



# A 10-year Evaluation of the NFL Combine. Do Combine Results Correlate with Career Longevity for NFL Offensive players?

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## Abstract

**Background:** The National Football League (NFL) combine has been found to play a significant role in NFL draft decisions. Previous studies have demonstrated correlations between a player's combine metrics and draft position and performance, but no study has investigated the purposes of our study, the relationship between these combine tests and NFL career longevity.

**Methods:** A retrospective review of combine test results from all offensive players participating in the NFL combine from 2005-2015 was completed. Tests included height, weight, BMI, 10-, 20-, 40-yard dash, bench press, vertical jump, broad jump, short shuttle, and 3-cone. Career length was determined by online review of NFL rosters from 2005-2017. Statistical analysis using logistic regression was completed to determine the association of each player's original (O) and normalized (N) combine test results with career longevity.

**Results:** Quarterbacks on an NFL roster at year five were 0.75 inches taller than quarterbacks not on a roster ( $p < 0.05$ ). There was an association between 10-yard (RB:  $p < 0.05$ ; WR:  $p < 0.05$ ), 20-yard (RB:  $p < 0.05$ ; WR:  $p < 0.05$ ) and 40-yard (RB:  $p < 0.05$ ; WR:  $p < 0.05$ ) dash times, as well as broad jump (RB:  $p < 0.05$ ; WR:  $p < 0.05$ ), for running backs (RB) and wide receivers (WR) on a roster at 5-years. Tight ends on a roster at 5-years were found to have performed significantly better in the vertical jump ( $p < 0.05$ ) and broad jump ( $p < 0.05$ ), while also having greater body weight ( $p < 0.05$ ) than those not on a roster. Vertical jump ( $p < 0.05$ ), broad jump ( $p < 0.05$ ) and 40-yard dash ( $p < 0.05$ ) were found to be associated with offensive lineman on an NFL roster at 5-years.

**Conclusion:** The combine has been used by NFL teams to gather objective data about player's athleticism, and this study shows the specific drills and corresponding traits that are related to longer careers for each position. This study found associations between traits that are reflected by the tests performed at the NFL combine and career longevity. The findings of this study may serve as an additional resource for teams to assist in the assessment of a player's potential career longevity based on their individual combine results.

**Keywords:** NFL combine, performance, career longevity, athleticism, injury rehabilitation

## Introduction

The annual National Football League (NFL) combine allows teams to assess former NCAA players' medical status, athleticism, and personality traits. The combine has been found to play a significant role in NFL draft decisions [1,2]. While other facets of a team's decision-making process remain subjective and generally not openly discussed by NFL teams, the standard-

ized athletic tests from the combine offer an opportunity for objective study. The drills players partake in during the combine are timed and measured, thus serving to provide insight into a player's athletic traits. Due to performance in combine drills being reflective of athletic and injury-reducing traits, such as ankle flexibility in the 3-cone drill and jump strength in the vertical jump, it is possible that studying a player's results at

the combine may offer insight into their performance and health throughout their career [3,4].

The athletic tests at the combine offer insight into the athletic traits that contribute to the productivity, health and therefore longevity of an NFL player’s career. Prior research has studied the relationship between measurements from the NFL combine and their relationship to draft order and NFL success [1,2]. The positive results from prior research offers insight into what traits may be important for productive careers. The existing research studies have varied in terms of positions studied, success metrics used and whether or not they normalized the combine drill results by player size [3,4]. Meanwhile, the medical information obtained at the combine has been studied in relation to career length. According to the NFL Players Association the average career of an NFL player is 3.3 years. Quarterbacks average a career of 4.44 years, running backs average 2.57 years, wide receivers average 2.81 years, with tight ends and offensive lineman averaging 3.5 years. To our knowledge, no study has investigated the relationship between both original and normalized combine drill performance and career longevity. Therefore, the purpose of our study is to investigate the relationship between combine drills and career length in the NFL for offensive players. We hypothesize that better performance in combine drills will be associated with increased career length across the offensive positions studied.

**Methods**

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, weight, BMI (body mass index), 10-, 20-, and 40-yard dash times, bench press repetitions, vertical jump height, broad jump distance, 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) [1,5]. Career length data was 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.

