

# **AN NCAP RATING FOR FEMALES**

**ESV Paper 23-323**

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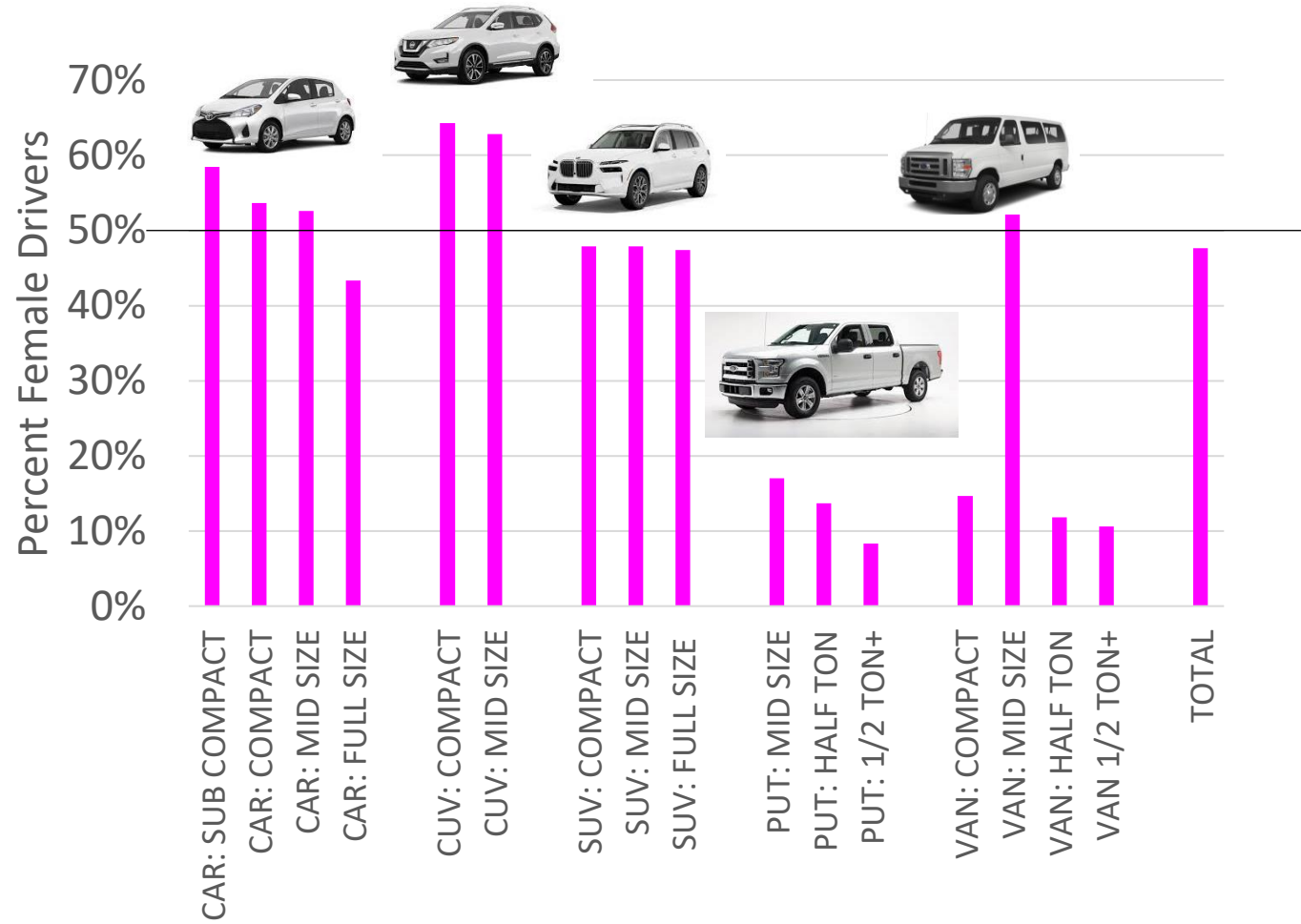
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# Female Representation in Well-defined 2 Vehicle Crashes by Vehicle Size/Classification



