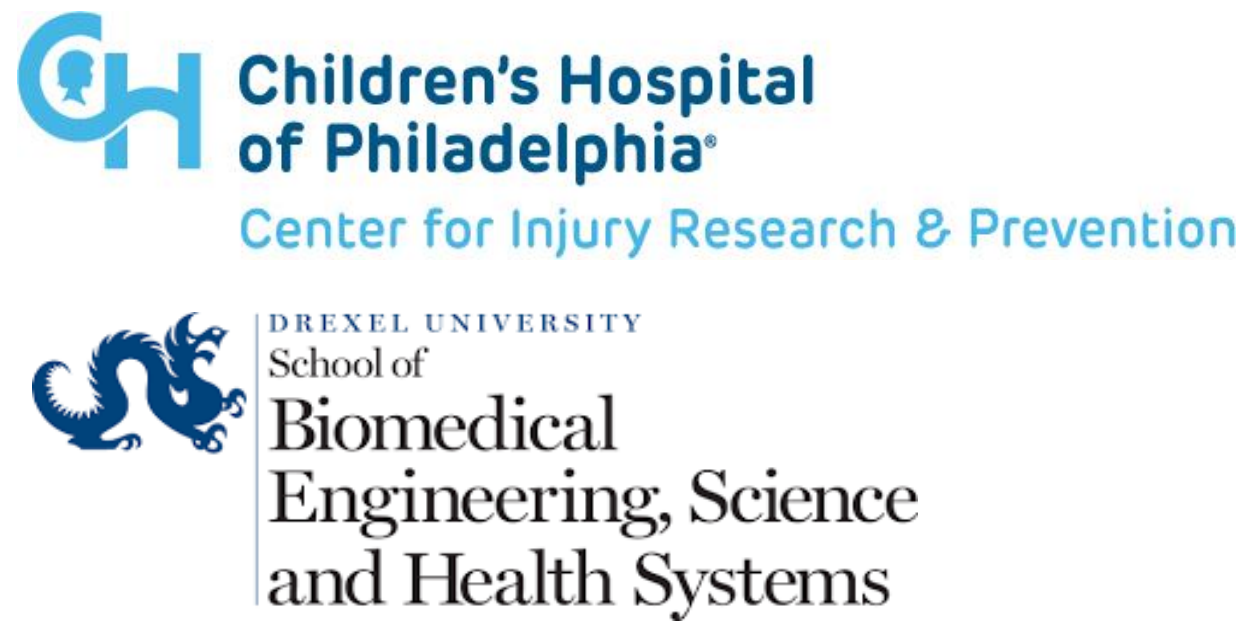


# THE RELATIONSHIP BETWEEN PAEB PULSES AND INJURY RISK IN CHILD, TEEN, AND ADULT PEDESTRIAN COLLISIONS

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## RATIONALE

- Pedestrian automatic emergency braking (PAEB) allows the vehicle to avoid a collision without the driver intervention.
- All new light vehicles must come equipped with AEB and PAEB systems by 2029 (FMVSS 127 NHTSA) → PAEB must avoid collisions during regulatory testing.
- However, in current vehicle model years on the road, PAEB still fails to avoid collisions in some conditions and pedestrian types.
- From 2029 we will have a mixed fleet equipped with PAEB systems with different efficacy.

Therefore, there is the need to understand injury risks in PAEB collisions.

## OBJECTIVE

To estimate the injury risk for pedestrians of different ages based on impact speed identified for different types of PAEB pulses involved in a collision.

