Lending a Hand in Bringing Ballcarriers Down

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Abstract. In this paper we examine National Football League (NFL) Next Gen Stats data to uncover insights on how defensive teammates collectively bring down offensive ballcarriers. Traditional defensive statistics focus on individual tacklers, which is certainly vital, but in a team game there is often more than one defender who contributes to the stop. This paper was our submission for the 2024 NFL Big Data Bowl to "create metrics that assign value to elements of tackling". We found that individuals who slowed down ballcarriers had a strong positive correlation with tackles and that the distance that defensive players were from the offensive ballcarrier was a statistically significant predictor of ballcarrier speed in its deceleration path down to zero. This paper aims to contribute to the conference topics of player evaluation and performance analysis.

Keywords: Individual Contributions, NFL Defender, Gridiron Football, Sports Analytics.

1 Introduction

The importance of studying film for National Football League (NFL) coaches and players cannot be overstated. Countless hours are dedicated to the act of analyzing an opponent's every move over the course of a season. Offensive coaches self-scout their tendencies and play-calling patterns to stay one step ahead of opposing defenses. Meanwhile, defensive coaches look for anything they can learn about the offenses they will face in upcoming weeks, hoping to counter offensive game plans. High-impact players will jump off the screen with flashes of brilliance between the sidelines for all to see, but what about unheralded players who do the little things right?

These players deserve credit too, and their contributions might not be spotted on a consistent basis since their actions may not result in a tackle for themselves, but it may help set one up for a teammate. Teams currently tally assisted tackle metrics. However, this project aims to go deeper than the act of tackling. We are interested in the ballcarrier's entire journey that led to the point where they could be brought down rather than

just the final action of a tackle taking place. Therefore, our goal is to add a new variable that coaches can account for in their statistical evaluations aside from just tackles and assisted tackles.

This project was made possible by using NFL Next Gen Stats player tracking and Pro Football Focus data from the 2022 NFL season, weeks 1-9. In it, we aim to shine light on defenders who contribute to bringing a ballcarrier down by slowing them down in the first place. After all, the objective of every team's defense as a whole is to work together to bring ballcarriers down as soon as possible, saving every yard[1] they can, and keeping ballcarriers out of the endzone[2] on each play. Many players are taught since their youth playing days that even if they cannot make an individual tackle themselves, as long as they slow a ballcarrier down until the cavalry arrives that they have fulfilled their duties and contributed on that play.

We believe that by analyzing ballcarrier speed and defender distance data we can assign credit to individual defenders who influence a ballcarrier's speed. By doing so we can identify who can be credited with the largest deceleration on any given play. These individual credits for slowing ballcarriers down will be referred to as *slowdowns*. The data was provided as part of the 2024 NFL Big Data Bowl competition on Kaggle [1]. Our submission was for the coaching presentation track, with the purpose of augmenting coaches' defensive player evaluation as an added layer to their film study throughout the season. Although we did not win the competition [2], we believe that our insights are still valuable for coaches at all levels to consider for implementation.

Our findings may even have implications for the other game of football that we call soccer back at home. Is working collectively with your teammates to slow down the ballcarrier not important for winning the Champions League as well? Although gridiron football is played in a non-continuous fashion, separated by individual plays, we believe that the two sports have at least one important shared aspect between them. We believe that defenders who can interrupt the flow of the offense and the advancement of the ball towards the goal or endzone should be evaluated and credited accordingly. Our assumption is that they would provide value in either version of football.

[1] Gridiron football is typically played in the United States of America, which is not on the metric system. Instead, yards (0.914 meters) are used to measure the field of play. The distance between the endzones is 100 yards.

[2] The endzone is where teams aim to end up on each offensive possession. This is where touchdowns are scored, resulting in six points for the offense which is the most points possible on any singular play.

2 Methodology & Findings

Our approach to this project began with ballcarrier speed data. The idea was to track the ballcarrier's speed in terms of yards per second (yds/sec), as well as miles per hour[3] (mph) from the beginning of the play until the end. We focused on the apex of speed on any given play and aimed to track the path down until the end of the play.