# Considerations

- Females are more likely to be drivers of smaller vehicles
- Males are more likely to be drivers of larger vehicles
- Smaller vehicles undergo higher acceleration in small to large vehicle crashes
- Improved structural compatibility can reduce vehicle acceleration in lower severity crashes
- Reduced vehicle acceleration can reduce injuries to all occupants and body regions
- Design of Female NCAP should be structured to encourage greater vehicle compatibility



# Approach to Developing Female NCAP

- Address priority body areas for further enhancement of protection.
- Help deployment of available countermeasures to further reduce female injury risks.
- Address relevant test procedures and risk measurement technologies while maximizing use of existing NCAP and available injury criteria
- Address other opportunities not addressed in today's testing.



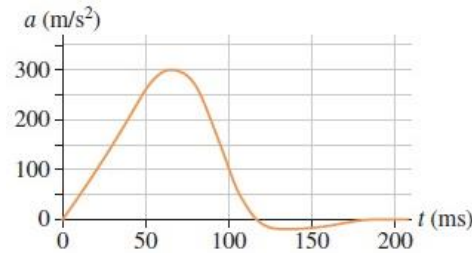
# Vehicle Aggressiveness Factors

- Three factors involved in aggressiveness

1. Mass



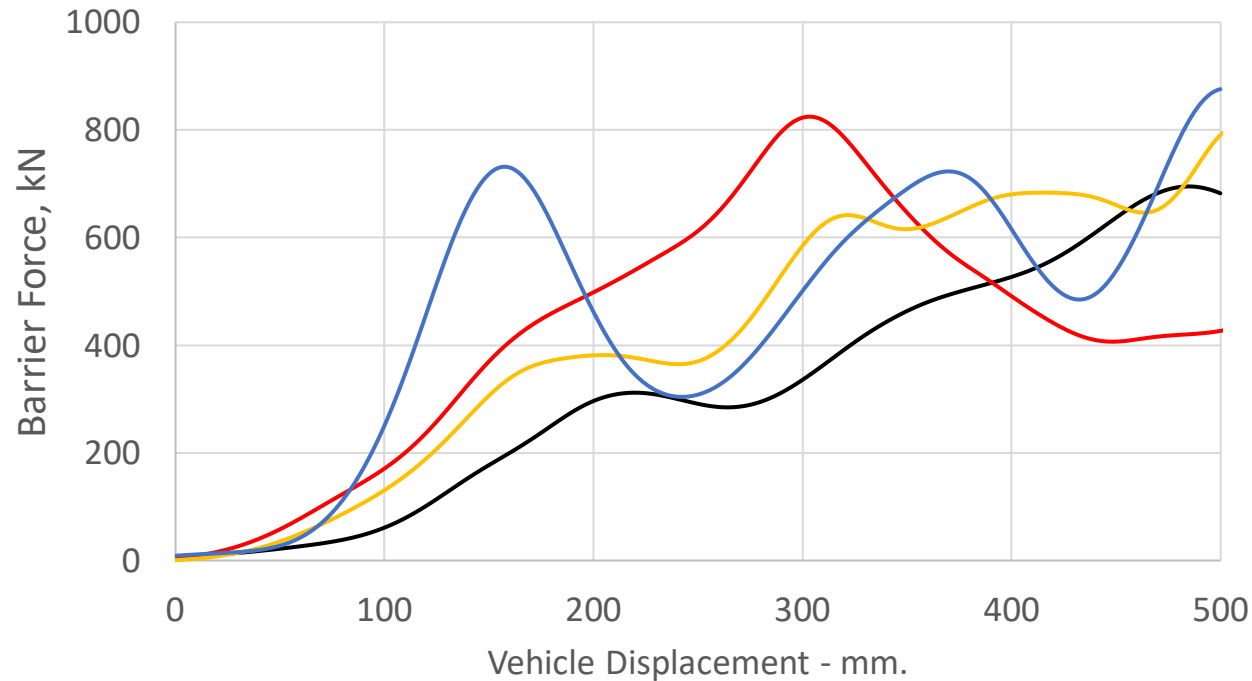
2. Stiffness



3. Geometry



# Vehicle Aggressiveness - Stiffness



Improved Stiffness  
Compatibility would  
reduce the severity of low  
deltaV crashes and be  
beneficial to all – especially  
Females



— 2017 Focus



— 2020 Polestar 2

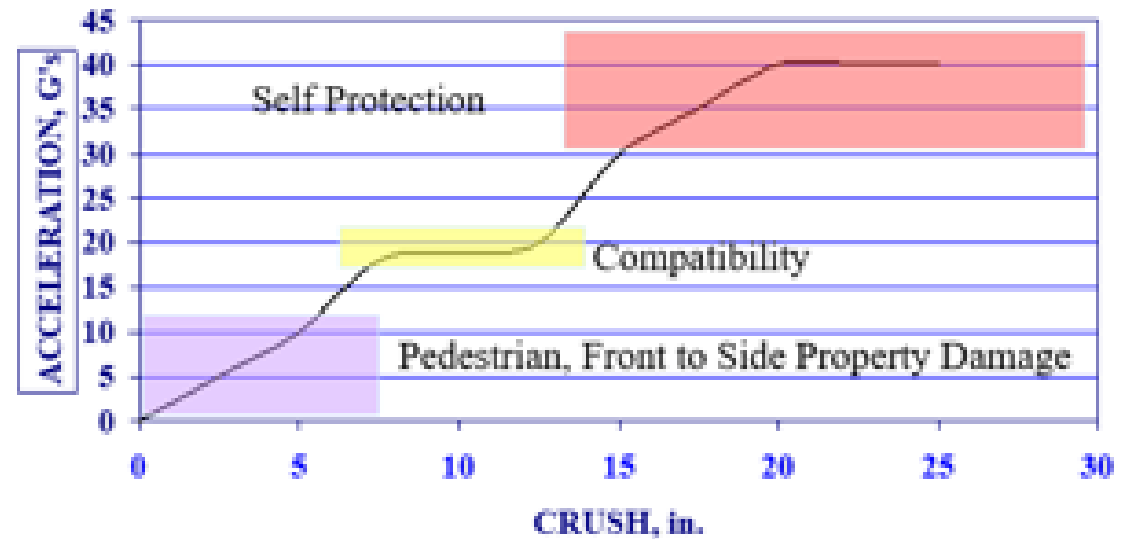
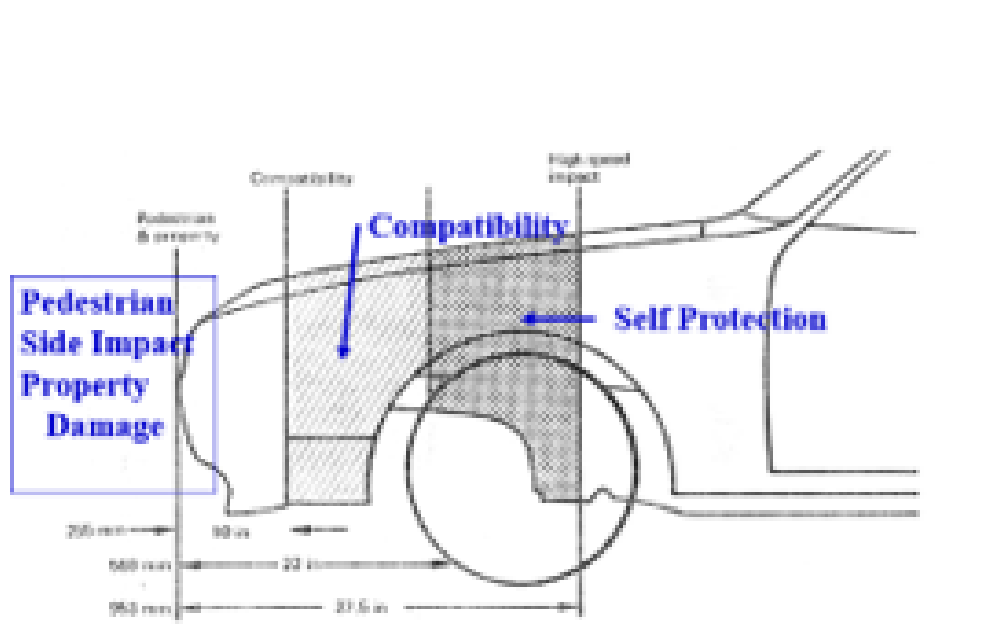


