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**Title:** Positional differences in running and non-running activities during elite American Football training

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**Abstract**

The aim of this investigation was to describe differences in training loads between position groups within professional American football. Integrated micro technology data was collected on 63 NFL football players during an American football training camp. Five key metrics (total distance, high speed distance, Player Load, Player Load per Minute, and Total Inertial Movement Analysis (IMA)) served to quantify both running and non-running activities. Players were classified into position groups (DB, DL, LB, OL, QB, RB, TE, and WR). Training sessions were identified by their relationship to the upcoming match (e.g., -4, -3, -2). Running and non-running activities varied between position groups relative to the training day. Differences in total distance were between DB and WR were observed to be unclear between the three training days (Game Day (GD) -4: 74 ± 392 m; GD -3: -122 ± 348; GD – 2: -222 ± 371 m). However, moderate to large differences were observed between these two positions and the other positional groups. A similar relationship was observed in Player Load and Player Load per Minute, with the DB and WR groups performing greater amounts of load compared to other positional groups. Differences in High Speed Distance varied across positional groups, indicating different outputs based on ergonomic demands. The OL and DL groups ran less but engaged in a higher amount of non-running activities (Total IMA) with differences ranging from moderate to large across the three training days. Total IMA differences between offensive and defensive linemen were unclear on GD -4 (-4 ± 9) and GD -2 (-2 ± 8) and likely moderate on GD -3 (-9 ± 9). Positional differences with regard to running and non-running activities highlight the existence of position specific training within a training micro-cycle. Additionally, Total IMA provides a useful metric for quantifying sport specific movements within the game of American football.

Keywords: American football; Training Load; GPS; accelerometer

## INTRODUCTION

Field-based team sports require that players compete in different positions that have specific technical, tactical and physical activity demands. Indeed, with increased use of micro technologies such as GPS and accelerometers, recent studies have described different positional activity profiles for a variety of team sports.[3, 6, 9, 10, 21] These studies have been used to gain greater insight sport specific requirements and may be used to aid in the design of specific training sessions.[22] Widespread profiling of activity profiles have been conducted in most field-based team sports,[3, 6, 9, 10, 21] as well as collegiate American football (DeMartini et al, 2012; Wellman et al., 2015).

American football is a collision-based sport characterized by high intensity efforts separated by brief periods of rest.[14, 20] The game is played at the collegiate level in the NCAA and the professional level in the National Football League (NFL). Players are divided into eight positional groups: Defensive Backs (DB), Defensive Linemen (DL), Linebackers (LB), Offensive Linemen (OL), Quarterback (QB), Running Back (RB), Tight End (TE), and Wide Receiver (WR)), each with different tactical and physical demands.[17] The limited quantification of such physical demands in the literature revealed that non-linemen (e.g., WR, DB, RB, QB) perform greater amounts of running activities compared to linemen during collegiate football training.[11] Similarly, during Division 1 college football games, WR and DB cover greater total distance (5531 ± 997 m and 4696 ± 1115 m, respectively) and perform a higher number of sprints (21.9 ± 8.1 and 20.9 ± 8.6, respectively) than other position groups.[24] An evaluation of impacts and collisions during collegiate football games revealed that RB and Defensive Tackles (a position on the DL) engage in a larger amount of severe (> 10 g-forces) and heavy impacts

(7.1 – 10 G force), respectively, than other position groups.[25] These data support the idea that positional differences in the physical demands exist in American football.

There are several limitations in the previous studies that have described the position demands of American football. Indeed, previous studies have divided playing positions into two broad groups (i.e. linemen and non-linemen),[11] which limited the ability to describe the discrete activity demands of the unique playing positions that exist within these two groups. Additionally, two previous studies that described positional differences in 12 collegiate American football games only examined position group differences between players who fulfilled the same function within the team (e.g., offensive players compared with other offensive players),[24-25] which limits the ability to understand how competition between position groups may influence activity. This study also monitored the same players across the season using repeated measures from the same players which violates fundamental assumptions the statistical analysis applied.[8] A final limitation is that these data are specific to the collegiate competitions, which limits the generalizability of these results to professional American football (i.e. the NFL).

At the present little is known about the specific positional differences in American football in players competing at the highest level within the NFL. Therefore, the aim of this paper is to investigate the differences among position groups during an NFL training camp. We hypothesize that position groups differ in activity due to their unique positional demands.

## METHODS

### Experimental Approach to the Problem

This study investigated the positional differences in training demands during an NFL training camp consisting of 4 match preparation weeks prior to the upcoming NFL season. The first 10 days of the training camp were dedicated to team practices with the remainder of the time devoted to preparing for 4 pre-season games (1x/week). For the purposes of this study, only the preparation weeks for the 4 games were considered as these weeks were used to prepare for competition and follow the typical in-season training structure. Eleven training sessions over this 4-week period were therefore included in the final analysis. The contents of the training sessions were determined by the coach with the goal of preparing the team for the upcoming opponent. Training sessions were divided into five key periods: warm up, position specific training drills, special teams drills, preparatory plays, and team plays which, represent the offense running plays against the defense and make up the bulk of the training session. The contents of these periods consisted of a diverse number of sporting actions, with certain position groups performing running and cutting activities (e.g., DB and WR), other groups performing a greater number of collisions and physical contact (e.g., OL and DL), and some position groups performing a combination of both locomotor and collision-based actions (e.g., TE and LB) (Table 1-2).

[Table 1 & 2 about here]

### Subjects

Sixty-three American football players from the same NFL team were included in this study (mean ± SD; age: 24 ± 2 y; height: 1.88 ± 0.06 m; weight: 109.4 ± 19.9 kg). The position groups consisted of DB (n = 12), DL (n = 7), LB (n = 10), OL (n = 11), QB (n = 2), RB (n = 8), TE (n =

5), and WR (n = 11). A total of 541 individual training files were obtained. The number of sessions performed by the athletes can be observed in **Table 3**. The variation in session number is a consequence of the availability of participants (e.g. non-availability through injury and participants being released or added to the playing staff). This study constitutes a retrospective analysis of archived data collected in an applied sports science setting where training load monitoring is considered best practice and within occupational purview.[26] All data was de-identified prior to analysis. Ethical approval for the methodology of this study was granted by a local university ethics committee and permission to publish was granted from the NFL team.

