

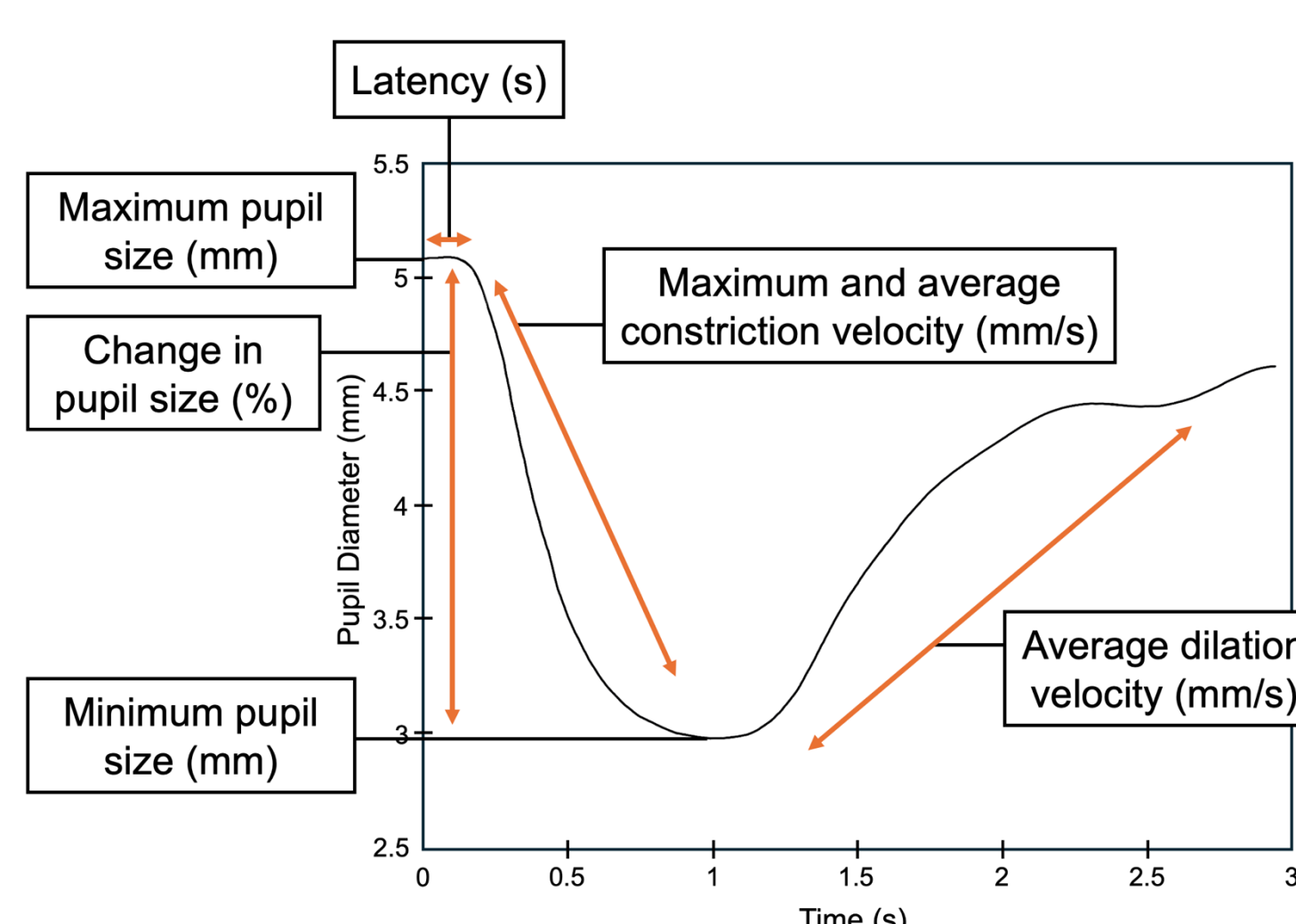
Quantifying Head Impact Exposure in Collegiate 15s Rugby and Relationship to Clinical Measures

