Child Occupant Posture and Belt Fit
Update: July 2004

Matthew P. Reed   Miriam A. Manary

Kathleen D. Klinich   Lawrence W. Schneider
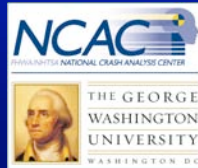
Trauma Link
The Interdisciplinary Pediatric Injury Control Research Center
The Children's Hospital of Philadelphia®
A pediatric healthcare network

NCAC
NATIONAL CRASH ANALYSIS CENTER
THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON DC

UMTRI
**University of Michigan
Transportation Research Institute**

Trauma Link
The Interdisciplinary Pediatric Injury Control Research Center
The Children's Hospital of Philadelphia®
A pediatric healthcare network

NCAC
NATIONAL CRASH ANALYSIS CENTER
THE GEORGE
WASHINGTON
UNIVERSITY
WASHINGTON DC

UMTRI
**University of Michigan
Transportation Research Institute**

Objectives

- Measure posture and belt fit for children from 40 to 100 lb with and without belt-positioning boosters

- Improve 6YO and 10YO ATD positioning procedures to better replicate child postures and restraint interactions

- Develop methods for predicting child belt fit from measures obtained with child ATDs

Child Occupant Posture and Belt Fit

Progress Since Last Update (January 2004)

- Completed laboratory testing with 62 children

- Verified data and began analysis

- Began measurements in test conditions with 3YO, 6YO, and 10YO ATDs (about 40% completed)

Child Occupant Posture and Belt Fit

Methods

- Laboratory mockup of three rear seats with adjustable back angles and belt geometry
- FARO Arm to measure body landmark locations
- Electronic inclinometer to measure pelvis orientation

Child Occupant Posture and Belt Fit

Methods: Vehicle Seats

- Taurus, Grand Am, Caravan
- Chevrolet Venture integrated harness
- Adjustable back angles
- All tested at high seat heights (no foot contact with floor)
- Adjustable buckle location in Grand Am

Child Occupant Posture and Belt Fit

Methods: Child Restraints

Evenflo Rightfit

Cosco Combination

Britax Husky

Graco TurboBooster

Methods: Participants

- 62 children
- 40 to 100 lb (mostly 50 to 80 lb)
- Recruited by word of mouth, fliers, and newspaper ads
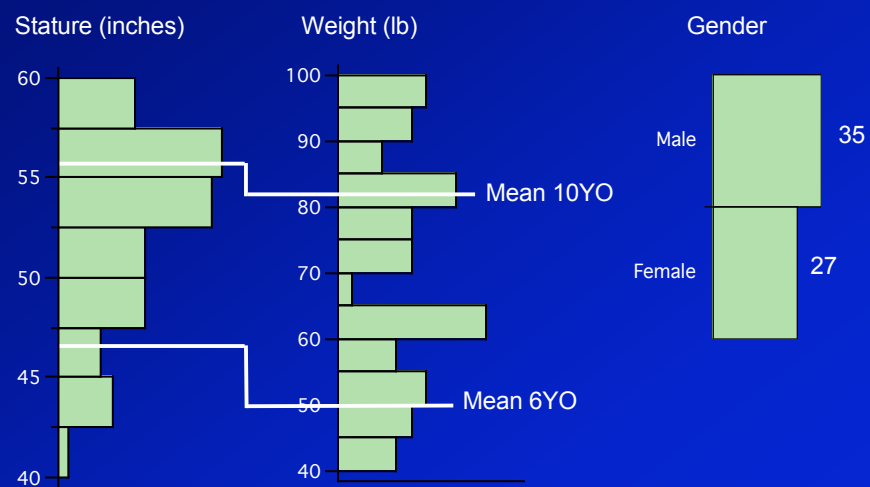- Additional contour measurements on 12 children near 6YO and 10YO ATD stature and weight

Methods: Standard Anthropometry

- Stature, sitting height, weight, limb lengths, etc.
- Widths and depths in auto posture (hardseat)
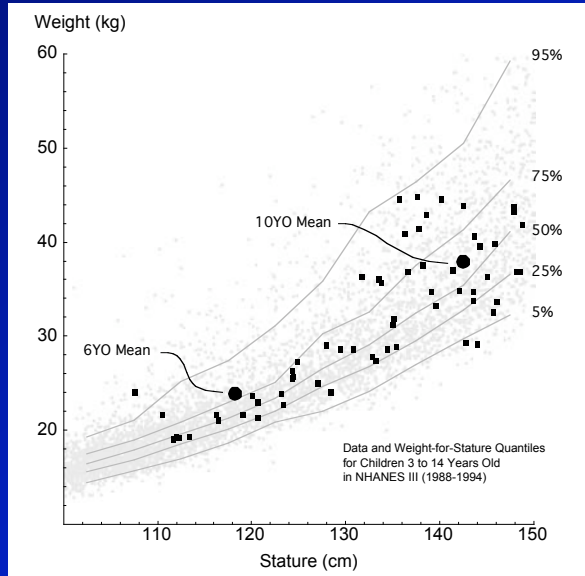
Child Occupant Posture and Belt Fit