For an example of ballcarrier speed on one play, consider this completion[4] to Devin Singletary of the Buffalo Bills in the 2022 season opener against the Los Angeles Rams. Here is a screenshot from the visualization we made of the entire play:

Fig. 1. This image is a representation of a single frame from an entire play where Buffalo Bills Quarterback[5] Josh Allen has passed the ball to his Running Back[6], Devin Singletary, who has evaded the defense (represented in yellow) for some positive yardage before being caught by the defense (represented in orange). Each player is represented by their jersey number in the cirlces, and the black arrows denote the direction that they are facing, thanks to the tracking data. This was Game #2022090800 and Play #122.

[3] Since the USA is not on the metric system, miles (1.609 kilometers) per hour is a common form of measuring speed.

[4] A completion occurs when a forward pass is transferred from one player to another and caught successfully.

[5] A Quarterback in Gridiron football is a position that is viewed as the most important, as they are the conductor of the offense. They are responsible for the distribution of the football to different players and leading the team down the field into the endzone.

[6] A Running Back in Gridiron football is mostly tasked with carrying the football and running forward for as many yards as possible on any given play. They also have responsibilities of blocking at times, as well as receiving the football via a pass through the air.

This next chart shows Singletary's speed by frame during the play:

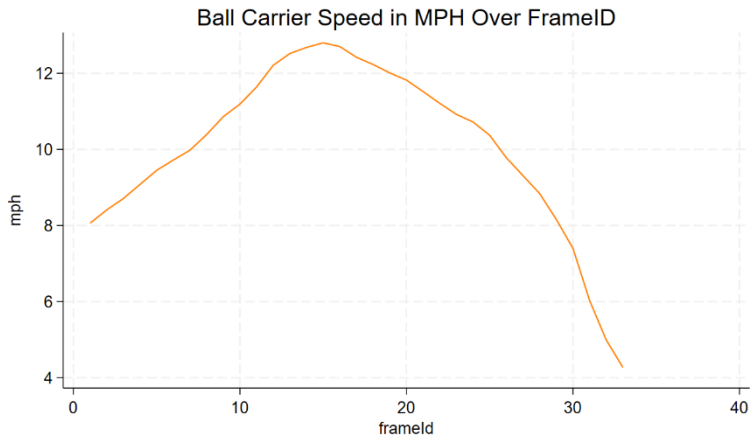


Fig. 2. This image represents what a fairly typical speed distribution would look like for a ball-carrier on a typical offensive play. In this case we are measuring Singletary's speed on play #122 of Game #2022090800.

The running back (RB) Singletary's speed gradually accelerates at first, and tops out at 12.8 mph. From there it is all downhill. Our approach was to measure the decreases in speed across the frames after peak speed. Here is what that looked like on this particular play:

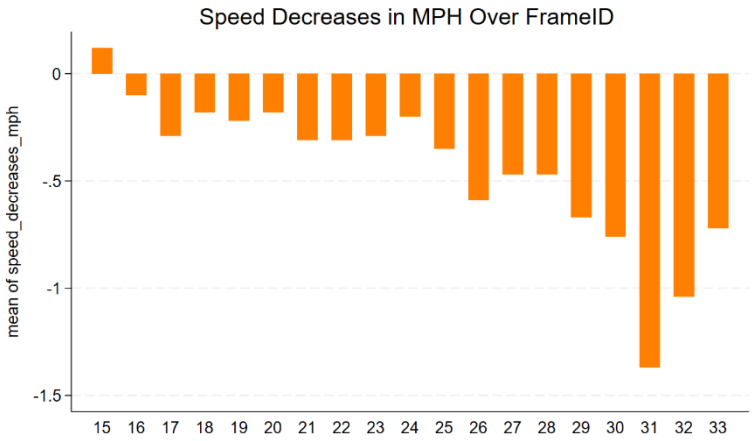


Fig. 3. Although the overall trend in this visual shows that decreases in speed were growing larger over the course of the play, the sharpest decrease was near the end, which would represent a typical play as speed should drop sharply to near zero just before a player is tackled.

Each of these decreases in speed, by frame, are able to be isolated and quantified. Since we wanted to assign credit for them we brought in the defender distance data as well. The idea here is that a defender should be given credit for causing a decrease in ballcarrier speed, however small the decrease might be. Just like a tackle or an assisted tackle can be recorded, we can also measure slowdowns for each defender's statistics on any given play, game, or across many games.

