# Incidence of Sports-Related Concussion among Youth Football Players Aged 8-12 Years

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**Objective** To determine the risk of concussion among youth football players (ages 8-12 years).

**Study design** Participants included 468 male youth football players in western Pennsylvania during the 2011 youth football season. Incidence rates (IRs) and incidence density ratios (IDRs) of concussion were calculated for games and practices and for age groups.

**Results** There was a total of 11 338 (8415 practice and 2923 game) athletic exposures (AEs) in the study period, during which 20 medically diagnosed concussions occurred. A majority of concussions were the result of head-to-head (45%) contact. The combined concussion IR for practices and games was 1.76 per 1000 AEs (95% CI 0.99-2.54). The concussion IR was 0.24 per 1000 AEs (95% CI 0.04-0.79) in practices and 6.16 per 1000 AEs (95% CI 3.76-9.54) in games. The IDR for concussions in games to practices was 25.91 (95% CI 6.01-111.70). The IDR of concussions for youth aged 11-12 years compared with youth aged 8-10 years was 2.72 (95% CI 0.66-4.78).

**Conclusions** The overall IR for concussion in youth football players aged 8-12 years was comparable with that reported previously for high school and collegiate samples. However, participation in games was associated with an increase in risk of concussion compared with practices, which was higher than rates previously reported for high school and collegiate athletes. Younger players were slightly less likely to incur a concussion than were older players. *(J Pediatr 2013;■:■-■).*

Sports-related concussion is referred to as an "epidemic" by the Centers for Disease Control and Prevention (CDC).[1] Emergency department visits for concussions increased 62% between 2001 and 2009,[2] and among 8- to 13-year-olds, the number of emergency department visits nearly doubled. Collision sports such as American football are purported to have high rates of concussion. Recent studies estimate that concussions comprise between 8.9%[3] and 13.2%[4] of all high school injuries and 7.9%[5] of all collegiate sport injuries.

High school football players have the highest likelihood (0.47 per 1000 athletic exposures [AEs]) of sustaining a concussion in the High School Reporting Information Online database.[3] There are, however, no published prospective studies on the prevalence and incidence rates (IRs) of concussion in youth football for children aged 8-12 years. Despite the lack of data, there is no shortage of claims that youth football at these ages is dangerous for children. These claims have begun to shape public opinion about whether children should be allowed to play youth football and, if so, how the game should be played or changed from its current form. In fact, Pop Warner, the largest national youth football organization in the US, recently limited youth football contact time to reduce the likelihood of concussion.[6]

In the US, there are approximately 3 million youth participating in tackle football compared with 2000 professional, 100 000 collegiate, and 1.3 million high school participants.[7] Organized youth tackle football leagues such as Pop Warner report that approximately 425 000 athletes ranging from 5 to 16 years are involved in their tackle football programs.[6] The IRs for concussion in high school football range from 0.47 to 0.60 concussion per 1000 AEs,[3,8] whereas IRs for college football range from 0.43 to 0.61 concussion per 1000 AEs.[3] Recent reports indicate that concussion IRs are on the rise for high school football. Lincoln et al[8] reported an 8% increase for concussions in high school football over a 20-year period from 1997-1998 to 2007-2008.

An empirical investigation of concussion incidence in this younger population is warranted because younger athletes demonstrate worse outcomes following concussion[9,10] and are at a high risk of catastrophic injury (ie, second impact syndrome) if they continue to play with a symptomatic concussion.[10-12] It has even been speculated that playing youth tackle football may lead to residual impairment; however, no empirical evidence supports this assertion. The purpose of the current study was to investigate concussion incidence in youth tackle football

| | |
|---|---|
| AE | Athletic exposure |
| CDC | Centers for Disease Control and Prevention |
| IDR | Incidence density ratio |
| IR | Incidence rate |

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participants aged 8-12 years. Specifically, we prospectively investigated the overall IR of sport-related concussion in youth tackle football games and practices and compared the rates of players aged 8-10 years with those of players aged 11-12 years. In addition, we compared the current study's IRs with published IRs for high school and college athletes.

