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A Total Score of Athleticism to Estimate the Amount of Variance Explained in On-Field Performance Within Collegiate American Football Players

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ABSTRACT

The identification of sport and position-specific key performance indicators has been of increased interest to practitioners working within high performance sport settings. The aim of this study was to create statistical models, across a spectrum of position groups, that explain the largest amount of variance in on-field performance over four collegiate American football seasons. A total of four position groups were analyzed, including Wide Receiver/Tight End (n = 29), Running Backs (n = 8), Linebacker/Defensive Line (n =41), Defensive Backs (n = 28). Different tests of physical performance (back squat, bench press, hang clean, 40-yard dash, pro-agility, L-drill, vertical jump, and broad jump) were set as the independent variables, while a Total Score of On-Field Performance, consisting of position-specific game statistics was set as the dependent variable. Linear mixed models, using backwards model selection were used to identify models that best fit the position-specific data. Results revealed that models consisted of at least three different physical performance tests, were position-specific, and explained the variance in on-field performance to different degrees. Significant correlations were found between physical performance models and on-field performance. Results from our study may be of interest to practitioners working within American football that are interested in maximizing success through and individual approach towards the implementation of training.

INTRODUCTION

American Football is arguably the most popular sport within the United States of America and is continuing to gain popularity around the globe. Game demands in American Football require athletes to show proficiency in a variety of physical abilities such as upper and lower body strength and power production ability, rapid accelerations and decelerations, change of direction ability, high running speeds, and muscular endurance[1].

Athletic performance personnel in the sport of American Football routinely tests different parameters related to the previously mentioned key performance indicators (KPI). The implementation of these testing batteries usually occurs during the offseason, and the performance of players during these tests is of interest to coaches, scouts, and professional team management. Recent investigations by different authors have looked into the relationships between performance in the NFL combine and success with regards to on-field performance at the professional level.[2-8] Different results were observed between Combine-related tests and on-field performance in the NFL. Some authors suggested correlations between combine performance and success in the NFL to be valuable tools for those in charge of making player personnel decisions[4], while others highlighted the lack of predictive ability with regards to the NFL combine and future success in the NFL. For example, Cook et al.[4] recently suggested that performance in the NFL combine was only able to explain 2.6% of the variance in average snaps played in the NFL.[2] On the other hand, Parekh and Patel[6] found that quarterbacks and running backs with faster forty-yard dash speeds were associated with better NFL rushing statistics[6].

At the collegiate level in the United States, physical performance tests conducted during the off-season usually resemble the National Football League's draft combine. Additionally, professional team scouts as well as coaches and other team personnel are interested in weight room-based assessments such as the Squat, Bench Press, or Olympic Weightlifting derivatives. Long et al.[9] have suggested that off-field testing batteries (e.g., vertical jump, hang clean max, squat max, 10 yd. dash, and 20 yd. dash) were able to significantly explain the variance in on-field contribution (e.g., starter vs. projected starter vs. bench players) within a sample of NAIA football players.[9] Additionally, Fry and Kramer[10] investigated differences in performance with regards to the bench press, back squat, hang clean, vertical jump, and 36.6 meter sprint across nineteen American Football teams, across three divisions. Performances were evaluated with regards to the division of play (1-3), as well as playing ability (starter vs. non-starter), and significant correlations were observed for most performance tests when compared to the division of play or playing ability.[10] However, research is rather scarce, investigating the relationships between physical performance test results and on-field performance for a single team at the collegiate American football level.

In an effort to maximize the potential positive effects of training on success within a given sport, practitioners have expressed interest identifying key performance indicators that relate to actual on-field, or on-court performance. Recently, Turner et al.[11] has introduced the Total Score of Athleticism (TSA) as a holistic athlete profiling tool to enhance decision-making for practitioners.[11] The TSA is made up of different feats of physical performance that practitioners consider important for success in their sport, and uses standardized scores (z-scores, t-scores) from a number of testing batteries. This allows practitioners to examine contextualized data of individual athletes compared to their teammates.[11] The TSA is indicative of the fact that sport often requires several athletic abilities, suggesting focusing on only one facet of physical performance may be short-sighted and misleading. The TSA is calculated by averaging the z- or t-scores from each test battery.[11] This form of visualizing player performance requires minimal statistical knowledge and is rather simple to employ for coaches and other practitioners. Ultimately, a good TSA should consist of the sport-specific KPI's that have the strongest relationship with success within a given sport.