**Table 1. Combine Drill Description.**

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"> <li>• Speed</li> <li>• Explosiveness</li> <li>• First-step quickness</li> </ul>
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"> <li>• Speed</li> <li>• Power</li> <li>• Flexibility</li> <li>• Agility</li> </ul>
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"> <li>• Agility</li> <li>• Acceleration</li> <li>• Power</li> <li>• Lateral quickness</li> <li>• Coordination</li> </ul>
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"> <li>• Power</li> <li>• Explosiveness</li> </ul>
Broad Jump	Requires the player to jump outward from a two-foot standing position	<ul style="list-style-type: none"> <li>• Lower body strength</li> <li>• Explosiveness</li> </ul>
Bench Press	Players bench press 225 pounds as many times as they can without re-racking the bar	<ul style="list-style-type: none"> <li>• Upper body strength</li> <li>• Endurance</li> </ul>

The influence of each performance metric on whether or not a player was on a roster after the combine was evaluated individually using a univariate logistic regression model. Analyses were conducted in R3.4.2. All hypotheses tested were two-sided with P<0.05 considered statistically significant. There was no adjustment for multiple testing.

This study received IRB Approval and deemed exempt from our institution’s approval board.

**Results**

Retrospective review identified 131 quarterbacks, 277 running backs, 428 wide receivers, 150 tight ends, and 263 offensive linemen that participated in the NFL combine from 2005-2015. Of these players, 37 quarterbacks, 197 running backs, 233 wide receivers, 121 tight ends, and 192 offensive linemen completed both ten NFL seasons and the entire list of combine drills. For the 37 quarterbacks, the vertical jump and bench press were not completed. Quarterbacks (Table 2).

**Quarterbacks (Table 2)  
 5-Year Roster**

Quarterbacks that were on a NFL roster at year five were found

to be 0.75 inches taller than QBs that did not make a roster at year five (mean=75.44 inches (sd=1.57) vs mean=74.676 inches (sd=1.45),  $p=0.032$ ). For every 0.25" taller, the odds that a QB made a roster at year five increased by approximately 9% (95% confidence interval (CI): 1.008-1.186,  $p=0.04$ ). For QBs, no other combine results were significant.

### Running Backs (Table 3) 1-Year Roster

For running backs at year one there was a significant association

between making a roster for one year and 40-yard dash (4.527 seconds (0.23) vs 4.634 seconds (0.241),  $p<0.001$ ), 20-yard dash (2.605 seconds (0.14) vs 2.673 (0.15),  $p=0.002$ ), and 10-yard dash (1.568 seconds (0.09) vs 1.611 seconds (0.09),  $p=0.002$ ). For every unit increase (0.1 seconds) of normalized 40-yard dash time, the odds of a running back making a roster at year 1 decreased by 17.7% (95% CI: 0.726-0.928,  $p=0.002$ ). For the normalized 20-yard dash, every 0.05 second increase in time decreased the odds of making a roster at year 1 by 15.3% (95% CI: 0.761-0.938,  $p=0.002$ ). In the normalized 10-yard

**Table 2. Average combine results for Quarterbacks compared to roster status.**

QB	1 Year		5 Years	
	Yes	No	Yes	No
Height Mean (sd)	75.05 (1.77)	74.83 (1.45)	75.44* (1.57)	74.68 (1.45)
Weight Mean (sd)	223.16 (11.30)	223.26 (10.85)	226.21 (10.54)	222.84 (11.89)
10-yard dash Mean (sd)	1.68 (0.09)	1.68 (0.08)	1.68 (0.09)	1.68 (0.08)
20-yard dash Mean (sd)	2.78 (0.12)	2.78 (0.13)	2.81 (0.12)	2.80 (0.12)
40- yard dash Mean (sd)	4.78 (0.20)	4.82 (0.22)	4.78 (0.20)	4.80 (0.22)
Broad Jump Mean (sd)	111.89 (7.71)	109.54 (8.31)	109.02 (6.41)	111.09 (9.62)
3-Cone Drill Mean (sd)	7.15 (0.35)	7.16 (0.30)	7.21 (0.30)	7.16 (0.32)
Shuttle Mean (sd)	4.32 (0.22)	4.34 (0.20)	4.27 (0.21)	4.33 (0.21)

