Equality across transport modes – vehicle design

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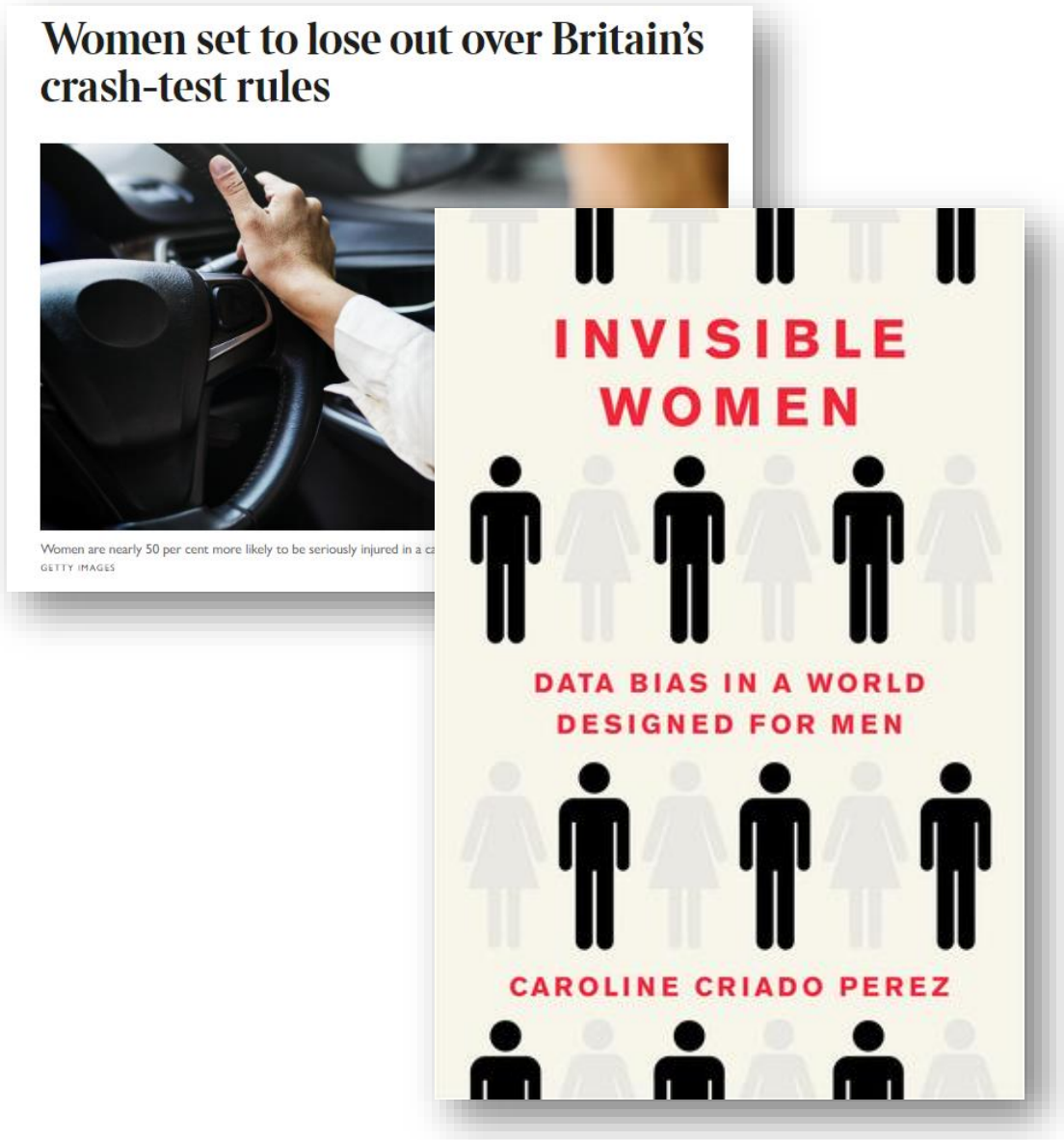
Thatcham Research
SAFER CARS. FEWER CRASHES