In order to do so we found the distances of all eleven defenders for every frame for all plays in weeks 1-9 of the 2022 NFL season. By focusing on the post-peak ballcarrier speed, we measured the slowdowns and who should be given credit for each. Ultimately, we decided that the nearest defender who caused the ensuing slowdown should be given credit for that slowdown. The logic being that there is a natural lag effect. If a slowdown occurred in one frame the assumption is that the nearest defender in the previous frame was the one who caused the ballcarrier's speed to decrease.

For the Singletary play, the speed decreases in mph and yds/sec were tracked, and so were the slowdowns. Thus, each defender who was the closest in terms of distance was given credit for their ballcarrier slowdown contribution for the next frame, so long as it was after peak ballcarrier speed.

The defender who made the largest contribution on that play was Linebacker[7] (LB) Bobby Wagner. He contributed a speed decrease of 1.37mph on that play. Highlighting all slowdowns and measuring the top contribution for any given play could be useful in the event that a coaching staff would want to review one play and figure out who contributed the most to slowing the ballcarrier down.

This would be especially true if that top slowdown contributor did not actually end up making the tackle or an assisted tackle. That would be a case where an unsung hero would be getting their due credit. In this case, Wagner did make the tackle, but that is not always the case.

In the next example play from the Week 1 game between the San Francisco 49ers and Chicago Bears, the description of the play from the play-by-play data on Pro Football Reference [3] is "Justin Fields pass complete short middle to David Montgomery for 16 yards (tackle by Tashaun Gipson)".

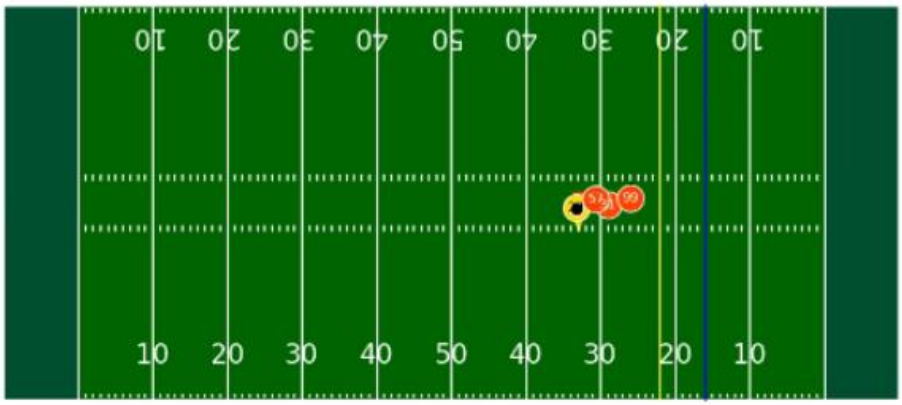
[7] In Gridiron football a Linebacker is a defensive player usually tasked with making the most amount of tackles on the defense as they are in the middle of the field. They are meant to stop running plays, and at times assist in pass defense as well, making them versatile members of the defense.

However, when watching the game tape from that play you can see multiple San Francisco 49er defenders impacted the speed of Bears running back Montgomery, not just the 49ers Safety[8] Gipson.

This is a perfect example of where a slowdown credit can highlight a contribution that would be missed when solely reviewing box score data[9]. Fred Warner had the biggest slowdown at frame 57 and decreased the ballcarrier's speed by 1.62 miles per hour.

Defensive Tackle[10] (DT) Javon Kinlaw as well as LBs Dre Greenlaw and Fred Warner also had a hand in bringing down Montgomery by getting near him. None of them were credited with an assist. Instead, Kinlaw and Greenlaw recorded missed tackles. By leveraging our slowdown metric, coaches could give them credit in addition to the tackle for Gipson.

A screenshot from our second animation highlights the players who were close to Montgomery all along the play. By parsing out the other eight defenders it becomes easier to see the main three defenders who contributed to bringing Montgomery down when viewing the full animation:



[8] In Gridiron football a Safety is usually in the very rear of the defense, as they are the last line of defense preventing opposing ballcarriers from entering the endzone.

[9] Box score data is where counting statistics and some advanced statistics from the game can be seen.

[10] In Gridiron football a Defensive Tackle is typically the largest player on the defense, with their main responsibility being to create pressure at the point of attack for an offense. They are as close as possible to the ball at the beginning of each play and they use their size and strength to occupy blockers and stymying the offensive gameplan from the beginning of each play.