Note: \*denotes p value <0.05

**Table 3. Average combine results for running backs compared to roster status.**

RB	1 Year		5 Years	
	Yes	No	Yes	No
Height Mean (sd)	70.50 (1.75)	70.14 (1.92)	70.68 (2.12)	70.56 (1.63)
Weight Mean (sd)	213.53 (14.16)	212.55 (16.09)	214.65 (14.70)	212.98 (15.21)
10-yard dash Mean (sd)	1.57* (0.09)	1.61 (0.09)	1.54* (0.09)	1.58 (0.10)
20-yard dash Mean (sd)	2.61* (0.14)	2.67 (0.15)	2.60* (0.13)	2.65 (0.16)
40-yard dash Mean (sd)	4.53* (0.23)	4.63 (0.24)	4.48* (0.20)	4.58 (0.26)
Broad Jump Mean (sd)	118.99* (9.62)	116.33 (11.08)	118.23 (9.65)	117.11 (10.09)
Vertical Jump Mean (sd)	34.86 (3.65)	33.90 (3.90)	34.42 (3.20)	34.42 (3.81)
3-Cone Drill Mean (sd)	7.06 (0.40)	7.12 (0.42)	6.98 (0.34)	7.11 (0.43)
Shuttle Mean (sd)	4.28 (0.25)	4.31 (0.26)	4.24 (0.18)	4.30 (0.27)
Bench Press Mean (sd)	19.69 (4.12)	19.13 (4.01)	19.37 (4.60)	19.61 (3.84)

Note: \*denotes p value <0.05.

dash, the odds of a running back making a roster for 1-season decreases by 9.4% for every additional 0.02 seconds (95% CI: 0.849-0.964, p=0.002).

### 5- Year Roster

Logistic regression analysis of running backs showed a significant association between making a NFL roster for five years and original and normalized 40-yard dash (4.482 seconds (0.20) vs 4.582 seconds (0.26), p=0.015), 20-yard dash (2.595 seconds (0.13) vs 2.654 seconds (0.155), p=0.02), and 10-yard dash (1.542 seconds (0.09) vs 1.580 seconds (0.10), p=0.019). For every unit increase (0.1 seconds) of normalized 40-yard dash time, the odds of a running back making an NFL roster for 5 seasons decreased by 16% (95% CI: 0.724-0.967, p=0.017). For running backs, every unit increase (0.05 seconds) in 20-yard dash decreased the odds of making a roster for 5 seasons by 13.2% (95% CI: 0.766-0.977, p=0.022). In the 10-yard dash, for every 0.02 seconds increase in time decreased the odds of making a roster for 5 seasons by 8.6% (95% CI: 0.844-0.985, p=0.021).

### Wide Receivers (Table 4)

#### 1-Year Roster

For wide receivers that played at least one year in the NFL, there was a significant association between making a roster and normalized 40-yard dash (4.469 seconds (0.25) vs 4.589 seconds (0.27), p<0.001), 20-yard dash (2.579 seconds (0.14) vs 2.646 seconds (0.16), p<0.001), 10-yard dash (1.555 seconds (0.094) vs 1.582 seconds (0.099), p=0.01), shuttle (4.221 seconds (0.26) vs 4.330 seconds (0.25), p<0.001), 3-cone drill

(6.934 seconds (0.40) vs 7.088 seconds (0.44), p=0.002), and vertical jump (35.774 inches (3.523) vs 34.879 inches (4.177), p=0.036).

For every unit (0.02 seconds) increase in normalized 10-yard dash, the odds of a wide receiver making a roster for one season decreased by 5.6% (95% CI: 0.901-0.988, p=0.013). The odds of being on a roster for 1 season decreased by 13.9% for every 0.05 seconds added to a wide receiver's normalized 20-yard dash (95% CI: 0.797 – 0.928, p<0.001). For wide receivers, the odds of being on an NFL roster for one season decreased 16.5% for every 0.1 seconds added to their 40-yard dash times (95% CI: 0.764–0.909, p<0.001). For the normalized shuttle drill, every 0.1 second increase in time decreased the odds of a wide receiver making an NFL roster for one season by 14.9% (95% CI: 0.775–0.933, p<0.001). For every 0.1 second increase in the 3-cone drill, the odds of a wide receiver making the roster decreased by 8.2% (95% CI: 0.867–0.971, p=0.003). The odds of a wide receiver being on a roster for 1 season increase by 3.4% for every 0.5" added to their vertical jump (95% CI: 1.002–1.067, p=0.037).