Methods: Standard Anthropometry

Stature (inches) · Weight (lb) · Gender

Mean 10YO

Mean 6YO

Male 35

Female 27

Child Occupant Posture and Belt Fit

5

Methods: Standard Anthropometry

- Weight-for-stature distributed similarly to U.S. children
- Good distribution of weight around 10YO ATD size

Methods: Coordinate Data

- 3D landmark coordinate data gathered with FARO Arm

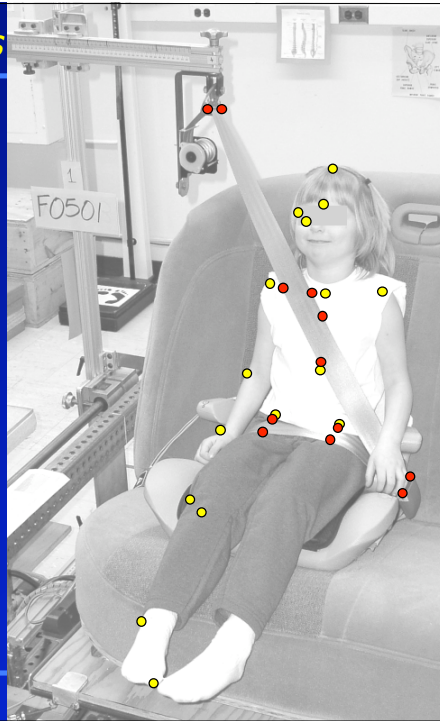
- Hardseat used to get detailed thorax and pelvis geometry

Methods: Digitized Landmarks

- Body landmarks (subset)
- Belt routing (subset)

Child Occupant Posture and Belt Fit

Methods: Test Matrix

20 trials in ~ 2 hours

12 trials in Taurus:
(no CRS, Evenflo) x
(comfortable, standard) x
(19, 23, 27 degree seatback angle)

2 trials in Taurus:
(Cosco, Graco) @ 23 degree seatback angle, standard posture

4 no-CRS trials:
Caravan @ 23 degrees
Grand Am @ 23 degrees x (low, medium, high buckle)

2 trials for children who fit:
Chevy Venture integrated, Britax harness in Taurus

Child Occupant Posture and Belt Fit

Methods: Posture/Belt Conditions

Comfortable:
- tested first
- child dons belt
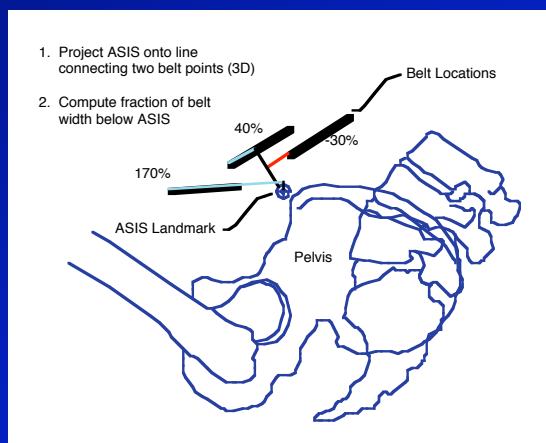- child selects posture

Standard:
- full rear on seat
- sagittally symmetric
- legs straight
- hands on thighs

Child Occupant Posture and Belt Fit

Preliminary Results: Belt Fit

Pelvis Belt Fit Metric:
   Fraction of belt
   "below" ASIS

1. Project ASIS onto line connecting two belt points (3D)

2. Compute fraction of belt width below ASIS

40%

30%

170%

Belt Locations

ASIS Landmark

Pelvis

Child Occupant Posture and Belt Fit

8

Belt Fit

- Belt fraction > 1 indicates belt fully below ASIS

- Pelvis belt fit in standard posture was significantly better with booster seats than without

- Evenflo and Graco had significantly higher fit scores than Cosco (both sides)

