

The Effect of the Number of Carries on Injury Risk and Subsequent Season's Performance Among Running Backs in the National Football League

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Background: In recent years, several studies have correlated pitch count with an increased risk for injury among baseball pitchers. However, no studies have attempted to draw a similar conclusion based on number of carries by running backs (RBs) in football.

Purpose: To determine whether there is a correlation between number of carries by RBs in the National Football League (NFL) and risk of injury or worsened performance in the subsequent season.

Study Design: Cohort study; Level of evidence, 3.

Methods: The ESPN NFL statistics archives were searched from the 2004 through 2014 regular seasons. During each season, data were collected on RBs with 150 to 250 carries (group A) and 300+ carries (group B). The following data were collected for each player and compared between groups: number of carries and mean yards per carry during the regular season of interest and the subsequent season, number of games missed due to injury during the season of interest and the subsequent season, and the specific injuries resulting in missed playing time during the subsequent season. Matched-pair *t* tests were used to compare changes within each group from one season to the next in terms of number of carries, mean yards per carry, and games missed due to injury.

Results: During the seasons studied, a total of 275 RBs were included (group A, 212; group B, 63). In group A, 140 RBs (66%) missed at least 1 game the subsequent season due to injury, compared with 31 RBs (49%) in group B ($P = .016$). In fact, players in group B missed significantly fewer games due to injury during the season of interest ($P < .0001$) as well as the subsequent season ($P < .01$). Mean yards per carry was not significantly different between groups in the preceding season ($P = .073$) or the subsequent season ($P = .24$).

Conclusion: NFL RBs with a high number of carries are not placed at greater risk of injury or worsened performance during the subsequent season. These RBs may be generally less injury prone compared with other NFL RBs.

Keywords: National Football League; running back; injury

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In recent years, pitch count has become a popular method of assessing injury risk among baseball pitchers, with several studies associating a higher pitch count with increased injury risk as well as worsened future performance.^{3,10,11} Despite this evidence, there have been no published studies seeking to determine whether a similar correlation exists between the number of carries by football running backs (RBs) and an increased risk of injury or reduced performance during the subsequent season. A number of studies have shown that the RB position is among the most injury prone in the National Football League (NFL).^{1,4,6} Therefore, determining ways to reduce the risk of injury in these players is of significant value to NFL teams and the players themselves. The purpose of this study was to compare

subsequent season risk of injury, missed playing time, and performance based on the preceding single season number of carries by RBs in the NFL. The authors hypothesized that RBs with a high number of carries in 1 season would miss significantly more games due to injury during the subsequent season compared with those with a moderate carry volume.

METHODS

A retrospective cohort analysis was performed by searching the ESPN archive for NFL RBs (<http://espn.go.com/nfl/statistics>) during the 2004 through 2014 regular seasons. During each season, RBs were included based on the following inclusion criteria: RBs with 150 to 250 carries (group A) and 300+ carries (group B). New players were added each season based on the number of carries in that particular season. Thus, some players were included multiple times over the study period. RBs with 251 to 299 carries were excluded to adequately separate group A (moderate carry volume) from group B (high carry volume). In addition, players who retired during the offseason or were suspended for a full season were not included for the preceding season.

The following data were collected for each player: age at the start of the season of interest, number of seasons played in the NFL, height, weight, body mass index, number of carries and mean yards per carry during the regular season of interest and the subsequent season, number of games missed due to injury during the season of interest and subsequent season, and the specific injuries resulting in missed playing time during the subsequent season. Height and weight were captured from each player's profile on the ESPN website. Specific injuries were found from injury reports released by the player's team in the year he was injured.

Finally, to account for a league-wide variation in mean rush attempts during the study period, the number of rush attempts per NFL team per game was collected during the 2004 through 2015 seasons.

Statistical Analysis

A Student *t* test was used to compare continuous variables (age, number of seasons played, height, weight, body mass index, number of carries, average yards per carry, missed games) between group A and group B. A Student *t* test was also used to compare rush attempts per NFL team per game between the 2004 through 2009 seasons and the 2010 through 2015 seasons. A matched-pair *t* test was used to compare changes in continuous variables from one season to the subsequent season, both within group A and group B. Missed playing time during the subsequent season was also categorized as a dichotomous variable (0 games vs 1+ games) and was compared between groups using a chi-square test. A chi-square test was also used to compare rates of particular injuries between groups during the subsequent season.