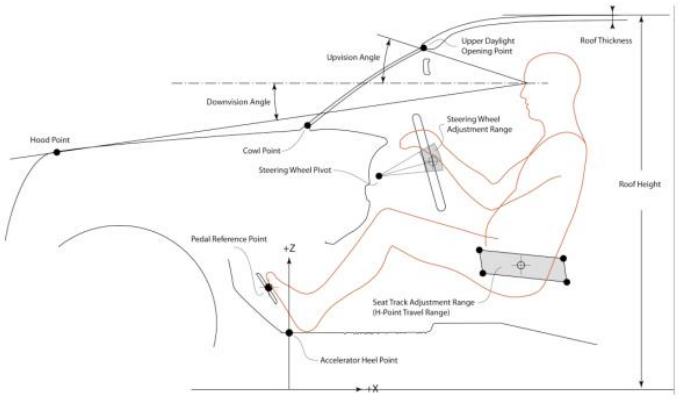
Current Issues

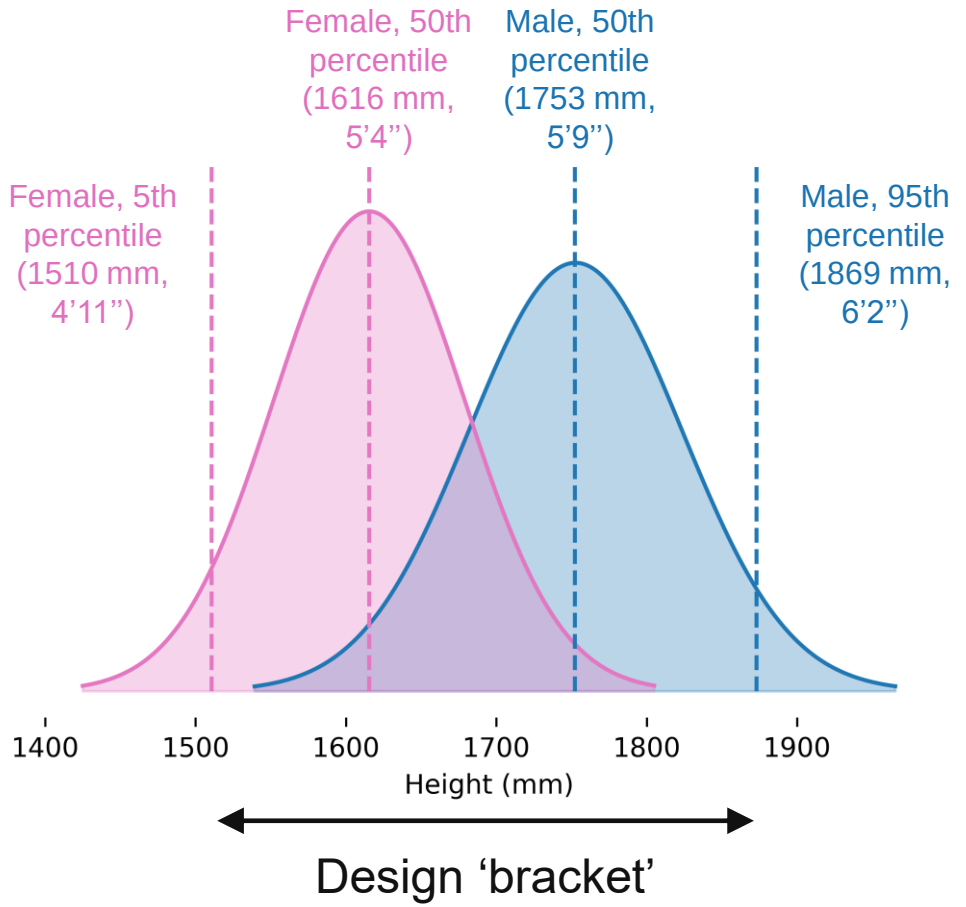
- *“if a woman is involved in a car crash, she is 17 per cent more likely to die, and 73 per cent more likely to be injured than a man in the same crash”*
- GSR 2 – Brexit and the adoption of safety equity measures



