5^{th} vs 50^{th}
Results of 56 KMPH Crash Tests

National Highway Traffic Safety Administration

NHTSA Public Meeting

Baltimore, MD.

July 18, 2002

Outline

- Motivation
- Test Set Up
- Injury Test Results
  - Driver Dummy
- Discussion
- Conclusion

Motivation

- Previous testing at speed of 48 KMPH (30 MPH) with the 5th percentile showed that the 5th had greater loads than the 50th.
- Performance data on the 5th percentile in a 56 KMPH (35 MPH) full frontal barrier crash was lacking.
- Congress provided funds for NHTSA to investigate

Previous Paired Testing with 5th Percentile Dummy

- 1998 – NHTSA and Transport Canada tested the 5th percentile dummy and the 50th percentile dummy in paired 48 KMPH (30 MPH) belted full-frontal crash tests.
  - 5th percentile dummy experienced increased injury measures to the neck and tibia compared to the 50th percentile dummy.

Dalmotis, D, et al., "Assessments of Air Bag Performance Based on the 5th Percentile Female Hybrid III Crash Test Dummy," 16th ESV, 1998.

Vehicle Matrix

Vehicle Size	Model	Driver and Passenger		
		Air Bag Inflator Type	Load Limiter	Pretensioner
Light	Civic 4 dr	Dual Stage	✓	✓
	Sentra	Single Stage	✓	✓
Compact	Echo	Single Stage	✓	✓
Medium	Maxima	Dual Stage	✓	✓
	Accord	Dual Stage	✓	✓
	Impala	Dual Stage	✓	
SUV	Escape	Single Stage	✓	✓
	Durango	Single Stage	✓	✓
Minivan	Grand Caravan	Multi-Stage	✓	✓
	Windstar	Dual Stage	✓	✓

Test Procedure

- Frontal NCAP laboratory procedure
  - Vehicle weight--modified
  - Seating procedure--modified
  - Dummy paint locations--modified
  - Calibration

HIC 15

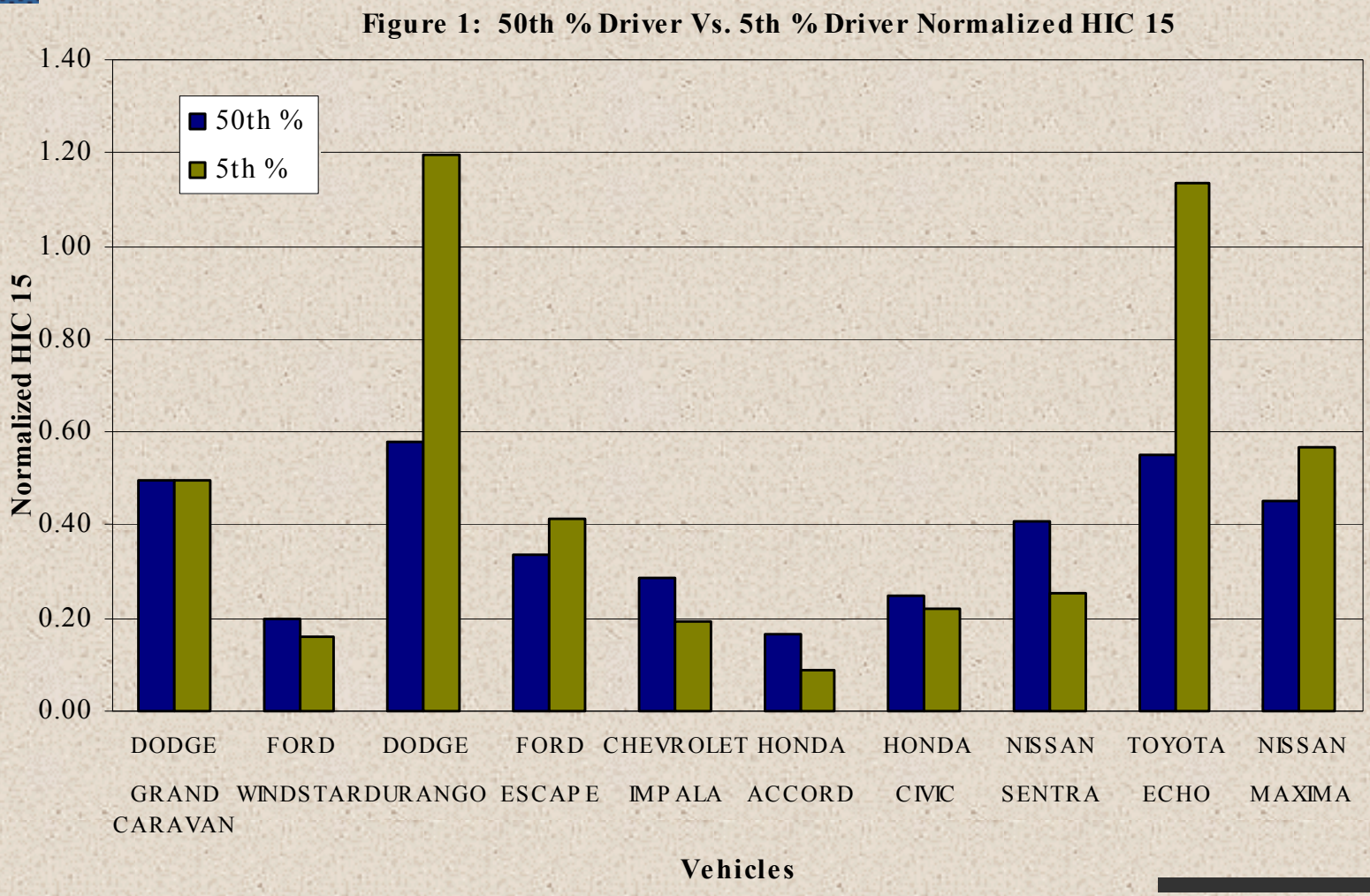
Figure 1: 50th % Driver Vs. 5th % Driver Normalized HIC 15
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
50th %
5th %
Normalized HIC 15
DODGE GRAND CARAVAN
FORD WINDSTAR
DODGE DURANGO
FORD ESCAPE
CHEVROLET IMPALA
HONDA ACCORD
HONDA CIVIC
NISSAN SENTRA
TOYOTA ECHO
NISSAN MAXIMA
Vehicles