#### 5-Year Roster

Receivers that were on a roster for five years had a significant association with normalized 40-yard dash (4.441 seconds (0.24) vs 4.537 seconds (0.25), p=0.004), 20-yard dash (2.569 seconds (0.14) vs 2.627 seconds (0.15), p=0.003), 10-yard dash (1.526 seconds (0.09) vs 1.560 seconds (0.10), p=0.007), shuttle (4.197 seconds (0.23) vs 4.281 seconds (0.25), p=0.01), and 3-cone (6.86 seconds (0.36) vs 7.01 seconds (0.41), p=0.008). For every unit (0.02 seconds) increase in 10-yard dash time,

**Table 4. Average combine results for wide receivers compared to roster status.**

WR	1 Year		5 Years	
	Yes	No	Yes	No
Height Mean (sd)	72.77 (2.25)	73.04 (2.46)	73.00 (2.04)	73.01 (2.37)
Weight Mean (sd)	202.57 (15.22)	200.89 (15.77)	203.13 (14.70)	201.18 (14.80)
10-yard dash Mean (sd)	1.56* (0.09)	1.58 (0.10)	1.53* (0.09)	1.56 (0.10)
20-yard dash Mean (sd)	2.58* (0.14)	2.65 (0.16)	2.57* (0.14)	2.63 (0.15)
40-yard dash Mean (sd)	4.47* (0.25)	4.59 (0.27)	4.44* (0.24)	4.54 (0.25)
Broad Jump Mean (sd)	121.29 (8.37)	120.26 (9.80)	121.54 (8.39)	120.31 (8.14)
Vertical Jump Mean (sd)	35.77* (3.52)	34.88 (4.18)	36.02 (3.21)	35.16 (3.81)
3-Cone Drill Mean (sd)	6.93* (0.40)	7.09 (0.44)	6.86* (0.36)	7.01 (0.41)
Shuttle Mean (sd)	4.22* (0.26)	4.33 (0.25)	4.20* (0.23)	4.28 (0.25)
Bench Press Mean (sd)	14.80 (4.28)	14.53 (3.77)	15.98 (3.76)	15.42 (3.93)

Note: \*denotes p value <0.05.

the odds of a wide receiver being on an NFL roster decreased by 7.8% (95% CI: 0.867–0.977, p=0.007). For wide receivers, the odds of making a roster for 5 seasons decreased by 13.5% for every additional 0.05 seconds for the player’s 20-yard dash (95% CI: 0.783–0.95, p=0.003). The odds of making a wide receiver making an NFL roster for 5 seasons decreased by 15.1% for every 0.1 seconds added to their 40-yard dash time (95% CI: 0.757–0.947, p=0.004). For the shuttle drill, the odds of a receiver making a roster for 5 seasons decreased by 14.9% for every 0.1 seconds added to their shuttle time (95% CI: 0.775 – 0.933, p=0.012). For every 0.1 seconds added to a wide receiver’s 3-cone time, the odds of making a roster for 5 seasons decreased by 8.2% (95% CI: 0.867-0.971, p=0.008).

**Tight Ends (Table 5)**

**1-Year Roster**

Tight ends that played at least one year in the NFL demonstrated a significant association between making a roster and normalized 40-yard dash (4.724 seconds (0.15) vs 4.803 seconds (0.20), p=0.028), 20-yard dash (2.723 seconds (0.10) vs 2.772 seconds (0.12), p=0.05), 10-yard dash (1.633 seconds (0.07) vs 1.662 seconds (0.08), p=0.041), vertical jump (33.413 inches (3.82) vs 31.696 inches (4.03), p=0.033), and broad jump (115.712 inches (7.49) vs 111.857 (8.64), p=0.02).