[Table 3 about here]

Procedures

During training, players wore an integrated micro technology unit (Minimax S4, Catapult Innovations, Scoresby, Australia) contained within a custom pouch, provided by the manufacture, sewn between the shoulder blades, on the inside of their practice shirt. These units contain a GPS sensor (10 Hz), accelerometer (100 Hz), gyroscope (100 Hz), and magnetometer (100 Hz). Following each training session, data was downloaded using the manufactures software (Catapult Sports Openfield software) and exported to Excel (Microsoft, Redmond, WA) for further analysis. To ensure intra-unit reliability, athletes were assigned their own individual units.[19] The reliability and validity of these units have been previously established.[5, 7, 19, 23]

Training sessions were classified specific to the number of days until the upcoming game. For example, day to game -4 (GD -4) indicates that there are 4 days until the next game. Three main training sessions were performed each week: GD -4 (n = 3), GD – 3 (n = 4), and GD – 2 (n = 4). The final session of the week, GD -1, included a brief review of the game plan, which did not

include significant physical activity and therefore was not included in the study. Total distance (TD) and high speed running distance were analyzed to compare running demands between position groups. High speed running distance (HSD) was defined as distances run above 70% of the maximum speed for the respective position group. This threshold was established using all training data from the previous season, collected via the GPSport system (SPI Pro X; GPSports, Canberra, Australia). As such, our data reflect the most frequently performed max speeds of each positional group during real training sessions. These position group thresholds were determined using the median maximum speed observed for each group during training sessions within the previous year (DB: > 6.8 $m \cdot s^{-1}$; DL > 5.9 $m \cdot s^{-1}$; LB > 5.9 $m \cdot s^{-1}$; OL > 4.5 $m \cdot s^{-1}$; QB: > 5.9 $m \cdot s^{-1}$; RB: 6.2 $m \cdot s^{-1}$; TE > 6.3 $m \cdot s^{-1}$; WR > 7.1 $m \cdot s^{-1}$).

Player Load (PL) and Inertial Movement Analysis (IMA) were used to quantify non-running activities such as collisions, impacts, or changes of direction and movements taking place in small spaces. Player Load represents the total amount of acceleration taking place on three axes of movement (X, Y, and Z) and is reported in arbitrary units.[5] We evaluated PL in both absolute and relative (Player Load per Minute (PL/min)) forms. IMA has been reported to quantify the displacement of force over different vectors of movement (Forward, Backward, Left, and Right) through the combined use of accelerometer, gyroscope, and magnetometer data.[1] Total IMA (the sum of IMA activities taking place above 3.5 $m.s^{-2}$) was used to investigate positional differences within this study. Player Load and IMA have good reliability when measuring on field movement activities[5] and game-to-game explosive actions.[16]

Statistical Analysis

Training data were pooled together by day (e.g., all GD -4 sessions were grouped together) in order to reflect the training demands during each day of a training week. Mixed models have been suggested as an analytical approach to deal with repeated measures data and unbalanced data sets, for example players performing different numbers of training sessions during the monitoring period.[8] A separate mixed model for each dependent variable (TD, HSD, PL, PL/min, and Total IMA) was constructed. Position group and Day to Game were treated as fixed effect independent variables. Random effects within the models were represented as the individual player and the training day. Models were fit iteratively and candidate models were compared using likelihood ratio tests with significance set at $p < 0.05$.

Data are represented as mean ± SD. Standardized mean differences (effect sizes) with 95% Confidence Intervals (CI), were used to evaluate the difference between position groups. Standardized differences relative to the between subject SD of the random effects within each model were interpreted as trivial (< 0.2), small (0.2 – 0.6), moderate (0.6 – 1.2), large (1.2 – 2.0), and very large (2.0 – 4.0). Qualitative statements about the effect were made based on the probability of a real difference between groups (75% - 95% probability indicated a "likely" difference, 95% - 99.5% probability indicated a "very likely" difference, and > 99.5% indicated a "most likely" difference).[4] In the event that the probability exceeded 5% in both the positive and negative directions, the effect was reported as "unclear", indicating that no clear difference could be detected given the data. This type of statistical approach was selected to provide a qualitative interpretation of the uncertainty surrounding the observed differences.[4] All analysis was conducted using the statistical software R (Version 3.1.2).

## RESULTS

### Overview of Mixed Models

The final model consisted of a main effect interaction between Position Group and Day to Game and a random effect allowing the slope and intercept to vary for the individual player and Day to Game. These models show training load was influenced by the interaction between playing position and the training day.

### Running Demands

Significant main effects were observed for the interaction between position groups and Day to Game for both TD ($\chi^2(21) = 92.1$, $p < 0.0001$) and HSD ($\chi^2(21) = 71.3$, $p < 0.0001$). Between-athlete standard deviations of 318 m and 39 m were observed for TD and HSD, respectively (**Tables 4-5, Figure 1**).

[Tables 4-5 and Figure 1 about here]

Defensive Backs and WR showed unclear differences in TD covered (GD -4: 74 ± 392 m; GD -3: -122 ± 348; GD – 2: -222 ± 371 m). However, when compared with all other positional groups, these two groups performed greater TD (moderate to large differences), with the exception of the TE and QB, who had an unclear difference with the DB on GD -2. The DL and OL positions were found to cover the least amount of distance.

There were variable responses in HSD between the playing positions. Tight Ends and RB performed more HSD than WR on GD -4 (64.3 ± 51.8 m, possibly large, and 81.3 ± 44 m, likely large, respectively). HSD differences between OL and RB were likely very large (-106.1 ± 41.8 m) on GD -4, likely large (-106.5 ± 49.2 m) on GD -3, and likely very large (-112.9 ± 36.6 m) on GD -2. Defensive backs performed less HSD than LB on GD -2 (-35.7 + 38.8 m, possibly moderate), GD -3 (-85.9 ± 46.2 m, possibly large), and GD -4 (-75.3 ± 33.8 m, possibly large). Linebackers performed more HSD than DL (GD -4: -35.3 ± 45.1, possibly moderate; GD -3: -110.5 ± 53.5, likely large; GD -2: -86.9 ± 38.7, likely large).