Nij

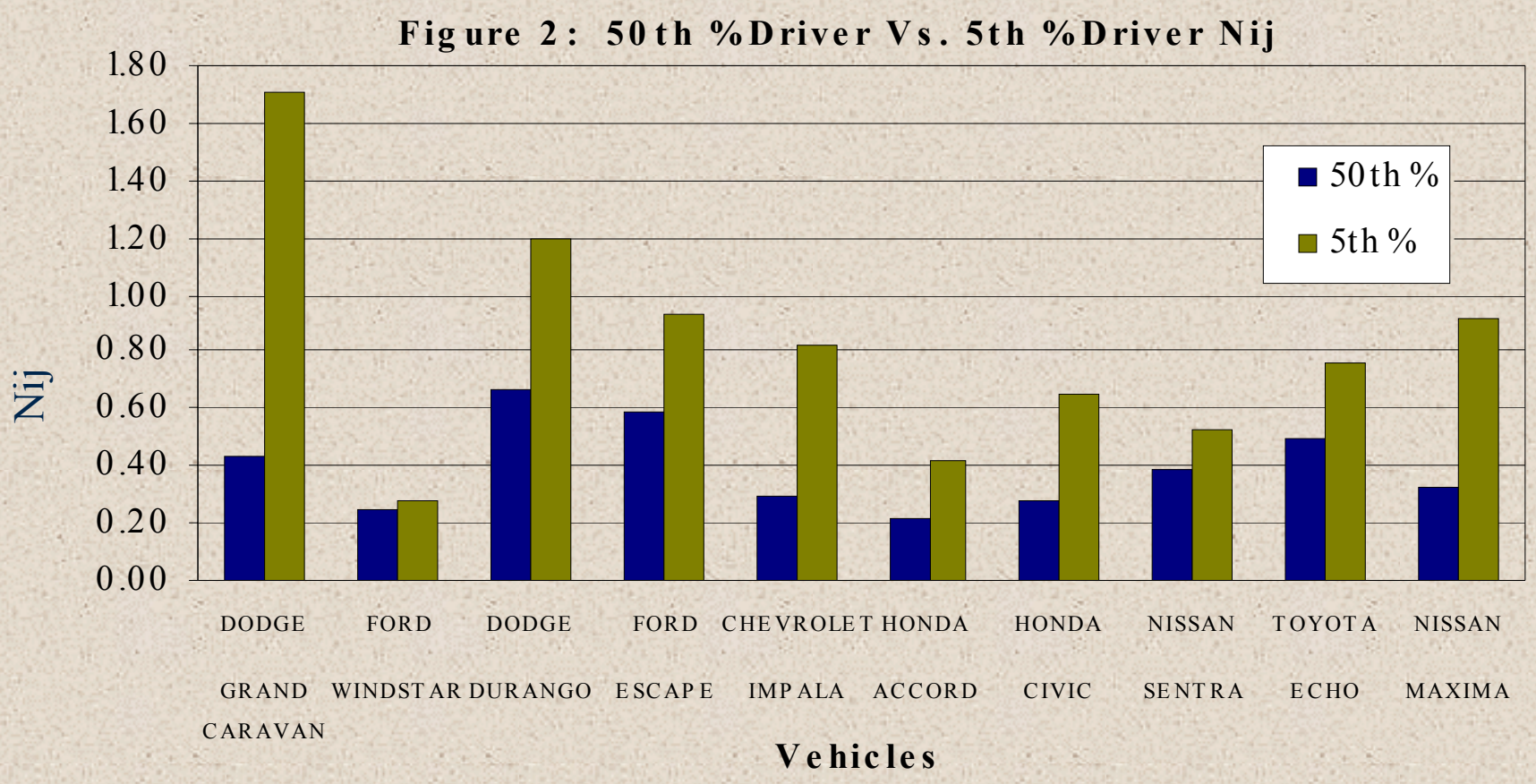
Figure 2: 50th %Driver Vs. 5th %Driver Nij
Nij
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
50th %
5th %
DODGE GRAND CARAVAN
FORD WINDSTAR
DODGE DURANGO
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CHEVROLET IMPALA
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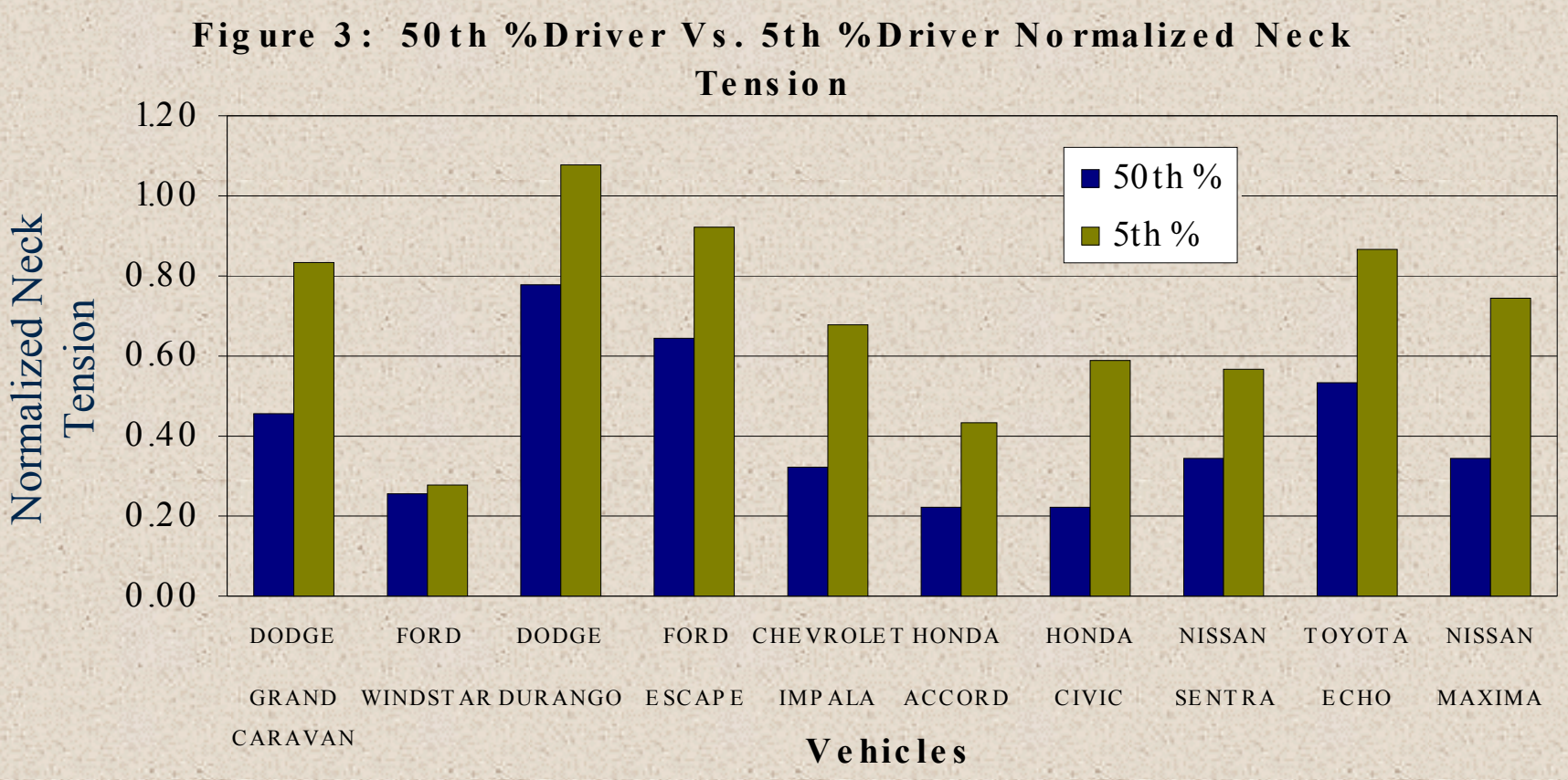
NISSAN MAXIMA
Vehicles

