## Pediatric Concussion Injuries in Soccer: Emergency Department Trends in the United States from 2012 to 2023

Georgia Rose Sullivan, Eugenia Lin, Alex Hoffer<sup>1</sup>, Meghan Richardson, Anikar Chhabra <sup>1</sup>Mayo Clinic

INTRODUCTION: Soccer is one of the most popular youth sports in the United States and worldwide. Due to growing concerns regarding repeated head trauma, in 2015 the United States Soccer Federation (USSF) banned headers for athletes aged 10 and under and limited athletes aged 11 to 13 to practicing headers for thirty minutes per week. The purpose of this study was to assess whether the USSF header ban policy was associated with fewer soccer-related concussions that presented to an emergency department following the 2015 season. METHODS:

A retrospective cohort from the National Electronic Injury Surveillance System (NEISS) database was assessed. Age, sex, and injury type were extracted for all soccer-related emergency department visits between January 1st, 2012, and December 31st, 2023. Univariate and multivariable regression analyses were conducted to assess concussions as a percentage of all soccer-related injuries based on sex, age group, and year.

RESULTS: The number of concussions as a percentage of all soccer-related injuries decreased from 8.2% in 2012-2015 to 6.1% in 2020-2023 (p<0.01). The 14–17-year-old subgroup concussion rate decreased by 3.1%, the 10–13-year-old subgroup concussion rate decreased by 1.7%, and the 6-9-year-old subgroup concussion rate decreased by 0.5%. From 2012-2023, the concussion rate among 14-17-year-olds and 10-13-year-olds was higher than 6-9-year-olds (8.9% and 6.6% compared to 4.9%, p<0.01). Despite a lower soccer-related injury rate overall, females were diagnosed with a greater proportion of concussions than males (9.6% compared to 6.2%, p<0.01). In a multivariable regression analysis, injuries that occurred in the years 2020-2023 were associated with lower odds of a concussion compared to 2012-2015 (OR: 0.75, 95% CI: 0.69- 0.81). The 10-13-year-old age group, 14-17-year-old age group, and female sex were associated with higher odds of concussion compared to the 6-9-year-old age group and male sex respectively (OR: 1.30, 95% CI: 1.16- 1.45; OR: 1.79, 95% CI: 1.61- 1.99; OR: 1.53, 95% CI: 1.43- 1.63).

DISCUSSION AND CONCLUSION: The USSF youth soccer header ban policy introduced in 2015 was associated with a 25.6% relative risk reduction to sustain a soccer-related concussion and present to the emergency department in 2020-2023 compared to 2012-2015. A header ban in players under 10 years old, and limitation to thirty minutes of header practice a week in players under 13 years old may improve player safety by reducing head impacts in the youth population.

Concussions Presenting to the ED as % of Total Soccer	Concussions Presenting to ED as % of Total Soccer Injuries by Sex	Table 1: Concessions presenting to the emergency department as a percentage of total soccer injusies from 2012-2023				Table 2: Concussions presenting to the emergency department as a percentage of all soccer- related injuries from 2012-2023 (age subgroups)				Table 3: Multivariate regression predicting concession as a percentage of all soccer-related injuries per year after adjusting for age and sex.			
Injuries by Age		all. (n)	All Succer-Related Injuries	Concussion Diagnoses (% of all	P-value		All Injuries	Concussion Disguesses (% of all	P- value	Variable	Odds Ratie	55% Caufidence Interval	P-value
			a=58,975	injures)		d from ald	max 201	injurn)		Intercept	0.05	0.05-0.06	<0.01
	10	A		Bridgeto (17474)	10.01	0.0 years and	11-10,770	2-471 (4.274)	0.55	345			
		203			4000	xcar			0.55	Mala	Reference	Reference	
		Naae	37,935 (64,3%)	2,345 (6,2%)		2012-2015	3(113(33,4%)	160 (5.1%)		Feende	1.53	1.43-1.63	-0.01
		Female	21,040 (35.7%)	2,010 (9.6%)		2016-2019	3,142 (35,7%)	154 (4.8%)		Arr			
8	8 × ×	Age			<0.01	2020-2023	2,538 (28.9%)	117 (4.6%)		6.9	Beference	Beference	
		6.9	8,793 (14.9%)	431 (4.9%)		10-13 years old	n=23,275	a+1,527 (6.6%)	+0.01	10-13	1.30	1.16-1.45	-9.81
8		10-13	23,275 (39,5%)	1,527 (6.6%)		Year				14-17	1.79	1.61-1.99	-0.91
F 0	8.6	14-17	26,907 (45.6%)	2,397 (8.9%)		2012-2015	8,243 (35,4%)	577 (7.8%)		Year			
	e mito	Year			<0.01	2016-2019	8.513 (36.6%)	602 (7.1%)		2012 2015	References	References	
5 4 - 14617	8 . Females	2012-2015	21.013 (35.6%)	1,729 (8,256)		2020-2023	6.519 (28.0%)	348 (5.2%)		2016-2018	0.94	0.85, 1.01	0.02
a	E 4	2016-2019	21.267 (36.1%)	1.61417.6%		14-17 years ald	nv26.907	min7 307 (\$ 000).		2020 2021	0.74	0.00 0.01	-0.01
2	£	2003-2023	16,695 (28,3%)	1.012 (6.1%)		Year	in angeot		10.01	2010-2023	16.17	0.004 0.01	5000
						2012 2018	0.417(21.05)	002/10 200					
	1					2012-2010	0.00000000	AND 10 0001					
						2010-2019	2012(33.750	4.55 (4.574)					
1017 ML I ML						2020-2023	7,638 (28.47%)	347(7,2%)					
Year	0												
	2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023												
	Mana												