Sport Specific Movements

Significant main effects were observed for the interaction between Position and Day to Game for PL ($\chi^2(21) = 131.2$, $p < .0001$), PL/min ($\chi^2(21) = 48.0$, $p = .0007$), and Total IMA ($\chi^2(21) = 965$, $p < .0001$). Between athletes standard deviations of 41 AU, 0.4 AU, and 9 were observed for Player Load, PL/min, and Total IMA, respectively (**Tables 6-8, figure 2**).

[Table 6-8 and Figure 2 about here]

Defensive Backs and WR performed the highest amount of PL compared to other position groups, with unclear differences observed between them (GD -4: 19 ± 41 AU; GD – 3: -2 ± 36 AU; GD -2: -11 ± 38 AU). Defensive linemen performed the lowest PL relative to all other positions. Conversely, the OL, the position group that opposes the DL on offense, performed more PL than the DL with effects ranging from moderate to large (GD -4: -58 ± 44 AU, likely large; GD -3: -44 ± 38 AU, likely moderate; -52 ± 42 AU, possibly Large). The DL group also

performed the lowest PL/min, with differences ranging from likely small to likely large when compared to other positional groups.

Position groups that oppose each other on offense and defense showed unclear differences in Total IMA. Defensive Line and OL performed a higher number of Total IMA compared to all other position groups with unclear differences between the two groups on GD -4 and GD -2 and OL performing more Total IMA on GD -3 (-9 ± 9, Likely Moderate). Wide Receivers and DB's had unclear differences in IMA as did LB's and TE's and LB's and RB's, with the exception of GD -3, where a possibly moderate difference was observed (7 ± 8).

**DISCUSSION**

This is the first study to investigate the positional differences in external training loads (both running and non-running activity) in American football players during a NFL training camp. The main findings show positional differences in both running and sports specific movements. Specifically, DB's and WR's exhibited moderate to most likely very large differences in TD covered compared to other position groups. Conversely, DL and OL performed a larger number of sports specific movements, as measured via Total IMA. The observed variations in training load between positions groups also appear to be influenced by the microcycle structure, whereby training intensity appears to decrease as the training days progress closer to competition. This decrease in training intensity across the week is a consequence of the training sessions being aimed at preparing for the game (e.g., installing plays) and may reflect a tapering approach as competition nears. These findings may have practical relevance in

illustrating differences in the training loads completed by different positions in the NFL, during the training camp period.

Total distance is often reported as a measure of training volume in field-based team sport athletes.[2] The heterogeneous nature of position demands in American football requires some positions to perform more running than others.[11] Differences in locomotor activity between position groups in our study are similar to previous findings in collegiate[11, 24-25] and high school[13] American football athletes. For example, WR and DBs in the college ranks were observed to have a higher amount of running distance and sprints during a season compared to all other positions.[24] Similarly, college non-linemen performed a higher amount of TD than linemen. These findings are similar to our observations for DB and WR who had a greater amount of running distance during training compared to other position groups. Notably, total distances observed in this sample of NFL players are greater than during a collegiate football practice.[11] This may be a direct consequence of playing at the higher NFL level where there are fewer players on training squads than college teams. While college football teams often support between 110-120 players, NFL teams are regulated by the number of players they can employ by the rules of the league. These lower numbers of available players may also result in lower opportunities for recovery periods from practice drills in our sample thereby increasing the need to be involved in practice activities. It is also possible that these differences may simply reflect a higher level of physical demand at the elite end of the game.

In addition to TD we also evaluated differences in HSD between NFL position groups. We observed differences in HSD between positions where WR performed less than TE's on GD -4 and GD -3 and RB on all three training days. In the defensive position groups, the LB's were found to perform more HSD than the other two position groups (DB and DL). These findings describe a difference in the positional requirements for HSD irrespective of total distance that is covered across positions. Our findings are in contrast to previous findings, from collegiate games, where WR and DB performed greater sprint distance (> 6.4 $m \cdot s^{-1}$) than other position groups.[24] These authors, however, used absolute speed zones for the entire team, which may overestimate and underestimate HSD for faster and slower athletes respectively.[12] In contrast, our study utilized a relative speed criteria specific to each position group. This may explain some of the observed differences between position groups within our study. Alternatively, our findings may indicate a potential volume-intensity relationship in position groups that perform larger amounts of total distance during training. For example, it is possible that the amount of total distance the WR and DB groups are required to perform impedes their ability to perform greater HSD during training.

To investigate sports specific movements, we utilized three accelerometer metrics – PL, PL/min, and Total IMA. Our study revealed that high PL values may be associated with the completion of a variety of specific actions other than running, such as collisions and tackles. This is evidenced by some positions demonstrating relatively high PL values in the context of low total distances. For example, differences in PL and PL/min between OL and WR ranged from Unclear to Possibly Moderate across all three training days, despite WR's performing very large differences in total distance covered. Similarly, the DB group performed greater running than the LB group,

though the PL differences between these two groups were less substantial. These findings indicate that PL may be a useful metric for differentiating training load between position groups due to its ability to capture actions related to non-running activities. Further validation of PL in American football is required to confirm its utility.

The DL produced the lowest PL and PL/min compared to all other position groups. Observed differences between DL and OL are interesting given the OL is the main opposition of the DL. These findings may be a consequence of the practice style for this group in this team. Practice is divided in such a way that portions of the sessions are dedicated towards position groups competing against each other in game specific tasks (e.g. running plays) while other parts of practice are devoted to individual position groups working on technical elements of play. It is possible that, even though position groups like the OL and DL compete against each other during structured periods of practice, their position specific training periods may provide different training load intensities for these groups when compared to other positions. A more thorough evaluation of within-session training drills would allow for a better understanding of how positional groups are affected by these training demands.