## Methods

A prospective cohort study was conducted between August 2011 and December 2011 on 468 of a total of 571 (82% participation rate) participants aged 8-12 years old (mean ± SD 10.12 ± 1.31 years) from 4 nonscholastic youth tackle football leagues composed of 18 teams. Inclusion criteria included age of 8-12 years, written informed consent (parent) and assent (child), players participating only in the sport of football (during the study period), and league and coach agreement to participate. Exclusion criteria included a history of any of the following: brain surgery, traumatic brain injury, or neurologic or psychiatric disorder and/or current concussion or a concussion in the past 6 months.

According to recent CDC guidelines[1] and the 3rd International Consensus Statement on Concussion in Sports,[13] a concussion was defined as any mild closed head injury involving altered cognitive functioning (eg, confusion, memory loss, disorientation) or signs or symptoms (eg, headache, dizziness, balance problems, nausea) or brief loss of consciousness of no longer than 1 minute following a direct or indirect blow to the head. Head injuries involving any structural damage or abnormality (eg, skull fracture, subdural hematoma, other lesions) were excluded from the research study.

The University of Pittsburgh institutional review board approved the protocol and consent forms before data collection. Following a brief overview of the risks and benefits of the study, informed written parental consent was obtained from each participant's parent/guardian, and assent was obtained from each participant. Throughout the study period, a designated and trained representative for each team recorded practice and game exposures for their players. Player exposures were only recorded if a player was present and actively participated in a game or practice. A member of the research team was present on the sidelines during games to record injury mechanism data for any suspected concussion. Licensed medical professionals (eg, emergency medical technicians, physicians) assessed and managed athletes with suspected concussions during games. However, medical coverage was limited during practices. Consequently, we contacted coaches 2 or 3 times per week to determine if any suspected concussions occurred during practices. To assist in this process, the coaches in the study participated in preseason concussion education and data collection training sessions. In addition, players and parents were provided with concussion education training. For each suspected concussion, we gathered information by structured phone and in-person interviews from all participants (and their parents) and recorded additional information regarding the mechanism of injury (ie, helmet-to-helmet contact, helmet-to-ground contact). Only participants with suspected concussions that were subsequently confirmed by a licensed medical professional, as per the definition, were recorded as concussed. Confirmation was in the form of a written physician's note, and players with a diagnosed concussion were removed from play as per their league's concussion policy.

### Statistical Analyses

Player exposure data were tabulated for each participant and used to calculate overall IRs per 1000 AEs with 95% CIs for both practices and games. Incidence density ratios (IDRs) with 95% CIs comparing the rates of concussion in games with that practice and between the 8- to 10-year-old and the 11- to 12-year-old age groups were also calculated. A $\chi^2$ analysis with OR was used to compare the odds of a concussion for 11- to 12-year-olds compared with 8- to 10-year-olds. A statistical significance level of $P \leq .05$ and 2-sided tests were used for all analyses in this study. SPSS version 20 (SPSS Inc, Chicago, Illinois) was used for all analyses.

## Results

Four male youth tackle football leagues consisting of 22 teams were asked to participate in the study. A total of 468 of 571 possible participants (82.0%) aged 8-12 years old (mean ± SD 10.12 ± 1.31 years) comprising 18 teams participated in the study. Four of the 22 teams declined to participate in the study due to perceived time requirements or disinterest in the study. The remaining 18 teams had full participation from their eligible and consenting players. A summary of the demographic data is presented in Table I. Reasons for nonparticipation at the team level included testing/scheduling conflicts and coach refusal to participate. Reasons for nonparticipation at the individual level included meeting ≥1 exclusion criteria, refusal of parent to sign consent form, and inability to attend informational meetings or testing sessions.

### Concussions in Practices and Games

There was a total of 11 338 (8415 practice and 2923 game) AEs in the study period during which 20 medically diagnosed concussions involving 20 different participants occurred. There were 2 concussions that occurred in practice and 18 concussions occurred during games. Identified mechanisms of concussions consisted of 45% head-to-head, 5% head-to-ground, and 5% head-to-body contact. The mechanisms