— 2017 Tesla X

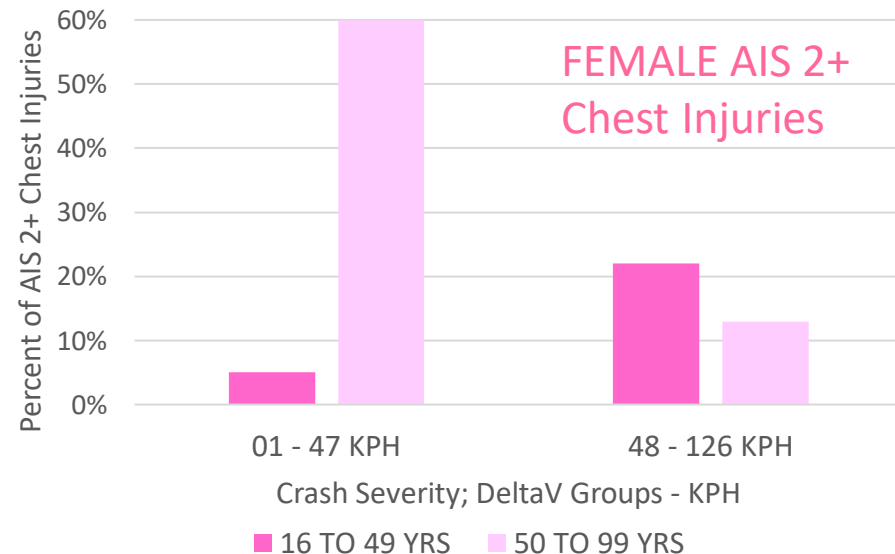


— 2018 F150

# Stiffness Compatibility Concept



# AIS 2-6 Chest injuries in Well-defined Frontal Crashes by Age and DeltaV

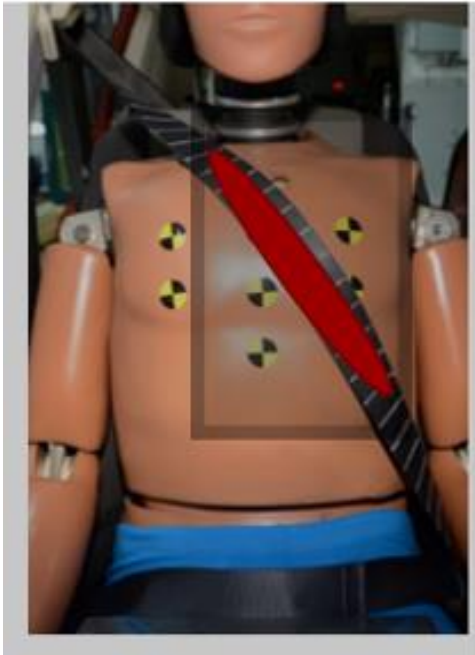


Female AIS 2+ Chest Injuries are most frequently older females at lower DeltaV (60%)

