Sex Differences in the Outcomes of Mild Traumatic Brain Injury in Children Presenting to the Emergency Department

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Background

- A concussion is a type of mild traumatic brain injury (mTBI) that involves a change in the normal functioning of the brain caused by a mechanical blow directly to the head or to the body with an impulsive force transmitted to the head, without accompanying structural injury.[1]
- Concussions in children and adolescents are particularly worrisome due to the vulnerability of the developing brain.[2]
- In the United States, more than half a million TBI-related Emergency Department (ED) visits involve children annually.[3]
- Historically, research on sport-related concussion has focused on males. However, since the establishment of Title IX, a growing number of females have begun participating in youth sports.[4]
- Since research suggests that females are more susceptible to sustaining concussions, an evaluation of sex differences in post-concussion outcomes becomes increasingly important.[5-7]

In comparison to boys, and relative to children with mild orthopedic injuries (OI), girls will experience poorer outcomes post-mTBI as measured by parent and self-reported cognitive and somatic symptoms, cognitive testing, and balance testing.

- Secondary analysis of a pre-existing, de-identified dataset collected as part of NIH grant, R01HD076885, entitled “Predicting Outcomes in Children with Mild Traumatic Brain Injury,” to Dr. Keith Yeates; therefore, ethical review was not required.
- Concurrent cohort, prospective, longitudinal design that included 8 to 16-year-old children with either mTBI or mild OI not involving the head.
- Initial assessment at the time of recruitment during visit to ED. Post-acute assessment within two weeks of injury.
- Outcomes included parent and child ratings of somatic and cognitive symptoms, and standardized tests of neurocognitive functioning and balance.

The flow of participants through the study is illustrated in Figure 1.