With the above ideas in mind, the primary aim of this study was to create models, across a spectrum of position groups that explain the largest amount of variance in on-field performance over 4 collegiate American Football seasons. We hypothesized that these models would include multiple physical performance tests rather than a single metric, reflecting the fact that successful sport performance relies on a variety of athletic abilities, as highlighted by Turner et al.[11] We also hypothesized that specific model components would differ between position groups, reflecting heterogeneity between the desired skill sets for respective position groups. The findings from this study can aid practitioners, including strength and conditioning coaches or sport coaches, with decision-making related to talent identification, recruiting, and off-season/in-season training programming priorities.

METHODS

Experimental Approach to the Problem

Researchers analyzed data from preexisting data sets. These data sets included off-season test results for the weight room-based assessments (back squat, bench press, and hang clean), as well as on-field tests, resembling the NFL combine (40-yard dash, pro-agility test, L-drill, broad jump, vertical jump) (table 1) for four athletic seasons (2016-2019). All physical performance data was provided by the head strength and conditioning coach of the respective NCAA Division 2 school.

Table 1. Explanation of Off-season testing batteries[4]

Term	Definition
40-yard dash	Run 40 yards as fast as possible from a static, three-point stance
Pro-Agility	Run 5 yards in one direction, 10 yards in the opposite direction, and back through the starting line. Tests lateral quickness and change of direction ability
L-Drill	Agility drill where 3 cones are set up 5 yards apart from each other in an "L-shape". Tests change of direction performance
Broad Jump	Jump as far forward as possible. Tests lower body horizontal power production ability
Vertical Jump	Jump as high as possible (Inclusion of arm swing, but no step). Tests lower body vertical power production ability
Squat	Calculation of a 1-repetition maximum from a 3-repetition maximum test in the bilateral back squat. Tests maximal lower body strength*
Bench press	Calculation of a 1-repetition maximum from a 3-repetition maximum test in the barbell bench press. Test maximal upper body strength*
Hang Clean	Calculation of a 1-repetition maximum from a 3-repetition maximum test in the Hang Clean. Tests maximal power production ability and strength*

Note. "" indicates that the Epley equation was used to calculate a 1-repetition maximum from a 3-repetition maximum test*[12]

Sufficient execution of physical performance tests (e.g., thighs parallel to the floor during the back squat) was ensured through visual observation and verbal feedback by a group of certified strength and conditioning specialists. On-field performance was analyzed through preexisting individual player statistics from the last four seasons.

Subjects

Study participants were grouped by position, and groups were made up as follows: "Line Backers and Defensive Line (n=41), Defensive Backs (n=28), Wide Receivers and Tight Ends (n=29), as well as Running Backs (n=8)". Respective sample sizes consist of player seasons, since some subjects have data for multiple seasons. Quarterbacks were excluded from the study due to their small sample size. Offensive Linemen were excluded from the study due to the lack of available statistics quantifying their success on the field. To be included in the data analysis, subjects had to have played a minimum of 6 games within each respective season. This study did not include data collection involving human subjects because data was already existing in de-identified fashion within a data set provided and approved by the head strength and conditioning coach at the respective NCAA division 2 school. Further, data for on-field statistics was obtained from publicly available sources. It was therefore deemed by the University of Kansas's Institutional Review Board (IRB) that review and IRB approval was not required.

Procedures

Once all data for the off-season tests as well as the on-field statistics were entered into the designated positional groups data set. All data points were then transformed to standardized z- or t-scores, with above average performers for a respective test or metric showing z- or t-scores above zero and below average performers showing z- or t-scores below zero. All on-field statistics were divided by the amounts of games each athlete played during the respective season, to account for variances due to illness, injury, or other reasons for absence. The positional groups' data sets, with inclusion of standardized scores for off-season performance tests, and on-field performance statistics were then entered into a statistical program for further statistical analysis. On-field performance was quantified by what authors of this study referred to as the Total Score of Performance (TSP). This TSP was acquired by calculating the mean of respective z-, and t-scores for season statistics that were considered important for each respective position group. Position-specific sport coaches from this team were surveyed prior to the study to determine which position-specific on-field performance statistics to include in the analysis. For example, the TSP for the group of Defensive Backs consisted of the following statistics: "Total Tackles, Tackles for Loss, Forced Fumbles, Interceptions, as well as Pass Break Ups". Table 1, 2, and 3 show all the off-season performance tests used, as well as all on-field performance statistics, with inclusion of position specific TSP's. A mixed model regression analysis was used to find the TSA with the largest amount of variance explained for on-field performance, as defined through the TSP. The statistical procedures used within this investigation will be highlighted in greater detail within the statistical analysis section.