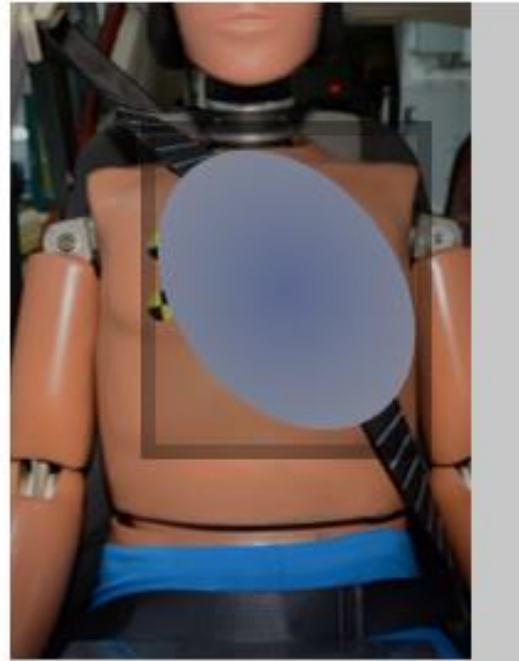
1. **Reduce crash severity by controlling stiffness of front-end at lower but more frequent velocities**
2. **Improved Belt Technology to reduce injury risk at all delta V's**



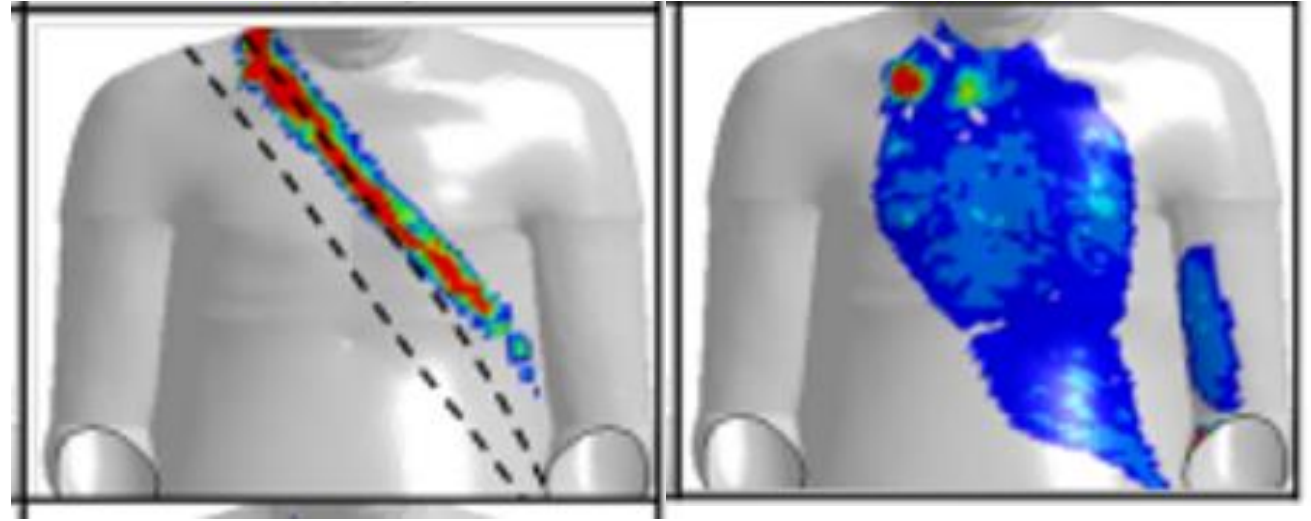
# Chest Pressure Distribution – Conventional vs. Inflatable Belts



