


Can NFL Combine Results be Used to Estimate NFL Defensive Players Longevity?



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ABSTRACT

The National Football League Scouting Combine is an annual event held to evaluate football players. The results of the combine are used to identify talent and player potential. Our study aims to examine the relationship between combine drill performance (e.g., speed, power, agility, explosiveness) and career longevity. We performed a retrospective review of The National Football League combine test results for all defensive players from 2005–2015 to determine the association of each player's combine test results with career longevity. The position that had the most significant associations for 1-year status was linebackers, with weight, 10-yard dash, 20-yard dash, 40-yard dash, broad jump, 3-cone drill, and shuttle being significantly associated with 1-year roster status. The position that had the most significant associations for 5-year status was cornerbacks, with weight, 10-yard dash, 20-yard dash, 40-yard dash, 3-cone drill, and shuttle being significantly associated with 1-year roster status. The least number of significant associations was found for safeties, with no drill being associated with 1-year roster status and only height and shuttle time significantly associated with 5-year career longevity. Our study demonstrates the utility of the combine results to help estimate the career longevity of NFL defensive players.

Introduction

The National Football League (NFL) Scouting Combine is an annual event where hundreds of college football players across the nation gather for physical, medical, and psychological evaluation [1, 2]. The combine includes substantial medical testing, with each player receiving an orthopedic grade that estimates a player's injury

risk [3]. For example, a study examining the combine from 1987 to 2000 showed players receiving a high orthopedic grade having a mean career length of 42 games, players with a low orthopedic grade playing 34 games, and players with a failed orthopedic grade playing 19 games [4]. Other studies have shown how injury prior to the combine, among other characteristics, can help estimate ca-

reer longevity and how a player's draft status may be negatively affected [4–8].

In addition to medical testing and orthopedic grade, the standardized physical testing performed at the combine are objective measures that provide a potential focus for study [9]. Furthermore, the drills players perform are related to potential injury-reducing traits, which are physical traits thought to reduce risk of injury, such as ankle flexibility, proprioceptive ability, proper biomechanics, and jump strength [10–13]. These are important factors to consider when assessing a player's risk for injury that are not directly measured in the orthopedic grading. Performance of athletes in the standardized physical testing of the NFL combine could offer insight into the performance and health of players in their future career [14].

Many previous studies have been performed that have sought to find a link between prior orthopedic injury or NFL combine orthopedic testing results and career outcomes [3, 15–21]. For example one such study found that certain injuries, such as cervical spine injury, rotator cuff repair, or navicular injury, led to decreased career length when compared to a control group [3]. However, our study aims to determine the relationship between combine physical testing and drill performance and career longevity. A study recently established the relationship between combine physical performance and career longevity for offensive NFL players, but information regarding defensive players is scarce [7]. To our knowledge, our study is the first to perform an in-depth analysis of original and normalized combine drill performance and career longevity for defensive NFL players. We hypothesize better performance in the NFL combine will have a significant association with career length for all defensive positions.

Methods

Due to the public nature of the NFL combine database and the de-identification of our results in this study, this study received institutional review board (IRB) approval and deemed exempt from our institution's approval board. Our analysis meets the ethical stand-

ards of the Sports Medicine International Open journal [22]. Analysis was completed of all players who competed in the NFL combine from 2005 through 2015. Combine results were retrospectively collected from NFLdraftscout.com, a public website that provides historical combine results. Results from each drill that a player had performed at the combine were recorded. These included height in inches (non-modifiable); weight; BMI (body mass index); 10-, 20-, and 40-yard dash times; bench press repetitions; vertical jump height in inches; broad jump distance in inches; short shuttle and 3-cone times. The significance of a player's performance on a given combine test can be evaluated by understanding what skills and traits each drill tests [► **Table 1**]. Career length data were collected using ProFootballReference.com and cross-referenced using NFL.com team websites from all NFL seasons between 2005–2017.