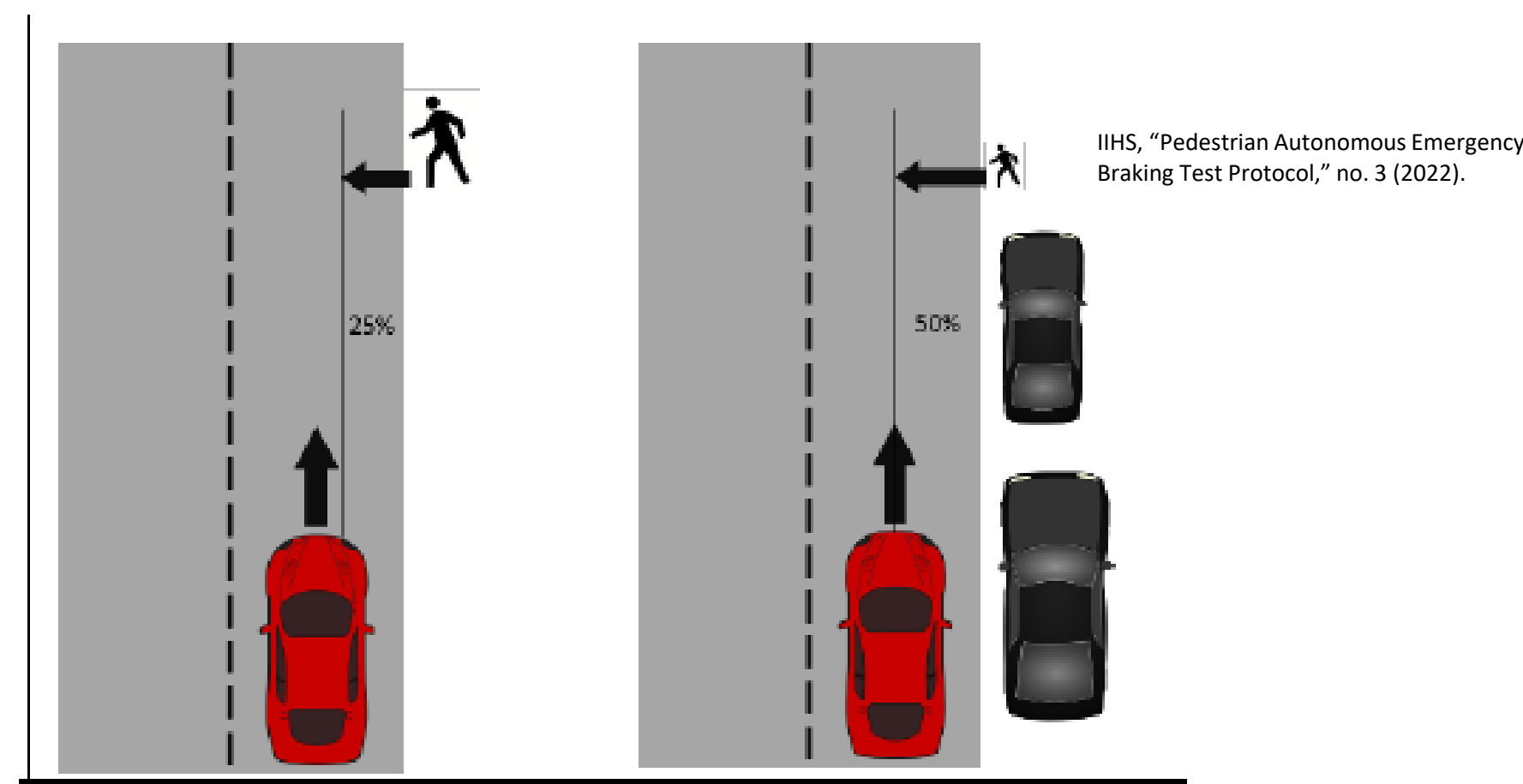
**AIM 1:** To categorize PAEB pulses resulting in collisions with a child and an adult pedestrian.

**AIM 2:** To identify the PAEB pulses associated with lower injury risk in collisions.

## METHODS

### AIM 1 approach

- 645 crossing child and adult PAEB evaluation tests from the IIHS (vehicle model years 2018-2023) resulted in a collision.



- PAEB tests conducted at 20 and 40 km/h without vehicles for the adult pedestrian and with parked vehicles for the child pedestrian.
- Machine learning (ML) k-mean categorization algorithm of PAEB pulses identified 2 clusters: C1 and C2.
- ML Features: impact speed, jerk, peak acceleration, pulse duration, ramp time, TTC, curb weight, vehicle model year, trial speed, vehicle classification, vehicle size, drive type.