While PL is influenced by a variety of actions, previous literature has suggested that PL can be biased towards upright running.[15, 18] Therefore, we attempted to further quantify the sports specific movements using Total IMA. Differences in Total IMA were unclear between position groups that compete against each other on offense and defense. These findings indicate that positions that oppose one another share similarities with regard to sport specific movements on the basis of these metrics. The DL and OL groups performed the highest Total IMA compared to

other position groups. The main actions of these two groups typically occur through collisions with one another to block or tackle. Our findings suggest that while the OL perform a greater amount of total distance and PL compared to the DL, a similar number of sports specific movements are performed between the two groups during training. These observed differences show that Total IMA could be used to identify the contribution of sports specific movements to the total training load in American football. This suggests that there is also a need for training load measures other than speed and distance in groups that perform greater sport specific actions (e.g., OL and DL) in this sport.

While this is the first study to describe training demands in NFL football, there are several limitations to consider when interpreting these results. First, these data are only specific to a single period of training completed in the training camp of a single team. These findings may not reflect training during the in-season phase when competitive demands are greater and the roster size is smaller. For example, during the pre-season phase teams are allowed to maintain a roster of 90 players, as opposed to 63 during the regular season, which allows training to be dispersed amongst a greater number of players. Therefore, the key players on the team are not required to train with the same amount of volume as they would during the in-season phase. Thus, this data may not reflect the outputs of the most elite players within the sport.

**PRACTICAL APPLICATIONS**

This study has described positional training loads during training of American football in the NFL. The results showed differences in running volume, intensity and sport specific movements. These data have implications for training interventions and establishing periodization strategies

when preparing for competition. For example, the observed decreases in physical output across the microcycle may be reflective of tapering as the competition nears. An additional finding of this study is that inertial sensor data provides the basis for a different conceptual approach to quantifying training load. These measures provide value in sports such as American football where players perform different types of actions that may not be running based. Future research should seek to better understand these metrics and their utility for determining not only training demands but also performance outcomes and injury risk.

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**Figure 1:** Mean ± 90% CI for Total Distance (A) and High Speed Distance (B) relative to each training day. Horizontal dashed lines represent the mean Total Distance and High Speed Distance for the entire group on each training day.

**Figure 2:** Mean ± 90% CI for Player Load (A), Player Load per Minute (B), and Total IMA (C) relative to each training day. Horizontal dashed lines represent the mean Player Load, Player Load per Minute, and Total IMA for the entire group on each training day.

**Table 1.** Weekly schematic of training duration and percentage of time devoted to specific drills.

| | **GD -4** | **GD -3** | **GD -2** |
|---|---|---|---|
| Duration | 115.6 ± 4.5 min | 115.6 ± 8.9 min | 102.2 ± 14.7 min |
| Warm Up | 8.1% | 7.7% | 8.8% |
| Position Specific Drills | 9.9% | 9.7% | 10.8% |
| Special Teams Drills | 21.5% | 20.8% | 20.0% |
| Preparatory Plays | 8.6% | 9.8% | 9.7% |
| Team Plays | 52.6% | 53.9% | 54.9% |

**Table 2.** Activities performed by each positional group during training drills.

| Position | Warm Up | Position Specific Drills | Special Teams Drills | Preparatory Plays | Team Plays |
|---|---|---|---|---|---|
| DB | General Warm up (stretching, mobility, skipping, running) | • Running<br>• Cutting<br>• Catching balls | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| DL | General Warm up (stretching, mobility, skipping, running) | • Accelerations<br>• Bag hitting<br>• Physical contact | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| LB | General Warm up (stretching, mobility, skipping, running) | • Sprinting<br>• Change of direction<br>• Bag hitting | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| OL | General Warm up (stretching, mobility, skipping, running) | • Accelerations<br>• Bag hitting<br>• Blocking drills<br>• Physical contact | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| QB | General Warm up (stretching, mobility, skipping, running) | • Throwing to WR and RB | Throwing and route timing drills | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| RB | General Warm up (stretching, mobility, skipping, running) | • Sprinting<br>• Change of direction<br>• Play running<br>• Catching balls | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| TE | General Warm up (stretching, mobility, skipping, running) | • Sprinting<br>• Change of direction<br>• Bag hitting<br>• Blocking drills | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | Slow speed walk thru of plays to be run during the Team Plays period | Full speed plays (Offense vs. Defense) |
| WR | General Warm up (stretching, mobility, skipping, running) | • Route Running<br>• Cutting<br>• Catching balls | Kickoff and Punt Return drills (sprinting, blocking, physical contact) | | Full speed plays (Offense vs. Defense) |

**Table 3.** Detailed representation of the training completed by each participant within the study period.

| Number of Players | Sessions Completed (n = 11) | % Of Athletes |
|---|---|---|
| 28 | 11 | 44.4% |
| 7 | 10 | 11.1% |
| 5 | 9 | 7.9% |
| 5 | 8 | 7.9% |
| 2 | 7 | 3.2% |
| 4 | 6 | 6.3% |
| 5 | 5 | 7.9% |
| 1 | 4 | 1.6% |
| 2 | 3 | 3.2% |
| 1 | 2 | 1.6% |
| 3 | 1 | 4.8% |

Note: For example, 28 participants (44.4%) completed 11 out of 11 training sessions while 2 participants (3.2%) completed 3 out of 11 sessions.