Fig. 4. This figure highlights only key defenders in Play #364 in Game #22091102. In short, the three defenders chosen were the ones who contributed the most to making the stop. The full animation can be seen here: https://www.youtube.com/watch?v=aUMYHo6KHOw. For the real play, please refer to this web page: https://www.nfl.com/videos/49ers-vs-chiefs-highlights-from-super-bowl-lviii-on-nickelodeon.

2.1 Analyzing Trends

We have gone over a couple of plays now as examples, which can be helpful for coaches' evaluation of players in a micro sense. However, it would be best to let patterns and trends emerge by reviewing slowdowns in a macro sense. In this case, that would mean over 9 weeks of games. By this point outliers would not have as strong of an effect on the final results, leading to accurate assessments of a defender's abilities.

Here we observe the relationship between the sum of slowdowns and the sum of individual tackles. We found that the correlation between total accumulated slowdowns in mph and tackles was 0.92:

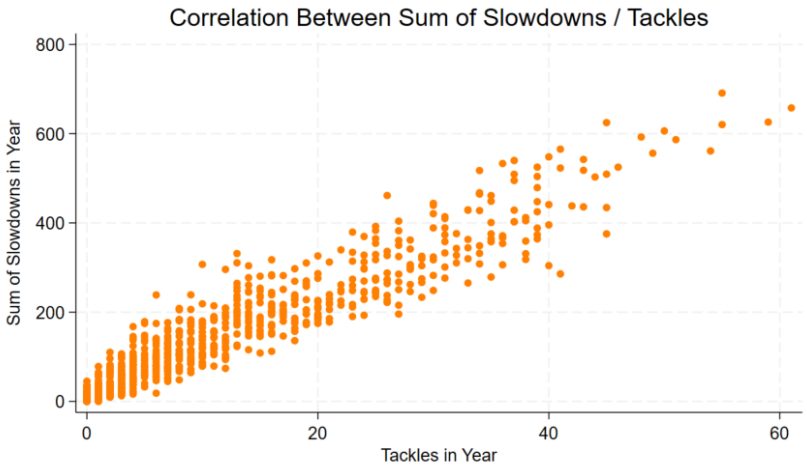


Fig. 5. This scatterplot shows the correlation between sum of slowdowns and sum of tackles over the first nine weeks of the 2022 NFL season. A strong, positive correlation has been revealed.

Here we can see the relationship between the sum of slowdowns and assisted tackles. The correlation that we observed was 0.82:

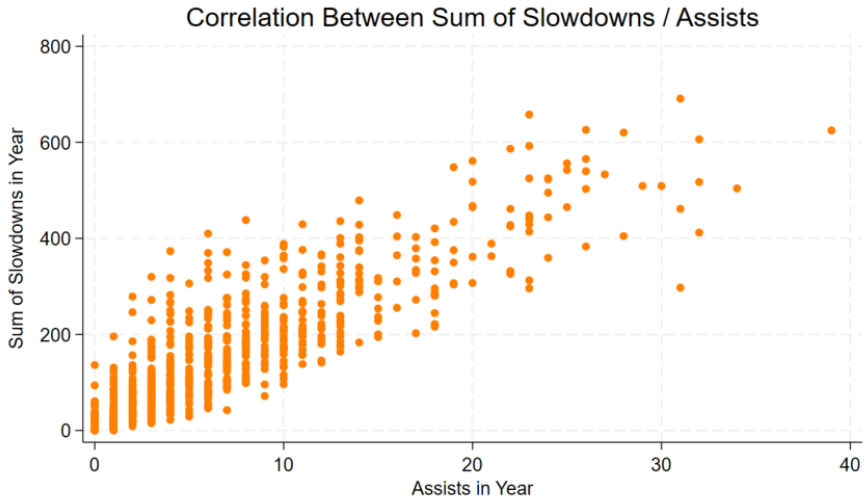


Fig. 6. This scatterplot shows the correlation between sum of slowdowns and sum of assisted tackles over the course of the first nine weeks of the 2022 NFL season. A strong, positive correlation is shown, but it is weaker than the relationship between the sum of slowdowns and sum of individual tackles across that timeframe.