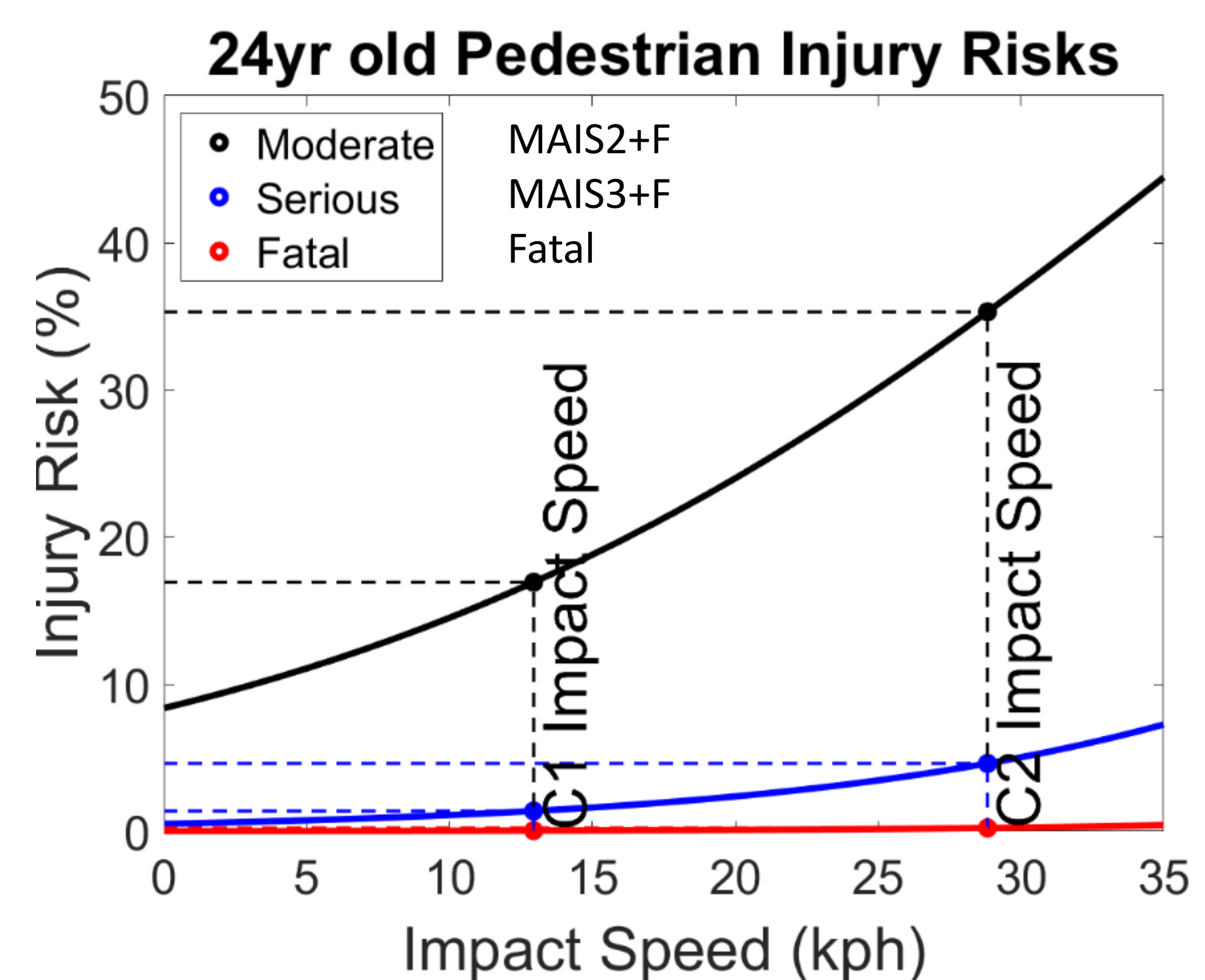