The odds of a tight end making a roster for one season decreased by 25.6% for every 0.1 seconds added to a player’s 40-yard dash time (95% CI: 0.579–0.942, p=0.016). For every 0.05 second increase in 20-yard dash time, the odds of a tight end making a roster decreased by 20.3% (95% CI: 0.65–0.969, p=0.025). The odds of a tight end making an NFL roster for

1 season increased by 6.3% for every 0.5” increase to their vertical jump (95% CI: 1.006–1.129, p=0.035). For tight ends, the odds of making a roster for 5 seasons increased by 3.6% for every 0.5” increase in broad jump distance (95% CI: 1.006–1.071, p=0.024).

**5-Year Roster**

In the logistic regression analysis of tight ends, there was a significant association between making a NFL roster for five years and normalized broad jump (116.993 inches (6.867) vs 111.806 (8.347), p=0.001), vertical jump (34.424 inches (4.219) vs 31.729 inches (3.896), p=0.001), and lower body weight (252.167 pounds (8.623) vs 256.411 pounds (10.411), p=0.05). For every 0.5” increase in normalized broad jump, the odds of a tight end making an NFL roster for 5 seasons increased by 4.8% (95% CI: 1.017–1.084, p=0.004). For the vertical jump, every 0.5” increase in jump height the odds of a wide receiver making an NFL roster for 5 seasons increased by 8.9% (95% CI: 1.032 – 1.157, p=0.003). The odds of a tight end making an NFL roster for 5 seasons decreased by 4.6% for every 1 pound increase (95% CI: 0.912–0.994, p=0.031).

**Offensive Line (Table 6)**

**1-Year Roster**

For offensive linemen that played at least one year in the NFL, there was a significant association between roster status and normalized 40-yard dash (5.212 seconds (0.21) vs 5.315 seconds (0.22), p<0.001), 20-yard dash (2.986 seconds (0.26) vs 3.051 seconds (0.129), p=0.041), 10-yard dash (1.790 seconds (0.15) vs 1.828 (0.08), p=0.046), broad jump (103.293 inches

**Table 5. Average combine results for tight ends compared to roster status.**

TE	1 Year		5 Years	
	Yes	No	Yes	No
Height Mean (sd)	76.63 (1.40)	76.15 (1.13)	76.65 (1.31)	76.41 (1.39)
Weight Mean (sd)	254.06 (9.53)	254.79 (9.61)	252.17* (8.62)	256.41 (10.41)
10-yard dash Mean (sd)	1.63 (0.07)	1.66 (0.08)	1.63 (0.06)	1.64 (0.08)
20-yard dash Mean (sd)	2.72 (0.10)	2.77 (0.12)	2.73 (0.11)	2.75 (0.12)
40-yard dash Mean (sd)	4.72* (0.15)	4.80 (0.20)	4.73 (0.16)	4.77 (0.18)
Broad Jump Mean (sd)	115.71* (7.49)	111.86 (8.64)	116.99* (6.87)	111.81 (8.35)
Vertical Jump Mean (sd)	33.41 (3.82)	31.70 (4.03)	34.42* (4.22)	31.73 (3.90)
3-Cone Drill Mean (sd)	7.17 (0.25)	7.16 (0.32)	7.16 (0.23)	7.14 (0.30)
Shuttle Mean (sd)	4.40 (0.18)	4.40 (0.19)	4.39 (0.17)	4.38 (0.20)
Bench Press Mean (sd)	21.17 (4.40)	20.06 (3.95)	21.40 (3.91)	20.53 (3.93)

Note: \*denotes p value <0.05.

