Title

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Journal

Journal of Athletic Training, 58(3)

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Publication Date

2023-03-01

DOI

10.4085/1062-6050-0132.22

Peer reviewed

Journal of Athletic Training 2023;58(3):220–223
doi: 10.4085/1062-6050-0132.22

www.natajournals.org

Similar Concussion Rates in Spring Football and Preseason: Findings From the Concussion Assessment, Research and Education Consortium

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Context: Increasing attention has been directed toward identifying aspects of football participation for targeted policy change that reduces the concussion risk. Prior researchers evaluated concussion risks during the preseason and regular seasons, leaving the spring season largely unexplored.

Design: In this nationally representative observational investigation of 19 National Collegiate Athletic Association Division I collegiate football programs, we assessed concussion rates and head impact exposures during the preseason, regular season, and spring practices from 2014 to 2019. All participating programs recorded the incidence of concussions, and a subset (n = 6) also measured head impact exposures.

Results: Analyses by time of year and session type indicated that concussion rates and head impact exposures during all practice sessions and contact practices were higher in the spring and preseason than those in the regular season ($P < .05$). Concussion rates during the spring season and preseason were statistically similar.

Conclusions: We identified comparable concussion risks in the spring season and preseason, highlighting the need for targeted policy interventions to protect athlete health and safety.

Key Words: head impact exposure, concussion risk

Key Points

- The concussion risk and head impact exposures during spring season football mimicked those of the preseason.
- This finding emphasizes the need for policy changes to reduce the injury risk and improve player health and safety.

Participation in football carries a known risk for concussion.[1] Over the previous decade, concussion researchers have worked to identify specific risk factors for injury and interventions to mitigate the risk. Data-driven changes in game play aimed at reducing the concussion risk include adjustments to the kickoff,[2] revisions to the preseason contact practice rules,[3,4] and increased penalty severity (ie, player ejection) for intentional helmet-to-helmet contact (ie, targeting). Of note, in a recent study[5] from the National Collegiate Athletic Association (NCAA)-Department of Defense (DoD) Concussion Assessment, Research and Education (CARE) Consortium, researchers indicated that 72% of football-related concussions and 67% of all head impact exposures (HIEs) occurred during practices. Furthermore, concussion incidences and HIEs were both disproportionately higher during preseason training camp (ie, August practices) than those during the regular season. In the same study, the preseason accounted for nearly 50% of all concussions (despite the preseason accounting for only about 20% of the fall football season) and had HIEs that occurred at twice the proportion of those during the regular season.[5] In response to this investigation, the NCAA altered preseason football rules to allow 25 practices over a 29-day period, with a maximum of 8 days in full pads, 8 days in helmets and shoulder pads, and 9 days in helmets only. The revised rules also restricted contact practices to a maximum of 2 consecutive days.

In addition to rule changes related to preseason and regular season activities, the spring football season represents another area for examination and possible guideline changes to reduce the incidence of concussions and HIEs. At the NCAA Division I level, the spring football season includes up to 15 days of team practices across 34 calendar days. During the 15 practices, 12 may be contact sessions, of which 8 may involve tackling, although no more than 3 of the 8 tackling sessions may be devoted to 11-on-11 scrimmages. Contact sessions on consecutive days are not permitted. Dick et al[6] evaluated the NCAA Injury Surveillance System data collected from Division I schools from 1988 to 2004 and noted that concussion rates during spring practices were 1.5 times higher than those during preseason practices (10.05 versus 7.05 injuries per 1000 athlete-exposures). Conversely, Houck et al[7] conducted a more recent study on a single Division I football program from 2006 to 2015 and reported that preseason practice concussion rates were nearly 2 times those of spring practices.

Table 1. Rate of Concussion During Practice by Type of Contact and Time for Division I Programs (n = 19)

Variable	Estimated Rate[a] (95% CI)			Comparison of Estimated Rates[b]	
	Spring	Fall Preseason	Regular Season	Seasons	*P*
All practice sessions	0.0012 (0.0007, 0.0021)	0.0011 (0.0009, 0.0013)	0.0003 (0.0002, 0.0003)	Spring > regular season	< .001
				Preseason > regular season	< .001
				Spring > preseason	.80
Contact practice only	0.0022 (0.0012, 0.0039)	0.0020 (0.0017, 0.0025)	0.0007 (0.0005, 0.0008)	Spring > regular season	< .001
				Preseason > regular season	< .001
				Spring > preseason	.79

[a] Rates were estimated from the negative binomial models as the expected number of concussions divided by practice exposure (number of participants × number of sessions).
[b] Based on the Wald test in a negative binomial model.

Despite increasing attention on athlete health and safety, we observed that few researchers had examined the concussion risk during these key points in the football season, specifically the spring season, and in a nationally representative sample. Therefore, we used data collected from the CARE Consortium to estimate and compare the incidence of concussions and HIEs during the fall football preseason, regular season, and spring season.