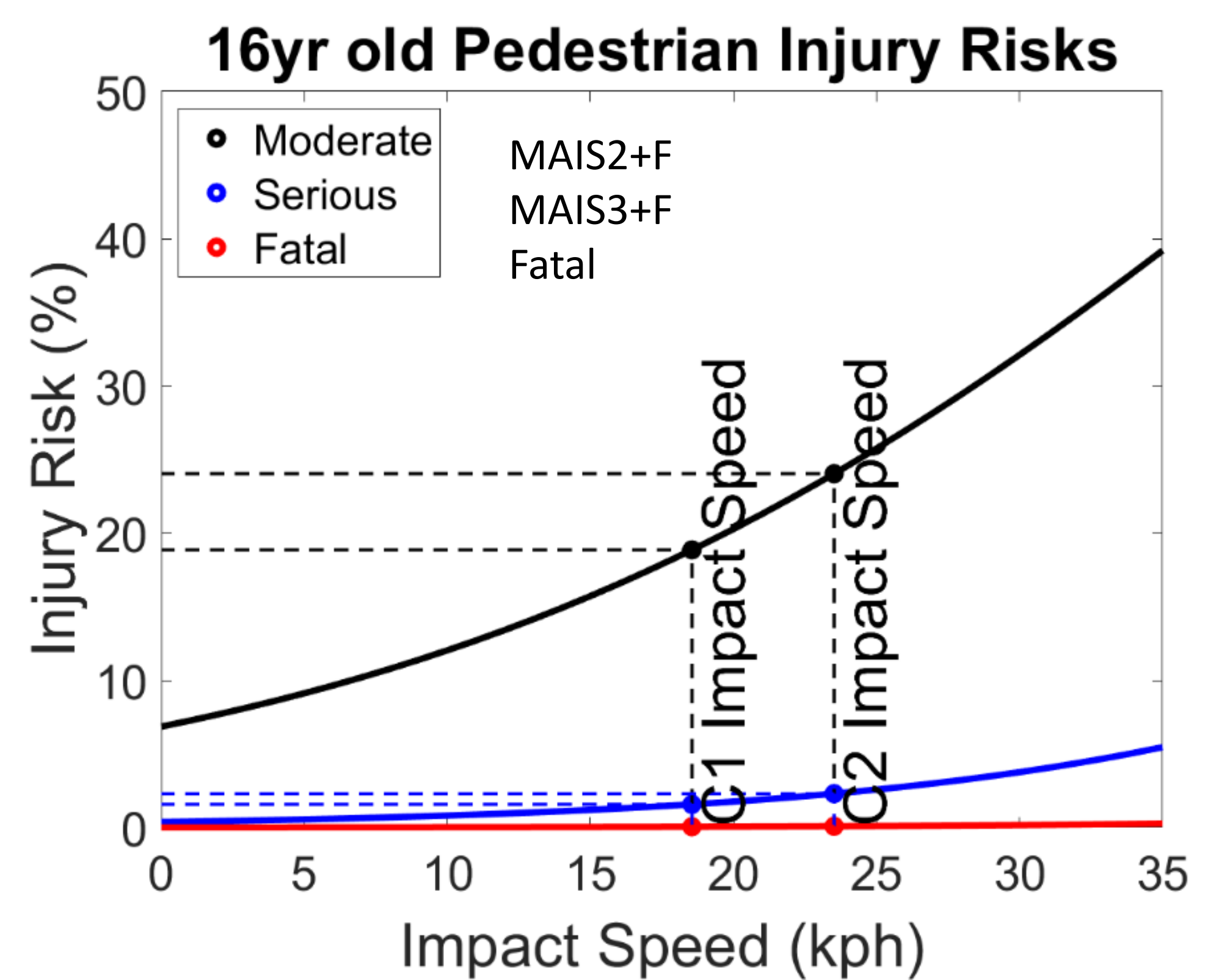
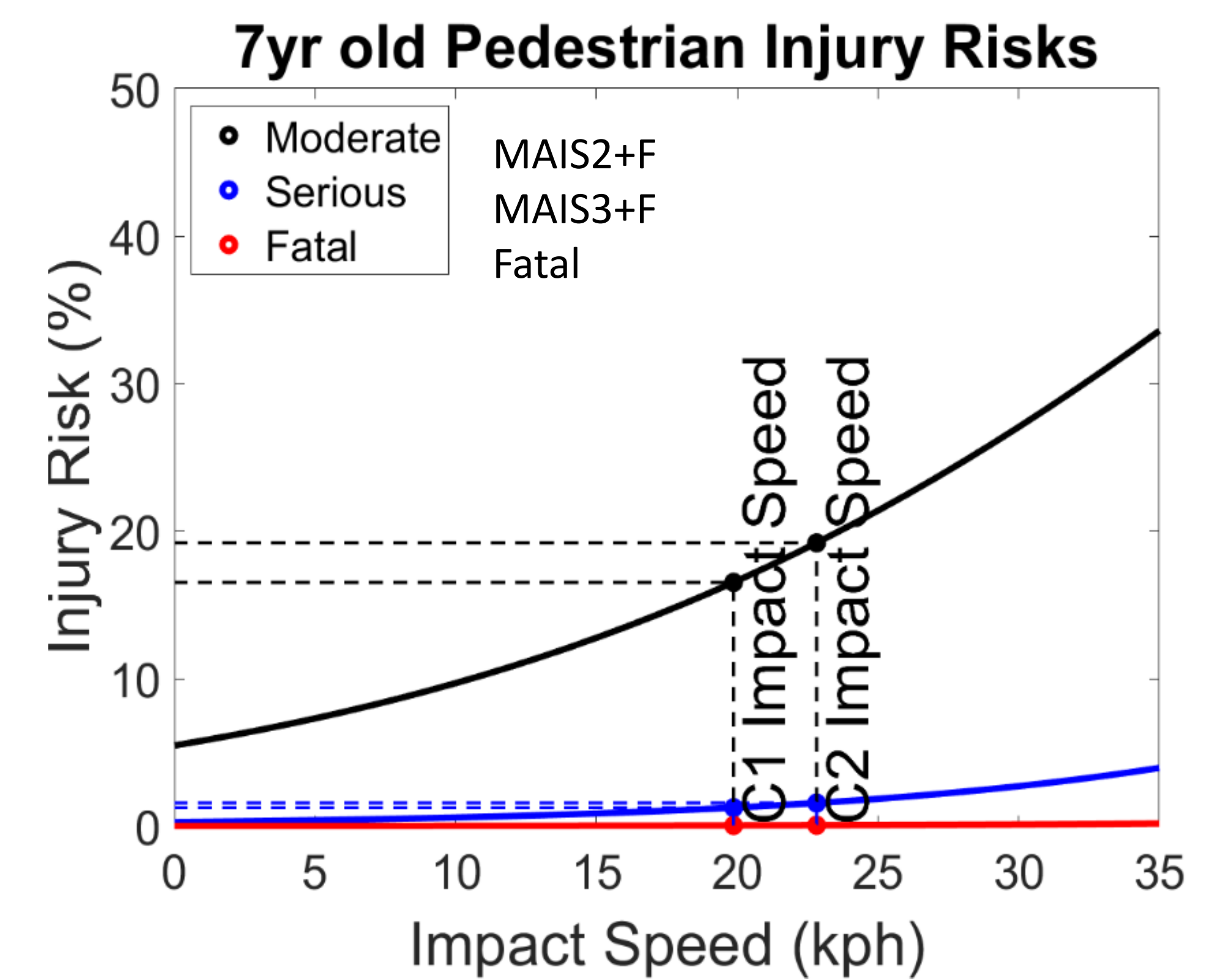
