

Improving Safety for Older Children: Static and Dynamic Belt Fit Evaluation

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Lifesavers 2009

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Research Questions

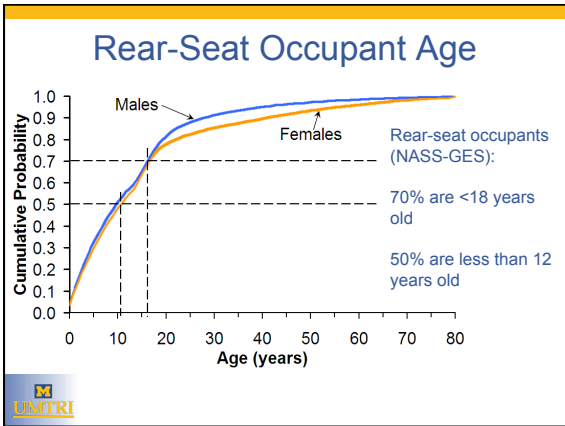
- How do three-point-belt anchorage locations affect static belt fit for children sitting on a vehicle seat and with a booster?
- How does booster design affect static belt fit for children with a wide range of body size?
- How do belt anchorage locations affect sled-test outcomes with the 10YO Hybrid-III ATD?
- How do belt routing features of boosters affect ATD outcomes?

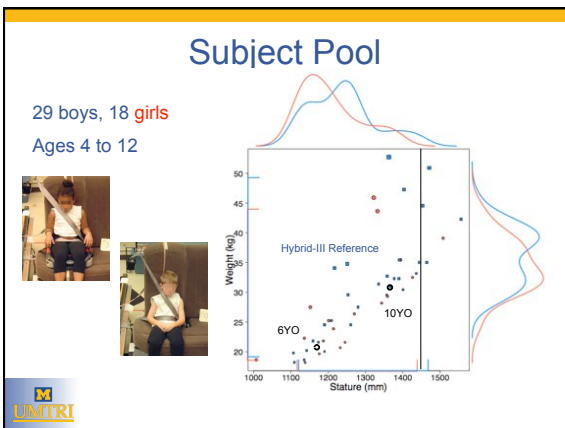


Rear-Seat Occupant Age

- Distribution of rear-seat occupant age from NASS-GES
- Statistical sample of U.S. tow-away crashes weighted to be nationally representative
 - Relevant data extracted for passenger cars, SUVs, and minivans