The analysis included each player's combine results and a ratio-scaled normalization of each player's combine results by position. Normalizing refers to adjusting a player's performance measures by his body size relative to those that he is being compared against, such as a position group. A ratio scaled normalization, which divides the player performance numbers by their body mass index, was used for this study. First, an average BMI was taken for each position. Next, each player's BMI was divided by the average for his position in their respective combine year, so that heavier players would have a higher relative density score. Lastly, combine scores were normalized for each player by dividing by their scaled BMI, which gave a normalized result for each test.

The influence of each performance metric on whether or not a player was on a roster after the combine was evaluated individually using Student's t-test. Analyses were conducted in R 3.4.2. All hypotheses tested were two-sided with $P < 0.05$ considered statistically significant. There was no adjustment for multiple testing.

Our study initially included 10-year roster status in our statistical analysis. However, due to the lack of NFL players who play ten seasons and subsequent lack of significance, we excluded the 10-year roster status from our study.

► **Table 1** Combine drill descriptions.

Test	How Test is Performed	Significance of Test
Sprints	Performed by running 40 yards from a 3-point stance. Split times recorded at 20 and 10 yards serve as the measurements for the 20- and 10-yard dashes, respectively	<ul style="list-style-type: none"> Speed Explosiveness First-step quickness
3-Cone Drill	Performed by a player running around 3 cones that are placed in the shape of an "L."	<ul style="list-style-type: none"> Speed Power Flexibility Agility
20-yard Shuttle	Requires a player to run 5 yards, turn, run back in the opposite direction for 10 yards, and then turn again to run 5 yards back to the starting point.	<ul style="list-style-type: none"> Agility Acceleration Power Lateral quickness Coordination
Vertical Jump	Measured using a Vertec device, which the player stands underneath, extends their arm to mark their maximum extension, and then jumps to hit markers on the Vertec. The measured difference between standing reach and jumping reach gives a final vertical jump.	<ul style="list-style-type: none"> Power Explosiveness
Broad Jump	Requires the player to jump outward from a two-foot standing position	<ul style="list-style-type: none"> Lower body strength Explosiveness
Bench Press	Players bench press 225 pounds as many times as they can without re-racking the bar	<ul style="list-style-type: none"> Upper body strength Endurance

Results

A total of 339 cornerbacks, 356 linebackers, 185 safeties, and 278 inside defensive linemen were identified from the NFLdraftscout.com database between 2005–2015. Of these players, 60 cornerbacks, 61 linebackers, 32 safeties, and 46 inside defensive linemen completed ten NFL seasons and the entire list of combine drills. The 20-yard dash was not completed by inside defensive linemen and was thus not included in this study for this specific position.

All defensive positions

A summary of significant results for each position are found in ► **Table 2**.

Physical characteristics (height and weight)

We found no association between height and 1-year roster status. Notwithstanding, we found an inverse relationship between height and 5-year roster status for safeties, with shorter safeties being more likely to be on a 5-year roster (72.19 inches vs. 72.83 inches).

We found that higher weight was significantly associated with 1-year status for linebackers (241.15 vs. 238.25) and inside defensive lineman (306.86 pounds vs. 301.21 pounds). We found a sig-

nificant association between weight and cornerback 5-year status (194.20 pounds vs. 191.20 pounds) (► **Table 3**).

Speed and first-step quickness (10-, 20-, 40-yard dash)

We found the 10-yard dash was significantly associated with 1-year roster status for linebackers (1.61 seconds vs. 1.65 seconds) and inside defensive lineman (1.74 seconds vs. 1.78 seconds). The 10-yard dash was also significantly associated with 5-year roster status for cornerbacks (1.52 seconds vs. 1.56 seconds) and linebackers (1.60 seconds vs. 1.62 seconds).

The 20-yard dash was significantly associated with 1-year status for cornerbacks (2.57 seconds vs. 2.63 seconds) and linebackers (2.69 seconds vs. 2.75 seconds). The 20-yard dash was also significantly associated with 5-year roster status for cornerbacks (2.55 seconds vs. 2.63 seconds) and linebackers (2.69 seconds vs. 2.74 seconds).