**Table 4.** Total Running differences and qualitative inference for the interaction between Position Group and Training Day. (Unclear differences have been omitted.)

| Day to Game | Group 1 | Group 2 | Difference ± 90% CL | Qualitative Inference |
|---|---|---|---|---|
| -4 | DB | DL | 1758 ± 426 | Almost Certainly Very Large |
| -4 | DB | LB | 999 ± 372 | Almost Certainly Very Large |
| -4 | DB | OL | 1323 ± 358 | Almost Certainly Very Large |
| -4 | DB | QB | 603 ± 626 | Possibly Large |
| -4 | DB | RB | 744 ± 406 | Possibly Large |
| -4 | DB | TE | 623 ± 505 | Likely Large |
| -4 | DL | LB | -759 ± 429 | Likely Large |
| -4 | DL | OL | -435 ± 416 | Likely Moderate |
| -4 | DL | QB | -1155 ± 661 | Likely Very Large |
| -4 | DL | RB | -1013 ± 464 | Likely Very Large |
| -4 | DL | TE | -1135 ± 548 | Likely Very Large |
| -4 | DL | WR | -1684 ± 446 | Almost Certainly Very Large |
| -4 | LB | OL | 324 ± 362 | Possibly Moderate |
| -4 | LB | RB | -254 ± 408 | Possibly Moderate |
| -4 | LB | TE | -376 ± 508 | Likely Moderate |
| -4 | LB | WR | -925 ± 395 | Likely Very Large |
| -4 | OL | QB | -720 ± 619 | Likely Large |
| -4 | OL | RB | -578 ± 403 | Likely Large |
| -4 | OL | TE | -700 ± 497 | Likely Large |
| -4 | OL | WR | -1249 ± 381 | Almost Certainly Very Large |
| -4 | QB | WR | -528 ± 640 | Possibly Large |
| -4 | RB | WR | -670 ± 433 | Likely Large |
| -4 | TE | WR | -549 ± 519 | Possibly Large |
| -3 | DB | DL | 1572 ± 379 | Almost Certainly Very Large |
| -3 | DB | LB | 638 ± 329 | Likely Large |
| -3 | DB | OL | 1278 ± 322 | Almost Certainly Very Large |
| -3 | DB | QB | 473 ± 573 | Possibly Large |
| -3 | DB | RB | 678 ± 360 | Likely Large |
| -3 | DB | TE | 255 ± 425 | Possibly Moderate |
| -3 | DL | LB | -933 ± 380 | Likely Very Large |
| -3 | DL | OL | -293 ± 373 | Possibly Moderate |
| -3 | DL | QB | -1098 ± 603 | Likely Very Large |
| -3 | DL | RB | -893 ± 410 | Possibly Very Large |
| -3 | DL | TE | -1317 ± 465 | Almost Certainly Very Large |
| -3 | DL | WR | -1694 ± 396 | Almost Certainly Very Large |
| -3 | LB | OL | 640 ± 323 | Possibly Large |
| -3 | LB | TE | -384 ± 426 | Possibly Moderate |
| -3 | LB | WR | -761 ± 349 | Likely Large |
| -3 | OL | QB | -805 ± 569 | Possibly Very Large |
| -3 | OL | RB | -600 ± 358 | Likely Large |
| -3 | OL | TE | -1023 ± 420 | Likely Very Large |
| -3 | OL | WR | -1400 ± 342 | Almost Certainly Very Large |
| -3 | QB | WR | -595 ± 584 | Possibly Large |
| -3 | RB | TE | -424 ± 452 | Likely Moderate |
| -3 | RB | WR | -801 ± 381 | Possibly Very Large |
| -3 | TE | WR | -377 ± 434 | Likely Moderate |
| -2 | DB | DL | 1397 ± 416 | Almost Certainly Very Large |
| -2 | DB | LB | 688 ± 366 | Likely Large |

| | | | | |
|---|---|---|---|---|
| -2 | DB | OL | 972 ± 358 | Almost Certainly Very Large |
| -2 | DB | RB | 607 ± 401 | Likely Large |
| -2 | DL | LB | -710 ± 416 | Likely Large |
| -2 | DL | OL | -426 ± 409 | Likely Moderate |
| -2 | DL | QB | -1102 ± 653 | Likely Very Large |
| -2 | DL | RB | -791 ± 450 | Possibly Very Large |
| -2 | DL | TE | -1212 ± 533 | Likely Very Large |
| -2 | DL | WR | -1619 ± 421 | Almost Certainly Very Large |
| -2 | LB | OL | 284 ± 359 | Possibly Moderate |
| -2 | LB | QB | -393 ± 623 | Possibly Moderate |
| -2 | LB | TE | -503 ± 495 | Possibly Large |
| -2 | LB | WR | -909 ± 372 | Possibly Very Large |
| -2 | OL | QB | -676 ± 618 | Possibly Large |
| -2 | OL | RB | -365 ± 398 | Possibly Moderate |
| -2 | OL | TE | -787 ± 489 | Possibly Very Large |
| -2 | OL | WR | -1193 ± 364 | Almost Certainly Very Large |
| -2 | QB | WR | -517 ± 626 | Possibly Large |
| -2 | RB | TE | -422 ± 524 | Possibly Moderate |
| -2 | RB | WR | -828 ± 410 | Possibly Very Large |
| -2 | TE | WR | -407 ± 495 | Possibly Moderate |

**Table 5.** High Speed Distance differences and qualitative inference for the interaction between Position Group and Training Day. (Unclear differences have been omitted.)