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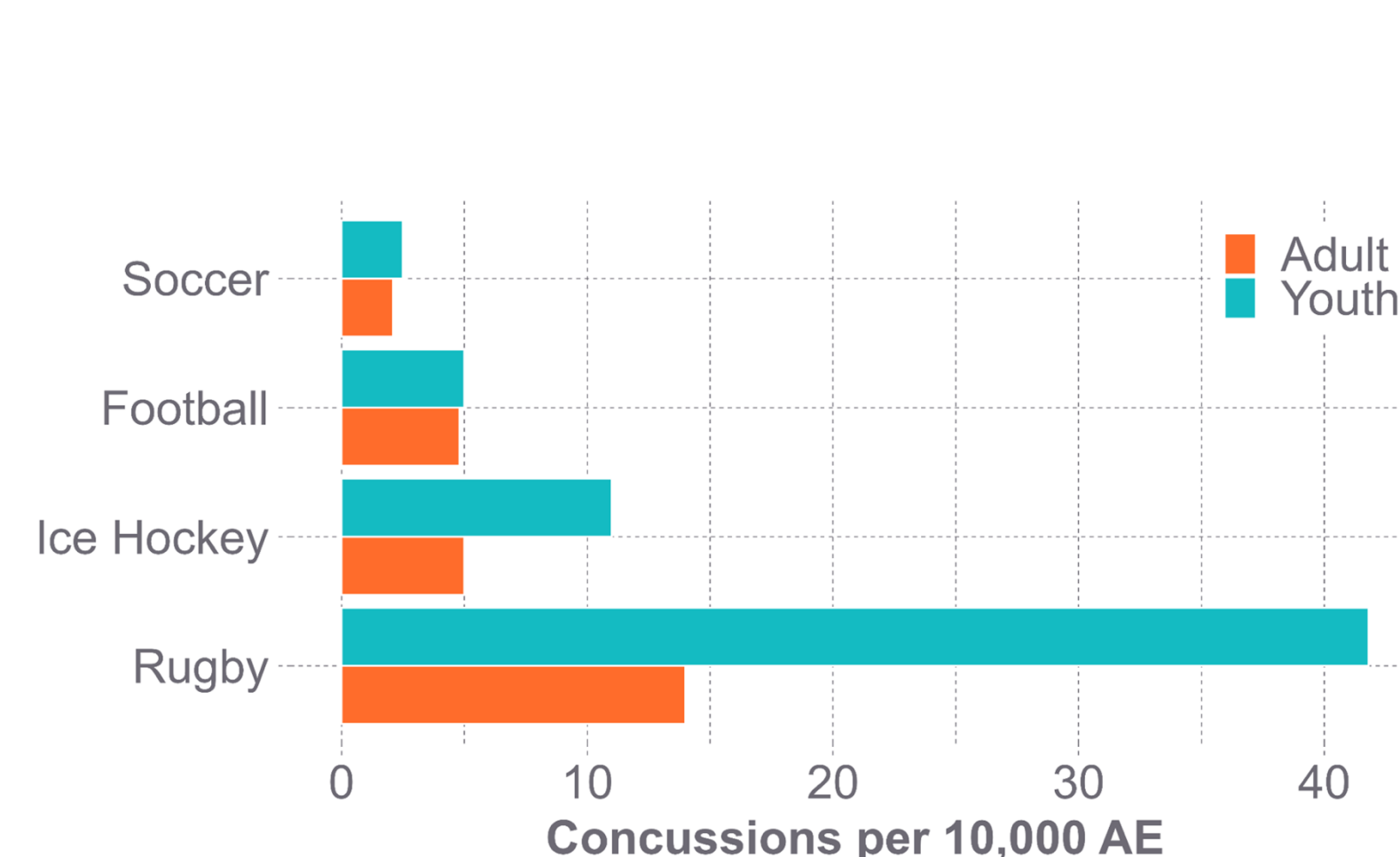
Background

- Concussions are a common sports-related injury, and repetitive concussions have been linked to long-term neurodegenerative processes
- However, less is known about the cumulative effects of **subconcussions**: head impacts that produce symptoms and functional changes but do not meet the diagnostic threshold for concussion
- Previous studies found that concussions can cause disruptions in the autonomic nervous system, resulting in measurable changes in the Pupillary Light Reflex (PLR) (Master et al.)
- Rugby has a high concussion rate and no mandatory protective headgear