The 40-yard dash was significantly associated with 1-year status for cornerbacks (4.47 seconds vs. 4.55 seconds) and linebackers (4.68 seconds vs. 4.82 seconds). The 40-yard dash was also significantly associated with 5-year roster status for cornerbacks (4.42 seconds, 4.54 seconds), linebackers (4.66 seconds vs. 4.75 seconds), and inside defensive lineman (5.03 vs. 5.13 seconds) (► **Table 4**).

Explosiveness and power (broad jump)

The broad jump was significantly associated with 1-year status for cornerbacks (122.71 inches vs. 118.98 inches) and linebackers (116.95 inches vs. 114.52 inches) but was not associated with 5-year roster status for any defensive position (► **Table 5**).

Agility (3-cone drill, shuttle)

The 3-cone drill was significantly associated with 1-year roster status for linebackers (7.13 seconds vs. 7.32 seconds), 5-year roster status for linebackers (7.11 seconds vs. 7.20 seconds), and 5-year roster status for cornerbacks (6.89 seconds vs. 7.00 seconds).

The shuttle drill was significantly associated with 1-year roster status for linebackers (4.29 seconds vs. 4.41 seconds) and inside defensive lineman (4.65 seconds vs. 4.74 seconds). The shuttle drill was also significantly associated with 5-year roster status for cornerbacks (4.14 vs. 4.23 seconds), linebackers (4.27 vs. 4.34 sec-

► **Table 2** Significant combine results by year and position.

Position	1 Year	5 Year
Cornerback	20-yard dash 40-yard dash Broad Jump	Weight 10-yard dash 20-yard dash 40-yard dash 3-cone drill Shuttle
Linebacker	Weight 10-yard dash 20-yard dash 40-yard dash Broad jump 3-cone-drill Shuttle	10-yard dash 20-yard dash 40-yard dash 3-cone drill Shuttle
Safety		Height Shuttle
Inside Defensive Lineman	Weight 10-yard dash Shuttle	40-yard dash Shuttle

► **Table 3** Average combine results for physical characteristics (height and weight) of defensive positions compared to roster status.

Physical Characteristics					
Position		1 Year		5 Year	
		Yes	No	Yes	No
Cornerback	Height Mean (sd)	71.24 (1.47)	70.90 (1.72)	71.31 (1.56)	71.13 (1.45)
	Weight Mean (sd)	193.04 (8.54)	192.12 (9.09)	194.20 * (9.44)	191.20 (8.02)
Linebacker	Height Mean (sd)	73.59 (1.28)	73.43 (1.55)	73.59 (1.21)	73.40 (1.41)
	Weight Mean (sd)	241.15 * (8.68)	238.25 (9.13)	240.46 (7.84)	240.00 (9.57)
Safety	Height Mean (sd)	72.28 (1.44)	72.83 (1.35)	72.19 * (1.46)	72.83 (1.51)
	Weight Mean (sd)	208.36 (9.03)	208.80 (9.49)	208.68 (9.69)	208.58 (9.40)
Inside Defensive Lineman	Height Mean (sd)	75.06 (1.45)	74.90 (1.47)	75.05 (1.32)	74.85 (1.41)
	Weight Mean (sd)	306.86 * (16.93)	301.21 (15.79)	305.63 (15.93)	303.39 (15.49)

* Denotes statistical significance with a p-value < 0.05.

► **Table 4** Average combine results for speed and first-step quickness (10-, 20-, 40-yard dash) of defensive positions compared to roster status.

