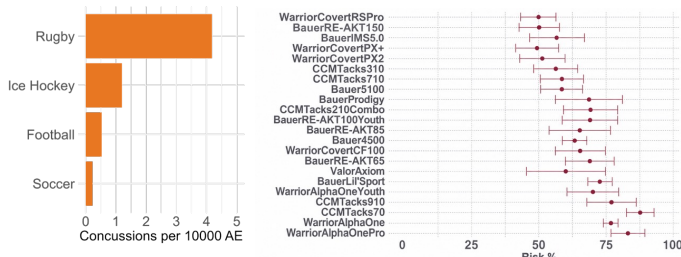


The Potential Effects of Youth Hockey Helmet Shell Add-Ons

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Background

- Hockey reports the **second-highest concussion incidence rate** among youth sports
- Outside of player-to-player contact, hard surfaces such as the ice and boards also pose a serious risk, as collisions with them can result in severe head injuries.
- Youth hockey helmets are tested to the **same standard as adult helmets**, so they do not reflect youth impact conditions. Also, they **do not evaluate rotational head kinematics**.
- Prior youth hockey helmet comparisons show substantial variation across models.
- **Youth hockey helmets still have meaningful room for performance improvement.**
- Even the **best-performing youth hockey helmet** still showed about **50% concussion risk at the high-speed condition** when completing STAR testing



- In other sports, **helmet shell add-ons are being implemented for added protection**

Methods

Experimental Setup

Pendulum impactor used for testing

- Pendulum impactor testing
 - Impact speeds: 2.3, 3.4, 4.9 m/s
 - 4 impact locations
 - 6 helmet models
 - 2 trials per condition
 - 3 shell add-on configurations
 - Control condition
 - VN600 foam shell add-on
 - Guardian Cap



- We measured peak linear acceleration (PLA) and peak rotational acceleration (PRA) and computed concussion risk using a youth-specific risk function
- Linear mixed-effect regression models were used to evaluate add-on condition, impact speed, impact location, and impact speed with helmet model as a random effect effects on PLA, PRA, and concussion risk

Shell add-on conditions tested and foam used inside Headcover



Objective: To evaluate whether **adding padding to the outside of a youth hockey helmet improves overall performance** by reducing linear and rotational head accelerations under youth-specific impact conditions.

Findings

- Impact speed, impact location, and externally mounted padding each affected PLA, PRA, and concussion risk (all $p < 0.001$).
- Relative to the control helmet, the one-inch **headcover Cap** had a **42.7 g reduction in PLA** (95% CI 34.4–50.9 g, $p < 0.001$) and **2091 rad/s² reduction in PRA** (1526–2657 rad/s², $p < 0.001$), which **reduced overall concussion risk by 27.7%** (17.6–32.2%, $p < 0.001$).
- The **Guardian Cap** produced a **12.6 g reduction in PLA** (4.3–20.9 g, $p = 0.005$) and a **921 rad/s² reduction in PRA** (356–1487 rad/s², $p = 0.003$), corresponding to an **8.9% decrease in concussion risk** (3.0–14.9%, $p = 0.006$).

Peak Linear Acceleration



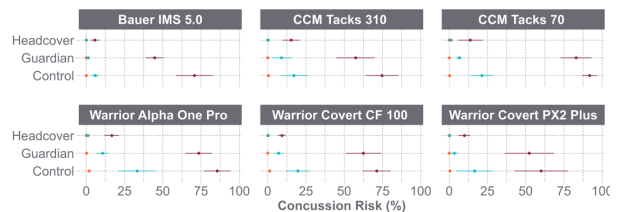
Headcover reduced PLA by 42.7 g ($p < 0.001$), and the Guardian Cap reduced PLA 12.6 g ($p = 0.005$) across all models

Peak Rotational Acceleration



Headcover reduced PRA by 2091 rad/s² ($p < 0.001$), and the Guardian Cap reduced PRA by 921 rad/s² ($p = 0.003$) across all models

Concussion risk



Headcover lowered risk by 27.7% ($p < 0.001$), and the Guardian Cap lowered risk by 8.9% ($p = 0.006$) across all models

Takeaway Message

- Most youth hockey helmets are **smaller versions of varsity hockey helmets** and are **not optimized for youth-specific impacts**.
- The **substantial improvement in performance associated with the add-ons** suggests there is further room to optimize youth hockey helmet design
- **Significance:** When designing youth hockey helmets and external padding technologies, manufacturers should focus on both the thickness and composition of foam materials to account for a range of impact scenarios.