Statistical Analysis

All player performance data from off-season testing, as well as on-field performance were organized by position group using Microsoft Excel. All performance data were standardized and converted to z-, or t-scores, based on sample size. With a sample size of 25 or greater, z-scores were used, while t-scores were used with sample sizes less than 25. Standardized scores for on-field performance were averaged together, based on the respective position group, in order to get a value reflecting overall on-field performance (TSP). Data were analyzed using the R statistical computing environment and language (v. 4.0; R Core Team, 2020) via the Jamovi graphical user interface. To investigate the primary study aim we developed linear mixed models, using backward model selection that best fit the position-specific data. To determine this, we used Akaike Information Criterion (AIC), and both the marginal and conditional r^2 values to identify the model of off-season performance data that explained the largest amount of variance in on-field performance. The marginal r^2 value was used to analyze the total proportion of variance in on-field performance explained through our fixed factors while the conditional r^2 value was used to analyze the total proportion of variance in on-field performance explained through fixed factors and any potential intra-individual random factors. In each model design, the TSP was set as the dependent variable while fixed effects included the respective off-season performance data. Athlete identification was used as a random effect since some athletes had data for multiple seasons. Once this model was identified, the resulting parameter estimates were used to formulate a regression equation to predict on-field performance. Bland-Altman plots were used to investigate the agreement between the original TSP and estimated TSP (TSPp) and to allow for potential adjustments to be made in effort to improve model precision. Further, Pearson's correlations, as well as intraclass correlation coefficients were used to determine the relationship and agreement between the original TSP and the TSPp. An alpha level of 0.05 was used for statistical inferences.

Table 2. Defensive Player Performance Definitions

Term	Definition
Total Tackles/Game	Rate of tackles acquired per game
Tackles for Loss/Game	Rate of tackles for a loss in yardage acquired per game
Sacks/Game	Rate of sacks acquired per game. A sack is when the quarterback gets tackled behind the line of scrimmage.
Forced Fumbles/Game	Rate of forced fumbles per game. A forced fumble is when a defender knocks the ball out of the possession of an offensive ball carrier
Interceptions/Game	Rate of interceptions acquired per game. An interception is when a defend-er intercepts the ball thrown by an offensive player
Quarterback Hurries/Game	Rate of quarterback hurries acquired per game. A quarter back hurry is when the defensive pass rusher pressures the quarter back, forcing him to make a decision with the ball that involves either an incomplete pass or an interception
Pass Breakups/Game	Pass breakups acquired per game. A pass breakup is when the defensive players knocks the ball down, hindering the receiver from catching it

Table 3. Offensive Player Performance Definitions

Term	Definition
Receptions/Game	Rate of passes caught per game
Receiving Yards/Game	Rate of yards acquired through catches per game
Average Catch/Game	Rate of yards per catch, per game
Rushing Yards/Game	Rate of yards acquired through rushing the ball per game
Average Rush/Game	Rate of yards acquired per rush, per game
All Purpose Yards/Game	The total yards acquired per game, coming from catches, rushes, as well as all forms of return yards
Touchdowns/Game	Rate of touchdowns scored per game

Table 4. Total Score of Performance (TSP) Make Up

Position Group	TSP Make Up
Wide Receiver/Tight End	All Purpose Yards per Game, Average Yards per Catch, Receptions per Game, Receiving Yards per Game, Touchdowns per Game
Running Back	All Purpose Yards, Average Yards per Rush, Rushing Yards per Game, Touchdowns per Game
Defensive Back	Total Tackles per Game, Tackles for Loss per Game, Forced Fumbles per Game, Pass Break Ups per Game, Interceptions per Game
Line Backer/Defensive Line	Total Tackles per Game, Tackles for Loss per Game, Forced Fumbles per Game, Sacks per Game, Quarterback Hurries per Game