Conventional Belt Pressure



Inflatable Belt Pressure

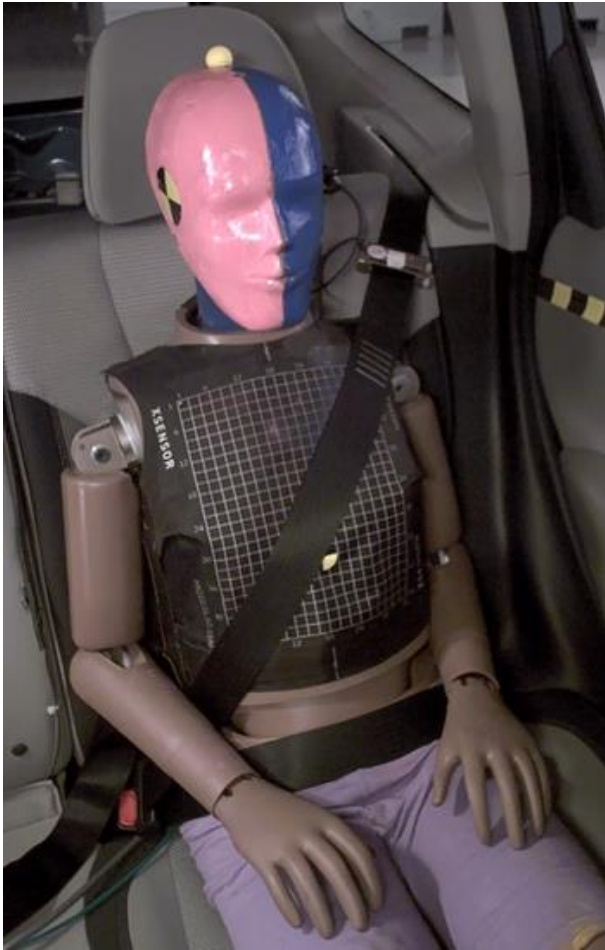


Conventional Belt and Inflatable Belt  
Computer Simulation of Chest Pressure

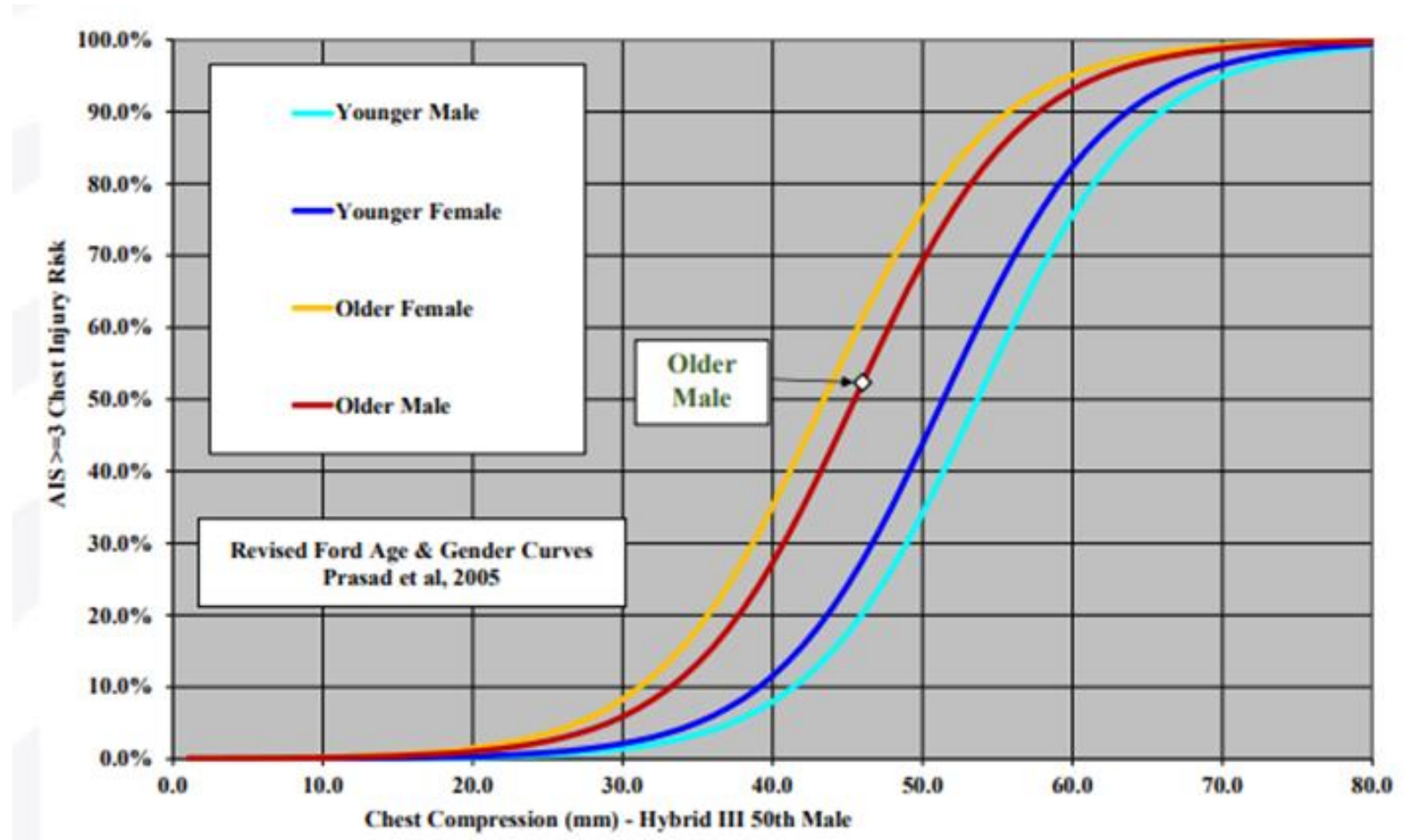
# Chest Injury Improved Technology – Inflatable Belts