TABLE 1
Player Demographics^a

Demographic	Group A	Group B	P Value
Age at start of season, y	25.6 ± 2.8	26.1 ± 2.1	.089
Number of seasons played in NFL ^b	7.9 ± 2.6	9.2 ± 1.9	<.0001
Height, in	71.2 ± 1.7	71.0 ± 1.6	.47
Weight, kg	100.4 ± 6.21	100.1 ± 4.90	.78
BMI, kg/m ²	30.7 ± 1.7	30.8 ± 1.6	.70

^aData are reported as mean ± SD. Group A = 150-250 carries, group B = 300+ carries. BMI, body mass index; NFL, National Football League.

^bIncludes season of interest.

RESULTS

A total of 275 RBs fit the inclusion criteria, including 212 RBs with between 150 and 250 carries in a season (group A, 77%) and 63 RBs with at least 300 carries in a season (group B, 23%). Over the course of the study period, a total of 118 different RBs formed group A, with 34 different RBs in group B and 24 RBs in both groups at some point over the 11-season span. No significant difference was found between groups in terms of age at the start of the season of interest, height, weight, or body mass index (Table 1). A statistically significant difference was found in the number of seasons played in the NFL, which was considered of possible but indeterminate clinical significance (Table 1).

Group B had a significantly greater mean number of carries both during the season of interest as well as the subsequent season (Table 2). Mean number of carries decreased significantly during the subsequent season for both groups by a mean 49 carries in group A and 68 carries in group B. In terms of mean yards per carry, no significant difference was found between groups during the initial season or the subsequent season, although group B had higher averages at both time points. Again, mean yards per carry decreased significantly for both groups from initial season to the subsequent season. During the season of interest, group A missed a significantly greater mean number of games due to injury compared with group B (group A, 1.86; group B, 0.19; $P < .0001$), though this difference alone would not account for the significantly greater number of carries in group B. During the subsequent season, group A again missed a significantly greater mean number of games due to injury compared with group B. When grouping missed playing time during the subsequent season as a dichotomous variable (0 games vs 1+ games), a significantly greater percentage of players in group A missed at least 1 game due to injury compared with group B ($P = .016$) (Table 3).

The mean number of rush attempts per NFL team significantly decreased from the 2004 through 2009 seasons (27.7 ± 3.3 rush attempts/team/game) to the 2010 through 2015 seasons (26.9 ± 3.1 rush attempts/team/game) ($P = .02$), though this difference would not completely account for the significant reduction in rush attempts by both groups in this study. Next, the mean number of rush

TABLE 2
Performance Characteristics^a

Performance Characteristic	Group A (n = 212)	Group B (n = 63)	P Value
Number of carries, initial season	197 ± 30.4*	333 ± 23.4 [‡]	<.0001
Number of carries, subsequent season	148 ± 88.4*	265 ± 72.6 [‡]	<.0001
Yards per carry, initial season	4.22 ± 0.64**	4.37 ± 0.53 ^α	.073
Yards per carry, subsequent season	4.07 ± 0.86**	4.17 ± 0.50 ^α	.24
Number of games missed due to injury, initial season	1.86 ± 1.90***	0.19 ± 0.50 ^β	<.0001
Number of games missed due to injury, subsequent season	3.27 ± 3.97***	1.89 ± 2.78 ^β	<.01

^aData are reported as mean ± SD. P values represent comparisons between group A (150-250 carries) and group B (300+ carries). Matched-pair *t* tests were also used to compare differences within groups: **P* < .0001, [‡]*P* < .0001, ***P* = .015, ^α*P* = .021, ****P* < .0001, ^β*P* < .0001.

TABLE 3
Missed Playing Time due to Injury^a

Missed Playing Time	Group A (n = 212)	Group B (n = 63)	Total (n = 275)
Players who missed 0 games, n (%)	72 (34)	32 (51)	104 (38)
Players who missed 1+ games, n (%)	140 (66)	31 (49)	171 (62)

^aBased on number of carries in the season of interest (group A, 150-250 carries; group B, 300+ carries), the number of games missed during the subsequent season was analyzed in a dichotomous fashion. A significantly greater proportion of players in group A missed at least 1 game the subsequent season (*P* = .016).