- Right-side fit generally better with tested configurations

Child Occupant Posture and Belt Fit

All Participants, Standard Posture, 23-degree Seatback Angle
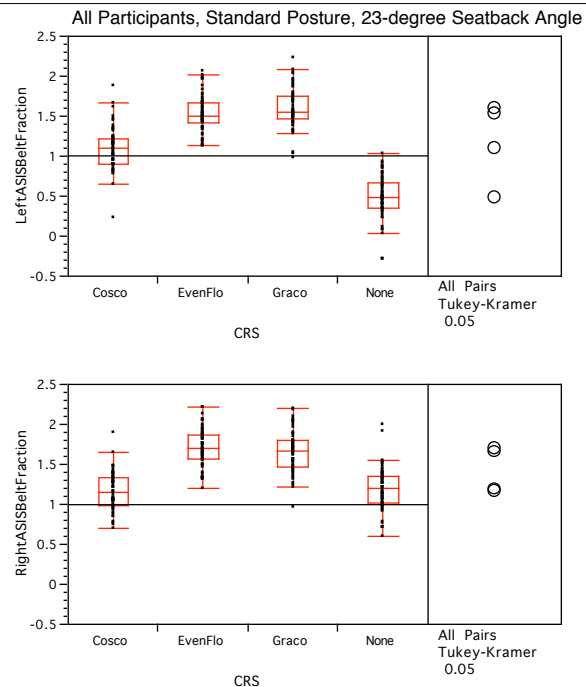
Belt Fit

- Pelvis belt fit without booster was poor (belt fit fraction < 1) even for larger children

- Pelvis belt fit was only slightly worse in Comfortable posture than in Standard posture

Child Occupant Posture and Belt Fit
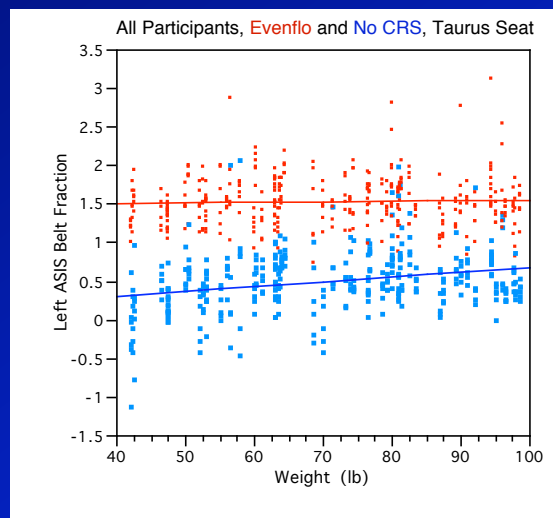
All Participants, Evenflo and No CRS, Taurus Seat

Stream Data

- Detailed contour data on 12 participants similar in size to 6YO and 10YO ATDs
- Anterior contours in hardseat, focusing on abdomen and lap/torso belt regions
- Belt and contours in Taurus
- Concurrent measurement of skeletal reference landmarks
- Primarily applicable to ATD design
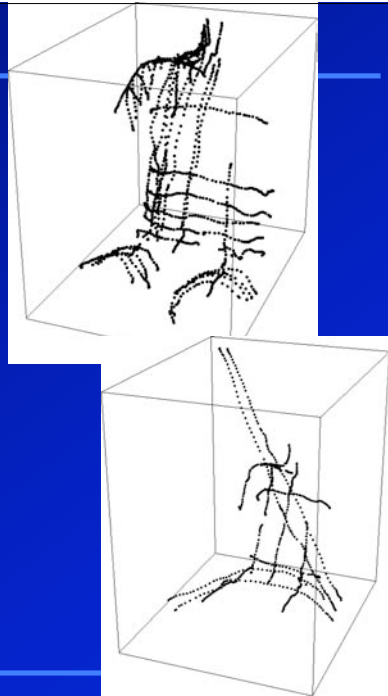
Child Occupant Posture and Belt Fit

ATD Testing

- Installing 3YO, 6YO, and 10YO Hybrid-III in each applicable test condition

- FMVSS 213 and as-tested-with-children belt tension

- Digitizing analogous landmarks
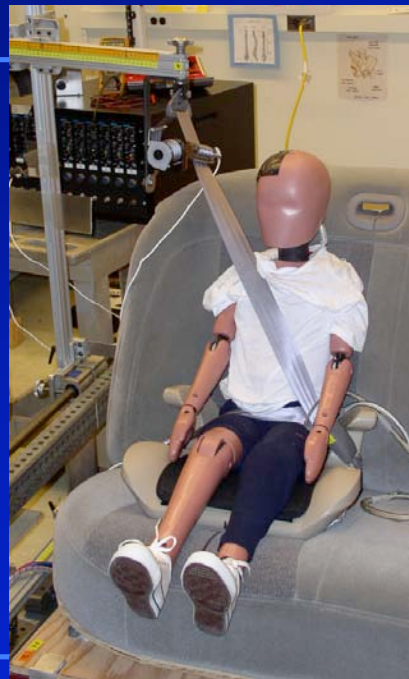
Child Occupant Posture and Belt Fit

Next Steps

- Continue to analyze data

- Complete ATD installations using standard installation procedures

- Compare ATD and human belt fit: predict human belt fit from ATD measures?

- Develop alternative ATD installation procedure for 6YO and/or 10YO, if justified by results

- Final report and articles/papers

Child Occupant Posture and Belt Fit