| Day to Game | Group 1 | Group 2 | Difference ± 90% CL | Qualitative Inference |
|---|---|---|---|---|
| -4 | DB | LB | -35.7 ± 38.8 | Possibly Moderate |
| -4 | DB | OL | 58.9 ± 38 | Likely Moderate |
| -4 | DB | QB | -70.2 ± 67.6 | Possibly Large |
| -4 | DB | RB | -47.2 ± 41 | Likely Moderate |
| -4 | DB | WR | 34.1 ± 40.9 | Possibly Moderate |
| -4 | DL | LB | -35.3 ± 45.1 | Possibly Moderate |
| -4 | DL | OL | 59.3 ± 44.3 | Likely Moderate |
| -4 | DL | QB | -69.8 ± 71.3 | Possibly Large |
| -4 | DL | RB | -46.8 ± 48 | Likely Moderate |
| -4 | DL | WR | 34.5 ± 46.8 | Possibly Moderate |
| -4 | LB | OL | 94.6 ± 38.5 | Very Likely Large |
| -4 | LB | WR | 69.8 ± 41.3 | Likely Large |
| -4 | OL | QB | -129.1 ± 67.3 | Likely Very Large |
| -4 | OL | RB | -106.1 ± 41.8 | Likely Very Large |
| -4 | OL | TE | -89.1 ± 51.3 | Likely Large |
| -4 | QB | WR | 104.3 ± 69 | Possibly Very Large |
| -4 | RB | WR | 81.3 ± 44.4 | Likely Large |
| -4 | TE | WR | 64.3 ± 51.8 | Possibly Large |
| -3 | DB | LB | -85.9 ± 46.2 | Possibly Large |
| -3 | DB | OL | 88.5 ± 46.1 | Possibly Large |
| -3 | DL | LB | -110.5 ± 53.5 | Likely Large |
| -3 | DL | OL | 63.9 ± 53.3 | Likely Moderate |
| -3 | DL | RB | -42.5 ± 56 | Possibly Moderate |
| -3 | DL | TE | -48.6 ± 64 | Possibly Moderate |
| -3 | LB | OL | 174.5 ± 46.2 | Almost Certainly Very Large |
| -3 | LB | QB | 121.9 ± 83 | Possibly Very Large |
| -3 | LB | RB | 68 ± 46 | Likely Moderate |
| -3 | LB | TE | 61.9 ± 58.3 | Likely Moderate |
| -3 | LB | WR | 106 ± 48.8 | Likely Large |
| -3 | OL | QB | -52.6 ± 82.9 | Possibly Moderate |
| -3 | OL | RB | -106.5 ± 49.2 | Likely Large |
| -3 | OL | TE | -112.6 ± 58.1 | Likely Large |
| -3 | OL | WR | -68.4 ± 48.6 | Likely Moderate |
| -3 | QB | RB | -53.9 ± 84.6 | Possibly Moderate |
| -3 | QB | TE | -60 ± 90.1 | Possibly Moderate |
| -3 | RB | WR | 38 ± 51.6 | Possibly Moderate |
| -3 | TE | WR | 44.1 ± 57 | Possibly Moderate |
| -2 | DB | LB | -74.3 ± 33.8 | Possibly Large |
| -2 | DB | OL | 37.5 ± 33.5 | Possibly Moderate |
| -2 | DB | RB | -75.4 ± 36.4 | Possibly Large |
| -2 | DL | LB | -86.9 ± 38.7 | Likely Large |
| -2 | DL | RB | -88 ± 41.5 | Likely Large |
| -2 | LB | OL | 111.8 ± 33.4 | Likely Very Large |
| -2 | LB | QB | 65.6 ± 58.7 | Possibly Large |
| -2 | LB | TE | 66.9 ± 44.9 | Possibly Large |
| -2 | LB | WR | 80.1 ± 34.3 | Likely Large |

| | | | | |
|---|---|---|---|---|
| -2 | OL | QB | -46.3 ± 58.4 | Possibly Moderate |
| -2 | OL | RB | -112.9 ± 36.6 | Likely Very Large |
| -2 | OL | TE | -45 ± 44.6 | Possibly Moderate |
| -2 | OL | WR | -31.8 ± 34 | Possibly Moderate |
| -2 | QB | RB | -66.6 ± 60.5 | Possibly Large |
| -2 | RB | TE | 68 ± 47.3 | Possibly Large |
| -2 | RB | WR | 81.2 ± 37.4 | Likely Large |

**Table 6.** Player Load differences and qualitative inference for the interaction between Position Group and Training Day. (Unclear differences have been omitted.)

| Day to Game | Group 1 | Group 2 | Difference ± 90% CL | Qualitative Inference |
|---|---|---|---|---|
| -4 | DB | DL | 81 ± 45 | Likely Large |
| -4 | DB | LB | 49.3 ± 39 | Likely Moderate |
| -4 | DL | LB | -31.7 ± 45 | Possibly Moderate |
| -4 | DL | OL | -58.2 ± 44 | Likely Large |
| -4 | DL | QB | -56.1 ± 71 | Possibly Large |
| -4 | DL | RB | -54.1 ± 48 | Possibly Large |
| -4 | DL | TE | -55.8 ± 57 | Possibly Large |
| -4 | DL | WR | -61.8 ± 47 | Possibly Large |
| -4 | LB | WR | -30.1 ± 42 | Possibly Moderate |
| -3 | DB | DL | 70.2 ± 39 | Likely Large |
| -3 | DB | LB | 25.5 ± 34 | Possibly Trivial |
| -3 | DB | OL | 26.3 ± 33 | Possibly Trivial |
| -3 | DL | LB | -44.7 ± 39 | Likely Moderate |
| -3 | DL | OL | -43.9 ± 38 | Likely Moderate |
| -3 | DL | QB | -54.3 ± 62 | Likely Moderate |
| -3 | DL | RB | -51.7 ± 42 | Likely Moderate |
| -3 | DL | TE | -71.7 ± 48 | Likely Large |
| -3 | DL | WR | -72.5 ± 41 | Likely Large |
| -3 | LB | TE | -27 ± 44 | Possibly Trivial |
| -3 | LB | WR | -27.8 ± 36 | Likely Small |
| -3 | OL | TE | -27.8 ± 43 | Likely Moderate |
| -3 | OL | WR | -28.6 ± 35 | Possibly Moderate |
| -2 | DB | DL | 71.1 ± 42 | Likely Large |
| -2 | DB | LB | 38.7 ± 37 | Possibly Moderate |
| -2 | DL | LB | -32.5 ± 42 | Possibly Moderate |
| -2 | DL | OL | -51.7 ± 42 | Possibly Large |
| -2 | DL | QB | -65.9 ± 67 | Possibly Large |
| -2 | DL | RB | -61 ± 45 | Possibly Large |
| -2 | DL | TE | -58.7 ± 54 | Possibly Large |
| -2 | DL | WR | -82.4 ± 43 | Likely Large |
| -2 | LB | RB | -28.5 ± 39 | Possibly Moderate |
| -2 | LB | TE | -26.2 ± 50 | Possibly Moderate |
| -2 | LB | WR | -49.9 ± 38 | Possibly Large |
| -2 | OL | WR | -30.7 ± 37 | Possibly Moderate |

