to the college level and the long-term health concerns this can cause (29).

Limitation

In terms of limitations, the listed body size measurements from an archival dataset are susceptible to exaggeration for those players that did not participate in national high school combines where they could be officially measured. Also, as mentioned prior, the use of BMI

as an indicator of potential obesity rather than an exact measurement of body fat percentage is not ideal. However, the procedures used in this study remain consistent with previous studies that also used body size data from archival data to ensure valid and robust results.

CONCLUSION

This study contributes to and expands the literature on body size changes among football players over time. Focusing on linemen, who are required to have the largest physical parameters on the field and have also been shown to have higher rates of obesity, allowed for an in-depth analysis of a growing health issue among high school linemen recruited to play for a “Power 5” college football program. Despite the growing number of academic and media articles on the unhealthy increase in physical parameters of linemen, along with the accompanying health concerns that impact overweight and obese players, little has been done to address the issue. As the results show, most linemen positions groups have continued to get heavier. Future research should consider extending this type of research by comparing this incoming recruits’ dataset with data on their final physical parameters at the end of their college playing careers.

APPLICATIONS IN SPORT

While there is a demonstrated concern for athlete safety relative to such issues as concussions, leading to the introduction and refinement of concussion protocol, there is a lack of similar policymaking regarding the body weight of football players. If the NCAA and college football administrators viewed the obesity problem among linemen on the same level as concussions, there would be some type of ‘Obesity Protocol.’ College football decision-makers should develop health protection policies for college athletes to cover obese and significantly overweight football players. The results of this study can provide further evidence to help initiate new policies that help reduce the chances of long-term health issues among high school recruits and college football linemen and improves their post-career health. It is impractical to believe that one or a few teams can stem the tide of increasing player size if the other teams fail to do so, as no school or coach wants to be at a clear competitive disadvantage.

Consideration should be given to broader policies on player body size limits that will impact all universities equally. These policies could include new protocols focusing on weight limits for players or, more conservatively, frequent checks with caps on the body fat percentage that players can maintain and still take the field. At the bare minimum, college football decision-makers should ensure care for the athletes after the playing days have ended through access to education and support systems to help in the process of safely losing weight and maintaining a healthy lifestyle conducive to a longer, healthier life.

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