**Table I. Summary of demographic information for 8- to 10-year-old and 11- to 12-year-old participants**

| Characteristic | Participants aged 8-10 y | Participants aged 11-12 y |
|---|---|---|
| Age, mean (SD) y | 9.28 (0.74) | 11.50 (0.71) |
| Height, mean (SD) cm | 138.08 (9.24) | 156.21 (12.57) |
| Weight, mean (SD) kg | 36.04 (7.68) | 55.79 (22.45) |
| No. of previous concussions, mean (SD) | 0.06 (0.24) | 0.50 (0.71) |

for the remaining 45% of concussions were indiscernible due to the context of play (ie, large group tackling with unclear mechanism). The combined concussion IR for practices and games was 1.76 per 1000 AEs (95% CI 0.99-2.54). The concussion IR was 0.24 per 1000 AEs (95% CI 0.04-0.79) in practices and 6.16 per 1000 AEs (95% CI 3.76-9.54) in games. The IDR for concussions in games to practices was 25.91 (95% CI 6.01-111.70).

### Concussions in 8- to 10-Year-Old and 11- to 12-Year-Old Age Groups

There was a total of 5398 (3970 practice and 1428 games) AEs for the 8- to 10-year-olds (n = 214), during which 5 medically diagnosed concussions occurred. There was a total of 5940 (4445 practice and 1495 game) AEs for the 11- to 12-year-olds (n = 231), during which 15 medically diagnosed concussions occurred. The combined concussion IR for practices and games in the 8- to 10-year-old age group was 0.93 per 1000 AEs (95% CI 0.30-2.16). The combined concussion IR for practices and games in the 11- to 12-year-old age group was 2.53 per 1000 AEs (95% CI 1.41-4.17). The combined practice and game IDR of concussions for 11- to 12-year-olds compared with 8- to 10-year-olds was 2.72 (95% CI 0.66-4.78). The results of $\chi^2$ analysis with OR ($\chi^2 = 4.47$, $P = .03$) indicated that players aged 11-12 years were 2.9 (95% CI 1.01-8.12) times more likely to have a concussion than were those aged 8-10 years.

## Discussion

Pop Warner, the largest (425 000 participants) youth football organization in the US, recently limited contact time to reduce concussion.[6] The current study's findings suggest that reducing contact exposures in youth football will likely have little effect on reducing concussion risk, as few concussions actually occur in practice. Practice is when tackling technique is taught and reinforced in a much safer environment than in games, where the incidence of concussion is higher than that in practice. Limiting practices in youth football may not only have little effect on reducing concussions but may also actually increase the incidence of concussions in games via reduced time learning proper tackling in practice. A better approach to reducing concussions in youth football may be to focus on awareness and education. To that end, the CDC's and USA Football's Heads Up concussion programs offer templates for improving awareness among youth football administrators, coaches, parents, and players.[1,14] It is important to note that we know little about the potential for long-term effects from repetitive exposures to subconcussive impacts that might occur in practices and games. As such, we cannot discount the potential effects of reducing practice exposures on effects related to repetitive subconcussive impacts.

The overall concussion IR for youth football players in the current study was comparable with those previously reported in high school and collegiate football (Table II).[3,8,15] In contrast, the IR in games was ~2 times higher than the rates reported in previous studies, whereas the practice rate was lower or comparable with previous findings. The majority of concussions in the current study (45%) involved helmet-to-helmet contact. Efforts to reduce concussions in youth football games include: (1) changes to rules (eg, playing with fewer players on the field); (2) equipment changes (eg, conducting helmet fit checks before each game); and (3) improving tackling technique (eg, increasing limited-contact practices focused on proper tackling technique). Ninety-five percent (19/20) of the concussions in the current study involved players in skilled positions (eg, running back, quarterback, linebacker). Rotating player positions such that exposure in these positions is limited may also help to mitigate concussion risk.

**Table II. Comparison of published concussion IRs and IDRs in American football**

| Study/date | Age | Practice IR | Game IR | Overall IR | IDR games/practices |
|---|---|---|---|---|---|
| Current study/2013 | Youth (8-12 y) | 0.24 | 6.16 | 1.76 | 25.91 |
| Gessel et al[3] | High school | 0.21 | 1.55 | 0.47 | 7.38 |
| Marar et al[4] | High school | 0.31 | 2.29 | 0.64 | 7.39 |
| Lincoln et al[8] | High school | NR | NR | 0.60 | NR |
| Hootman et al[5] | College | NR | NR | 0.37 | NR |
| Gessel et al[3] | College | 0.39 | 3.02 | 0.61 | 7.74 |

*NR*, not reported.

