Full Impact: Physical, Cognitive, Behavioral, and Emotional Measures to Predict and Prevent Concussion and Traumatic Brain Injury (TBI)

**Research Goals:** Evaluate head impacts by integrating biomechanics and biomarkers measures with post-impact/longitudinal analysis of physical, cognitive, behavioral, and emotional measures to develop (1) predictive models of concussion and TBI risk; (2) prevention protocols; and (3) statistical relationships between head impact and brain disease/impairment across the lifespan.

**Current Research**

**Paratroopers**
Assess head impact attenuation characteristics of protective equipment to prevent concussion and TBI

Establish methodology for field-based head impact detection in U.S. Army Paratroopers (Texas and Georgia Army National Guards)

Provide real-time head impact data to assist U.S. Army Aeromedical Research Laboratory in mathematical modeling for protective gear to mitigate head movement experienced by paratroopers

**Athletes**
Study head impact biomechanics in martial arts training and competition

Evaluate associations among sport-related concussions, head impact biomechanics, sex, contact level (high, low, no), concussion history, and emotional dysregulation in athletes

**Research Resources**

**Currently Utilized Resources**

- 100 Triax Technologies SIM-G
- NOCSAE “drop tester” to assess impact attenuation abilities of protective helmets
- Custom material tensile testing apparatus
- Low and high velocity air-pressured rifles used for body armor and helmet ballistic impact testing

**Needed Resources & Collaborators**

- Head Impact Telemetry (HIT) System
- X2 Kinesia
- Collaborators to develop new measures for longitudinal study

**Biomarkers**

- Blood, serum, saliva plasma
- Blood, serum, plasma
- MRI, MRS, DTI
- Brain imaging
- Neurocognition
- Emotion dysregulation
- Emotional responses, and brain disease/impairment

**Brain Imaging**

- MRI, MRS, DTI

**Emotion Dysregulation**

- Emotion, behavior, affect

**Behavioral Measures**

- Player position, play type, body position at impact

**IMMEDIATE DATA**

**Biomechanics**

- Impact frequency, magnitude, location

**Biochemistry**

- Position at impact

**Pre/Post Data**

- Cognitive function, vision, coordination, balance

**Research Significance**

**Paratroopers**

- Improve accuracy in detecting potential training-related head impact injuries suffered by military paratroopers, resulting in better instruction on proper landing skills and more effective protective head gear

- Development of an emotion dysregulation-based injury prediction model for athletes that will allow coaches and healthcare providers to implement safety interventions to reduce injury incidence

- Application of these measures in post-injury and return to play assessments to: (1) improve short- and long-term health outcomes for athletes; (2) reduce the risk of returning athletes too early; and (3) assist in medical disqualifications for athletes when necessary

**Athletes**

- Relationships among accelerometer, head impact biomechanics, clinical measures, and behavior changes in 50 instrumented Texas State football players involving evaluation of videos with ~10,000 impacts (practices, games) and requiring over 1,000 research hours

- Causative associations between and among head impact, concussion, TBI, cognitive functioning, emotional response, and brain disease/impairment (e.g., dementia, Alzheimer’s, CTE) in a large sample of individuals followed from age 6 to death

**FUTURE RESEARCH**

**Paratroopers**

- Head impact magnitude characteristics of paratroopers and related improvements in protective helmet design

- Integration of appropriate field-based concussion and TBI detection protocols into military medical education programs

- Association between head impact magnitudes and other field-based physiological measures (e.g., eye tracking behavior)

**Athletes**

- Relationships among accelerometer, head impact biomechanics, clinical measures, and behavior changes in 50 instrumented Texas State football players involving evaluation of videos with ~10,000 impacts (practices, games) and requiring over 1,000 research hours