Design Consideration

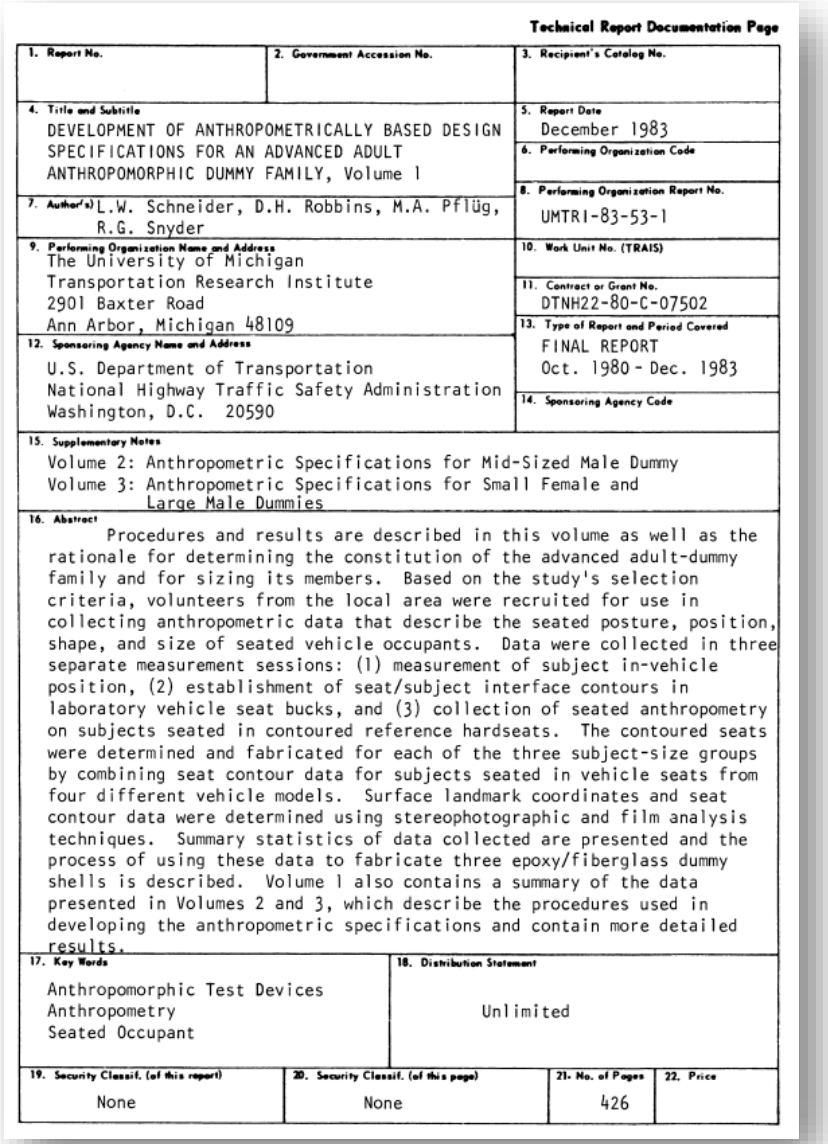
- Variation of physical attributes like size, shape, mass, strength etc. is a critical consideration in the design of vehicles
- Test devices (dummies) are tools to evaluate restraint systems and interior designs with respect to contact areas and injury potential of interior components
- Critical dummy dimensions are **mass** and **size**





ATD Family

- U.S. DOT contract, 1980-83
- Define realistic human automotive seating positions
- Determine the anthropometric specifications for members of the advanced dummy family
- Four-member dummy family recommended as optimal based on height and weight values of U.S adults:
  1. Small female, 5th percentile
  2. Mid-sized female, 50th percentile
  3. Mid-sized male, 50th percentile
  4. Large male, 95th percentile



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Volume 2: Anthropometric Specifications for Mid-Sized Male Dummy
Volume 3: Anthropometric Specifications for Small Female and Large Male Dummies

16. Abstract

Procedures and results are described in this volume as well as the rationale for determining the constitution of the advanced adult-dummy family and for sizing its members. Based on the study's selection criteria, volunteers from the local area were recruited for use in collecting anthropometric data that describe the seated posture, position, shape, and size of seated vehicle occupants. Data were collected in three separate measurement sessions: (1) measurement of subject in-vehicle position, (2) establishment of seat/subject interface contours in laboratory vehicle seat bucks, and (3) collection of seated anthropometry on subjects seated in contoured reference hardseats. The contoured seats were determined and fabricated for each of the three subject-size groups by combining seat contour data for subjects seated in vehicle seats from four different vehicle models. Surface landmark coordinates and seat contour data were determined using stereophotographic and film analysis techniques. Summary statistics of data collected are presented and the process of using these data to fabricate three epoxy/fiberglass dummy shells is described. Volume 1 also contains a summary of the data presented in Volumes 2 and 3, which describe the procedures used in developing the anthropometric specifications and contain more detailed results.