Pupil diameter during the PLR



Concussion rates in sports



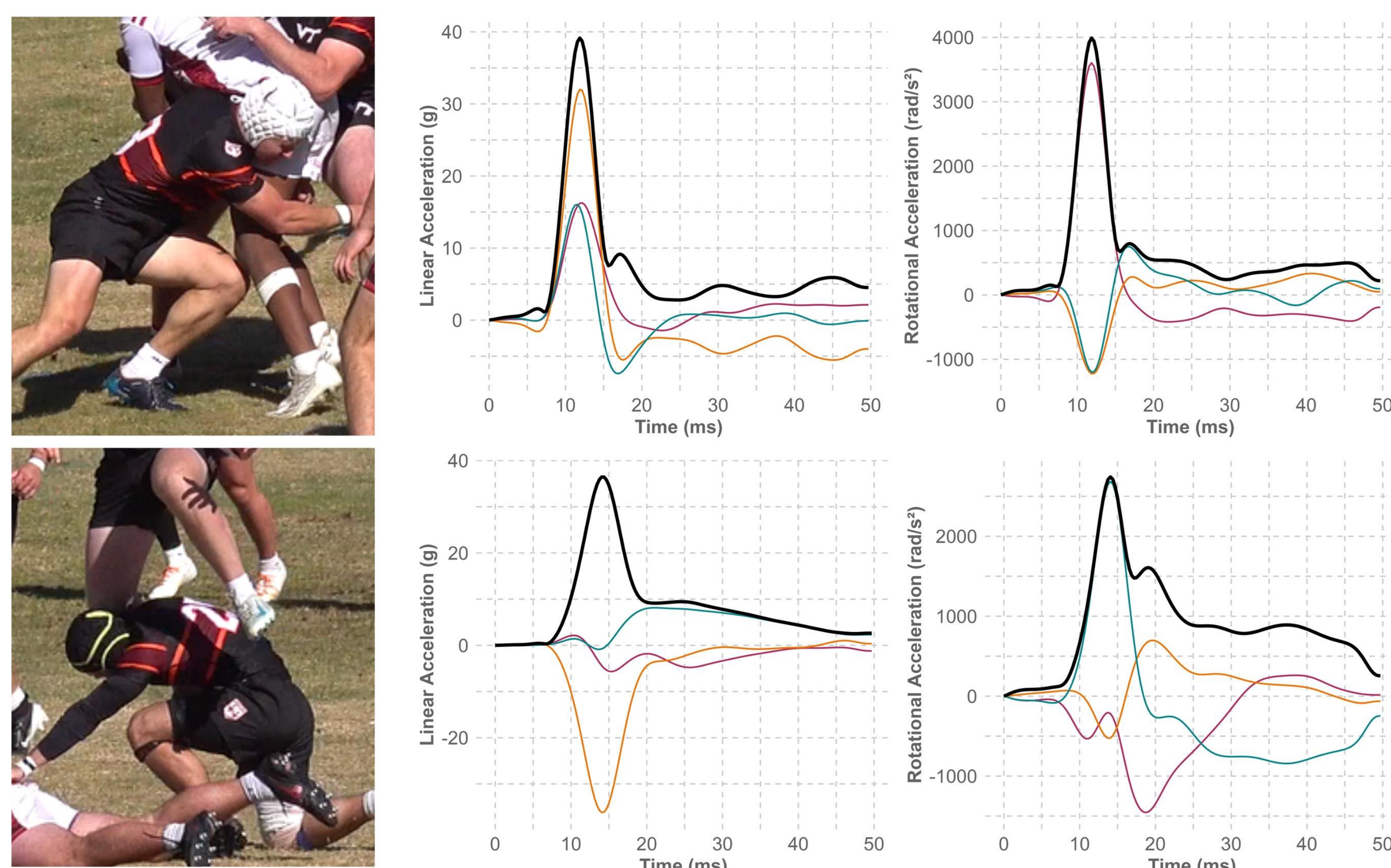
This study's **objective** was to **quantify head impact exposure** across a season of collegiate 15s rugby and to **relate impact exposure to changes in symptom reporting and PLR metrics**

Methods

- The Virginia Tech Men's Rugby Club wore Prevent Biometrics instrumented mouthguards (iMGs) during the Fall 2025 season:
 - 7 games of 15s rugby
 - 21 players
 - 125 player matches



Example Head Acceleration Event (HAE) traces



- Before and after each game, players completed a Graded Symptom Checklist (GSC) and PLR measurement
 - Changes calculated by subtracting **baseline** from **post-game** measurements
- GSCs: players rate 22 concussion symptoms from 0-6
 - **Symptom Severity Score (SSS)**: sum of all symptom ratings
 - **Elevated Symptoms**: change in SSS ≥ 7