Since we have observed such strong correlations between both tackles and assists by the sum of slowdowns in mph, slowdowns prove to be valuable in assessing a defender's contributions to the team's goals of tackling ballcarriers as soon as possible. Even if a defender does not record a lot of tackles or assists in any one game in particular, it is possible that they had a great effect on the game if they accumulated a lot of slowdowns.

2.2 Top Performers

We became interested in finding out who among all of the defenders in the NFL in 2022 were best at accumulating slowdowns across the first nine games of the season. We thought this might make for a good sanity test or proof of concept to demonstrate the value of the slowdowns metric in hopes that it not only correlated with both individual and assisted tackles, but also overall high-quality defender play. Here were the top 10 defenders in terms of slowdowns:

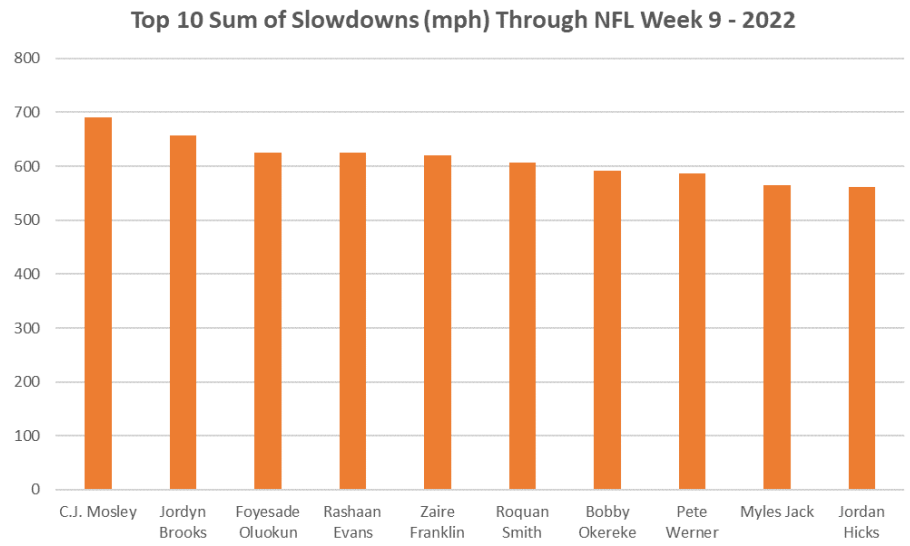


Fig. 7. This bar chart displays the top ten players by sum of slowdowns. C.J. Mosley earned first place with nearly 700 points worth of accumulated slowdowns (in mph) in the span of the first nine weeks of the 2022 NFL season.

Each of these players is clearly contributing to the defenses in a large way, and they each deserve to receive credit for doing so. Although it is unlikely that coaching staffs have not noticed their tenacity in pursuit of ballcarriers, it may be possible that other players on the complete list are hidden gems. If so, coaching staffs and general managers would do well to identify those high-value contributors early on and give them more playing time and sign them to contract extensions.

To say that the players who made the top ten sum of slowdowns list are quite accomplished would be an understatement. C.J. Mosley and Roquan Smith made the 2022 All-Pro team[11] [4]. The table below shows that every player who made the top ten sum of slowdowns list and who played 16 or more games also ended up making the top ten total tackles list by the end of the season, except for Jordan Hicks of the Minnesota Vikings, who finished 18th with 129 tackles. It appears safe to say that as long as a player stays healthy, slowdown data is a great predictor of tackles and therefore, contributions to the defense.

[11] An All-Pro player is one who was selected by the media as the best at their respective position for that year. It is a very prestigious award due to the scarcity and the fact that fan voting is not considered.

Table 1. This table outlines the top-ten players in terms of the sum of slowdowns (mph).