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ATD Family

Small female,
5th percentile

Mid-sized male,
50th percentile

Large-sized male,
95th percentile

Euro NCAP Assessments

Adult Occupant assessments:

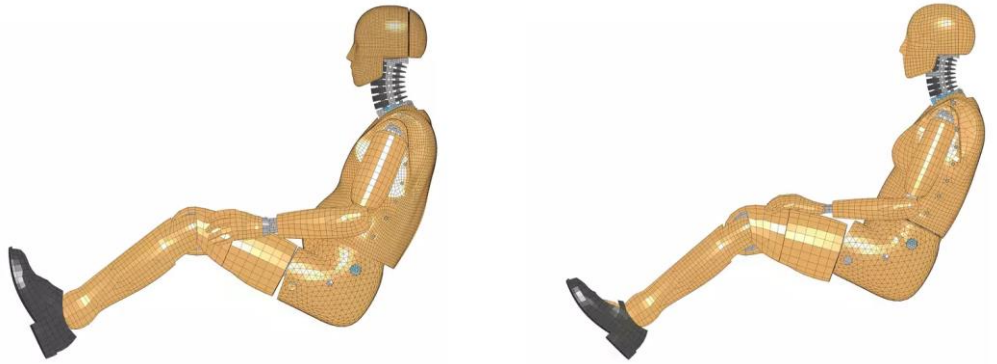
- Mobile Progressive Deformable Barrier (THOR-50M, HIII 50M)
- **Full-Width Rigid Barrier (HIII 5F x2)**
- Side Mobile Barrier (WorldSID 50M)
- Side Pole (WorldSID 50M)
- Far-Side Impact (WorldSID 50M)
- Whiplash (BioRID 50M)
- [Rescue and Extrication]