We believe that youth football is a generally safe activity with regard to concussions for children aged 8-12 years, particularly during practice. However, similar to research on high school and college-aged athletes,[8,15] age was associated with increased concussion incidence. Athletes aged 11-12 years were ~2.5 times more likely to have a concussion compared with the 8- to 10-year-olds. This finding is not surprising given that these older players are bigger, faster, and stronger and engage in more tackling than their younger counterparts. The researchers observed that there were 1-2 players on these teams in skilled positions who accounted for the majority of tackle and contact/collisions. Identifying such players is paramount to reduce concussions in this age group.

This study was limited by several factors. The sample size was small for an epidemiologic study, and the surveillance period was composed of only a single competitive season. In addition, the sample was delimited to youth football players in western Pennsylvania and may not reflect trends in other geographic areas. With limited access to medical care during practices, concussion IRs in practice may have been underestimated. Partial exposures (ie, playing part of practice or game) were recorded in the same manner as full exposures, thereby potentially inflating the exposures and reducing the IRs. It is also important to note that certified athletic trainers or physicians recorded the concussion data for the studies depicted in Table II. In contrast, the concussion data from practices in the current study were not recorded in this manner, thereby potentially resulting in an underestimate of concussion in practices. A total of 45% of concussions involved unclear mechanisms of injury due to the nature of

play and/or the sideline vantage points (typically at field level or 1-3 m above field level) afforded researchers at the youth football fields in the study. Consequently, the mechanism of injury data may be inaccurate. ■

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## References

1. Centers for Disease Control and Prevention (CDC). Heads up: Concussion in youth sports. Available at: http://www.cdc.gov/concussion/HeadsUp/youth.html. Accessed October 22, 2012.
2. Bakhos LL, Lockhart GR, Myers R, Linakis JG. Emergency department visits for concussion in young child athletes. Pediatrics 2010; 126:e550-6.
3. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. J Athl Train 2007;42:495-503.
4. Marar M, McIlvain NM, Fields SK, Comstock RD. Epidemiology of concussion among United States high school athletes in 20 sports. Am J Sports Med 2012;40:747-55.
5. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train 2007;42:311-9.
6. Pop Warner National Office. Rule Changes Regarding Practice and Concussion Prevention. Available at: http://www.popwarner.com/About_Us/Pop_Warner_News/Rule_Changes_Regarding_Practice___Concussion_Prevention_s1_p3977.htm. Accessed August 21, 2012.
7. Powell JW, Barber-Foss KD. Traumatic brain injury in high school athletes. JAMA 1999;282:958-63.
8. Lincoln AE, Caswell SV, Almquist JL, Dunn RE, Norris JB, Hinton RY. Trends in concussion incidence in high school sports: a prospective 11-year study. Am J Sports Med 2011;39:958-63.
9. Field M, Collins MW, Lovell MR, Maroon J. Does age play a role in recovery from sports-related concussion? A comparison of high school and collegiate athletes. J Pediatr 2003;142:546-53.
10. Guskiewicz KM, Valovich McLeod TC. Pediatric sports-related concussion. J Injury Funct Rehabil 2011;3:353-64.
11. Maugans TA, Farley C, Altaye M, Leach J, Cecil KM. Pediatric sports-related concussion produces cerebral blood flow alterations. Pediatrics 2012;129:28-37.
12. Shrey DW, Griesbach GS, Giza CC. The pathophysiology of concussions in youth. Phys Med Rehabil Clin N Am 2011;22:577-602.
13. McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M, et al. Consensus statement on Concussion in Sport 3rd International Conference on Concussion in Sport held in Zurich, November 2008. Clin J Sport Med 2009;19:185-200.
14. USA Football's Tackle Advisory Committee. USA Football: Heads up tackling. Available at: http://usafootball.com/health-safety/how-to-tackle. Accessed October 22, 2012.
15. Guskiewicz KM, Weaver NL, Padua DA, Garrett WE. Epidemiology of concussion in collegiate and high school football players. Am J Sports Med 2000;28:643-50.