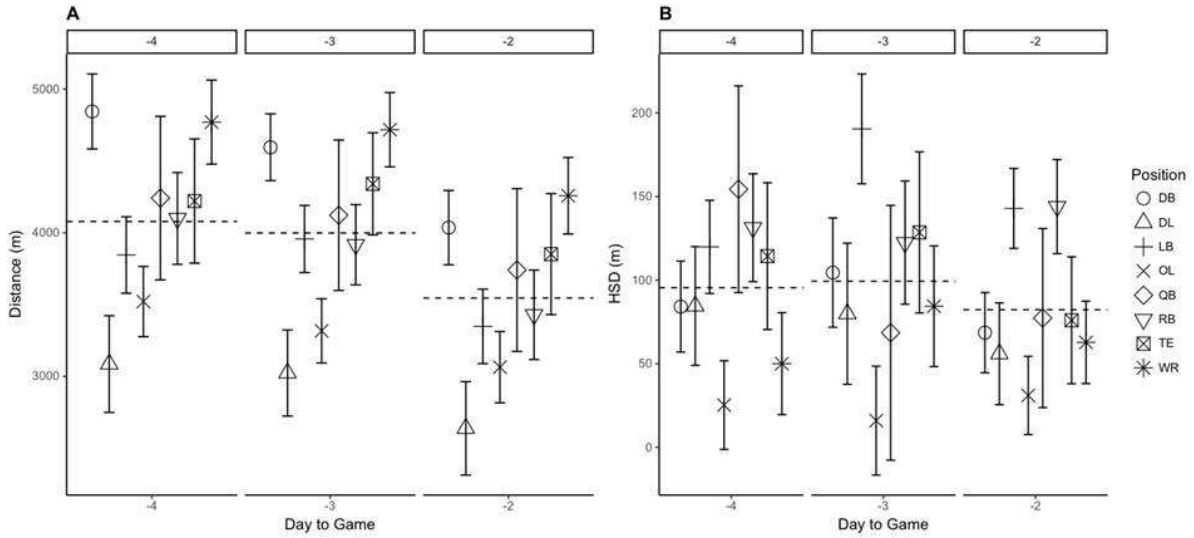
**Table 7.** Player Load per Minute differences and qualitative inference for the interaction between Position Group and Training Day. (Unclear differences have been omitted.)

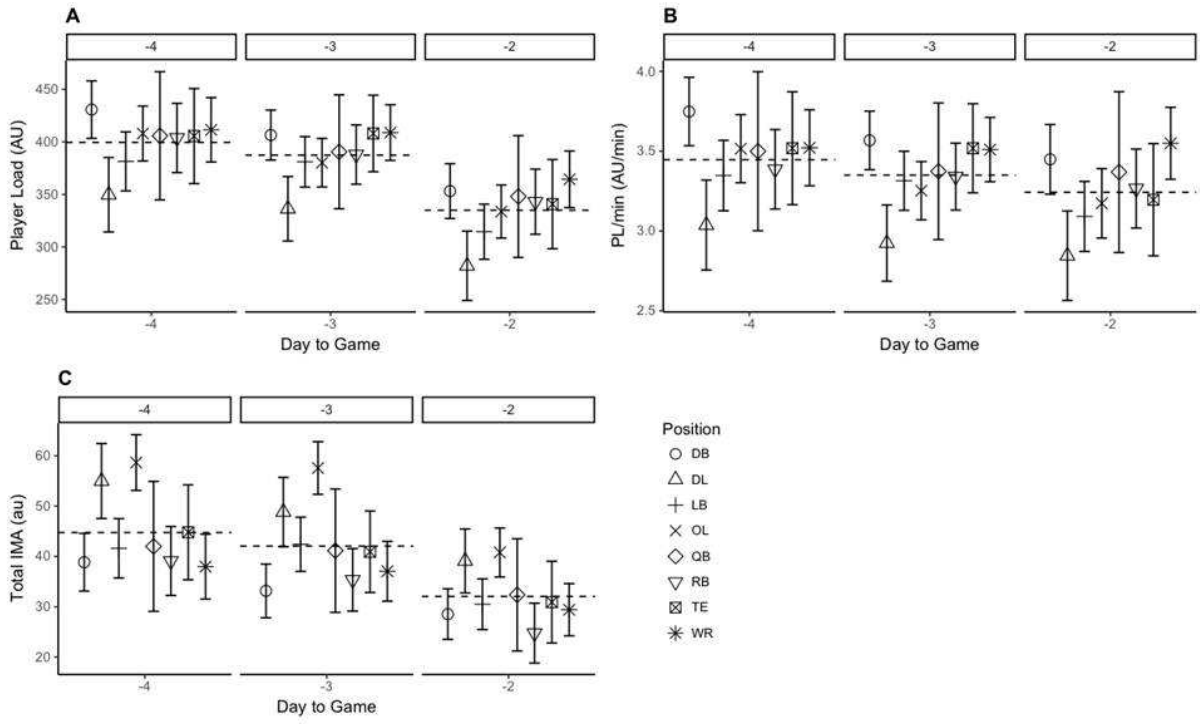
| Day to Game | Group 1 | Group 2 | Difference ± 90% CL | Qualitative Inference |
|---|---|---|---|---|
| -4 | DB | DL | 0.7 ± 0.35 | Likely Large |
| -4 | DB | LB | 0.4 ± 0.31 | Likely Moderate |
| -4 | DB | OL | 0.2 ± 0.3 | Likely Small |
| -4 | DB | RB | 0.4 ± 0.32 | Likely Moderate |
| -4 | DL | LB | -0.3 ± 0.36 | Possibly Moderate |
| -4 | DL | OL | -0.5 ± 0.35 | Possibly Large |
| -4 | DL | QB | -0.5 ± 0.57 | Possibly Large |
| -4 | DL | RB | -0.3 ± 0.38 | Possibly Large |
| -4 | DL | TE | -0.5 ± 0.45 | Possibly Large |
| -4 | DL | WR | -0.5 ± 0.37 | Possibly Large |
| -4 | LB | RB | 0 ± 0.31 | Almost Certainly Trivial |
| -4 | OL | QB | 0 ± 0.54 | Almost Certainly Trivial |
| -4 | OL | TE | 0 ± 0.41 | Almost Certainly Trivial |
| -4 | OL | WR | 0 ± 0.32 | Almost Certainly Trivial |
| -4 | QB | TE | 0 ± 0.61 | Almost Certainly Trivial |
| -4 | QB | WR | 0 ± 0.55 | Almost Certainly Trivial |
| -4 | TE | WR | 0 ± 0.42 | Almost Certainly Trivial |
| -3 | DB | DL | 0.6 ± 0.3 | Possibly Large |
| -3 | DB | LB | 0.3 ± 0.26 | Possibly Moderate |
| -3 | DB | OL | 0.3 ± 0.26 | Possibly Moderate |
| -3 | DB | RB | 0.2 ± 0.27 | Likely Small |
| -3 | DB | TE | 0.1 ± 0.33 | Almost Certainly Trivial |
| -3 | DL | LB | -0.4 ± 0.3 | Likely Moderate |
| -3 | DL | OL | -0.3 ± 0.3 | Possibly Moderate |
| -3 | DL | QB | -0.5 ± 0.49 | Likely Moderate |
| -3 | DL | RB | -0.4 ± 0.32 | Likely Moderate |
| -3 | DL | TE | -0.6 ± 0.37 | Possibly Large |
| -3 | DL | WR | -0.6 ± 0.31 | Possibly Large |
| -3 | LB | RB | 0 ± 0.26 | Almost Certainly Trivial |
| -3 | LB | WR | -0.2 ± 0.27 | Possibly Small |
| -3 | OL | TE | -0.3 ± 0.33 | Possibly Moderate |
| -3 | OL | WR | -0.3 ± 0.27 | Possibly Moderate |
| -3 | QB | RB | 0 ± 0.48 | Almost Certainly Trivial |
| -3 | TE | WR | 0 ± 0.33 | Almost Certainly Trivial |
| -2 | DB | DL | 0.6 ± 0.36 | Almost Certainly Moderate |
| -2 | DB | LB | 0.4 ± 0.31 | Likely Moderate |
| -2 | DB | OL | 0.3 ± 0.31 | Possibly Moderate |
| -2 | DB | TE | 0.3 ± 0.41 | Possibly Moderate |
| -2 | DL | LB | -0.3 ± 0.36 | Possibly Trivial |
| -2 | DL | OL | -0.3 ± 0.35 | Possibly Moderate |
| -2 | DL | QB | -0.5 ± 0.58 | Possibly Large |
| -2 | DL | RB | -0.4 ± 0.37 | Likely Moderate |
| -2 | DL | TE | -0.4 ± 0.45 | Possibly Moderate |
| -2 | DL | WR | -0.7 ± 0.36 | Likely Large |
| -2 | LB | WR | -0.5 ± 0.31 | Possibly Large |
| -2 | OL | TE | 0 ± 0.41 | Almost Certainly Trivial |
| -2 | OL | WR | -0.4 ± 0.31 | Likely Moderate |