RESULTS

Offensive Position Groups

Wide Receiver/Tight End

At this position (n=29), the model explaining the largest amount of variance in for on-field performance (AIC = 62.43, BIC = 84.13, marginal r^2 = 0.487, conditional r2 = 0.487) consisted of performance in the Broad Jump, Bench Press, L-drill, Hang Clean, as well as Pro-Agility, explaining 48.7-, and 48.7 percent of the variance in on-field performance, respectively. However, Bench Press and Pro-Agility had a negative fixed effects parameter sign. Fixed Effects Parameter Estimates for this position-groups model can be seen in table 5. The following regression equation was used within this position group to predict on-field performance: TSPp = 0.259 + (0.436 * z-Broad) - (0.598 * z-Bench Press) + (0.005 * z-L-drill) + (0.215 * z-Hang Clean) – (0.187 * z-Pro-Agility) - 0.121. Strong agreement was identified between the TSP and TSPp (ICC=0.711), as well as a statistically significant positive correlation (r=0.736, p=<.001).

Running Backs

At this position (n=8), the model explaining the largest amount of variance in on-field performance (AIC = 40.50, BIC = 41.85, marginal r^2=0.48, conditional r^2=0.48) consisted of performance in the Squat, 40-yard dash, as well as Broad Jump, explaining 48 percent of the variance in on field performance, respectively. Fixed Effects Parameter Estimates for this position-groups model can be seen in table 6. The following regression equation was used within this position group to predict on-field performance: TSPp = 1.1085 + (0.2939 * t-Squat) + (0.8585 * t-40YD) + (0.0945 * t-Broad Jump) – 2.239. Substantial agreement was identified between the TSP and TSPp (ICC=0.789), as well as a statistically significant positive correlation (r=0.762, p=0.037).

Defensive Position Groups

Defensive Backs

At this position group (n=28), the model explaining the largest amount of variance in on-field performance (AIC = 58.51, BIC = 78.07, r^2 marginal = 0.22, r^2 conditional = 0.80) consisted of performance within the squat, 40-yard dash, vertical jump, as well as L-drill, explaining 22 percent and 80 percent of the variance in on-field performance, respectively. Fixed Effects Parameter Estimates for this position-groups model can be seen in table 7. The following regression equation was used within this position

Table 5. Fixed Effects Parameter Estimates WR/TE

		95% Confidence Interval				
Names	Estimate	Lower	Upper	df	t	p
(Intercept)	0.259	-4.61e-4	0.518	20.0	1.957	0.065
Z-Broad	0.436	0.123	0.749	20.0	2.731	0.013
Z-Bench	-0.598	-1.066	-0.131	20.0	-2.508	0.021
Z-L-drill	0.005	-0.380	0.390	20.0	0.024	0.981
Z-Hang Clean	0.215	-0.299	0.729	20.0	0.820	0.422
Z-Pro-Agility	-0.187	-0.524	0.149	20.0	-1.092	0.288

Table 6. Fixed Effects Parameter Estimates RB's

		95% Confidence Interval				
Names	Estimate	Lower	Upper	df	t	p
(Intercept)	1.1085	-0.2989	2.52	4.00	1.544	0.198
T-Squat	0.2939	-0.4327	1.02	4.00	0.793	0.472
T-40YD	0.8585	-0.0938	1.81	4.00	1.767	0.152
T-Broad	0.0945	-1.0520	1.24	4.00	0.162	0.879

group to predict on-field performance: TSPp = "0.0225 + (0.3055* z-Squat) + (0.1785* z-40YD) + (0.1274* z-Vert) + (0.0831* z-L-drill) + 0.0277. Moderate agreement was identified between the TSP and TSPp (ICC=0.41), as well as a statistically significant positive correlation (r=0.479, p=0.013).

Line Backers / Defensive Line

At this position group (n=41), the model explaining the largest amount of variance in on-field performance (AIC = 74.84, BIC = 99.28, r^2 marginal = 0.478, r^2 conditional = 0.806) consisted of performance in the Squat, Hang Clean, L-drill, and Pro-Agility drill, explaining 47.8 percent, and 80.6 percent of the variance in on-field performance, respectively. However, squat performance within this model having a negative fixed effects parameter sign, while the other three performance data have positive signs. Fixed Effects Parameter Estimates for this position-groups model can be seen in table 8.