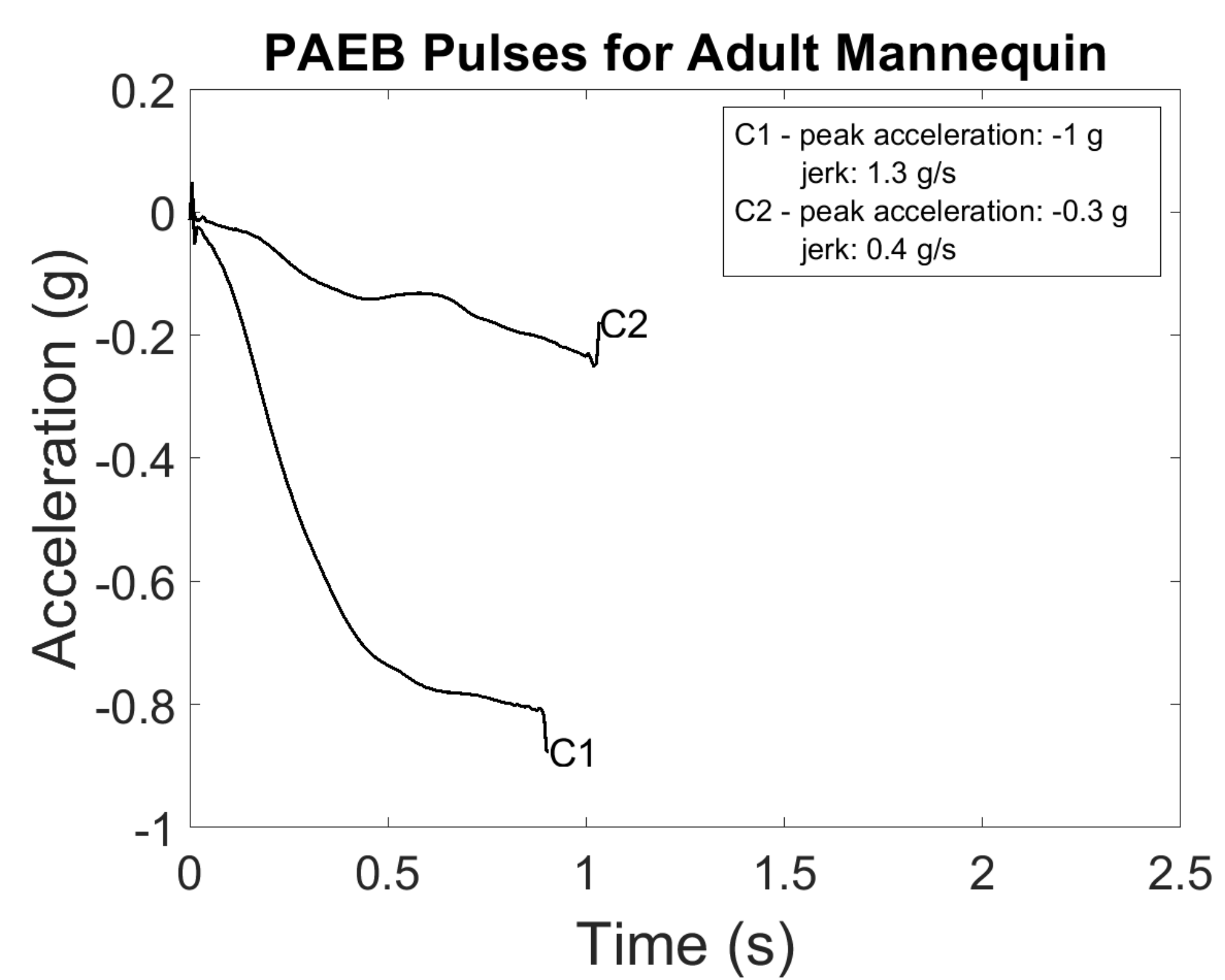
