

SEX DIFFERENCES IN THE ACOUSTIC STARTLE RESPONSE OF ADOLESCENT ATHLETES FOLLOWING CONCUSSION

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BACKGROUND

The brainstem is particularly vulnerable to injury from head impacts, [1,2] and the acoustic startle response is a cross-species, brainstem-mediated reflex that may be a sensitive marker for concussion-related impairment. [3]

Sex differences may be present across multiple domains following concussion in adolescents, [4] but further research is warranted.

While healthy females traditionally exhibit a larger startle response compared to males, [5] it is currently unknown whether this difference persists following concussion.

OBJECTIVE

To examine sex differences in the acoustic startle response in adolescent athletes following concussion.

We hypothesized that female adolescent athletes would have a more suppressed acoustic startle response compared to male athletes.

PARTICIPANTS

	Female (n = 14)	Male (n = 12)
Age (years)	14.9 ± 2.5	14.5 ± 1.9
Concussion History (%)	0: 29%	0: 41%
	1: 43%	1: 17%
	2: 21%	2: 17%
	3+: 7%	3+: 25%
Time Since Concussion (days)	36.6 ± 18.0	36.3 ± 15.8

Table 1. Participant Demographics.

METHODS

Design: Prospective, cross-sectional

Setting: Specialized children's hospital concussion clinic

Procedures: The eye blink component of the startle reflex was recorded via electromyography activity of the orbicularis oculi muscle. Measurement sessions began with a one-minute period of white noise followed by twelve 103db acoustic startle probes delivered 15-25 seconds apart. Acoustic startle probes were administered through noise-canceling headphones.



Data Analysis: The outcome was mean startle magnitude (μV), and biological sex (male/female) was the independent variable. We used an independent samples t-test to determine if mean startle magnitude differed between sexes at $p < 0.05$.

CONCLUSION

There do not appear to be statistically significant sex differences in the acoustic startle response of adolescent athletes following concussion.

Greater variability in the acoustic startle magnitudes of the female cohort may indicate that startle response is influenced by physiological variables (e.g, hormone levels, phase of cycle), and future research is warranted.

While not the primary focus, the mean startle magnitudes of both sexes were suppressed following concussion compared to healthy controls, suggesting concussions may result in physiological dysfunction that is detectable through evaluation of the acoustic startle reflex.

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RESULTS

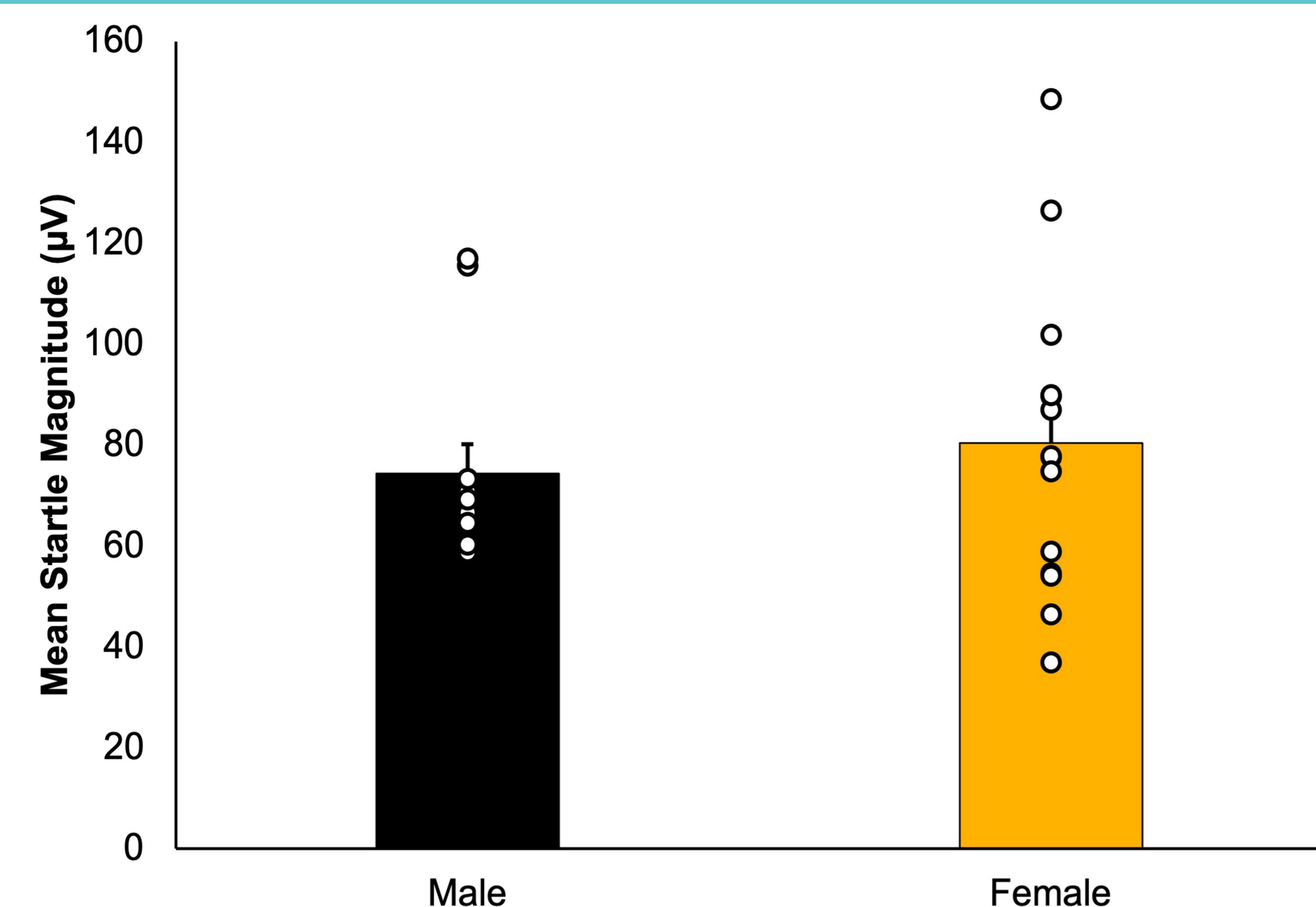


Figure 1. Mean startle magnitude compared between sexes

- Male and female adolescent athletes did not significantly differ in age ($p=0.69$) or time since concussion ($p=0.96$). (Table 1)
 - No significant sex differences in acoustic startle response were observed in adolescent athletes following concussion ($p=0.57$, 95% CI= 61.7, 87.1)
- Mean Acoustic Startle Magnitudes
Female: 80.4 ± 30.8 μV
Male: 74.4 ± 20.0 μV
(Figure 1)

REFERENCES

- 1) Hiram A, Bazarian J, Merchant-Borna K, et al., A common neural signature of brain injury in concussion and subconcussion. *Science Advances*. (2019). 5:1-11.
- 2) Arbogast K, Margulies S. Material characterization of the brainstem from oscillatory shear tests. *Journal of Biomechanics*. (1998). 31:801-7.
- 3) Oldham J, Meehan W, Bradford D, et al., Concussion-related general startle suppression in adolescent athletes: a preliminary study. (2024). *In Press*.
- 4) Hannah T, Li A, Spiera Z, et al., Sex-related differences in the incidence, severity, and recovery of concussion in adolescent student-athletes between 2009-2019. *Am J Sports Med*. (2021). 49(7): 1929-37.
- 5) Quevedo K, Smith T, Donzella B, et al., The startle response: developmental effects and a paradigm for children and adults. *Dev Psychobiol*. (2010). 52(1):78-89.