METHODS

The NCAA-DoD CARE Consortium is a multicenter study of the natural history of concussion. A detailed explanation of the methods has been provided elsewhere.[8] All participants supplied informed consent in accordance with their local institutional review board and the US Office for Human Research Protections.

Germane to this investigation, concussions occurring during Division I football practices were included in the analyses. Data collection began at the start of the 2014 preseason (ie, August) and continued through the end of the 2019 regular season. Performance sites were phased into the Consortium over 3 years, with 11 sites contributing data in 2014–2015, 14 in 2015–2016, and 19 in 2016–2017 through the 2019 regular season. Data from the 2018 spring season were excluded as a result of a transition in funding and from 2020 because of widespread university closures related to the COVID-19 pandemic.

A study-wide definition of *concussion* was implemented,[9] and injury diagnoses were made by local medical staff. All relevant injury data were entered into a centralized database by local research or medical staff. The number of practice sessions was estimated by school and year based on NCAA regulations. For each phase of the season, contact practices were estimated as the maximum allowed, and noncontact sessions were estimated as the total number of allowable practices minus the number of allowable contact practices. Athletes (n = 745) from a subset of sites (n = 6) were equipped with the Head Impact Telemetry (HIT) System[10] (Simbex Corp) to capture athlete-level data on HIEs.

Statistical Methods

For the school-level data on the number of concussions, a negative binomial model was fit using the generalized estimating equations method to account for multiple observations per school. The outcome was the number of concussions during practice per school and school year. Predictors were time (spring, preseason, and regular season), school year (2014–2015 to 2019–2020), and the time-by-school year interaction. The natural log of the number of participants × the number of sessions (either all sessions or estimated contact sessions) was used as an offset to account for the different practice exposure levels across school, time, and school year. Within each model, the time effect was estimated, averaging over any effects of school year and the time-by-school year interaction. Comparisons between times were made with the models using Wald tests. For athlete-level HIEs, median impacts per participant per day for spring, preseason, and regular season practices (collapsed over school and school year) were compared using Wilcoxon signed rank tests to avoid assuming normality given the small sample.

RESULTS

A total of 556 concussions were observed during 9364 total practice sessions (4250 contact practices) between 2014 and 2019. As shown in Table 1, using school-level data, we found that the rates of concussion in the spring and preseason were not different from each other, but both were greater than those during the fall. For example, the rate shown is the number of concussions expected per participant per practice; so, if 1000 participants each participated in 10 spring sessions (10 000 total sessions), we would expect to see 12 concussions. The expected numbers are 11 for the preseason and 3 for fall. Qualitatively similar results were seen at the athlete level for median head impacts (Table 2).

DISCUSSION

In this investigation, we sought to make use of a diverse, nationally representative sample of collegiate football programs to evaluate and compare the incidences of concussion and HIEs during all phases of football: preseason, regular season, and spring practice. We suggest that the concussion risk, as specifically examined during all practices and contact practices, was significantly greater during the spring and fall preseason than that during the fall regular season. We found no difference between the incidences of concussion in the preseason and spring season. This result was supported by examination of the HIE data, which showed that the individual athlete exposure to head impacts was greatest during the spring season and preseason.

A number of researchers have evaluated the concussion risk in the preseason and regular season. McCrea et al[5] noted that approximately one-half of football-related concussions occurring in the fall take place in the month

Table 2. Median Head Impacts per Player per Contact Session by School and Time for Programs (n = 6)[a]

Team	Spring Season	Fall Preseason	Regular Season	Comparison[b] Seasons	*P*
1	9 (36)	9 (42)	7 (45)	Spring > preseason	.06
2	8.5 (20)	8 (25)	5 (26)	Spring > regular season	.03
3	12 (24)	10 (42)	7 (43)	Preseason > regular season	.03
4	10 (27)	9 (36)	6 (34)		
5	10 (20)	9 (35)	6 (35)		
6	13 (35)	10 (36)	8 (39)		

[a] The average number of athletes participating in each season (spring, preseason, regular season) across all years (2015–2019) is presented in parentheses.

[b] Based on Wilcoxon signed rank tests; data were collected from football athletes instrumented with the Head Impact Telemetry System (Simbex Corp).

of August (ie, preseason), a time interval that approximates one-fifth of the entire fall season. Similarly, Wasserman et al[11] reported a 3-fold increase in concussion risk during the preseason over the regular season. In addition, during a given time of year (eg, preseason), the concussion risk increased based on the equipment worn, whereby full-pad sessions carried a 5-fold greater risk for concussion than helmet-only sessions. Equivalently, fewer than 2% of concussions occurred during helmet-only sessions, compared with more than two-thirds in full-pad sessions.[12] Although similar concussion estimates and risks were described during the preseason and spring football season, the underpinnings for these findings are not clear. Coaches likely maximize the number of full-contact sessions allowed by the practice guidelines, which carry the greatest concussion risk by practice type. Furthermore, athletes may be putting forth maximum effort to improve their skill and team standing.