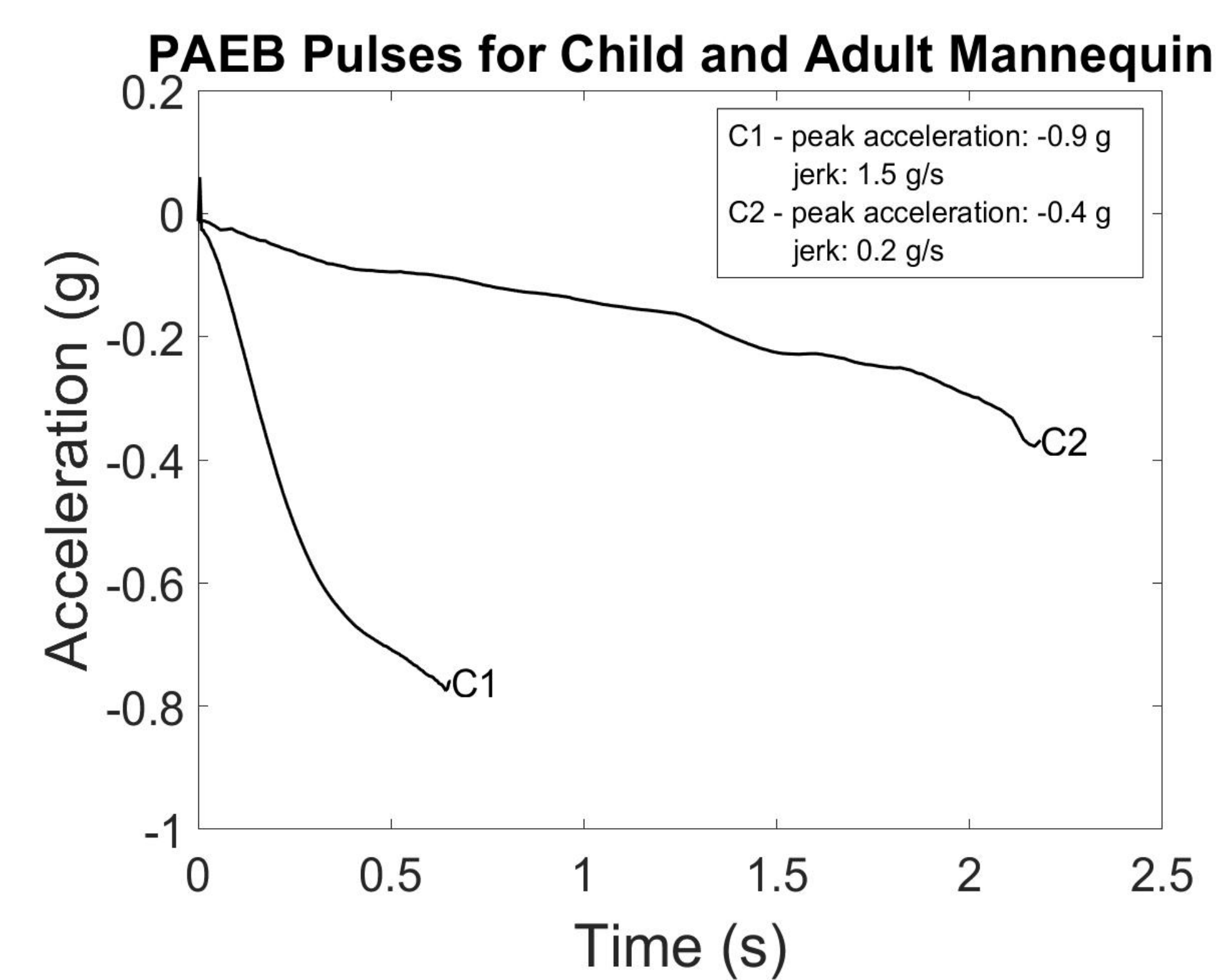