| | | | | |
|---|---|---|---|---|
| -2 | RB | WR | -0.3 ± 0.33 | Possibly Moderate |
| -2 | TE | WR | -0.4 ± 0.41 | Possibly Moderate |

**Table 8.** Total IMA differences and qualitative inference for the interaction between Position Group and Training Day. (Unclear differences have been omitted.)

| Day to Game | Group 1 | Group 2 | Difference ± 90% CL | Qualitative Inference |
|---|---|---|---|---|
| -4 | DB | DL | -16 ± 9 | Possibly Large |
| -4 | DB | OL | -20 ± 8 | Possibly Very Large |
| -4 | DB | TE | -6 ± 11 | Possibly Small |
| -4 | DL | QB | 13 ± 15 | Possibly Moderate |
| -4 | DL | RB | 16 ± 10 | Likely Large |
| -4 | DL | TE | 10 ± 12 | Possibly Moderate |
| -4 | DL | WR | 17 ± 10 | Likely Large |
| -4 | LB | OL | -17 ± 8 | Likely Large |
| -4 | OL | QB | 17 ± 14 | Likely Large |
| -4 | OL | RB | 20 ± 9 | Possibly Very Large |
| -4 | OL | TE | 14 ± 11 | Likely Moderate |
| -4 | OL | WR | 21 ± 8 | Possibly Very Large |
| -3 | DB | DL | -16 ± 9 | Likely Large |
| -3 | DB | LB | -9 ± 8 | Likely Moderate |
| -3 | DB | OL | -24 ± 7 | Most Likely Very Large |
| -3 | DL | LB | 6 ± 9 | Possibly Moderate |
| -3 | DL | OL | -9 ± 9 | Likely Moderate |
| -3 | DL | RB | 14 ± 9 | Possibly Large |
| -3 | DL | WR | 12 ± 9 | Likely Moderate |
| -3 | LB | OL | -15 ± 8 | Very Likely Moderate |
| -3 | LB | RB | 7 ± 8 | Possibly Moderate |
| -3 | OL | QB | 16 ± 13 | Possibly Large |
| -3 | OL | RB | 22 ± 8 | Likely Very Large |
| -3 | OL | TE | 17 ± 10 | Likely Large |
| -3 | OL | WR | 21 ± 8 | Possibly Very Large |
| -2 | DB | DL | -11 ± 8 | Likely Moderate |
| -2 | DB | OL | -12 ± 7 | Likely Moderate |
| -2 | DL | LB | 9 ± 8 | Likely Moderate |
| -2 | DL | RB | 14 ± 9 | Very Likely Moderate |
| -2 | DL | WR | 10 ± 8 | Likely Moderate |
| -2 | LB | OL | -10 ± 7 | Likely Moderate |
| -2 | OL | RB | 16 ± 8 | Likely Large |
| -2 | OL | TE | 10 ± 9 | Likely Moderate |
| -2 | OL | WR | 11 ± 7 | Likely Moderate |


A
B
-4
-3
-2
Distance (m)
HSD (m)
Day to Game
Position
DB
DL
LB
OL
QB
RB
TE
WR


A
-4
-3
-2
Player Load (AU)
450
400
350
300
250
Day to Game
B
PL/min (AU/min)
4.0
3.5
3.0
2.5
C
Total IMA (au)
60
50
40
30
20
Position
DB
DL
LB
OL
QB
RB
TE
WR