Characterizing Posture, Body Shape, and Belt Fit for Older Occupants

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The fraction of the population over age 65 is increasing rapidly in the U.S., Japan, and most other high-income countries.
Motivation

Older occupants are at increased risk of injury in crashes, particularly fractures in the thorax (ribs) and lower extremities.

From Rupp et al. SAE GI 2011 Presentation

Images from Nalla et al. (2004)
Motivation

Occupant shape, mass distribution, and posture affect injury potential in crashes.

Change in body shape with age at the same total body mass for midsize men and women (Example from UMTRI analysis of U.S. CAESAR Data)

Differences in posture and belt fit between young and old.
**Motivation**

Vehicle restraint systems are developed and tested using crash test dummies and computational models that represent specific occupant shapes and sizes.

<table>
<thead>
<tr>
<th>Dummy Specification</th>
<th>Hybrid III 95th %ile male</th>
<th>Hybrid III 50th %ile male</th>
<th>Hybrid III 5th %ile female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Population</td>
<td>6’3”, 271 lb.</td>
<td>5’9”, 189 lb</td>
<td>5’0”, 113 lb</td>
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*Dummy images from Humanetics*

*Current 5th, 50th, and 95th %ile weights from NHANES 2005-2006*

Midsize elderly male and midsize male and Hybrid III midsize male ATD in the same seat.
Research Questions

Questions

Do elderly drivers and passengers sit differently from younger drivers and passengers?

Are body shapes of elderly and younger occupants different at the same stature and body weight?

Do elderly occupants experience different belt fit in driving postures?

What Would Be Affected

Load-sharing between belts, airbags, and knee bolsters; patterns of injury across body regions

Amounts of soft tissue between belt and skeleton; load sharing between restraints, occupant kinematics

Belt loading could be changed by patterns of soft tissue shape and by elderly belt routing preferences
Research Objectives

1. Quantify differences in
   - posture
   - body shape
   - belt fit
   between young and old in driver and rear-seat passenger environments.

2. Create design and analysis tools: add “age” effect to:
   - vehicle interior design tools
   - crash-dummy-positioning methods
   - models of seated body shape
   - belt-fit prediction model
Participants

Study participants with a wide range of body size and age (N=200)

60% over age 60
Research Methods: Passenger Posture
Research Methods: Body Shape

- Standard anthropometry
- Whole-body laser scanner
- Additional landmarks with FARO Arm
- Standing and seated postures
Results – Body Scans

Hybrid-III ATD
Potential Application: Parametric Modeling

Example of torso shape modeling using statistical model from a previous study.

BMI 20
BMI 26
BMI 32
BMI 38

THUMS 4 - baseline
BMI 30
BMI 35
Acknowledgements

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http://www.toyota.com/csrc/

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