Sports-Related Concussions in High School Females: An Epidemiologic Analysis of Twenty-Year National Trends
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INTRODUCTION: The epidemiology of sports-related concussions (SRCs) and closed head injuries (CHIs) in high school females remains largely undefined at the national level, especially for unorganized sports and recreational activities. The aim of this study was to report national estimates, demographic characteristics, and trends of female patients presenting to United States (US) emergency departments (EDs) with SRCs and CHIs. We hypothesize that the greatest proportion of such injuries will occur in those athletes participating in contact sports, and that increases across time will parallel overall sports participation rates.

METHODS: We report demographic and injury characteristics from 1,176,092 national weighted estimates of SRCs or CHIs in female patients presenting to US EDs between 2000 and 2019 in the National Electronic Injury Surveillance System (NEISS). We also collected data from the National Federation of State High School Associations (NFHS) nationwide survey archives in order to correlate NEISS estimates with the number of female high school sports participants during the study period.

RESULTS: The national weighted estimate of female patients 14-18 years of age presenting to US EDs with SRCs or CHIs increased significantly (p<0.001) between 2000 (9,835, CI 7,105 - 12,566) and 2019 (31,751, CI 26,392 - 37,110). The vast majority of patients (96.7%, CI 96.0% - 97.5%) were treated and released from the ED. Across all settings, the top five ranked sports and recreational activities most commonly associated with concussions and CHIs in female patients 14-18 years of age were: soccer (20.6%, CI 17.6% - 23.6%); basketball (18.5%, CI 16.9% - 20.1%); cheerleading (10.4%, CI 8.9% - 11.9%); softball (10.1%, CI 9.0% - 11.3%); volleyball (6.5%, CI 5.7% - 7.2%). Simple univariate regression models showed that an increase of 10,000 annual female participants across all high school sports and recreational activities was associated with 308.7 (SE=20.8, p<0.001, R^2=0.92) additional annual SRCs and CHIs presenting to US EDs. The same regression models specific to volleyball, soccer, cheerleading, basketball, and softball had R^2 values of 0.80, 0.78, 0.56, and 0.22, respectively.

DISCUSSION AND CONCLUSION: A combination of both organized and recreational sports contribute significantly to the proportion of annual SRCs and CHIs sustained by high school age female patients. Given the dramatic increase in the national burden of SRCs over the past 20 years across a broad range of sports, the promotion of impactful concussion awareness and educational programs directed toward female student-athletes should be adopted as a principal agenda across all high schools in the US.