Sum of Slowdowns 2022 Weeks 1-9 Rank (mph)	Player	Team	Player Position	Sum of Slowdowns 2022 Weeks 1-9 (mph)
1	C.J. Mosley	New York Jets	LB	691.02
2	Jordyn Brooks	Seattle Seahawks	LB	657.76
3	Foyesade Oluokun	Jacksonville Jaguars	LB	625.95
4	Rashaan Evans	Atlanta Falcons	LB	624.83
5	Zaire Franklin	Indianapolis Colts	LB	620.37
6	Roquan Smith	Baltimore Ravens	LB	606.22
7	Bobby Okereke	Indianapolis Colts	LB	592.47
8	Pete Werner	New Orleans Saints	LB	586.51
9	Myles Jack	Pittsburgh Steelers	LB	565.25
10	Jordan Hicks	Minnesota Vikings	LB	561.30

Not surprisingly, we found that all members of the top-ten in terms of sum of slowdowns were Linebackers. This position group is generally placed in the center of the defense and is responsible for being involved in almost every play, whether it be against the run or pass. Due to this responsibility, it is logical that Linebackers would be provided with ample opportunities to rack up lots of slowdowns over the course of nine weeks.

Table 2. This table retains the sorting from Table 1, but now displays tackling data.

Total Tackles 2022 Rank	Player	Total Tackles	Games Played	Tackles per Game
9	C.J. Mosley	158	17	9.29
6	Jordyn Brooks	161	16	10.06
1	Foyesade Oluokun	184	17	10.82
7	Rashaan Evans	159	17	9.35
4	Zaire Franklin	167	17	9.82
3	Roquan Smith	169	17	9.94
10	Bobby Okereke	151	17	8.88
99	Pete Werner	80	12	6.67
48	Myles Jack	104	15	6.93
18	Jordan Hicks	129	17	7.59

What we found interesting here is that although most of the members of the top-ten for sum of slowdowns also finished the season in the top-ten for total tackles, C.J. Mosley only finished in 9th place for total tackles as opposed to 1st for sum of slowdowns. Since he earned All-Pro honors for the 2022 season along with Roquan Smith, this suggests that there is inherent value in a metric such as slowdowns, as it captures what the eye is seeing in terms of a player being involved and influencing plays. In short, individual tackles are shown to not be the end-all and be-all. Slowdowns provide a way to actually quantify the player tracking and defensive influence data that our eyes seek out as spectators watch the games or when coaches study film.

Table 3. This table retains the original order, while displaying salary and experience data.

Player	Years of Experience	2022 Base Salary (in Millions)	LB Base Salary Ranking 2022
C.J. Mosley	8	$1.12	69
Jordyn Brooks	3	$1.72	30
Foyesade Oluokun	5	$1.50	35
Rashaan Evans	5	$1.03	87
Zaire Franklin	5	$1.10	79
Roquan Smith	5	$0.57	240
Bobby Okereke	4	$2.54	17
Pete Werner	2	$0.91	141
Myles Jack	7	$1.50	49
Jordan Hicks	8	$1.45	50

Unfortunately for Linebackers, their position group has become devalued as of late in terms of their salary share relative to other position groups. This would explain the low salaries, but not the rankings. Curiously, the Linebacker salary rankings [5] shown here for 2022 did not correlate well with slowdown data. Experience would not be a factor for the low salaries shown here, as the years of experience listed here would suggest that many of these players are in prime earning years.

The likely answer is that Edge Rushers/Defensive Ends/Outside Linebackers[12] and Linebackers have been categorically lumped together as a recent trend in the NFL. Edge Rushers, Defensive Ends, and Outside Linebackers in certain types of defensive

[12] Edge Rushers are players who are primarily tasked with lining up on the outer edge of a defensive front, facing the offensive line and near the line of scrimmage. They are tasked with applying pressure on opposing Quarterbacks, and setting the "edge" so that they can contain ballcarriers within their own or their teammates reach.

schemes tend to get paid much more than Interior Linebackers. With most players on this list being not being Edge Rushers or that archetype of Outside Linebacker, that would explain the discrepancy in pay relative to their Outside counterparts. Other factors for pay would include draft position and scarcity or team needs at the time. Player contracts are structured so that the position in which the player was drafted matters in terms of what they can expect to be paid, moving from different scales depending on when they were selected by their teams in the NFL Draft[13] or in the Undrafted Free Agent (UDFA[14]) pool. Teams hope to discover "diamonds in the rough" when it comes to finding talent in the UDFA pool that all teams passed on, originally.

Regarding the hidden gem aspect that slowdown data might provide, a player like Pete Werner of New Orleans stands out. After the first nine weeks of the NFL season he finished 8th in sum of slowdowns, but he only had two years of experience up to that point, and in terms of Linebacker pay he was ranked #141 for the year.