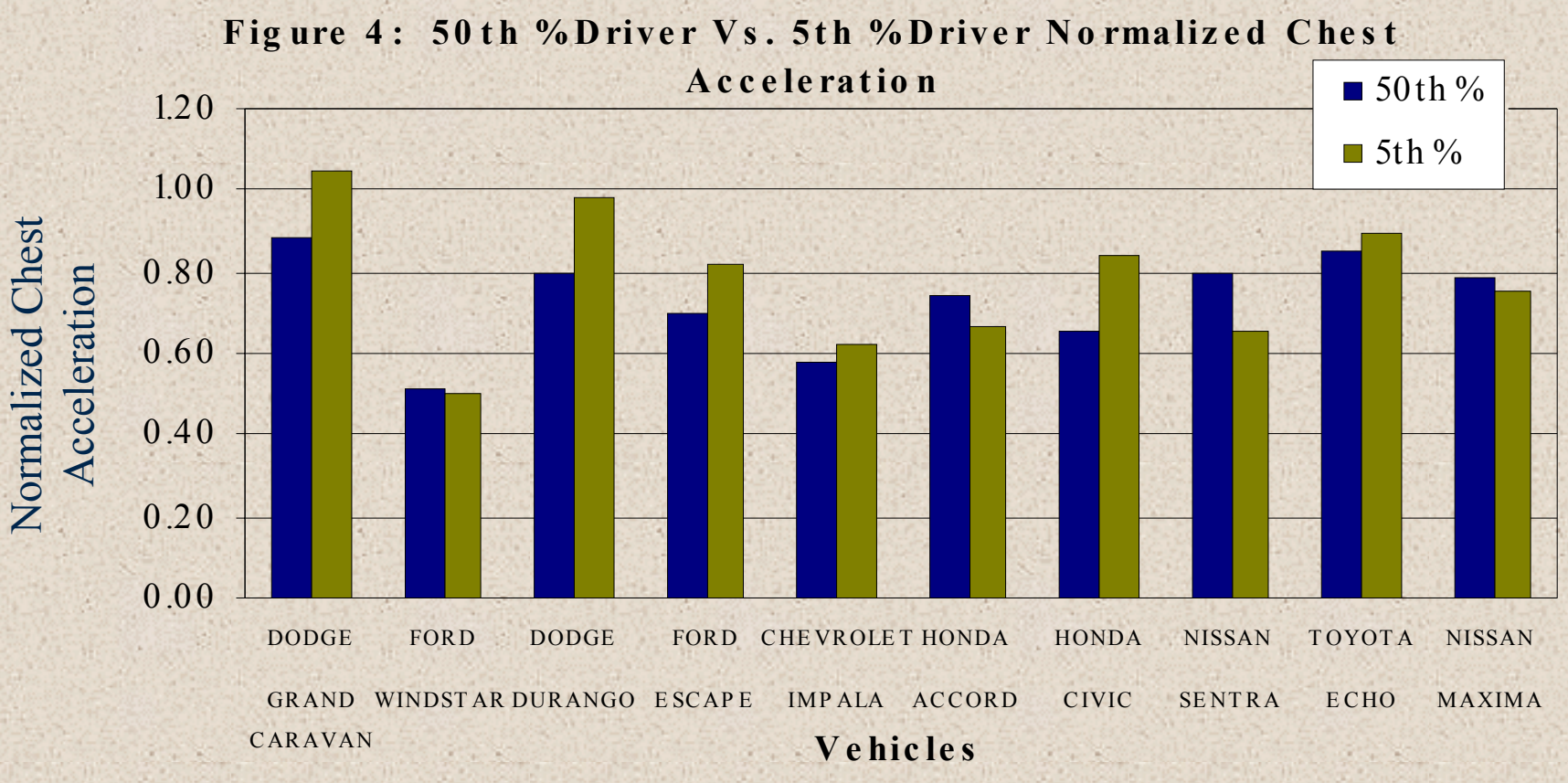
Neck Tension



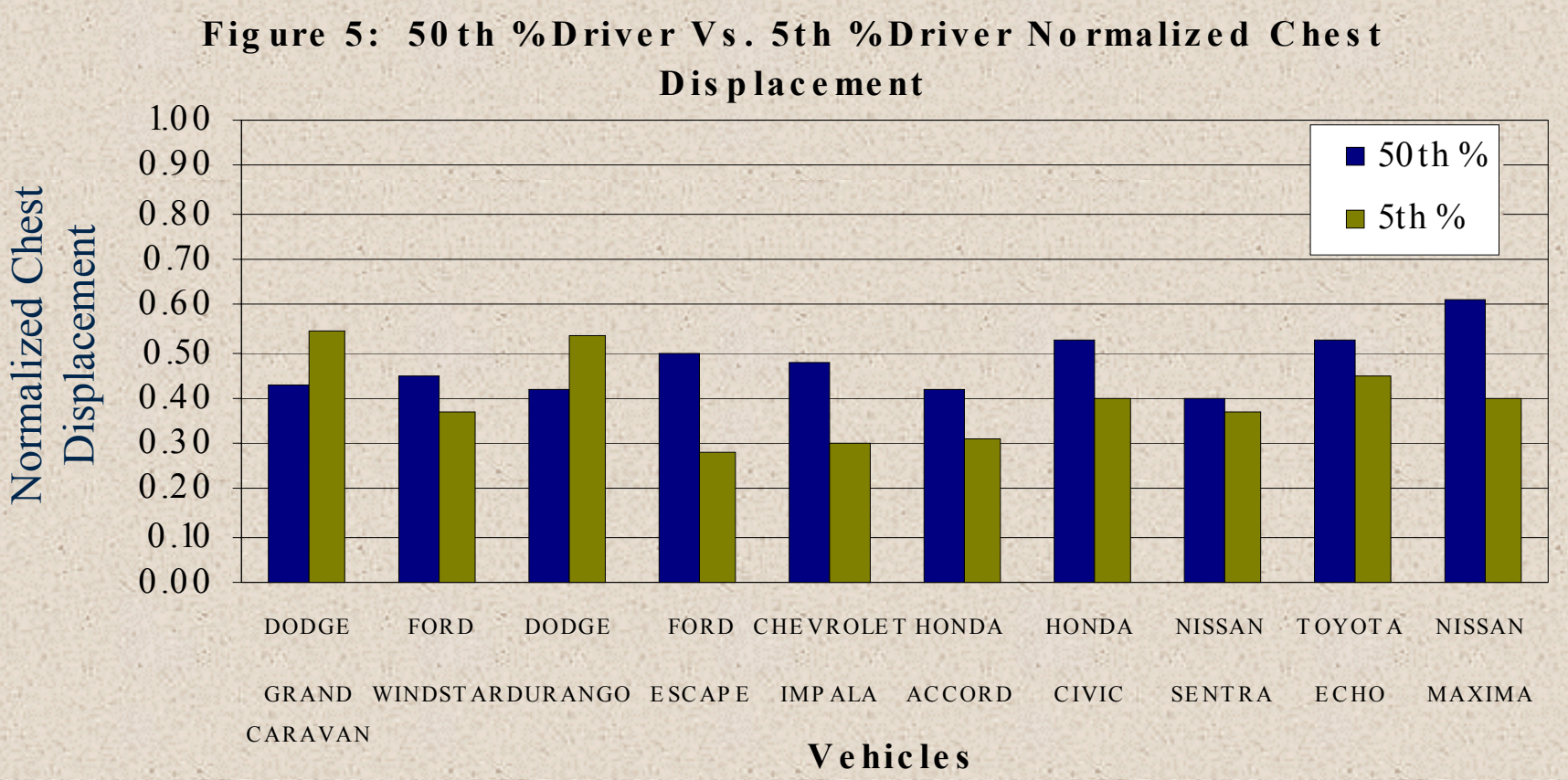
Test Results – Neck Compression

- Neither 50th nor 5th percentile driver and passenger dummies exceeded the peak neck compression values for each respective dummy. All were well below the IARV by more than 20%.