**Table 6. Average combine results for offensive linemen compared to roster status.**

OL	1 Year		5 Years	
	Yes	No	Yes	No
Height Mean (sd)	77.60 (1.20)	77.59 (1.47)	78.06 (1.30)	77.71 (1.29)
Weight Mean (sd)	315.45 (11.39)	314.35 (11.52)	315.57 (10.68)	315.30 (10.60)
10-yard dash Mean (sd)	1.79* (0.15)	1.83 (0.08)	1.79 (0.07)	1.81 (0.07)
20-yard dash Mean (sd)	2.99* (0.26)	3.05 (0.13)	3.02 (0.13)	3.03 (0.12)
40-yard dash Mean (sd)	5.21* (0.21)	5.32 (0.22)	5.22 (0.20)	5.28 (0.22)
Broad Jump Mean (sd)	103.29* (8.13)	100.45 (8.79)	103.47 (7.10)	100.36 (8.46)
Vertical Jump Mean (sd)	28.53* (3.33)	27.54 (1.47)	29.04* (3.35)	27.66 (3.61)
3-Cone Drill Mean (sd)	7.80 (0.30)	7.88 (0.30)	7.82 (0.30)	7.79 (0.29)
Shuttle Mean (sd)	4.75* (0.18)	4.82 (0.19)	4.77 (0.19)	4.76 (0.19)
Bench Press Mean (sd)	24.98 (4.90)	23.87 (4.82)	25.03 (4.70)	24.36 (4.84)

(8.13) vs 100.450 inches (8.79),  $p=0.023$ ), vertical jump (28.526 inches (3.33) vs 27.537 (3.69),  $p=0.042$ ), and shuttle time (4.747 seconds (0.184) vs 4.815 seconds (0.19),  $p=0.013$ ).

The odds of an offensive lineman making an NFL roster for 1 season decreased by 9.5% for every 0.02 seconds added to their 10-yard dash time (95% CI: 0.839–0.974,  $p=0.009$ ). For the 20-yard dash, every 0.05 seconds added to an offensive lineman's time decreased the odds of making a roster for one season by 14.8% (95% CI: 0.755–0.954,  $p=0.007$ ). Offensive lineman odds of making a roster for 1 season decreased by 20.9% for each 0.1 seconds added to their 40-yard dash time (95% CI: 0.687–0.902,  $p<0.001$ ). For every 0.5" added to an offensive lineman's broad jump, the odds of making a roster for 1 season increase by 2.1% (1.003–1.04,  $p=0.025$ ). The odds of an offensive lineman making an NFL roster for 1 season decreased by 1.9% for every 0.01 seconds added to their shuttle time (95% CI: 0.965–0.996,  $p=0.014$ ). For every 0.5" added to an offensive lineman's vertical jump, their odds of making a roster for 1 season increased by 4.3% (95% CI: 1.002–1.087,  $p=0.044$ ).

### 5-Year Roster

For offensive linemen that played five seasons, there was a significant association between normalized vertical jump ( $p=0.02$ ) and roster status. The odds of an offensive lineman being on a roster for 5 seasons increased by 4.3% for every 0.5" added to their vertical jump (95% CI: 1.002–1.087,  $p=0.026$ ).

### Summary of Results (Table 7)

Significant results for all positions at each time are listed in Table 7.

**Table 7. Significant Combine Results by Position for Roster Year.**

	1 year	5 year
Quarterbacks	N/A	Greater Height
Running backs	40 yard dash 20 yard dash 10 yard dash	40 yard dash 20 yard dash 10 yard dash
Wide Receivers	40 yard dash 20 yard dash 10 yard dash Shuttle time 3 cone drill Vertical jump	40 yard dash 20 yard dash 10 yard dash Shuttle time 3 cone drill
Tight Ends	40 yard dash 20 yard dash 10 yard dash Broad jump Vertical jump	Broad jump Vertical jump Lower body weight
Offensive Lineman	40 yard dash 20 yard dash 10 yard dash Shuttle time Broad jump Vertical jump	Vertical jump

### Discussion

The NFL combine is regarded as a measure of a player's athleticism and is a tool used by teams when making draft decisions [5]. This study found that specific combine drills correlated with longer NFL careers for each position for offensive players. While other studies have investigated the use of combine data to predict success or injury, this is the first

strictly focused on career longevity.

In agreement with prior evidence that increased height is a favorable trait for quarterbacks, associated with higher draft position and career performance, we show that taller quarterbacks are more likely to have longer careers [6,7]. Additionally, a study investigating the relationship between individual performance awards, Pro-Bowl and All-Pro selection, and combine performance found that award winning quarterbacks tended to be taller and weigh more [7]. Hedlund's study also showed that award-winning tight ends tended to be taller, however, our study found no association between height and career longevity for tight ends. There was an association with decreased body weight and at least a five-year career for players at the tight-end position, suggesting that lower weight is an important factor for a tight end's longevity and performance.