Subsequent to these and other investigations have been calls to change the sport in ways that improve athlete health and safety. As the risk for concussion nearly doubled during contact sessions (Table 1), augmenting practice rules by reducing the number of spring contact sessions appears to be the most effective route for reducing concussion risk without changing game play. Limiting the number of contact sessions at the high school level has been shown to reduce overall HIEs by nearly 50%,[13] and researchers have identified an association between HIEs and injury risk.[14] To that end, regular season practices allow for fewer full contact sessions per week, and we hypothesize that coaches may reduce contact practice intensity to reduce the injury risk, resulting in a significantly lower concussion rate (Table 1).

Football is a complex athletic game requiring substantial training to optimize performance, and contact practice sessions should not be eliminated at the cost of player education and training. Consistent with prior recommendations for maintaining athlete instruction,[5] any reduction in the number of spring contact sessions could be offset with noncontact sessions that promote skill building and player development. Indeed, replacing contact sessions with noncontact sessions can be used to train tackling maneuvers in a way that reduces head-first contact,[15] thus reducing the concussion risk and keeping athletes on the field for the largest training benefit. Decreasing the number of in-practice injuries is known to improve game performance[16] and may help facilitate the adoption of rule changes by administrators.

This study was not without limitations. Importantly, we estimated athlete-exposures, as the study design precluded the collection of exact participation numbers. Moreover, some teams may not have used the maximum number of contact or the total allowable sessions. In addition, total injuries were not directly linked to specific session type. Also, despite broad implementation of the HIT System in head impact studies, data collected through this system are known to have measurement error. Regardless, the data presented here are consistent with data presented elsewhere.[5] Lastly, we included only NCAA varsity football athletes, and the HIE data are from Division I athletes. As such, these results may not be applicable to other levels of play (eg, lower NCAA divisions and high school and youth football).

CONCLUSIONS

In this research, we evaluated and compared the incidences of concussions and HIEs during 3 distinct periods in the football calendar, namely, preseason, regular season, and spring. We observed no difference in concussion incidence and HIEs during the spring and preseason, yet both were significantly higher than those during the regular season. Given the increased attention on athlete health and safety relative to concussions and all injuries, policy changes to how spring football is conducted are recommended. Following on advice from other authors, we suggest that reducing the number of contact practice sessions while maintaining opportunities for skill development is likely to have a substantial effect in reducing exposures and the related injury risk.

ACKNOWLEDGMENTS

The CARE Consortium Investigators include Scott Anderson, ATC (University of Oklahoma); Holly Benjamin, MD (University of Chicago); Kenneth L. Cameron, PhD, MPH, ATC, and Steven Svoboda, MD (United States Military Academy); James Clugston, MD, MS, CAQSM (University of Florida); Michael Collins, PhD, and Anthony Kontos, PhD (University of Pittsburgh); Sara Chrisman, MD (University of Washington); JT Eckner, MD, MS (University of Michigan); Luis Feigenbaum, DPT (University of Miami); Christopher Giza, MD; Joshua Goldman, MD; and John DiFiori, MD (University of California at Los Angeles); April Hoy, MS, ATC, CSCS (Azusa Pacific); Jonathan Jackson, MD (United States Air Force Academy); Thomas Kaminski, PhD, ATC, and Thomas Buckley, EdD, ATC (University of Delaware); Louise Kelly, PhD (California Lutheran University); Justus Ortega, PhD (Humboldt State University); Jane McDevitt, PhD, ATC, CSCS, and Dianne Langford, PhD (Temple University);

Christina Master, MD (University of Pennsylvania); Jason Mihalik, PhD, CAT(C), ATC (University of North Carolina); Christopher Miles, MD (Wake Forest University); Patrick O'Donnell, MHA (United States Coast Guard Academy); Nicholas Port, PhD (Indiana University); Margot Putukian, MD (Princeton University); Steve Rowson, PhD (Virginia Tech); and Adam Susmarski, DO (United States Naval Academy).

This research was supported by the Grand Alliance Concussion Assessment, Research, and Education (CARE) Consortium, funded in part by the National Collegiate Athletic Association (NCAA) and the Department of Defense (DoD). This work was supported by the Office of the Assistant Secretary of Defense for Health Affairs, through the Combat Casualty Care Research Program, endorsed by the DoD, under award no. W81XWH1420151. Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by the DoD.

We also thank Jody Harland, Janetta Matesan, and Michael Menser (Indiana University School of Medicine); Ashley Rettmann and Nicole L'Heureux (University of Michigan); Melissa McEachern (Medical College of Wisconsin); Michael Jarrett, Vibeke Brinck, and Bianca Byrne (Quesgen); Melissa Baker, Christy Collins, and Will Felix (Datalys Center for Sports Injury Research and Prevention); and the research and medical staff at each of the CARE participation sites. We are grateful for the participation of the student-athletes, without whom this research would not be possible.

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