Speed and First-step Quickness					
Position		1 Year		5 year	
		Yes	No	Yes	No
Cornerback	10-yard dash Mean (sd)	1.55 (0.08)	1.57 (0.08)	1.52 * (0.08)	1.56 (0.08)
	20-yard dash Mean (sd)	2.57 * (0.11)	2.63 (0.12)	2.55 * (0.11)	2.63 (0.12)
	40-yard dash Mean (sd)	4.47 * (0.18)	4.55 (0.21)	4.42 * (0.17)	4.54 (0.19)
Linebacker	10-yard dash Mean (sd)	1.61 * (0.07)	1.65 (0.07)	1.60 * (0.07)	1.62 (0.08)
	20-yard dash Mean (sd)	2.69 * (0.10)	2.75 (0.18)	2.69 * (0.10)	2.74 (0.12)
	40-yard dash Mean (sd)	4.68 * (0.17)	4.82 (0.17)	4.66 * (0.16)	4.75 (0.18)
Safety	10-yard dash Mean (sd)	1.56 (0.08)	1.57 (0.07)	1.54 (0.09)	1.57 (0.08)
	20-yard dash Mean (sd)	2.61 (0.12)	2.62 (0.12)	2.61 (0.14)	2.64 (0.11)
	40-yard dash Mean (sd)	4.54 (0.20)	4.55 (0.20)	4.52 (0.21)	4.58 (0.20)
Inside Defensive Lineman	10-yard dash Mean (sd)	1.74 * (0.10)	1.78 (0.10)	1.72 (0.1)	1.75 (0.10)
	40-yard dash Mean (sd)	5.06 * (0.25)	5.18 (0.26)	5.03 * (0.24)	5.13 (0.26)

* Denotes statistical significance with a p-value < 0.05.

► **Table 5** Average combine results for explosiveness and power (broad jump) of defensive positions compared to roster status.

Explosiveness and Power					
Position		1 Year		5 Year	
		Yes	No	Yes	No
Cornerback	Broad Jump Mean (sd)	122.71 * (7.53)	118.98 (7.96)	122.28 (7.72)	121.60 (8.13)
Linebacker	Broad Jump Mean (sd)	116.95 * (7.67)	114.52 (8.34)	116.41 (7.67)	114.97 (7.86)
Safety	Broad Jump Mean (sd)	120.74 (7.43)	121.88 (10.05)	120.82 (7.68)	120.08 (7.74)
Inside Defensive Lineman	Broad Jump Mean (sd)	105.72 (10.69)	107.47 (11.36)	106.81 (10.13)	106.14 (10.96)

* Denotes statistical significance with a p-value < 0.05.

► **Table 6** Average combine results for agility (3-cone drill and shuttle) of defensive positions compared to roster status.

Agility					
Position		1 Year		5 Year	
		Yes	No	Yes	No
Cornerback	3-Cone Drill Mean (sd)	6.93 (0.32)	7.02 (0.37)	6.89 * (0.34)	7.00 (0.33)
	Shuttle Mean (sd)	4.18 (0.22)	4.23 (0.25)	4.14 * (0.22)	4.23 (0.21)
Linebacker	3-Cone Drill Mean (sd)	7.13 * (0.28)	7.32 (0.28)	7.11 * (0.27)	7.20 (0.31)
	Shuttle Mean (sd)	4.29 * (0.19)	4.41 (0.21)	4.27 * (0.18)	4.34 (0.21)
Safety	3-Cone Drill Mean (sd)	6.96 (0.31)	7.04 (0.33)	6.91 (0.37)	7.04 (0.27)
	Shuttle Mean (sd)	4.21 (0.21)	4.26 (0.12)	4.16 * (0.24)	4.26 (0.18)
Inside Defensive Lineman	3-Cone Drill Mean (sd)	7.68 (0.38)	7.73 (0.35)	7.65 (0.38)	7.76 (0.37)
	Shuttle Mean (sd)	4.65 * (0.25)	4.74 (0.25)	4.62 * (0.22)	4.71 (0.26)

* Denotes statistical significance with a p-value < 0.05.

onds), safety (4.16 vs 4.26 seconds), and inner defensive lineman (4.62 seconds vs. 4.71 seconds) (► **Table 6**).

Discussion

The standardized physical testing performed by players in the NFL combine is utilized by NFL coaches, teams, and team physicians to measure a player's athleticism and future potential [14]. Our study found certain combine drills correlated with longer NFL careers for

each position for defensive players. Out of all the combine tests, the 20-yard dash results had the highest number of significant associations with 1-year roster status, with 3 of 4 defensive positions yielding significant results. We found a significant association with the shuttle results and 5-year roster status for all 4 defensive positions. This was closely followed by the 40-yard dash results, which was significantly associated with 5-year roster status for 3 of 4 positions. The combine results that were not significantly associated with 1-year roster status and 5-year roster status were height and

weight, respectively. Whereas other studies have investigated the use of various combine tests to estimate NFL career success or propensity for injury, our study is the first to perform an in-depth analysis examining the relationship between standardized physical testing in the NFL combine and career longevity.