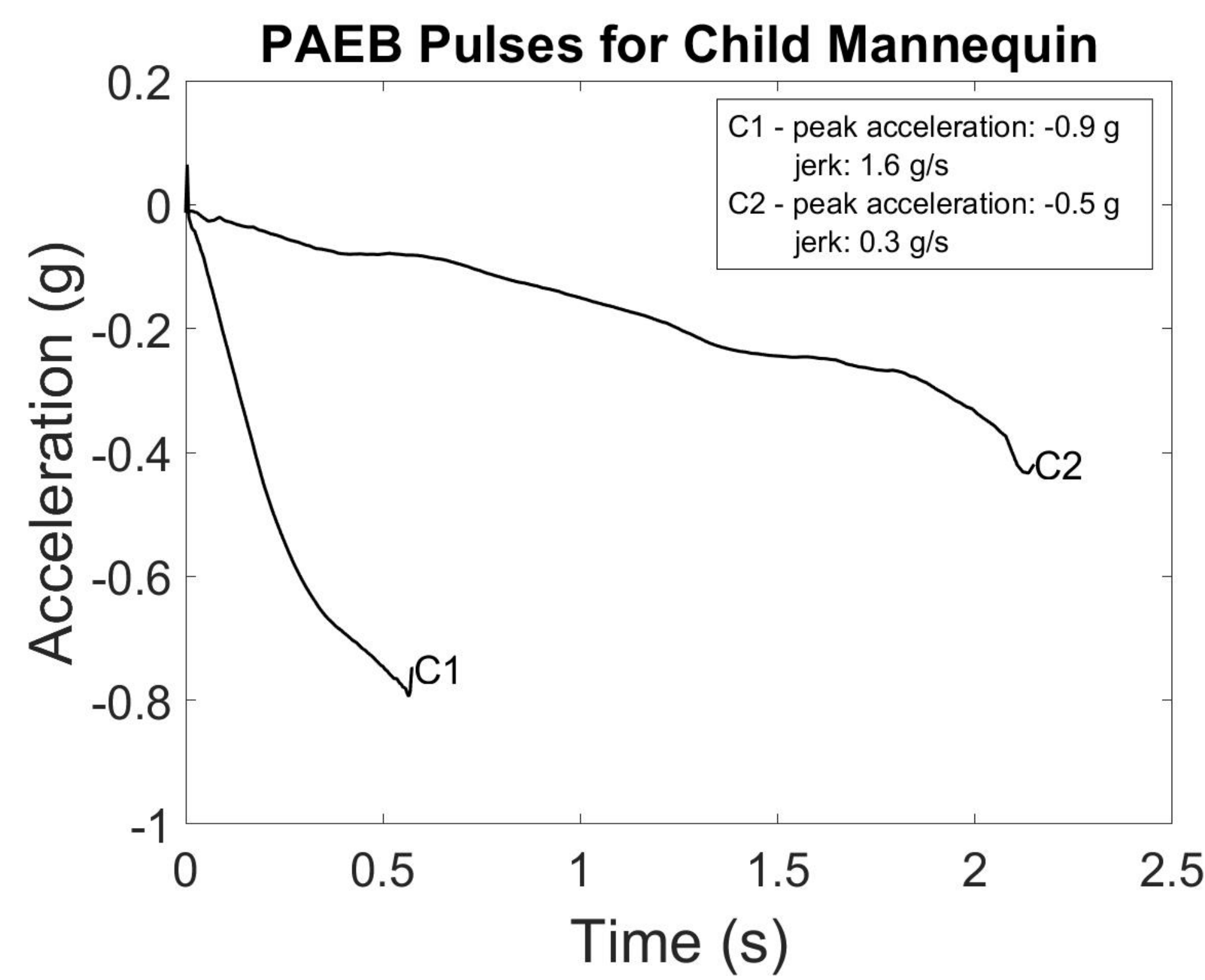
### AIM 2 approach

