Sport Concussion and the Female Athlete

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KEYWORDS

• Neurocognitive • Hormone • Concussion • Sex differences

KEY POINTS

- Current evidence is mixed regarding sex differences in cognitive performance after a sport concussion (SC).
- Female athletes have a higher symptom burden before and after injury, which should be accounted for when making evidence-based decisions regarding SC.
- Female athletes have been routinely observed to have increased risk for SC, which may be partially explained by physical and physiologic differences.
- In terms of protracted recovery after an SC, the data remain equivocal; regardless of biological sex, athletes diagnosed with an SC should be managed based on clinical presentation.

INTRODUCTION

In 2016, a survey-based study asked the question, "Would you let your child play football?"[1] Given the popularity of American football and that it is primarily a male sport, the title of this study emphasized the incidence and cumulative effects of sport concussion (SC) in male athletes. Since 1999,[2] an increasing body of literature has reported that female athletes who participate in sports with a male counterpart (eg, softball vs baseball) have an equal if not increased risk of SC. Despite awareness of female athletes' increased susceptibility to injury[3] and postconcussion symptom reporting,[4] as well as decreased neurocognitive[5] and balance performance,[4] SC-related research attention is primarily focused on male athletes. Our current knowledge of specific risk factors and outcomes related to SC and the female athlete compels additional questions about the risk(s) associated with female participation in contact and noncontact sports.

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EPIDEMIOLOGY

When all sports are considered, epidemiologic studies of SC within the last 2 decades have demonstrated that male athletes sustain more concussions than female athletes.[2,3,6–23] However, when considering female sports with a male equivalent (eg, basketball and soccer), female athletes sustain more SCs compared with male athletes. Fig. 1 summarizes published SC injury rates (IR) between male and female sports.[3,6,8,10]

Overall, male high school and collegiate athletes have been found to have a higher SC rate than female athletes.[6,7,9] However, when considering male sports with an equivalent female counterpart, high school and collegiate females have an equal or higher rate of SC compared with males.[3,6,8,10] Based on data collected by the National Collegiate Athletic Association Surveillance System between the 1988 and 1989 sports seasons, only 1 study indicated a higher SC rate for males (IR = 45 per 100,000 athletic exposures [AEs]) compared with females (IR = 38 per 100,000 AEs) for all sports.[9] The discrepancy between this study compared with the majority of investigations was due to the inclusion of football and wrestling in addition to other male sports. In contrast, when all secondary school and collegiate female sports were considered, SC rates ranged between 13 and 38[6,7,9] per 100,000 AEs. For high school and collegiate male sports, reported IR have ranged between 25 and 45 per 100,000 AEs.[6,7,9] In summary, the epidemiologic evidence suggests that female athletes who participate in a sport with a male counterpart have an equal if not increased risk of sustaining an SC.

PHYSICAL AND PHYSIOLOGIC ASPECTS OF THE FEMALE ATHLETE AND CONCUSSION

Neck Strength

One plausible reason for the previously discussed increased incidence of SC in female sports is neck strength. Early studies that examined sex differences in terms of neck

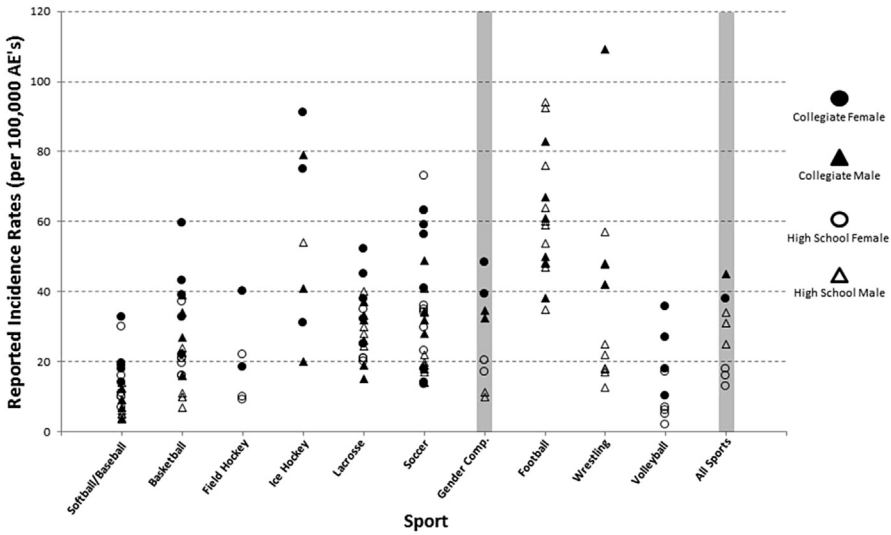

Fig. 1. Concussion incidence rates reported in original research from 19 different studies; athletic years 1997 to 2015 in collegiate athletes (11 studies) and 1995 to 2014 in high school athletes (15 studies). AE, athlete exposure, defined as one athlete participating in a single game or practice; All Sports, all sports for each sex as reported by each study that calculated this as a separate comparison; Gender Comp., gender comparable sports as reported by each study that calculated this as a separate comparison. (*Data from* Refs.[2,7–9,11–25])