



Background & Study Objective

- Concussion is a common but serious health concern among athlete and military populations, affecting daily functioning and physical readiness.
- To improve understanding of concussion, the NCAA and US DoD/DoW established the Concussion Assessment, Research, & Education (CARE) Consortium, which collected comprehensive baseline assessment and post-injury data in service academy members at the US Military, Naval, Air Force, and Coast Guard Academies from 2015-2020.
- While ongoing research seeks to identify individuals at elevated concussion risk using baseline assessment data, the value of repeated annual baselines for concussion risk prediction remains unexplored.
- Objective:** using baseline CARE data, we examined the ability of baseline assessments to predict subsequent concussions and how their predictive performance changes over time.

Methods

- Using eXtreme Gradient Boosting, we first determined how the predictive accuracy of baseline assessments changes over time during a single academic year in 16,642 male and female US service academy cadets and midshipmen.
- In the subset of 5,099 individuals with baseline data available from two consecutive years, we then compared same-year and subsequent-year concussion prediction models and evaluated whether combining baseline data collected over two years improves model performance.

Results

- Predictive accuracy decreased over the first year after baseline assessment from AUC=0.68 to AUC<0.64 (Fig 1).

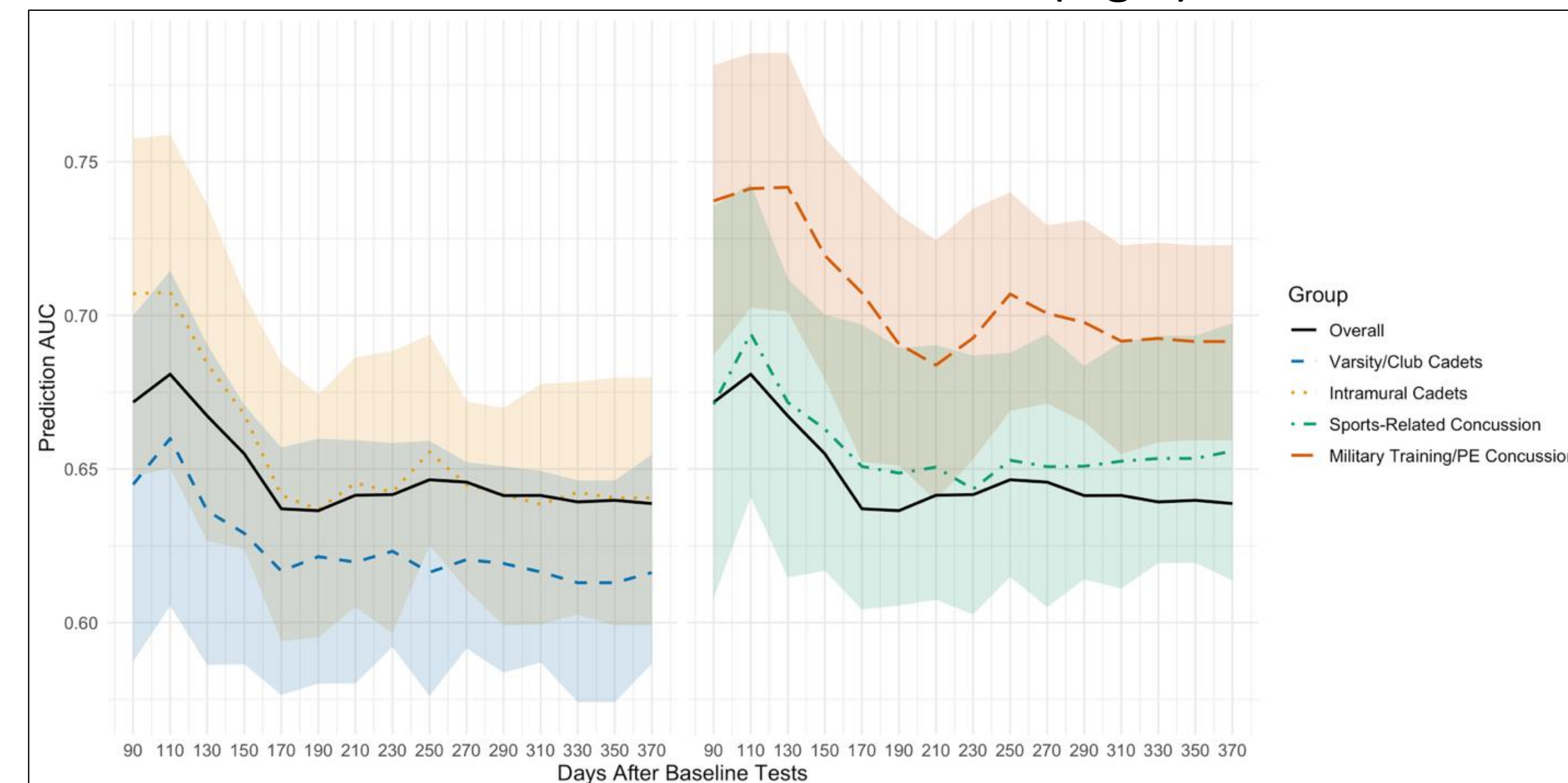


Fig 1. AUC over time in full group (black solid) as well as by sport subgroup (left) and mechanism of injury (right).

