An estimated 2.5 million high school students suffered at least one concussion annually. Altitude has been a suggested modulator of concussion incidence and severity. Previous studies have found mixed results and have all used low cutoffs for high altitude (none > 284 meters).

In our current study, we explored how altitude modulates concussion incidence, severity, and recovery.

**METHODS:**

Data Collection:
25,815 ImPACT tests were performed for athletes aged 12-22 in Colorado (high altitude, 2070 meters mean elevation) and Florida (low altitude, 30 meters mean elevation).

Injuries were compared using ImPACT testing and a novel metric, Severity Index (SI). SI is defined as number of standard error differences at the 80% confidence interval (SdIf) from baseline for ImPACT composite scores. 

Figure 1: Incidence and Severity of Diagnosed Concussions are Lower at High Altitude

(A-B) Incidence of all head injuries and diagnosed concussions per 1,000 person years at high and low altitude. (C) Severity Index for all head injuries at the first post injury test (PI1) comparing high and low altitude. (D-G) Individual metrics composing severity index for all head injuries at PI1 expressed as 80% confidence intervals.

**RESULTS:**

- Incidence of head injury was 701.4/1000 person-years at high altitude and 498.1/1000 person-years at low altitude.
- Incidence of diagnosed concussion was 171.5/1000 person-years at high altitude and 206.7/1000 person-years at low altitude.
- High altitude injuries exhibited less severe SdIf values for all ImPACT composite scores and SI (p<0.0001).
- For diagnosed concussions, high altitude athletes showed less severe ImPACT composite scores for symptom score (p=0.0041), reaction time (p=0.0029), visual motor (p=0.0014), and SI (p=0.0012).
- In recovery analysis, high altitude showed more severe scores for post injury SI (p=0.0004), post injury percent concussed (p=0.0266), migraine (p<0.0001), cognition (p<0.0001), sleep (p<0.0001), neuropsychiatric (p<0.0001), processing speed (p<0.0001), and reaction time (p=0.0008).
- Kaplan-Meier plots showed slower recovery at high altitude for SI-12 (p=0.0210) and insignificant differences for both all concussions and SI-12.

**CONCLUSIONS:**

- High altitude has increased incidence of head injury, decreased incidence of concussion, and less severe ImPACT composite scores and SI.
- During recovery, high altitude has more severe post-concussion symptoms, ImPACT composite scores, and slower recovery for injuries with SI above 12.
- Future studies should increase location diversity to allow for generalization of findings.

**REFERENCES:**


[5] Kaplan Meier plots showed slower recovery at high altitude for SI-12 (p=0.0210) and insignificant differences for both all concussions and SI-12.