TABLE 4
Most Common Injuries Resulting in Missed Playing Time
During the Subsequent Season^a

Injury	Group A (n = 212)	Group B (n = 63)	P Value
Concussion	23 (10.8)	2 (3.2)	.063
Foot/ankle sprain	18 (8.5)	5 (7.9)	.89
Lower leg/foot/ankle fracture	16 (7.5)	3 (4.8)	.44
ACL tear	14 (6.6)	1 (1.6)	.12
Hamstring strain	5 (2.4)	4 (6.3)	.12
Shoulder dislocation	4 (1.9)	1 (1.6)	.88
Meniscus injury	4 (1.9)	0 (0.0)	.27

^aData are reported as n (%). Percent represents the percentage of all players within that group who missed playing time during the subsequent season as a result of that injury. ACL, anterior cruciate ligament.

attempts was calculated for the top 10 rookie RBs (based on most rush attempts in rookie season) each season from 2004 to 2015. Rookies starting their NFL career during each “subsequent” season would not be accounted for during the previous season (the “season of interest”), and therefore could explain the reduced rush attempts by the players in groups A and B from season of interest to subsequent season. During this time, the top 10 rookie RBs each rushed for a mean 114.1 ± 79.7 attempts per season.

Overall, the most common injury suffered by RBs resulting in missed playing time during the subsequent season was a concussion, followed by foot/ankle sprain (Table 4).

There was no injury that was suffered by one group at a significantly greater rate than the other, although statistical significance was nearly reached for concussion (group A, 10.8%; group B, 3.2%; *P* = .063).

DISCUSSION

In recent years, several studies have found a positive association between high pitch count and risk of injury or worsened future performance among baseball pitchers at various levels of play.^{3,10,11} Based on the results of these studies, the authors hypothesized that, among RBs in the NFL, a high carry number in one season would result in a significantly greater risk of injury and worsened performance during the subsequent season. However, the results of this study suggest that RBs in the NFL with a high number of carries are not at increased risk of injury or worsened performance during the subsequent season. In some cases, the opposite association was found: RBs with a high carry total missed significantly fewer games and continued to have significantly more rush attempts during the subsequent season than RBs with a moderate carry total.

Interestingly, players in both groups analyzed in this study were found to have a significant decrease in number of carries and mean yards per carry from one season to the next. This finding can only be explained by a few scenarios. The authors initially hypothesized that teams in the NFL have progressively run the ball less often over the past several seasons, though the results of this study suggest that the change in team rush attempts over time is negligible. Another potential reason for the reduction in carries by RBs in this study during subsequent seasons is that rookie NFL RBs, who are not captured during the preceding season, are taking a substantial number of carries. This is the most likely explanation, as the authors found that each of the top 10 rookie RBs averaged 114 carries per season over the course of the study period. Finally, there is the potential that offensive strategies have changed over time such that NFL teams are now using multiple RBs, with each RB attempting fewer carries, rather than using a single RB for the majority of the team’s rush attempts over the course of a season.

Overall, 62% of players in this study missed at least 1 game due to injury during the subsequent season, with concussion resulting in missed playing time more than

any other injury. This is a high injury rate and speaks to the generally high risk of injury facing RBs in the NFL. Interestingly, there was a trend found toward a significantly higher concussion rate in players from group A during the subsequent season. Teramoto et al⁹ analyzed concussions in NFL players during the 2012 to 2014 regular seasons and found that players most involved in pass plays reported more concussions, with the West Coast offense found to be a significant predictor of the number of concussions sustained by offensive players. Thus, the results of that study may explain the higher concussion rate found in players from group A (moderate carry volume) compared with group B (high carry volume) if players in group A were on more pass-friendly offenses.

Using an Internet-based data collection tool, Badgeley et al² found that, among 10,100 high school football injuries sustained during the 2005-2006 to 2009-2010 academic years, RBs sustained more injuries than any other position. Kaplan et al⁶ analyzed foot and ankle injuries among 320 intercollegiate football players participating in the NFL Combine. RBs suffered the third-highest proportion of foot and ankle injuries after only kickers/punters and special teams players. Among all RBs included in this study, 83% had a history of foot and/or ankle injuries.