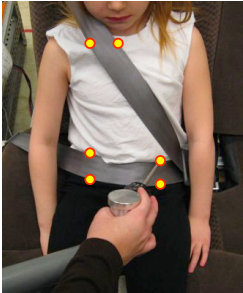




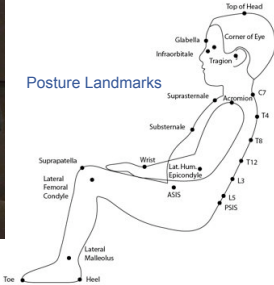





Digitized Landmarks



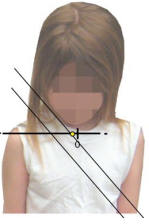
Belt-Fit Landmarks



Posture Landmarks

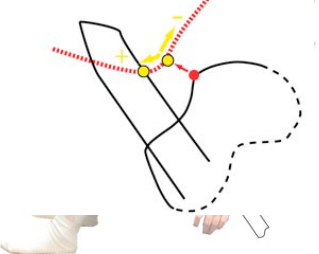



Calculating Belt Fit



Shoulder Belt Score: mm outboard of centerline

Lap Belt Score: mm "below" ASIS on sagittal contour





Qualitative Results: Boosters



Belt flat on lap



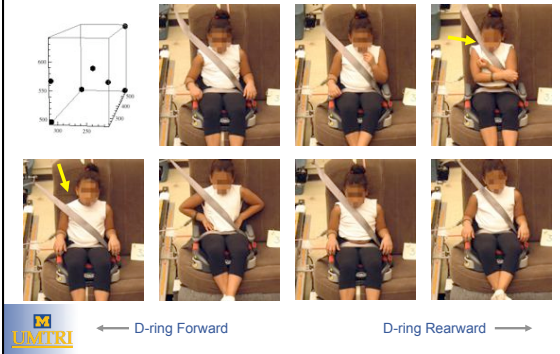
Belt on arm



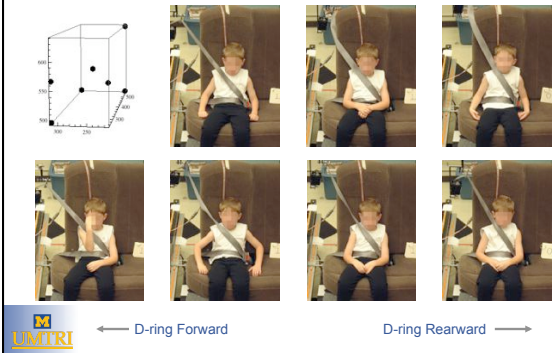
Belt on lower abdomen

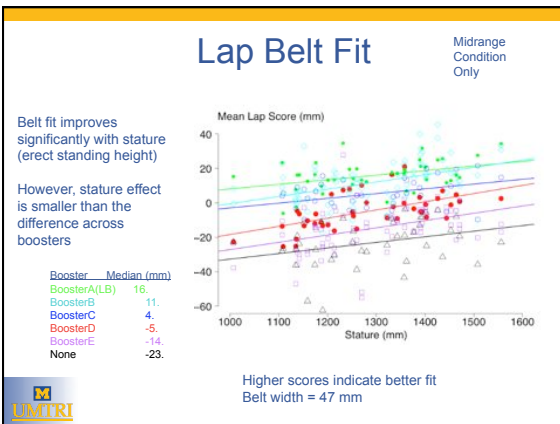


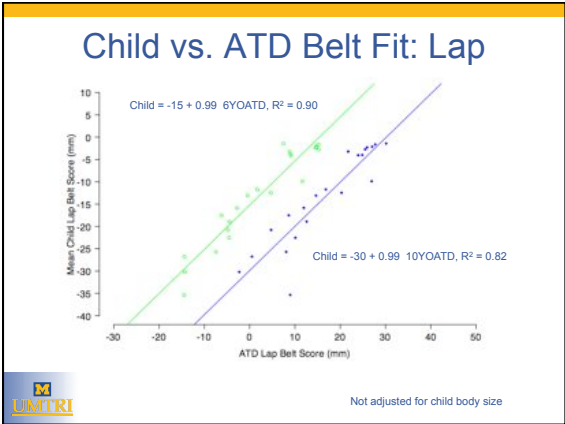
Qualitative Results: D-Ring Position

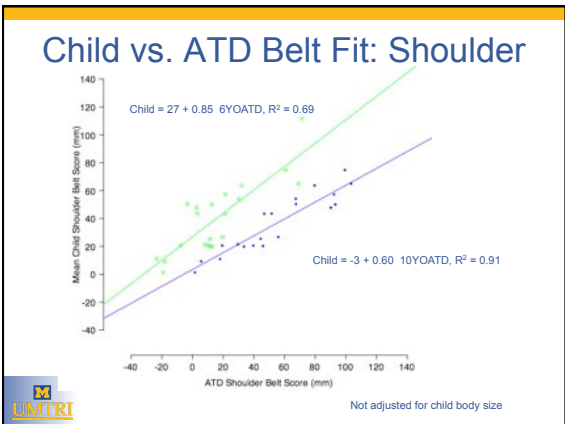


Qualitative Results: D-Ring Position









Sled Testing Objectives

- Develop methods for accurate, repeatable evaluation of restraint conditions for older children
- Evaluate ATD response to realistic belt geometries and belt fit
- Identify dependent measures that differentiate between good and poor restraint performance
- Relate ATD performance to static belt fit with children

UMTRI

Sled Test Conditions

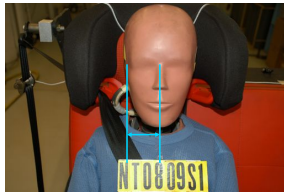
- Realistic lap belt tension of ~2 lb
- UMTRI seating procedure with three static drops to develop target head, hip, and belt locations for each dynamic test
- Two-piece fixed-length three-point belt
- Angular rate sensors in chest and pelvis



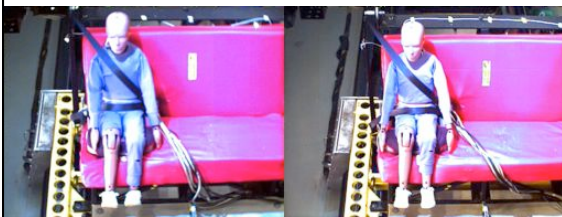
Torso Rollout

Shoulder belt score (SBS) is distance between ATD centerline and inboard edge of shoulder belt measured at height of base of neck

Rollout occurs when an outboard belt condition causes the belt to slip off of the shoulder



Good Kinematics vs. Rollout



SBS: 47 mm
Belt stays on shoulder

SBS: 90 mm
Belt slides off shoulder



Outcomes

- The data show **wide variation in the belt fit provided by boosters** -- some provide belt fit only slightly better than sitting without a booster
- **Booster designs should be improved** to perform as well as the best with respect to static belt fit
- **More attention should be paid to D-ring location**: good boosters can overcome poor lap belt geometry, but even highback boosters may not be able to keep the belt on the child's shoulder with an outboard D-ring location
- **Static belt fit is related to dynamic measures** obtained using ATDs.



Acknowledgments

This work was funded by NHTSA under contract number DTNH22-05-H-01020.

Laura Malik of the UMTRI Biosciences Division gathered the child belt fit data.