Based on a profile like this we would predict that this sort of player might be one to watch out for in terms of future success at the Linebacker position with an increase in salary to compensate for his efforts. This might hinge on slowdown ability assuming that they can stay healthy. Given the 0.82-0.92 correlation between slowdowns and assisted or individual tackles, combined tackles can be a proxy for slowdowns. Werner's #74 overall ranking in combined tackles across *all* position groups was quite impressive for the 2023 season [6]. Entering the 2024 season [7], Werner will earn $1.43M, an increase of about 57%, landing him the #69 ranking for LB base salary pay. Werner provides tremendous value relative to his production.

2.3 Further Analysis

To do another check that our assumption of the speed and defender distance relationship made sense, we looked to see if there was a statistical relationship between the distance a defender is from the ballcarrier and the ballcarrier speed in yards per second. We calculated the Pearson correlation coefficient between speed and distance within one yard. There were 283,336 records and we found a weak, positive correlation between the two (0.09).

We then did an Ordinary Least Squares regression with distance under one yard as a predictive variable and discovered it was significant. The coefficient was 0.75 and the p-value was 0. So, we found that as the defender's distance away from the ballcarrier decreases by one yard, the ballcarrier's speed is expected to decrease by 0.75 yds/sec.

[13] The NFL Draft is where incoming players are selected by the 32 active teams. There are seven rounds, with the best players being selected in the earlier rounds. Teams can trade their picks for players or other picks in the same draft or future drafts.

[14] Undrafted Free Agents are incoming players who were not selected in the NFL Draft. Instead, they are a part of the open market player pool. They are free to sign with any team that they wish, instead of being selected by a team, albeit to a lower wage compared to their drafted counterparts.

Next, we did the same thing for defenders less than two yards away. There again was a weak, positive correlation (0.17) and a statistically significant, positive coefficient (0.71). We repeated it for less than three and four yards. Each also had a significant coefficient (0.61 for three yards and 0.51 for four).

The main takeaway here for coaches is that players who are less than four yards away have a significant impact on slowing down the ballcarrier. So, defenders should be encouraged to get as close as they can to the ballcarrier. They may not think it matters if they are not close enough to tackle, but even if they are four yards away, it is helpful as any potential cutback lanes or ways for the ballcarrier to have an escape route would be taken away as options. Players who can close the gap should be rewarded using slowdown data.

A typical saying that coaches say is to "swarm" the ballcarrier and this is why that matters. Even if the defenders are on the backside of the play they can reduce any other options for the ballcarrier by increasing proximity as soon as possible. This is why everyone praises defenses where they see "11 shirts" headed towards the ballcarrier right away on a consistent basis.

Table 4. This table shows the results of statistically testing the relationship between distance from ballcarrier and ballcarrier speed.

Distance from Ball Carrier	Coefficient	P-Value Significance of Coefficient	Correlation
< 1 Yard	.7537	.000	.0918
< 2 Yards	.7099	.000	.1711
< 3 Yards	.6063	.000	.2227
< 4 Yards	.5056	.000	.2503

3. Conclusion

It would make the most sense for coaching staffs to compare players in the same position group to see who sticks out in terms of slowdowns, assuming that all else about the players being compared to each other is about equal. This remains true whether we are talking about American gridiron football or soccer. That could be the difference between seeing the field or being offered a contract extension. Player agents could leverage slowdown data as a means to highlight the contributions that the player they represent has made to the team.

Advanced defensive statistics in most sports are notoriously hard to measure and rely on, but we believe that this straightforward approach to capturing the relationship between ballcarrier speed and defender distance data can finally shed light to those who assist other players in making tackles by hustling on each play. Slowdowns can provide insight on "hustle metrics" like "who wants it more" and "who gets after it" best, as announcers and coaches tend to praise.

Fig. 8. Image of defenders swarming to slowdown the ballcarrier is from OpenAI's DALL·E 3

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Appendix

Videos of plays were via code refactored from this 2021 Big Data Bowl submission "NFL Big Data Bowl 2021: Animating Players Movement" https://www.kaggle.com/code/ar2017/nfl-big-data-bowl-2021-animating-players-movement/notebook

Image at the end of this submission showing players generated using OpenAI's DALL·E 3 https://openai.com/dall-e-3

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