In addition to concussions and foot and ankle injuries, knee injuries are also common among RBs. Bradley et al⁴ analyzed knee injuries among 332 college football players participating in the 2005 NFL Combine. Knee surgery had been performed on a greater proportion of RBs (36%) than any other position. Aune et al¹ followed 72 NFL players who underwent a total of 77 partial lateral meniscectomies, of whom only 61% returned to regular-season NFL game play. RBs underwent meniscectomy more than any other position other than defensive backs. Speed position players (RBs, wide receivers, linebackers, and defensive backs) were 4 times less likely to return to play than non-speed position players.

Among NFL players undergoing ACL reconstruction, return to NFL game play is between 63% and 79%.^{5,8} Carey et al⁵ studied outcomes of ACL injuries among NFL RBs and wide receivers from 1998 to 2002 and found that, among players with a high power rating, 14 ACL ruptures occurred among RBs compared with 10 among wide receivers. Overall, 21% of ACL injuries (7/33) resulted in no subsequent return to an NFL game. Among players who were able to return, the mean missed playing time was 14.8 games. In the present study, it was found that players in group A sustained a higher (though not statistically significant) rate of ACL tear during the subsequent season (6.6% vs 1.6% in group B players). This may help explain the greater mean number of games missed due to injury by group A during the subsequent season but also points to the potentially increased durability of players in group B. In a study of all NFL players requiring orthopaedic surgical procedures from 2003 to 2013, Mai et al⁷ found that ACL reconstruction resulted in a significant decrease in performance in postoperative season 1 compared with

preinjury values, and that decreased performance continued in postoperative seasons 2 and 3. Furthermore, ACL reconstruction resulted in a mean reduction of 1.6 games played from the preinjury season to postoperative season 1 ($P = .001$).

Based on the studies described, NFL RBs are at significant risk to injury and may be less likely to return to play compared with other positions given the high demands of the RB position. However, it was found in the present study that RBs with a high carry volume miss significantly fewer games due to injury during the subsequent season compared with those with a moderate carry volume. This may simply be explained by the fact that RBs with a high number of carries (group B, 300+ carries in 1 season) are not only among the most talented athletes in the game (only 63 players in this category over an 11-season span), but they also have demonstrated an innate ability to perform in a way that minimizes injury risk. This is further evidenced by the fact that players in group B missed significantly fewer games during the season of interest as well as the subsequent season compared with players in group A. Thus, the unique players in group B may simply be more durable and less injury prone compared with other NFL RBs. Interestingly, the high level of durability demonstrated by group B is not specifically related to body dimensions, as no significant differences were found between groups in height, weight, or body mass index.

The strengths of this study include the large sample size of NFL RBs analyzed over an 11-season span. The limitations of this study should also be noted. First, this was a retrospective study design. The results of this study are dependent on the accuracy of the data found in the NFL game summaries analyzed. The 2 groups differed in mean number of games missed due to injury during the season of interest (group A, 1.86; group B, 0.19). However, this difference alone would not account for the significant difference in mean number of carries between groups during this season (group A, 197; group B, 333). Furthermore, the significant decrease in the number of carries by both groups from the season of interest to the subsequent season is another factor that may confound the results of this study. Another limitation of this study is that specific injury information was not available in all cases. Based on the study inclusion criteria, particular players were included during multiple seasons and therefore could potentially bias the results of this study based on individual injury risk or performance abilities. Yards per carry may not be the best statistic to assess RB performance, and the recently used defense-adjusted yards above replacement (DYAR) may be more suitable in future studies. In addition, short receptions (such as on-screen passes) that result in running plays were unaccounted for in this study. Finally, and perhaps most importantly, the number of carries and yards per carry by an NFL RB are subject to multiple sport-specific confounding factors that limit the conclusions that can be drawn from this study. These include play call distribution between pass and run, offensive philosophy, offensive line performance, quality of the opponent, and weather changes.

CONCLUSION

Although multiple potential confounding factors exist and may limit the results of this study, it should not be assumed that NFL RBs with a high carry total are placed at greater risk of injury or worsened performance in the subsequent season. These players are likely more durable and less injury prone compared with other NFL RBs. However, regardless of carry numbers, RBs in the NFL are at an increased risk of injury and missed playing time due to injury.

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