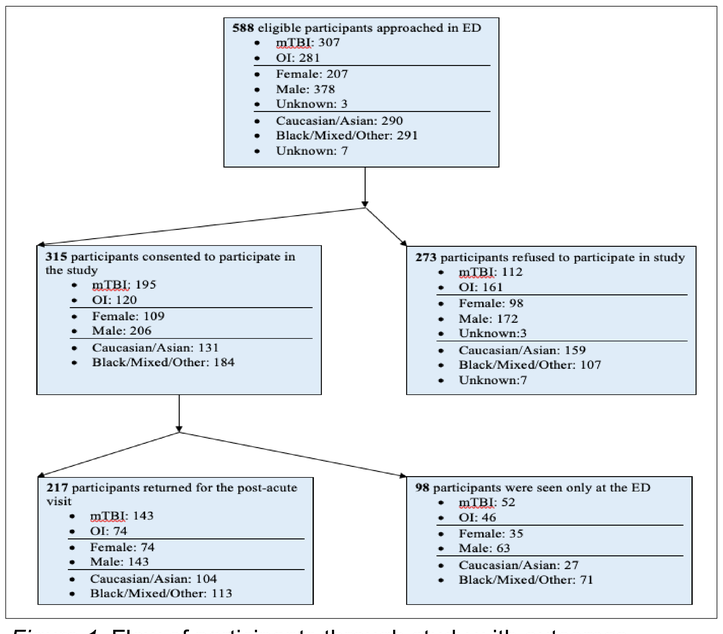


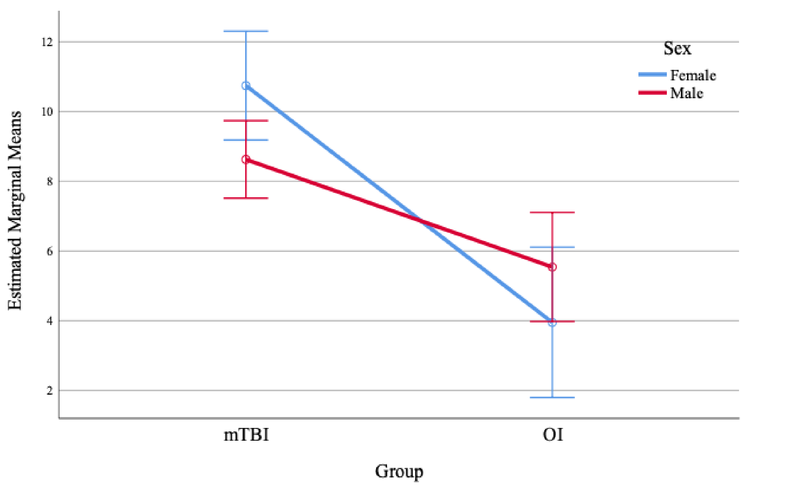
Figure 1. Flow of participants through study with outcomes.

Results

- The results are depicted in Table 1. The group by sex interaction was significant for child ratings of somatic symptoms (see Figure 2), but not for parent ratings of somatic or cognitive symptoms, child ratings of cognitive symptoms, cognitive testing scores, or balance testing.
- The main effect of group was significant for all symptom ratings by parents and children, with more severe symptoms in the mild TBI group than the OI group in all cases.
- The main effect of sex was significant for parent ratings of somatic symptoms, such that parents reported more somatic symptoms for girls than boys, but in both groups.

Table 1. *Estimated Marginal Means for Dependent Variables*

	OI		Mild TBI	
	74		143	
Outcome measures	Female	Male	Female	Male
Parent ratings of cognitive symptoms, M (std. error)	10.469 (1.395)	9.096 (.986)	13.775 (.989)	11.770 (.714)
Parent ratings of somatic symptoms, M (std. error)	4.377 (.960)	2.824 (.682)	8.323 (.681)	6.934 (.489)
Child ratings of cognitive symptoms, M (std. error)	8.769 (1.615)	10.542 (1.188)	15.229 (1.188)	13.266 (.849)
Child ratings of somatic symptoms, M (std. error)	3.949 (1.094)	5.539 (.794)	10.744 (.793)	8.624 (.564)
Age standardized Cognitive Fluid Composite Score, M (std. error)	93.755 (3.747)	101.633 (2.289)	91.750 (2.797)	93.068 (1.924)
Age standardized Cognitive Crystallized Composite Score, M (std. error)	96.064 (2.657)	102.906 (1.946)	99.720 (2.004)	100.554 (1.386)
BESS Total Score, M (std. error)	23.128 (2.566)	27.579 (1.727)	24.147 (1.333)	23.646 (.955)



Covariates appearing in the model are evaluated at the following values: Parent ratings of pre-injury somatic symptoms = 3.44

Error bars: 95% CI

Figure 2. Interaction plot for child ratings of somatic symptoms.

Discussion and Conclusion

- The results showed a larger effect of concussion (relative to OI) for girls than boys only for self-reports of somatic symptoms. No differential effects by sex were found for self-reports of cognitive symptoms, parent ratings of cognitive or somatic symptoms, cognitive abilities, or balance.
- The findings have potential implications for both clinical practice and public health.
  - Healthcare providers need to be aware that girls’ and boys’ reporting styles may differ after concussion, and that symptom reporting is influenced by many factors, including sex. Additionally, girls’ propensity to report more somatic symptoms than boys may mean they require more aggressive treatment.
  - The results may help to guide implementation of policies related to pediatric injury prevention. Given the objectives and aims of national injury prevention strategies, including Healthy People 2020 and the Surgeon General’s National Prevention Strategy, the results may suggest the need for equipment and rule changes to provide additional protection for female athletes.
- Future research could expand upon the current study by examining the interaction of concussion and sex over time, by involving more participants to provide greater statistical power, and by extending the outcomes studied to include neuroimaging and fluid biomarkers, to tease out potential mechanisms for the sex differences found in somatic symptoms after concussion.
- The findings suggest only limited sex differences in the outcomes of concussion in a pediatric ED population, but may nonetheless have implications for clinical and public health.

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