- Logistic Regression Equation to assess the percent of injury risk based on PAEB impact speed and pedestrian age based on GIDAS crash database (Lubbe et al. 2022).

$$P = \frac{e^{(\beta_0 + (\text{speed} * \beta_{\text{speed}}) + (\text{age} * \beta_{\text{age}}))}}{1 + e^{(\beta_0 + (\text{speed} * \beta_{\text{speed}}) + (\text{age} * \beta_{\text{age}}))}}$$

- Injury risk assessed for moderate, serious, and fatal injury for 7-, 16-, and 24-year-old pedestrians.

## RESULTS



### AIM 1 results

- PAEB C1 had greater acceleration and jerk and lower moderate risk across all ages than C2
- PAEB C2 had lower accelerations (0.3-0.5 g), lower jerk (0.2-0.4 g/s), and ramp time (1.0-2.4 s) and higher impact speed than C1.

### AIM 2 results

- Overall, severe to fatal injury risk was low (<5%); moderate injury risk was 16% to 35%.
- PAEB C2 was estimated to result in greater moderate injury risk for adults (35.3%) than teens (24.0%) and children (16.2%) but similar moderate injury risk for all age groups for PAEB C1.

## CONCLUSIONS

- PAEB pulses with lower acceleration and lower jerk (C2) were associated with greater impact speed and injury risk across all age groups and particularly in adults.
- PAEB pulses with high acceleration and high jerk (C1) led to more homogeneous risk of injury across all age groups, suggesting that those pulses were less dependent on pedestrian characteristics (i.e., age) and environmental scenarios (i.e., occlusion in the child testing).

### Limitations:

- Adults may have had a greater injury risk with C2 pulses than teens and children because the injury risk curves from Lubbe et al. were based on pedestrians with a median-age of 46 years old. C1 pulses may be less affected by this limitation.

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