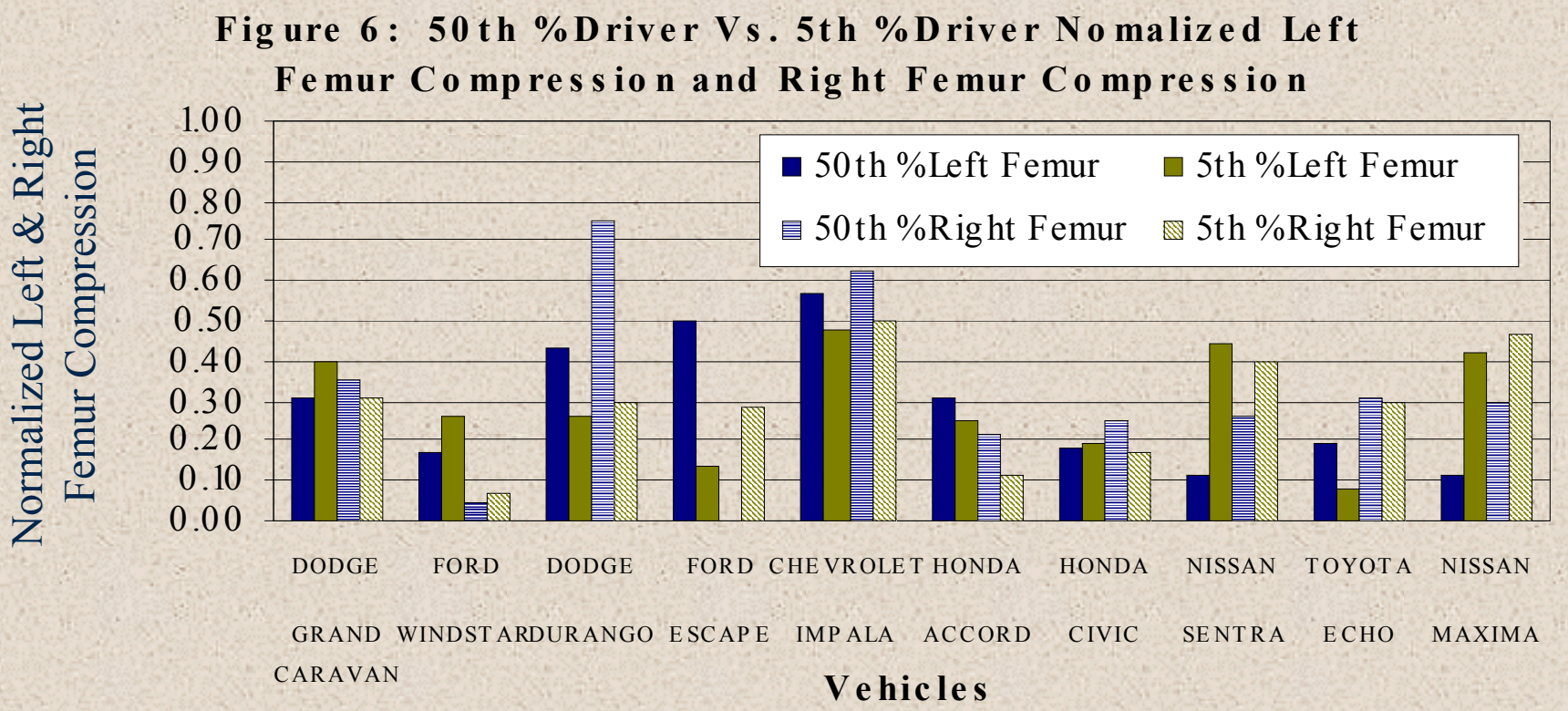
Chest Acceleration



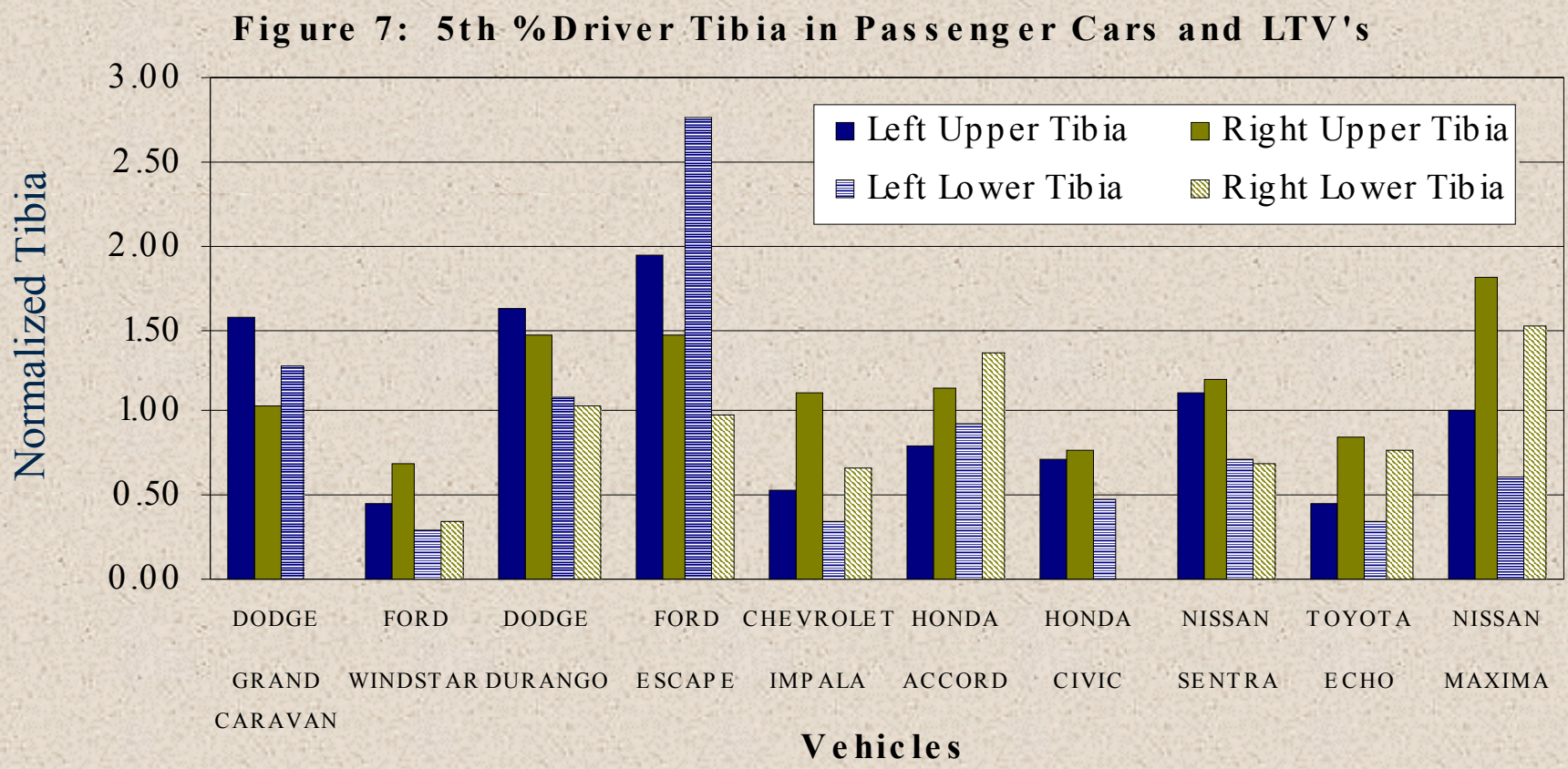
Chest Deflection



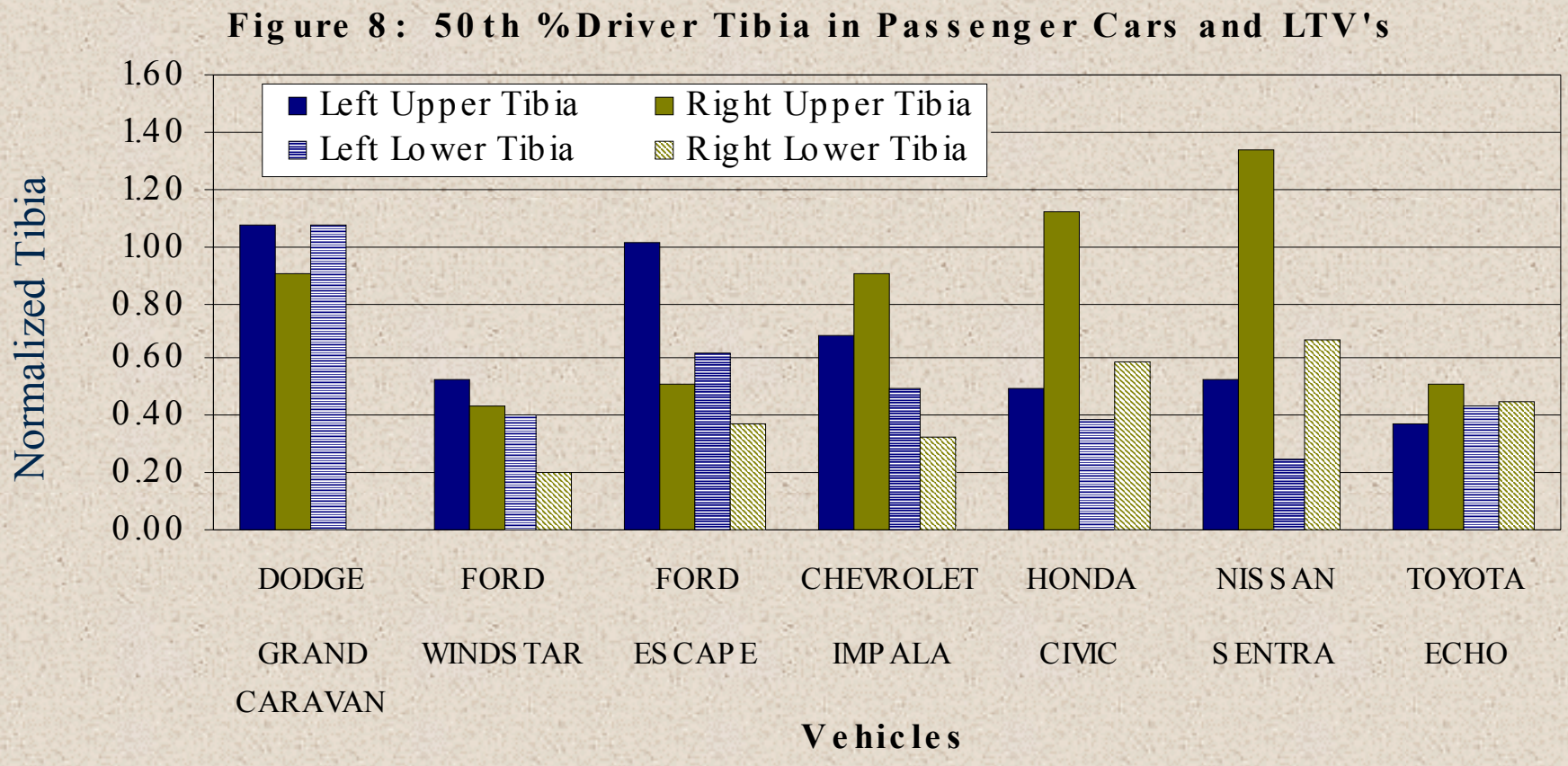
Femur Compression



Tibia Index Cont….



Tibia Index Cont….



Test Results – Tibia Index

- 5th percentile driver dummy - all but 3 vehicles exceeded one of the four indices for the tibia
- 50th percentile driver dummy - only 4 vehicles exceeded one of these indices
- 5th percentile passenger dummy - all but 2 vehicles exceeded one of the four indices for the tibia
- 50th percentile passenger dummy - only 3 vehicles exceeded one of the tibia indices.

The Need For Different Dummies

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- It appears that most vehicles would achieve dummy injury values below the IARV.
- In some instances, vehicles exceeded injury criteria for the 5th percentile dummy, but did not exceed injury criteria for the 50th percentile dummy. Two main players
  - Vehicle structure
  - Occupant restraint systems (seat belt, pretensioners, and air bags)