Explosiveness and power is measured in the NFL combine through the vertical and broad jumps [23]. Our study shows a significant association between broad jump and 1-year roster status for cornerbacks and linebackers. However, there was no significant association between the broad jump and 5-year status for any of the studied defensive positions.

Agility is measured through the 3-cone drill and shuttle. The shuttle test had the most significant findings among the two tests, with faster times significantly associated with 1-year roster status for linebackers and inside defensive lineman and significantly associated with 5-year roster status for all positions – cornerbacks, linebackers, safeties, and inside defensive lineman. The 3-cone drill speed was significantly associated with 1-year roster status among linebackers and 5-year status among cornerbacks and linebackers.

Short distance speed and first-step quickness are extrapolated from the 10-, 20- and 40-yard dashes. Faster 10-, 20-, and 40-yard dash times were correlated with increased likelihood of 1-year and 5-year roster status among linebackers, indicating a significant association between all linebacker dash times and career longevity. Among a variety of significant findings, the 40-yard dash was the most valuable test for cornerbacks and inner defensive lineman, with an increased likelihood of 1-year and 5-year roster status for both positions. No significant association was found with 10-, 20-, and 40-yard dashes among safeties for 1-year or 5-year roster status, however, this was likely due to the small sample size of safeties and should be studied further.

A previous study by Berri et al. [24] reported height as having a significant association with career length for certain positions, such as quarterbacks, however our results demonstrated height was inversely correlated with career longevity for safeties, with each 0.25-inch increase in height correlating with a decrease of 7.2% chance of being on the 5-year roster. Height was not significantly correlated with any defensive position. Inside defensive lineman and linebackers with higher weights had significantly increased chances of being on the 1-year roster; however weight had no significant effect on 5-year roster status. In contrast, we found a significant association with weight and 5-year roster status for cornerbacks, indicating increased weight among cornerbacks leads to longer career longevity.

A limitation to our study is the use of online NFL combine results, which are dependent on accurate data collection and recording. Despite this limitation, the NFL combine results are widely used in scientific study. Another limitation of our study is the use of normalized data, which we calculated without allometric adjustments. Although BMI can be less useful in individuals at the extremes of body mass, such as professional athletes, we attempted to account for this by normalizing the data and comparing individuals by position group using a ratio-scaled normalization. A ratio-scaled normalization refers to normalizing BMI by dividing weight over group BMI, and allosteric normalization uses specific exponents tailored to the group that is being studied to derive its normalization. By using a scaled BMI approach in interpreting the data, we feel it al-

lowed for the most accurate comparison in the absence of a consistent exponent for allometric adjustments in football players. Allometric adjustments are intended to provide a more accurate normalization of athletic drill performance by assigning an exponent value to describe body shape and size rather than simply BMI. Therefore, allometric adjustments could be useful if an accurate exponent for American football athletes is developed. Our study also attempts to determine the relationship of combine results and career longevity for a dynamic sport in which athletes experience an extreme variance of situations, playing conditions, and more. Although our results are useful and informative, caution must be taken when applying these results to individual athletes. Of course, athletes with excellent results could experience catastrophic injuries and shortened careers, and athletes with below-average results could have lengthy careers. Further, injury mechanism was not accounted for when considering career length variance,

The NFL combine is used to evaluate football players. Although the combine is useful to help NFL teams gather medical histories, perform physical exams, and perform athletic tests to filter through and recruit the most promising players, our study demonstrates the utility of the combine physical testing results for estimating career longevity for defensive players. This study can be used by NFL teams, team physicians, and other healthcare professionals to assist in the assessment and treatment of NFL defensive players. Future studies should examine whether the NFL combine results could be used in other areas of sports medicine, such as injury prevention.

Conflict of Interest

AC is a consultant and speaker's bureau member for Arthex. AC is a consultant for Zimmer Biomet. AC received an educational grant from Stryker. None of these present conflicts of interest for this work.

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