

The relationship between injury risk for child, teen, and adult pedestrians in collisions preceded by PAEB activation and PAEB pulse characteristics.

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Introduction: The National Highway Traffic Safety Administration (NHTSA) will require Pedestrian Automatic Emergency Braking (PAEB) in all new cars by September 2029 (NHTSA 2024). However small, cases in which current PAEBs fail to avoid collisions still exists. Which brings forth the need to evaluate pedestrian injury in the event of PAEB failing to avoid a collision and potentially understand what type of PAEB pulses are associated with greater impact speed and therefore greater injury risk.

Objective: The goal of this study was 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.

Methodology: This study examined 645 PAEB pulses from controlled tests resulting in a collision in scenarios were a child (n=454) or an adult (n=191) pedestrian mannequin crossed into the path of an oncoming vehicle traveling 20 or 40 km/h. The tests were performed by the Insurance Institute of Highway Safety (IIHS) for various 2018-2023 model year vehicles. In this study, the PAEB pulses resulting in a collision were grouped based on the crash scenario: 1) a child pedestrian, 2) an adult pedestrian, and 3) any pedestrian type. A machine learning (ML) k-mean categorization algorithm was applied to all 3 groups using features such as: peak acceleration, jerk, impact speed, among others. The injury curves were created as a function of closing speed and road user age using a weighted binary logistic regression (Lubbe et al. 2022). Injury severities were based on the Abbreviated Injury Scale 2015 revision and included moderate (MAIS2+), serious (MAIS3+) and fatal. The representing impact speed of each cluster was used to estimate the injury risk percentage for pedestrians aged 7, 16, and 24-years-old for each moderate, serious and fatal injury risk curve.

Results: In each PAEB group, 2 clusters of PAEB pulses emerged from the ML analysis (6 total clusters). Severe to fatal injury risk estimated from the PAEB collision scenarios was low (<5%). Moderate injury risk ranged between 16% and 35% with adults showing greater risk (35.3%) than teens (24%) and children (16.2%). Children may have had a lower injury risk than teens and adults because the injury risk curves from Lubbe were based on real-world impacts with a 16-year-old or older pedestrian excluding younger children. The clusters of PAEB pulses with greater impact speed showed lower peak accelerations (0.30-0.49 g), lower jerk (0.21-0.44 g/s), and longer time from the start to peak braking, or ramp time (1.03-2.44 s) compared to clusters with lower impact speeds.

Conclusions: PAEB pulses with low peak acceleration and jerk, and longer ramp time were associated with greater impact speed and injury in pedestrians. Although early deceleration was associated with fewer collisions in PAEB tests (Kidd et al 2024), in cases where the collisions are not avoided these pulses may have the worse injury outcome for the pedestrians.

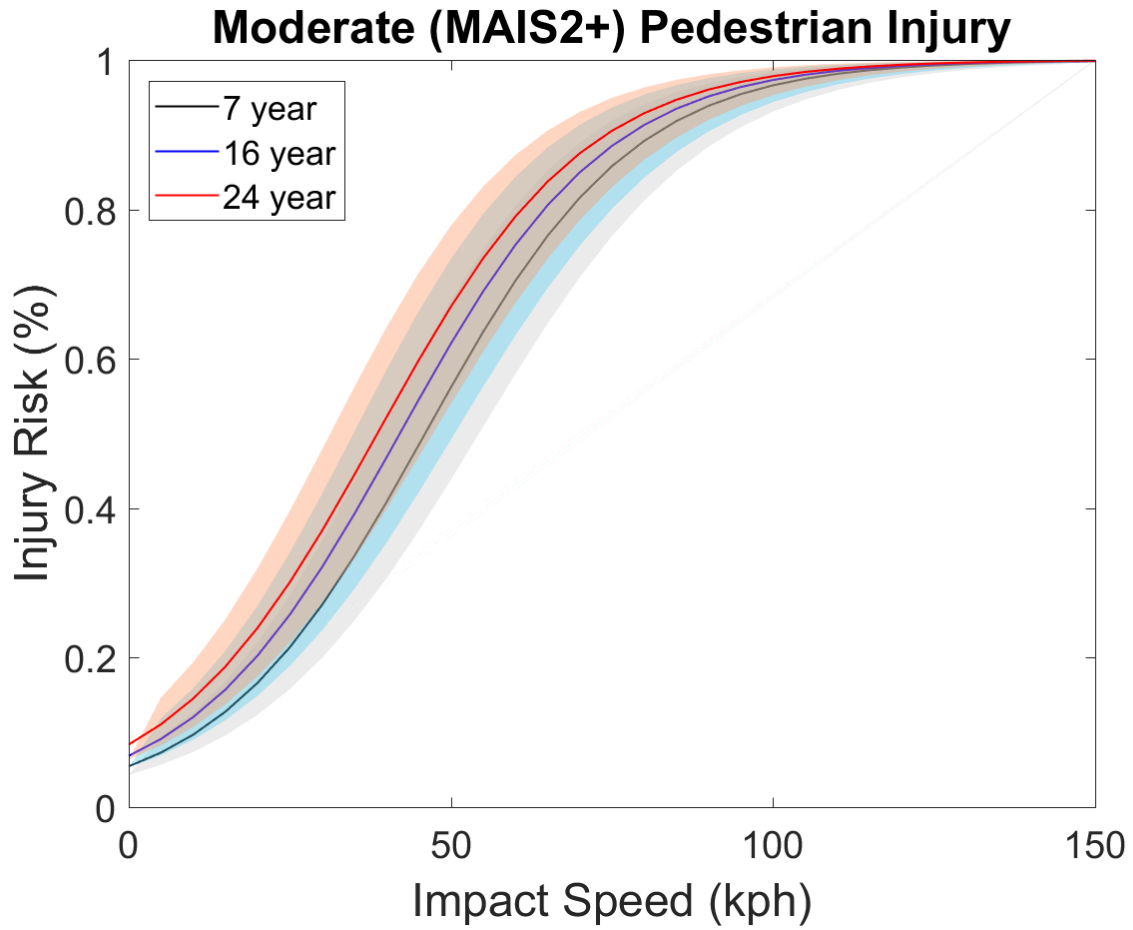


Figure 1. Moderate (MAIS2+) Pedestrian Injury Risks for 7-, 16-, and 24-year-old pedestrian when struck by a vehicle.