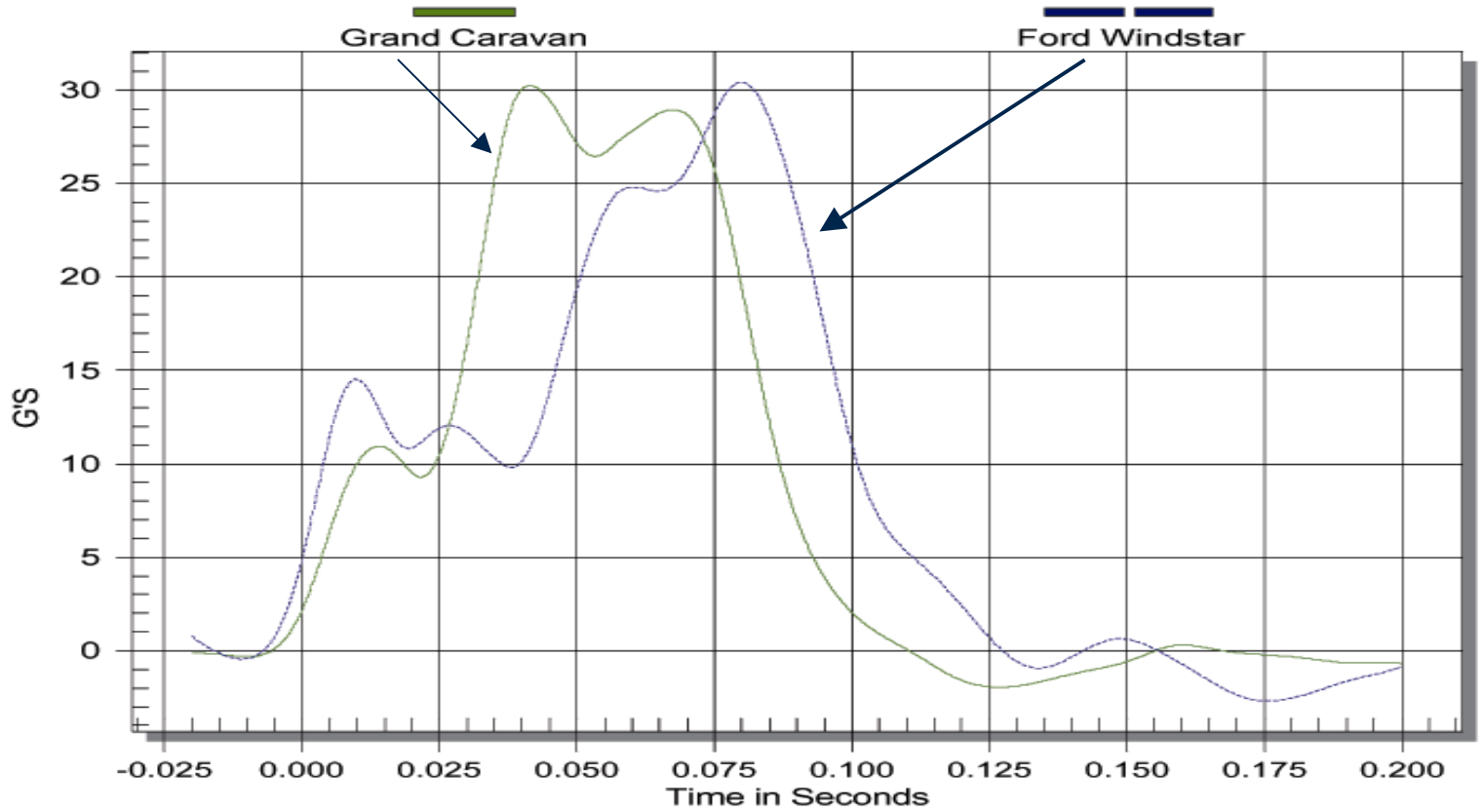
Windstar and Grand Caravan Film

Discussion – Vehicle Structure

- Vehicle pulses were analyzed
- 3 factors associated with crash management:
  - Dynamic crush
  - Maximum acceleration of the occupant compartment
  - Time period of the acceleration pulse
- Vehicle pulses for both vehicles show:
  - The Grand Caravan and the Windstar have roughly the same peak G
  - The Windstar peaks later in time than the Grand Caravan

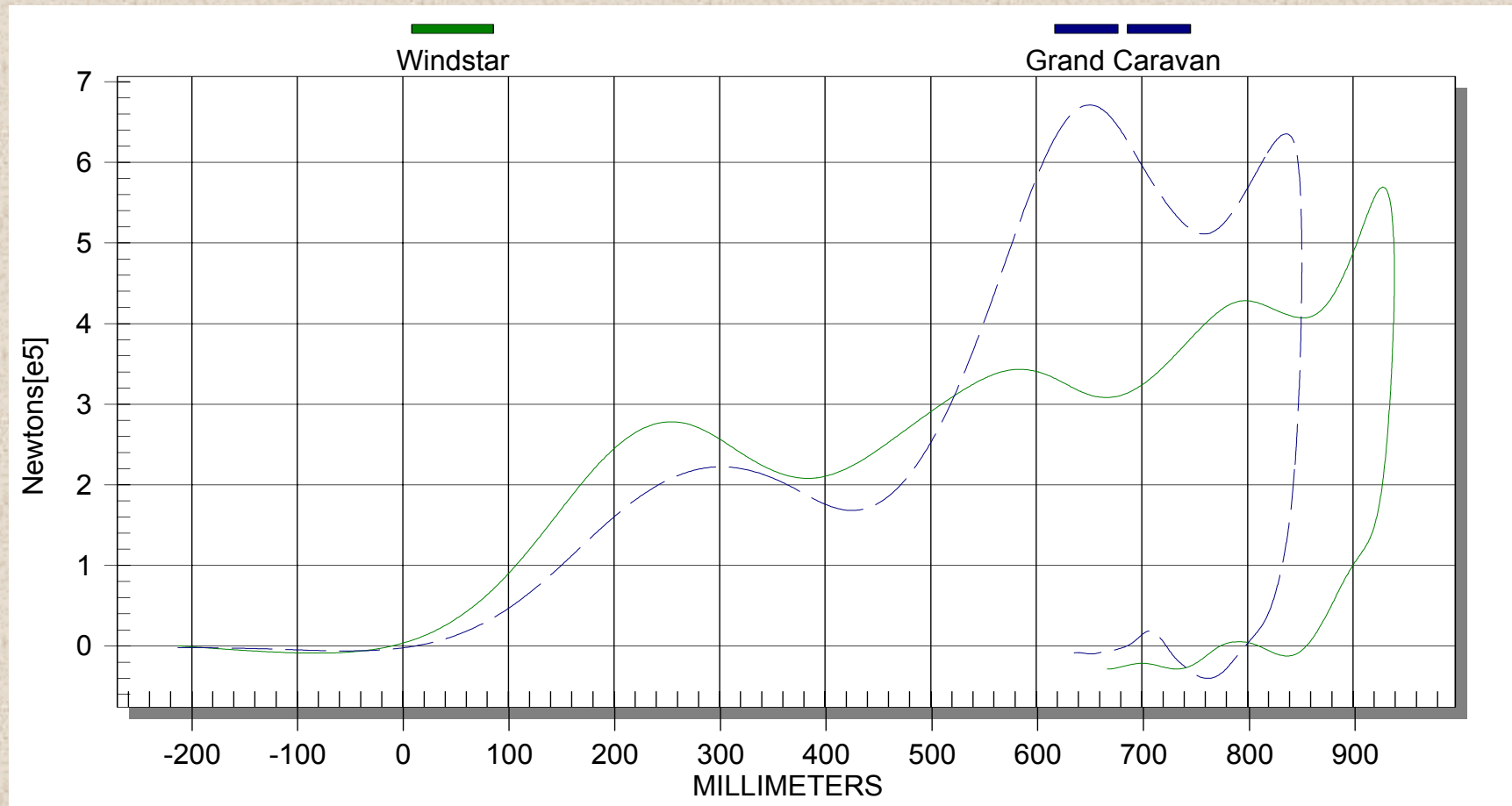
Discussion Cont….

Peak G



Discussion Cont….