The following regression equation was used within this position group to predict on-field performance: TSPp = 0.2433 – (0.1890* z-Squat) + (0.5882* z-Hang Clean) + (0.2442* z-L-drill) + (0.0840* z-Pro-Agility) – 0.268. Substantial agreement was identified between TSP and TSPp (ICC=0.693), as well as a statistically significant positive correlation (r=0.696, p=<.001).

DISCUSSION

The present study sought to investigate the predictive ability of models, comprised of commonly utilized physical performance tests, with regards to on-field performance over four seasons within a collegiate American football team. It was hypothesized that models would consist of more than one performance test, and that the make-up models would differ between positions groups, reflecting not only the task-specific nature of position groups, but also

Table 7. Fixed Effects Parameter Estimates DB's

		95% Confidence Interval				
Names	Estimate	Lower	Upper	df	t	p
(Intercept)	0.0225	-0.2956	0.341	14.9	0.139	0.892
Z-Squat	0.3055	-0.0291	0.582	19.9	2.166	0.043
Z-40YD	0.1785	-0.0992	0.456	20.3	1.260	0.222
Z-Vert	0.1274	-0.2287	0.483	18.2	0.701	0.492
Z-L-drill	0.0831	-0.1388	0.305	12.5	0.734	0.476

Table 8. Fixed Effects Parameter Estimates LB/DL

		95% Confidence Interval				
Names	Estimate	Lower	Upper	df	t	p
(Intercept)	0.2433	-0.0354	0.4512	20.0	2.294	0.033
Z-Squat	-0.1890	-0.4636	0.0856	33.1	-1.349	0.187
Z-HC	0.5882	0.3096	0.8668	29.8	4.138	<.001
Z-L-drill	0.2442	-0.0203	0.5087	35.7	1.809	0.079
Z-Pro Agility	0.0840	-0.2101	0.3782	35.5	0.560	0.579

the fact that success within American football depends on a variety of different athletic abilities. Further, researchers aimed to create position specific regression equations, based on model characteristics that explained the largest amount of variance in on-field performance.

The results of this investigation are in line with our hypotheses. It was revealed that position-specific models that best fit our data consisted of at least three different performance metrics. Further, model characteristics differed between position groups. Position-specific models within our investigation explained between 22 and 49 percent of the variance in on-field performance. The models for the Wide Receiver/Tight End, Running Back and Linebacker/ Defensive Line groups showed the largest r^2 values, while the model for the Defensive Backs showed the lowest r^2 value. It may be speculated that model characteristics, in our case physical performance metrics, align with respective position-specific key performance indicators. For instance, based on our findings, athletes with success at the positions of Wide Receiver and Tight End show proficiency in explosive strength, as highlighted through performance in the Hang Clean, change of direction ability, as highlighted through performance within the L-drill, as well as horizontal power production ability, as highlighted through performance within the Broad Jump. One may argue that these physical performance traits align with position-specific tasks such as route running, which included rapid accelerations and decelerations linearly, as well as direction-specific.

Further, Pro-Agility, and Bench Press performance were included in this position groups model, however with negative fixed effects parameter signs. This indicates for instance that pass catchers with bigger Bench Press numbers reported worse on-field performance. It may be speculated that players with the largest Bench Press numbers are also players who are heavier in weight. LaPlaca et al.[4] highlighted that those Tight Ends lighter in weight also had better "longest catch statistics".[4] Further results for this position group are in partial agreement with findings from other recent investigations at the professional level. For instance, LaPlaca et al.[4] found that within the groups of Wide Receivers and Tight Ends, 40-yard dash and Broad Jump performance at the NFL combine were associated with having a greater "longest catch statistic" over a 12-year period in the NFL.[4] This trend towards a need for linear speed and horizontal power production capability was also observed for the Running Backs within our study and was seen in previous literature as well. Our model for RB's consisted of performance within the Squat exercise, 40-yard dash, as well as Broad Jump. Earlier findings by Kuzmits and Adams[13], looking at the RB position highlight a relationship between 40-yard dash performance at the NFL combine and year 1 salary, games played during years 1 and 2, as well as average yards per carry during year 1 and 2 within the NFL.[13] Similar findings were seen by LaPlaca et al.4 who suggested that performance in the 40-yard dash and Broad Jump at the NFL combine were related to having a better "longest run statistic", as well as more games played within the NFL.[4] Lastly, Vincent et al.[8] mentioned that Running Back success was most strongly related to 40-yd dash times.[8]