Assessment Tools

Autonomous Vehicle ATDs – THOR-AV-5F, THOR-AV-50M

Elderly ATD – 50F, 70y/o

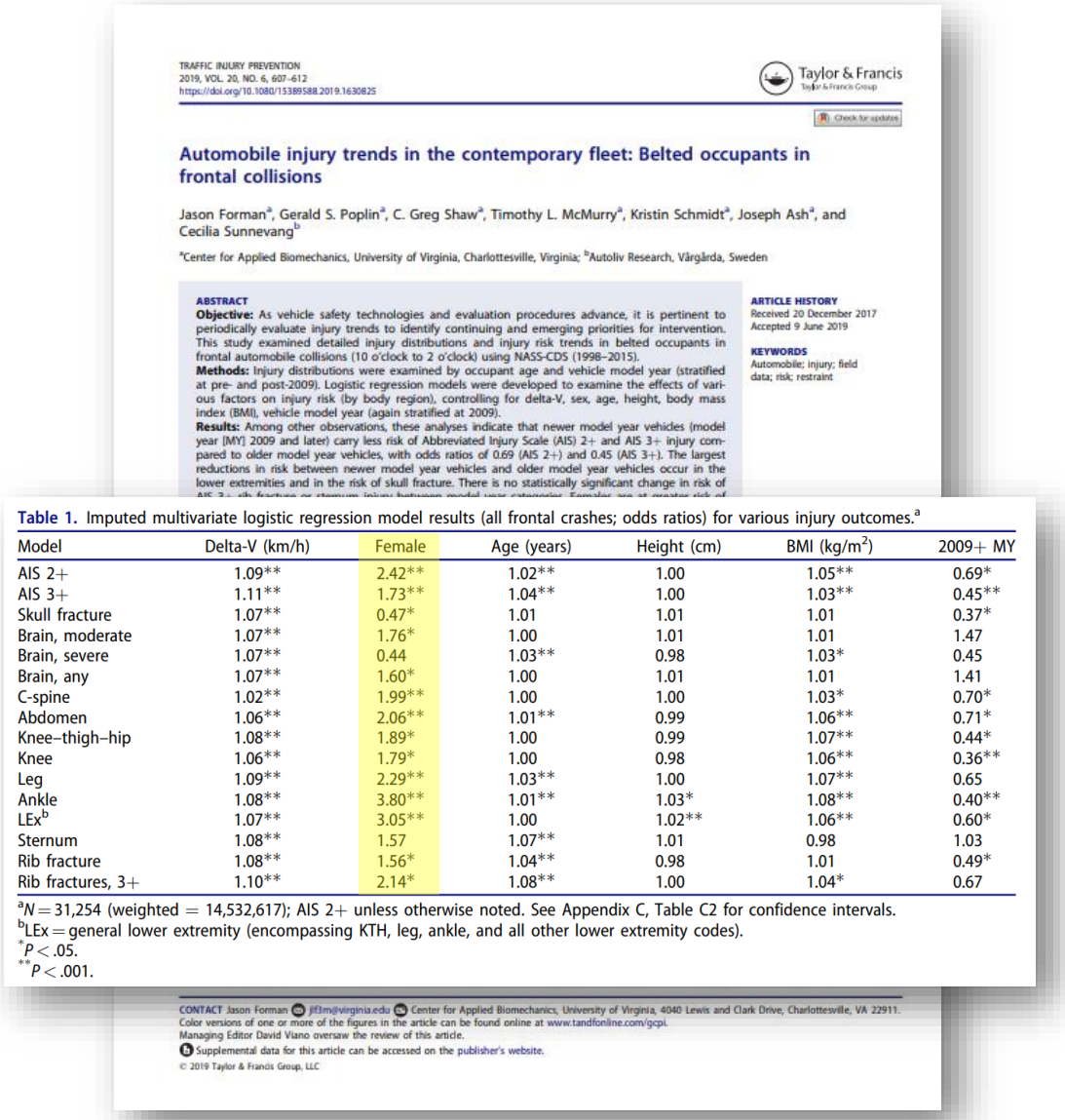
Obese ATD – THOR-50M @ 124kg



BioRID-II and EvaRID Finite Element (FE) models

Real-world data

- University of Virginia, 2019
- Belted frontal occupants
- Control for occupant factors, estimated crash severity and vehicle model year as safety proxy
- Female injury risk compared to male:
  - Serious injury +73%
  - Moderate injury +142%
  - Greatest difference – Lower Extremity injuries



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Automobile injury trends in the contemporary fleet: Belted occupants in frontal collisions

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ABSTRACT

Objective: As vehicle safety technologies and evaluation procedures advance, it is pertinent to periodically evaluate injury trends to identify continuing and emerging priorities for intervention. This study examined detailed injury distributions and injury risk trends in belted occupants in frontal automobile collisions (10 o'clock to 2 o'clock) using NASS-CDS (1998–2015).

Methods: Injury distributions were examined by occupant age and vehicle model year (stratified at pre- and post-2009). Logistic regression models were developed to examine the effects of various factors on injury risk (by body region), controlling for delta-V, sex, age, height, body mass index (BMI), vehicle model year (again stratified at 2009).

Results: Among other observations, these analyses indicate that newer model year vehicles (model year [MY] 2009 and later) carry less risk of Abbreviated Injury Scale (AIS) 2+ and AIS 3+ injury compared to older model year vehicles, with odds ratios of 0.69 (AIS 2+) and 0.45 (AIS 3+). The largest reductions in risk between newer model year vehicles and older model year vehicles occur in the lower extremities and in the risk of skull fracture. There is no statistically significant change in risk of

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Automobile; injury; field data; risk; restraint

Table 1. Imputed multivariate logistic regression model results (all frontal crashes; odds ratios) for various injury outcomes.[a]

Model	Delta-V (km/h)	Female	Age (years)	Height (cm)	BMI (kg/m^2)	2009+ MY
AIS 2+	1.09**	2.42**	1.02**	1.00	1.05**	0.69*
AIS 3+	1.11**	1.73**	1.04**	1.00	1.03**	0.45**
Skull fracture	1.07**	0.47*	1.01	1.01	1.01	0.37*
Brain, moderate	1.07**	1.76*	1.00	1.01	1.01	1.47
Brain, severe	1.07**	0.44	1.03**	0.98	1.03*	0.45
Brain, any	1.07**	1.60*	1.00	1.01	1.01	1.41
C-spine	1.02**	1.99**	1.00	1.00	1.03*	0.70*
Abdomen	1.06**	2.06**	1.01**	0.99	1.06**	0.71*
Knee–thigh–hip	1.08**	1.89*	1.00	0.99	1.07**	0.44*
Knee	1.06**	1.79*	1.00	0.98	1.06**	0.36**
Leg	1.09**	2.29**	1.03**	1.00	1.07**	0.65
Ankle	1.08**	3.80**	1.01**	1.03*	1.08**	0.40**
LEx[b]	1.07**	3.05**	1.00	1.02**	1.06**	0.60*
Sternum	1.08**	1.57	1.07**	1.01	0.98	1.03
Rib fracture	1.08**	1.56*	1.04**	0.98	1.01	0.49*
Rib fractures, 3+	1.10**	2.14*	1.08**	1.00	1.04*	0.67