- Same-year models predicted concussion better than subsequent-year models ($D = 1.13$, $p < 0.001$; Fig 2a, 2b).
- While combined-year models predicted concussions incrementally better than same-year models, effect sizes were small ($D = 0.28$, $p < 0.001$; Fig. 2c).

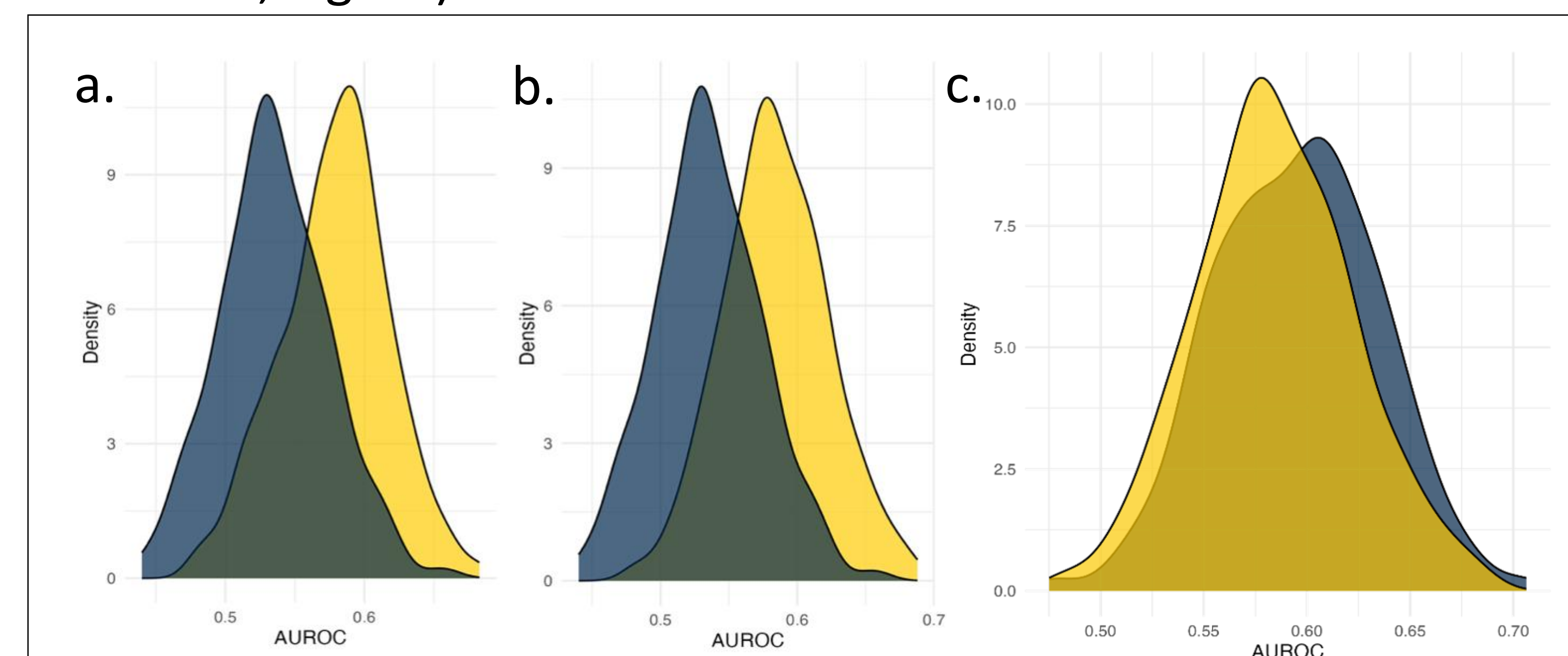


Fig 2. Same year (maize) vs. subsequent year (blue) comparisons (a, Y1; b, Y2); same year (maize) vs. combined year (blue) comparison (c).

Discussion

- In this study, we extended the application of baseline assessments from their typical use as reference values for direct pre-injury/post-injury comparisons to include prediction of future concussion risk.
- These results suggest that factors influencing concussion risk are dynamic and time-sensitive, so the performance of concussion prediction models using baseline assessment data diminishes over time.
- Further, only small improvements in model performance should be anticipated with use of combined baseline data collected over multiple years.

Impact & Future Directions

- The ability to predict future concussion risk would offer potential opportunities for more targeted concussion prevention, education, and surveillance efforts based on risk stratification.
- Given the significant time and resource investment required to conduct baseline concussion testing, baseline assessments being used to predict concussion risk should be performed as close to time periods of greatest risk as possible.
- Future research should focus on the most highly predictive variables, with additional consideration of state vs. trait variables and collinearity between variables, to develop streamlined, clinically accessible prediction tools capable of maintaining accuracy while reducing baseline assessment costs.