Our model for the group of LB's and DL explained 48% of the variance in on-field, and consisted of performance within the Hang Clean exercise, Pro Agility, as well as L-drill. Interestingly, performance in the Squat exercise was also included in this model, however, with a fixed effects parameter sign going in the negative direction. Further, our results are not completely in agreement with results from LaPlaca et al.[4] who found 40-yard performance at the NFL combine to be frequently related to a number of on-field performance statistics within the different LB and DL groups.[4] However, similar to our findings, in their study, performance in the L-drill and Pro-Agility showed a significant correlation with more pressures per pass rush snap count, sacks per pass rush snap count, and hits per pass rush snap counts in the group of Defensive Tackles. Further, Vincent et al.[8] also found a significant relationship between the Pro-Agility drill, and sacks completed, within their group of LB's.[8] Our data for this position group suggest that LB's and DL players at the collegiate level may need to possess sufficient levels of explosive strength, as well as the ability to rapidly accelerate, decelerate, and change directions.

Lastly, while only explaining about 22% of the variance in on-field performance, our model for the group of DB's, might have been the most complete, or truest TSA, when referring to suggestions by Turner et al.[11] Consisting of performance within the squat exercise, 40-yard dash, vertical jump, as well as L-drill, this model suggests that athletes playing DB at the collegiate level may need to possess athletic abilities related to strength, linear speed, vertical power, as well as the ability to rapidly accelerate, decelerate, and change direction. These suggestions agree with findings by LaPlaca et al.[4], who found that those cornerbacks with faster 40-yard dash times at the NFL combine had a higher number of break ups per pass coverage snap count, as well as games played in the NFL.[4] Further, within the same study, Free Safeties with better performance in the vertical jump had more tackles per total snap count, and Strong Safeties with faster times in the L-drill had more interceptions per pass coverage snap count.

A closer look at the differences between our respective r^2 marginal and r^2 conditional values may offer insight to practitioners on variables that might also affect player performance, beyond physical attributes, such as coaching, training, and/or environmental factors. As mentioned within our statistics section, in a linear mixed model regression approach, the r^2 marginal value accounts the total proportion of variance in on-field performance explained through our fixed factors (e.g., Physical Performance Tests), while the r^2 conditional value accounts for the total proportion of variance explained through fixed factors and any potential intra-individual random factors (e.g., training age, maturation level, motivation, sport IQ, sport-specific skill, offensive and defensive schemes used by respective sport coaches) that may exist. Thus, larger differences between the r^2 marginal and r^2 conditional values may potentially show greater influence of these outside random/external factors could have on players' on-field performance. For example, looking at the WR/TE group, we can see that the two r^2 values are identical (0.487 vs. 0.487). One may speculate that intra-individual factors such as sport-specific skill, training age, or motivation do not add much to our model with regards to explaining the variance in on-field performance. This could indicate that the rest of the variance may stem from factors such as opponent play, coaching style, Quarterback play, amongst others. Compared to the WR/TE group, the LB/DL group showed a much greater difference between the r^2 marginal and r^2 conditional values (0.478 vs. 0.806). This shows that about 48% of the variance in on-field performance for this position group was explained through the physical performance tests in our model, while 81% of the variance in on-field performance was explained through the physical performance tests in addition to interindividual random factors such as training age, motivation, or sport-specific skill. This large difference between the two r^2 values may indicate that interindividual random factors impact on-field performance to a greater degree, compared to the WR/TE group. While speculative, one may suggest that practitioners working with the WR/TE group may place a larger emphasize on sport specific tactics, as well as communication amongst players, in addition to others. On the other hand, results from our sample for the LB/DL group indicate that practitioners may find more room for improvement in the interindividual random factors such as sport-specific skill, sport IQ, as well as motivation, in addition to others. We believe that another factor that might have influenced the difference between the two position groups is the coaching turnover within the defensive position groups over the four seasons analyzed within our study. On the other hand, the coaching staff for the offensive position groups remained steady over the four seasons.