Greater first-step quickness and short area speed, as described by the 10-yard dash, and sprint speed, as described by the 20- and 40-yard dashes, were significantly correlated to greater career length for all offensive positions except quarterback. Similarly, prior studies have shown an association between these athletic qualities and several measures of success, including draft order, Pro-Bowl, and All-Pro selection for running backs, wide receivers, tight ends, and offensive linemen [5,7]. One study of the relationship between sprint speed of running backs and wide receivers showed a positive correlation with a running back's number of yards per carry, number of games played, and player salary, with the 10-yard dash being the greatest predictive measure [1,8]. The priority placed on speed across all non-quarterback offensive positions in the draft seems to be reinforced by its association with success and how this may translate to increased career longevity.

Agility is an important quality for players to execute offensive plays and routes effectively and the most accepted measures of athletic agility are the 3-cone drill and shuttle. NFL teams have emphasized agility for quarterbacks, running backs, wide receivers, and offensive linemen, evidenced by the relationship between a player's 3-cone time and the increased probability of higher draft position for these positions [2,5]. Career performance studies have shown the 3-cone drill to be associated with greater likelihood of award recognition for wide receivers, tight ends, and offensive linemen [7]. The shuttle was shown to be associated with greater salary for running backs and higher likelihood of being selected for the Pro-Bowl and All-Pro awards for running backs and offensive linemen [7]. We show that faster shuttle and 3-cone drill times are significantly associated with greater career length for running backs, wide receivers and offensive linemen. It is reasonable to conclude that players who are more agile are likely to be more successful and would also be more likely to make an NFL roster for multiple years.

Explosiveness and power, as demonstrated by the broad and vertical jumps, has been shown to correlate with higher

draft position, and elite individual performance awards for running back, wide receivers, tight ends, and offensive linemen [2,5,7]. In regards to performance, wide receivers with greater vertical jumps were found to have significantly higher yards per reception throughout their career [8]. Our data shows a strong association between the jumps and career longevity with wide receivers, tight ends, and offensive linemen having a significantly higher chance of being on a roster for at least five years.

Of note, our study also initially included 10-year roster status in our statistical analysis. This was ultimately not included given the paucity of NFL players that play ten seasons, which resulted in only one significant association, increased bench press reps for tight ends. In order to better understand the athletic traits that may contribute to careers of ten years or more, future studies that include 10-year roster status would be well served to have a greater range of career length and combine performance data beyond the ten year windows used for each in our study in order to have a greater sample size.

A limitation to our normalized data is that we did not use allometric adjustments. While we do realize that BMI can be less useful in individuals at the extreme of body mass, we did try to account for this by normalizing the data and comparing like sized individuals by position group. This did help us to create some validity when studying individuals that may be outliers with a high muscular component. By using this scaled BMI approach in interpreting the data we feel it allowed 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 body shape and size rather than simply BMI and therefore could be useful if an accurate exponent for American football athletes is developed [1]. This study was limited to only the select offensive positions and therefore cannot be generalized to other player positions. Future studies will evaluate the association of combine metrics with career longevity for other positions, and potential contributing factors to career length, such as performance and games missed due to injury.

## Conclusions

The combine has been used by NFL teams to gather objective data about player's athleticism, and this study shows the specific drills and corresponding traits that are related to longer careers for each position. This study found associations between traits that are reflected by the tests performed at the NFL combine and career longevity. The findings of this study may serve as an additional resource for teams to assist in the assessment of a player's potential career longevity based on their individual combine results.

## Competing interests

The authors declare that they have no competing interests.

### Authors' contributions

Authors' contributions	WLA	BMF	JLM	DLD	KW	JG	AC
Research concept and design	✓	✓	--	✓	--	--	✓
Collection and/or assembly of data	✓	✓	--	--	✓	✓	--
Data analysis and interpretation	✓	✓	✓	✓	✓	✓	✓
Writing the article	✓	✓	--	✓	--	--	✓
Critical revision of the article	✓	--	✓	--	--	--	✓
Final approval of article	✓	✓	✓	✓	✓	✓	✓
Statistical analysis	✓	✓	✓	--	✓	✓	✓

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