[a]$N = 31{,}254$ (weighted = 14,532,617); AIS 2+ unless otherwise noted. See Appendix C, Table C2 for confidence intervals.
[b]LEx = general lower extremity (encompassing KTH, leg, ankle, and all other lower extremity codes).
*$P < .05$.
**$P < .001$.

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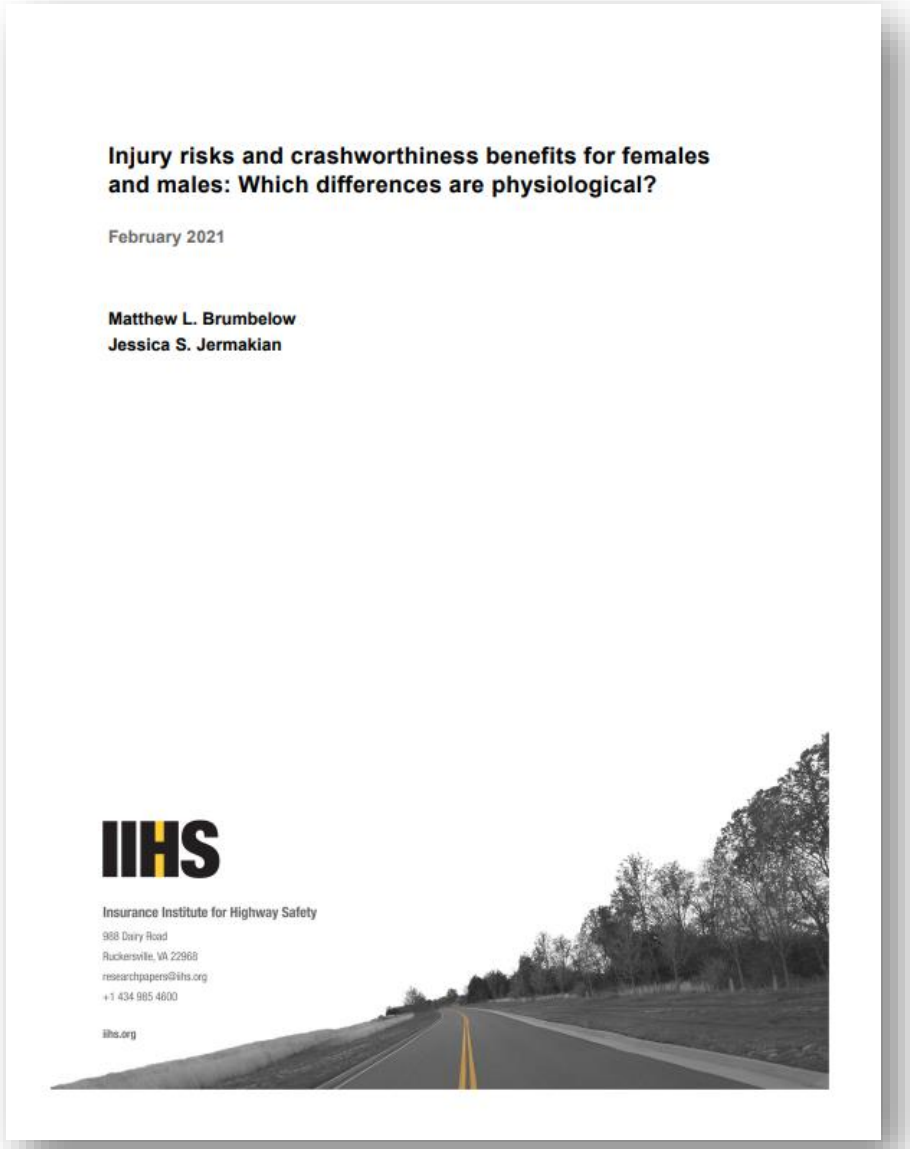
Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/gcpi.
Managing Editor David Viano oversaw the review of this article.
Supplemental data for this article can be accessed on the publisher's website.