Force vs Deflection

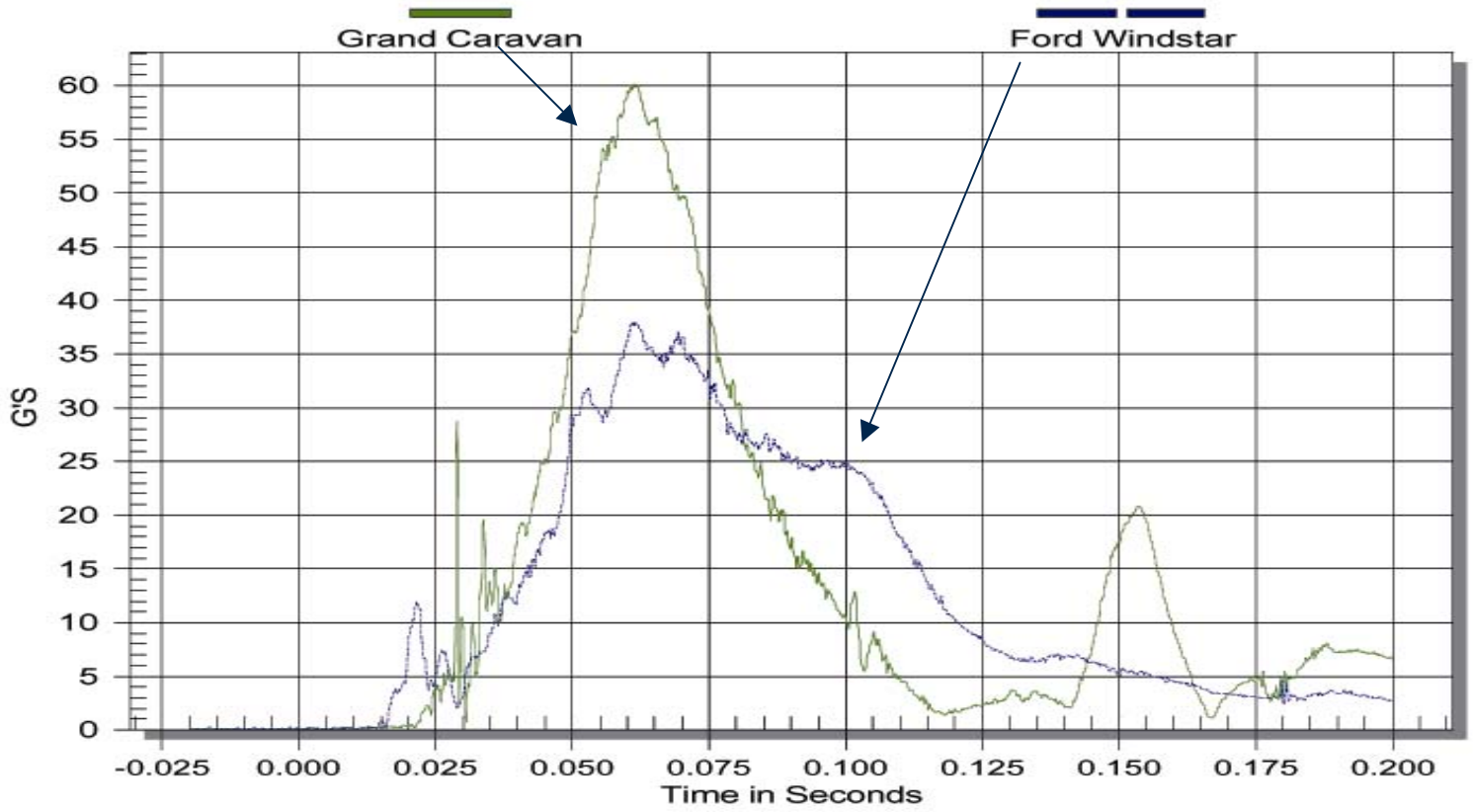


Discussion Cont.…

- Overall lengths of the 2 vehicles are almost the same.
- Bumper to firewall distance:
  - Windstar – 1201 mm
  - Grand Caravan – 725 mm
- So, for about the same mass and overall length of vehicle, the Windstar has more bumper to firewall distance to absorb the crash energy than does the Grand Caravan. Then, less force is transmitted to the occupant, reducing the chance for injury.