There are a few limitations within the current study. For one, due to difficulties with regards to the acquisition of on-field performance data for the Offensive Line, this position group was excluded from our analysis entirely. Further, based on a lack of sample size, Quarterbacks were also excluded from our study. Future investigations may strive to include the previously mentioned positions groups when analyzing relationships between physical performance metrics and on-field performance at the collegiate American football level. Further, future investigations may use similar methods to the ones used by other authors[4], to investigate the relationships between individual performance tests that were part of our models, and players statistics for separate position-specific on-field tasks (e.g., Interceptions, Yards per Carry, Sacks). Such findings may help practitioners at the collegiate football level individualize their physical preparation schematics, based on a specific style of play, or coaching preference. Lastly, future studies may replicate methodologies while including different anthropometric measures in respective models.

CONCLUSION

The present study demonstrates that our models, aimed at estimating the amount of variance explained in American football on-field performance, based on physical performance tests include at least three different feats of athletic performance, and are different for respective position groups. As expected, this shows that success in American football relies on a number of different athletic abilities, and that these athletic abilities are position specific. However, while physical performance tests do explain on-field performance, many of these models have a higher proportion of unexplained variance potentially due to individual factors that were unmeasured (e.g., sport skill, motivation, tactical schemes). Results from our study may be acutely interesting to all practitioners working within American football that are interested in maximizing their success through an individual approach towards the implementation of training.

DECLARATION OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

REFERENCES

1. Fullagar HH, McCunn R, Murray A. Updated Review of the Applied Physiology of American College Football: Physical Demands, Strength and Conditioning, Nutrition, and Injury Characteristics of America's Favorite Game. International Journal of Sports Physiology and Performance 2017; 12: 1396-1403.
2. Cook J, Ryan GA, Snarr RL, Rossi S. The Relationship Between the National Football League Scouting Combine and Game Performance Over a 5-year Period. Journal of Strength and Conditioning Research 2020; 34: 2492-2499.
3. Hedlund DP. Performance of Future Elite Players at the National Football League Scouting Combine. Journal of Strength and Conditioning Research 2018; 32: 3112-3118.
4. LaPlaca DA and McCullick BA. National Football League Scouting Combine Tests Correlated to National Football League Players Performance. Journal of Strength and Conditioning Research 2020; 34: 1317-1329
5. Mulholland J and Jensen ST. Optimizing the Allocation of Funds of an NFL Team Under the Salary Cap. International Journal of Forecasting 2019; 35: 767-775.
6. Parekh S and Patel A. The NFL Combine as a Predictor of On-Field Success. Foot & Ankle Orthopedics 2017; 2: 3.
7. Teramoto M, Cross CL, Willick SE. Predictive Value of National Football League Scouting Combine on Future Performance of Running Backs and Wide Receivers. Journal of Strength and Conditioning Research 2016; 30: 1379-1390.
8. Vincent LM, Blissmer BJ, Hatfield DL. National Scouting Combine Scores as Performance Predictors in the National Football League. Journal of Strength and Conditioning Research 2019; 33: 104-111
9. Long GB, Walker J, Herron RL, Bishop SH, Katica CP, Ryan GA. Predicting Caliber of Performance and On Field Contribution of NAIA Division Football Players. International Journal of Exercises Science: Conference Proceedings 2014; 8: 68.
10. Fry AC and Kraemer WJ. Physical Performance Characteristics of American Collegiate Football Players. Journal of Strength and Conditioning Research 1991; 5: 126-138.
11. Turner AN, Jones B, Stewart P, Bishop C, Parmar N, Chavda S, Read P. Total Score of Athleticism. Strength and Conditioning Journal 2019; 41: 91-101.
12. DiStasio T. Validation of the Brzycki and Epley Equations for the 1 Repetitition Maximum Back Squat Test in Division 1 College Football Players. Master's Thesis, Southern Illinois University Carbondale, USA, 2014.
13. Kuzmits FE and Adams AJ. The NFL Combine: Does it Predict Performance in the National Football League?. Journal of Strength and Conditioning Research 2008; 22: 1721-1727.