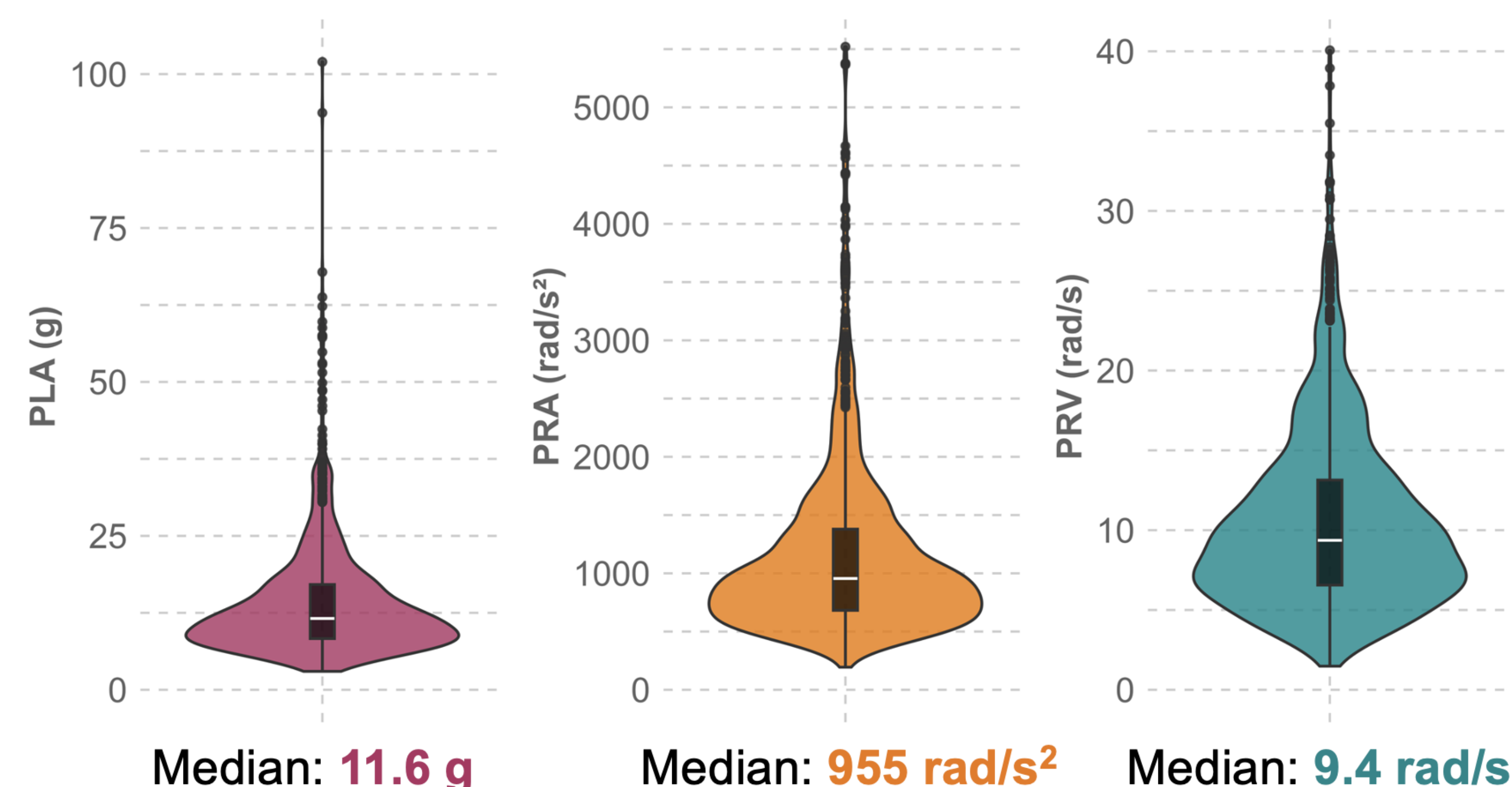


NeuroOptics PLR-4000

Findings

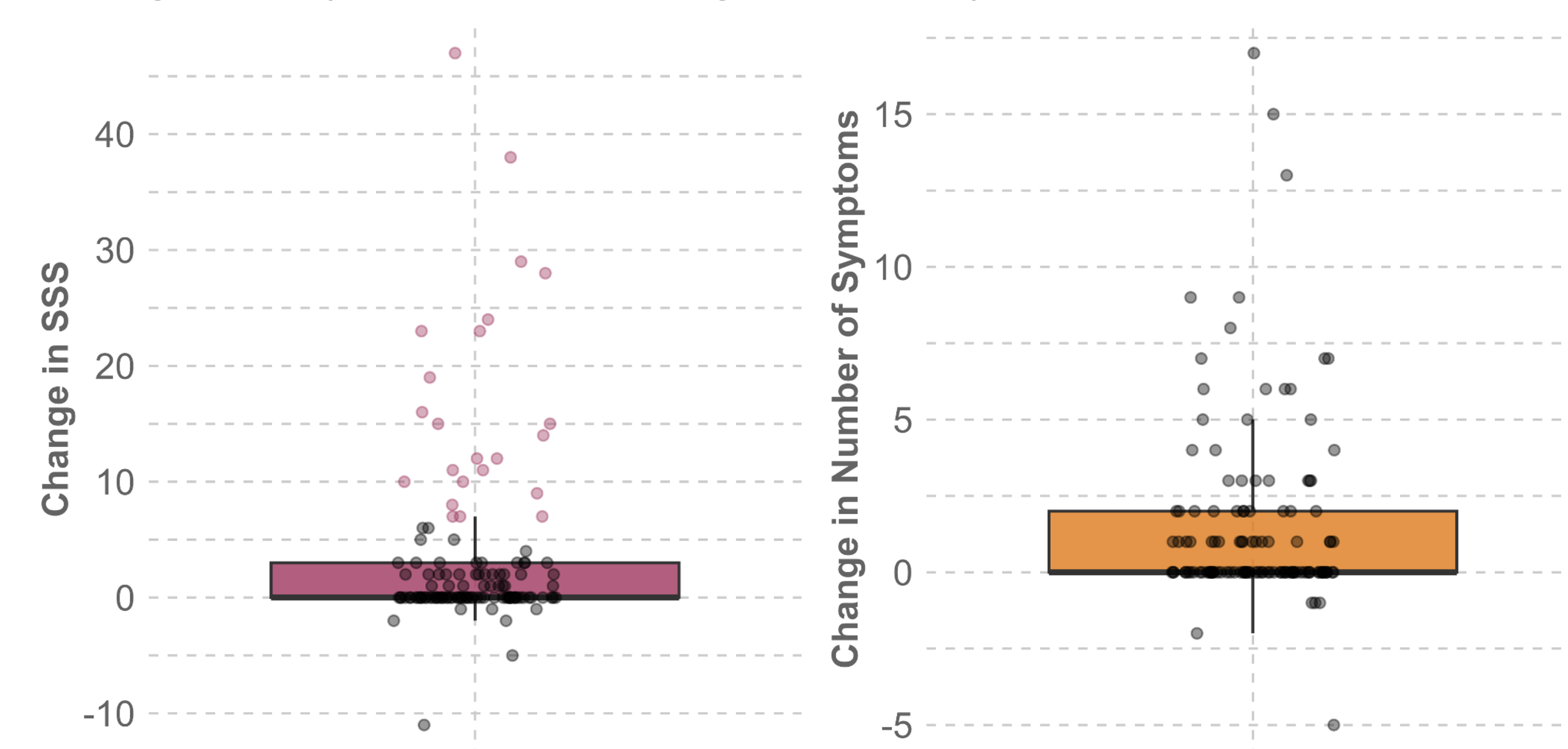
- 1287 HAEs were recorded over the season

PLA, PRA, and PRV distributions for all HAEs



- **18.4% of player matches** reported elevated symptoms
- **38.1% of players** reported elevated symptoms at least once across the season

Changes in symptom reporting for all player matches



- Total HAEs during the current game were **significantly associated** with increases in SSS (LMM: $\beta = 0.20$, $p = 0.013$)
- For each additional HAE, players were 1.2 times more likely to have elevated symptoms (GLMM: odds ratio = 1.10, $p = 0.042$)
- No significant associations between HAE exposure and changes in any of the PLR metrics

Linear Mixed Models: Change in SSS

Exposure window	HAE exposure metric	Coefficient	p-value
Current game	Total HAEs	0.204	0.013**
	HAEs ≥ 30 g	1.094	0.081
	Max PLA	0.084	0.070
Past 7 days	Total HAEs	0.066	0.240
	HAEs ≥ 30 g	0.229	0.624
Season to date	Total HAEs	0.043	0.318
	Total HAEs	0.011	0.613
	HAEs ≥ 30 g	0.162	0.525
	Max PLA	0.051	0.196

* $p < 0.05$; **significant after Bonferroni correction

Change in SSS as a function of HAE exposure across different exposure windows, with player as a random effect

Takeaway Message

- Players often reported **symptoms associated with head impact exposure** in the absence of a diagnosed concussion
- **Within-day HAE exposure** had the largest effect on symptom reporting, with diminishing effects as the time window was extended
- The head impacts observed in this study were likely **not severe enough to result in changes in the PLR** as observed in previous studies with concussed athletes