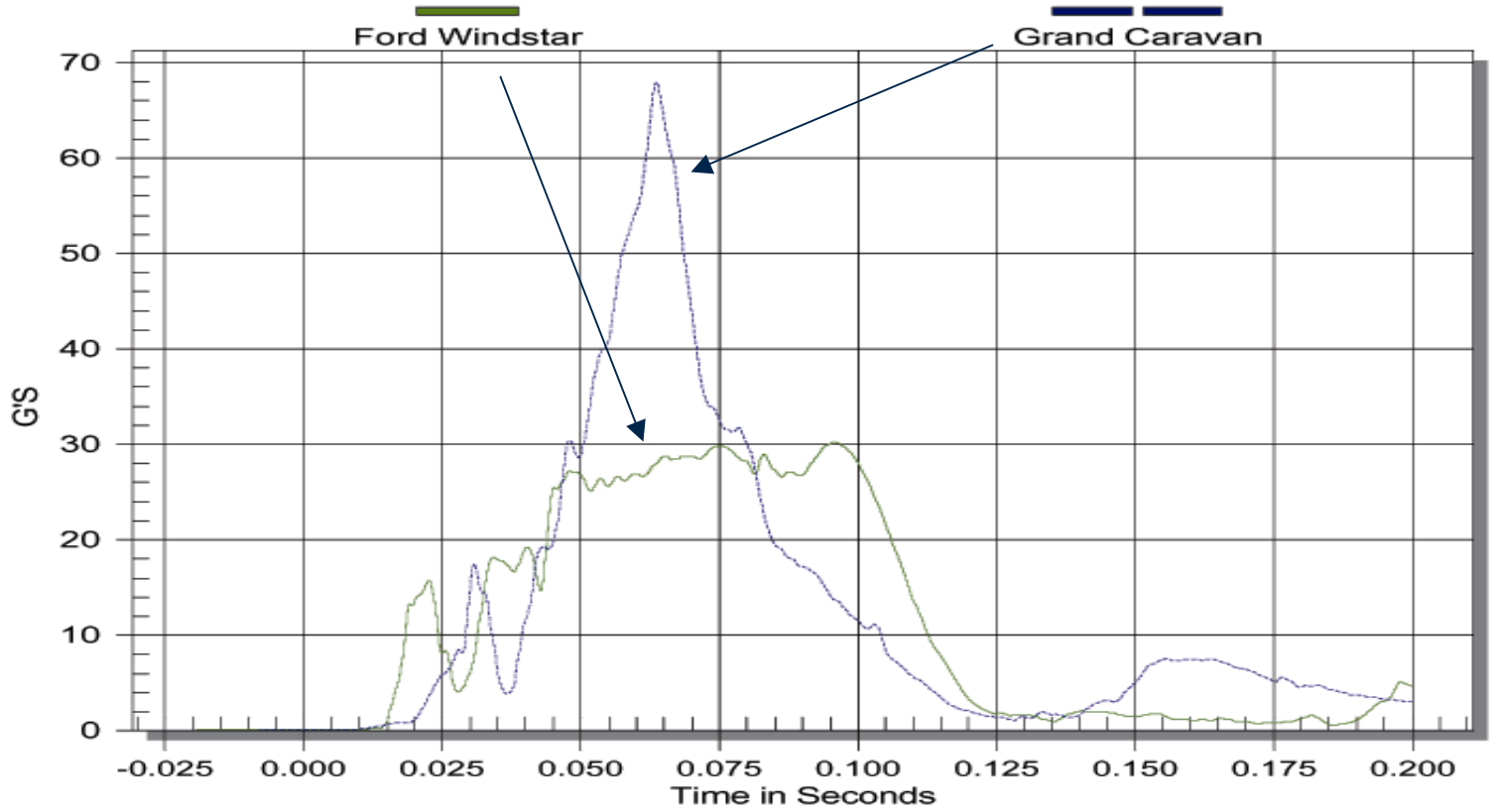
Discussion Cont…

Head Resultant



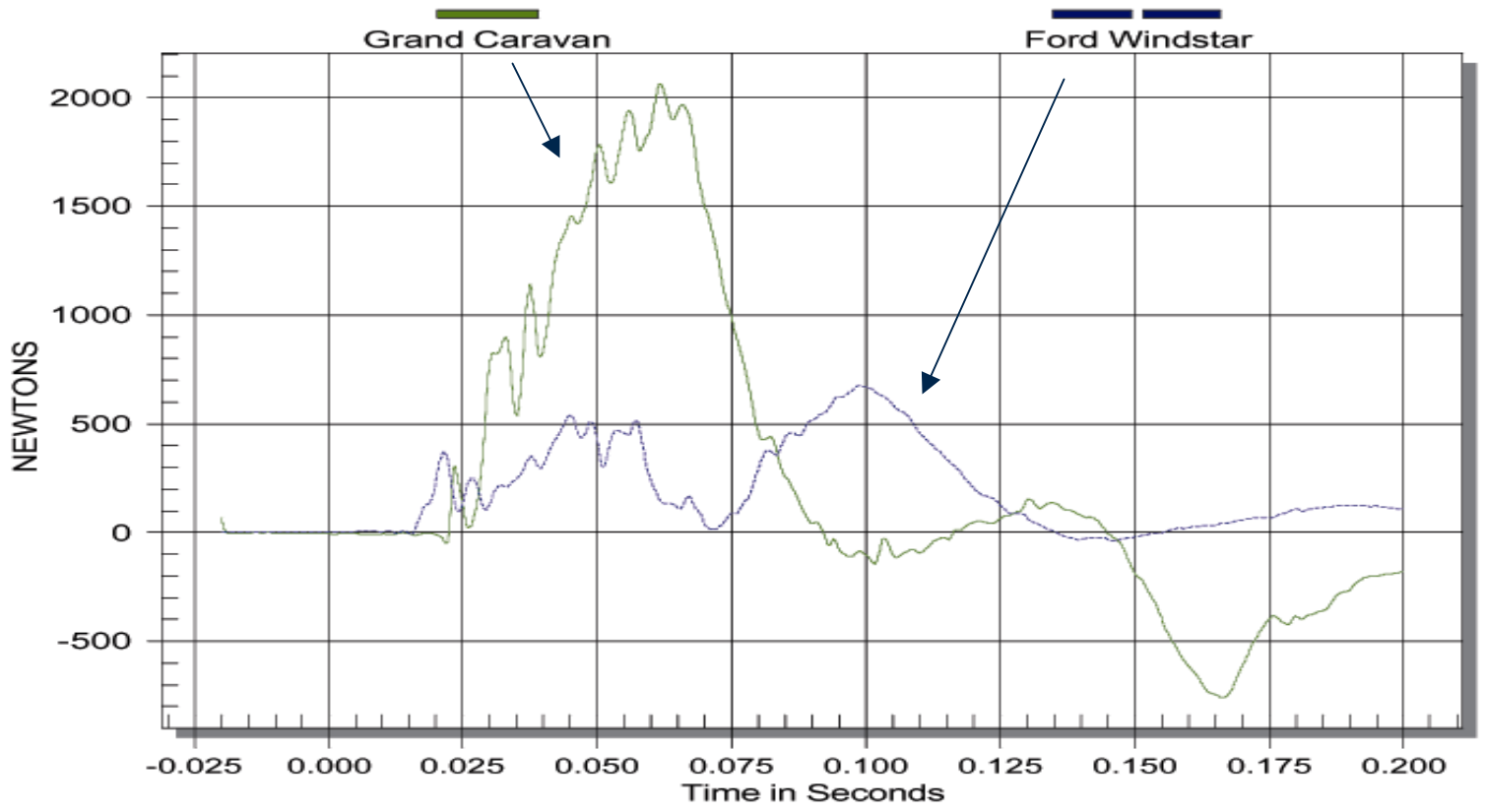
Discussion Cont….

Chest Resultant



Discussion Cont….

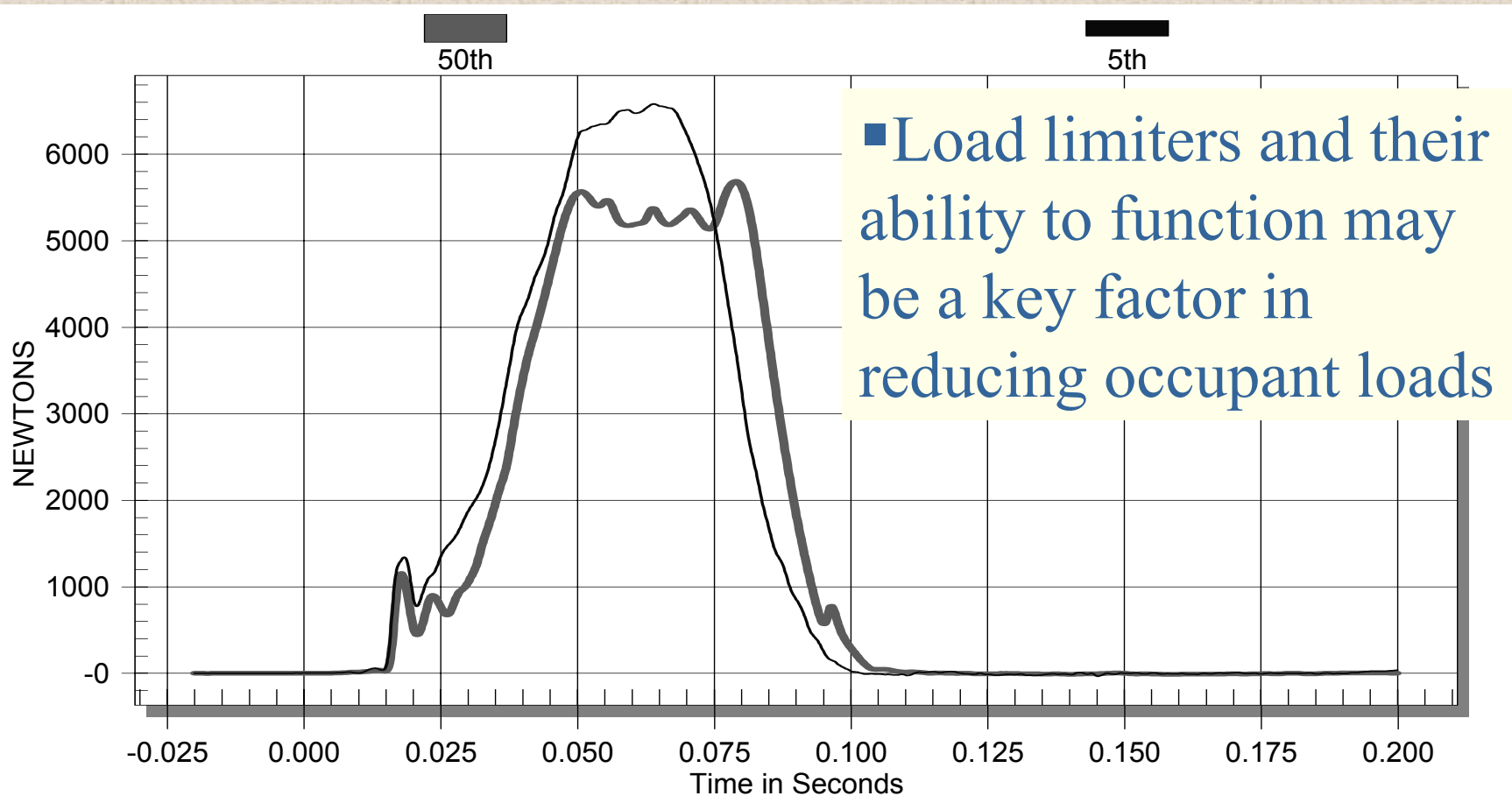
Neck Force Z



Discussion Cont.…

- Driver shoulder belt load data for the Toyota Echo (for both the 5th and 50th percentile dummies) was analyzed to see the effect pretensioners and load limiting seat belts had on occupant performance.

Discussion Toyota Echo Cont….



- Load limiters and their ability to function may be a key factor in reducing occupant loads

Conclusion

- 2001 – NHTSA conducted 10 belted 56 KMPH (35 MPH) frontal vehicle crash tests using the 5th percentile dummy.
  - 5th percentile dummy is robust and very durable
  - 5th percentile dummy incurred greater injury than the 50th percentile dummy, particularly for the neck and lower extremities in some vehicles tested
  - Need for dummies of different stature to ensure equal protection for all occupants

Additional Information

- Docket http://dms.dot.gov
  - For 5th Percentiles 10687
  - For NCAP Frontals 4962
- Films at NCAC 703-726-8236

Thank you for your attention !!