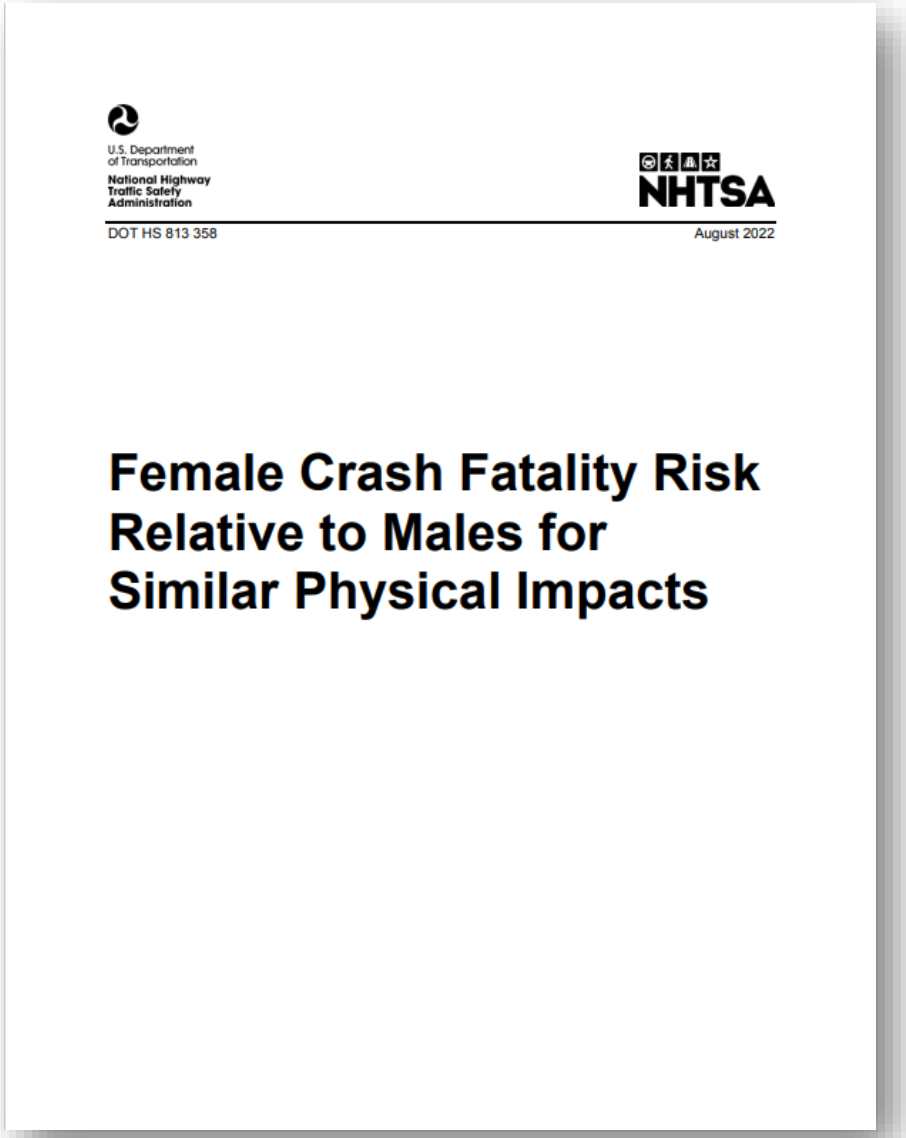
Real-world data

- IIHS, 2021
- Belted drivers in frontal crashes
- Control for occupant factors, vehicle factors, accident type
- Female injury risk compared to male:
  - All frontal impacts – Serious + 45%, Moderate +123%
- Injury risk for ‘Good’ rated vehicles vs. other vehicles:
  - Moderate, Male -21%, Female -32%
  - Serious, Male +6%, Female -46%



Real-world data

- NHTSA, 2022
- Female fatality risk compared to male fatality risk is reduced in newer vehicles
  - 18.3% higher risk for women for model year 1960-2009 vehicles
  - 6.3% for model year 2010-2020
  - 2.9% for model year 2015-2020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Female Crash Fatality Risk Relative to Males for Similar Physical Impacts

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