# Chest Improvements – Better Chest Injury Measurements and Older Female Criteria



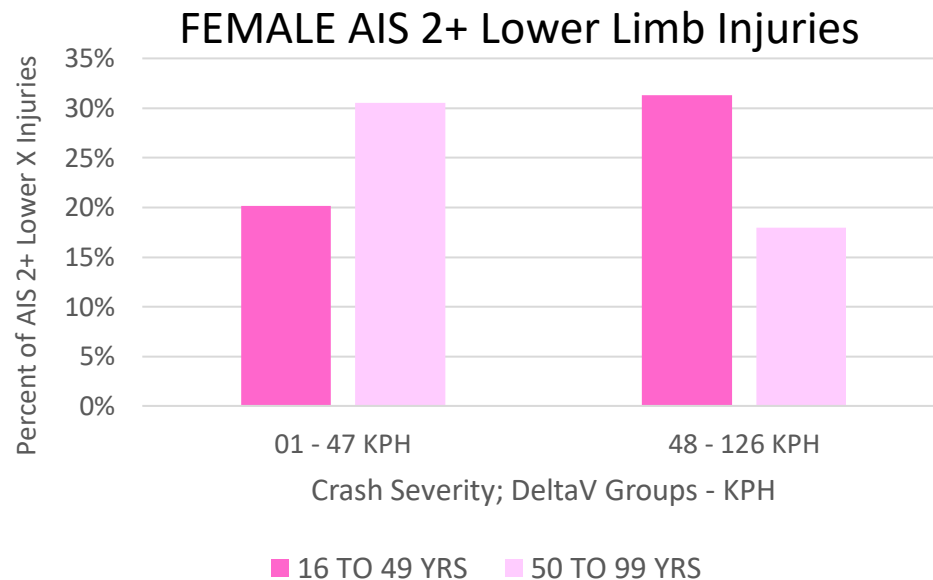
Chest Pressure Measurement



Older Female Chest Injury Risk Curve

# AIS 2+ Lower Extremity Injuries in Frontal Crashes by Age and Crash Severity

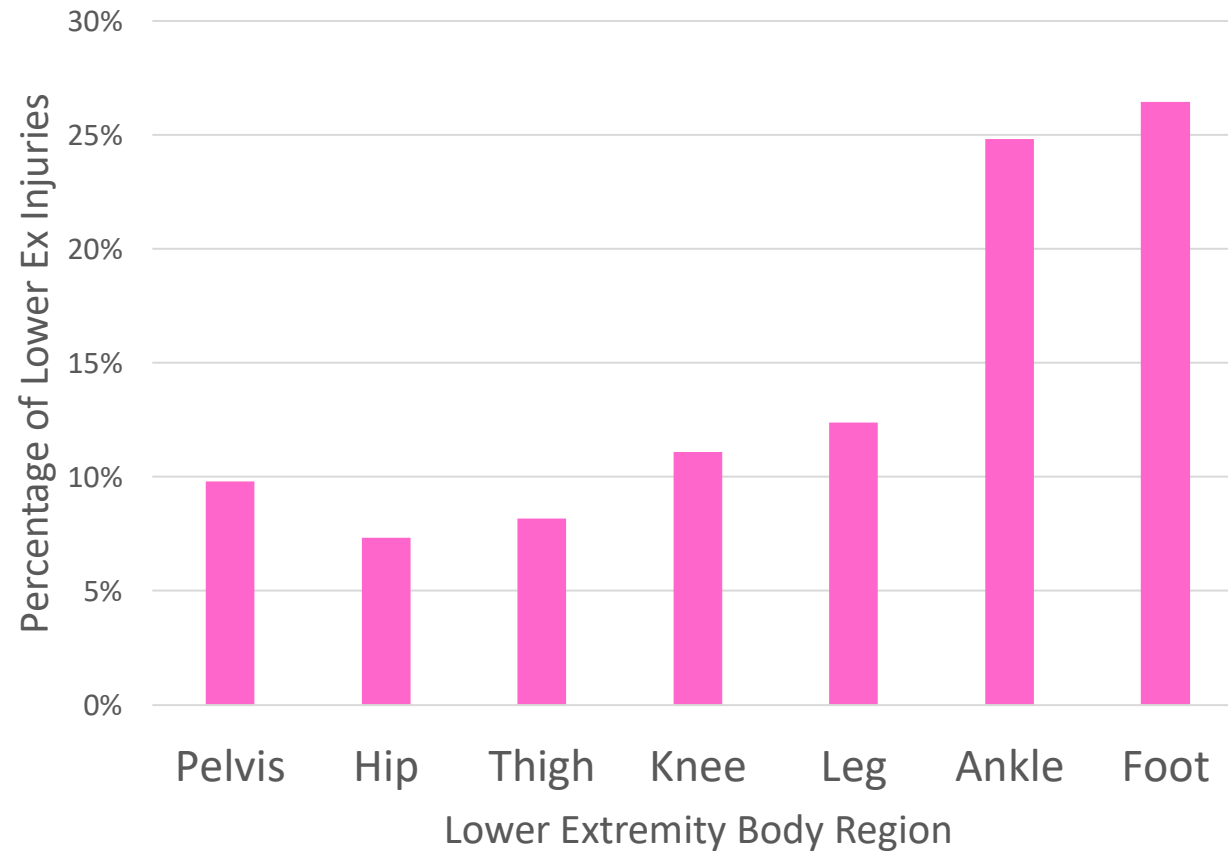
Females suffer 61% of the AIS 2+ Lower Extremity Injuries



1. **Vehicle Stiffness Control** reduces injury risk at lower deltaV's
2. **Energy Absorbing Floor** reduces injury risk at all deltaV

Female Lower Limb AIS 2+ injuries are most frequently older females at lower DeltaV and younger females at higher DeltaV

# Distribution of Pelvic and Lower Extremity AIS 2+ Injuries to Females in CISS 2017-2020 Well-defined Frontal Crashes



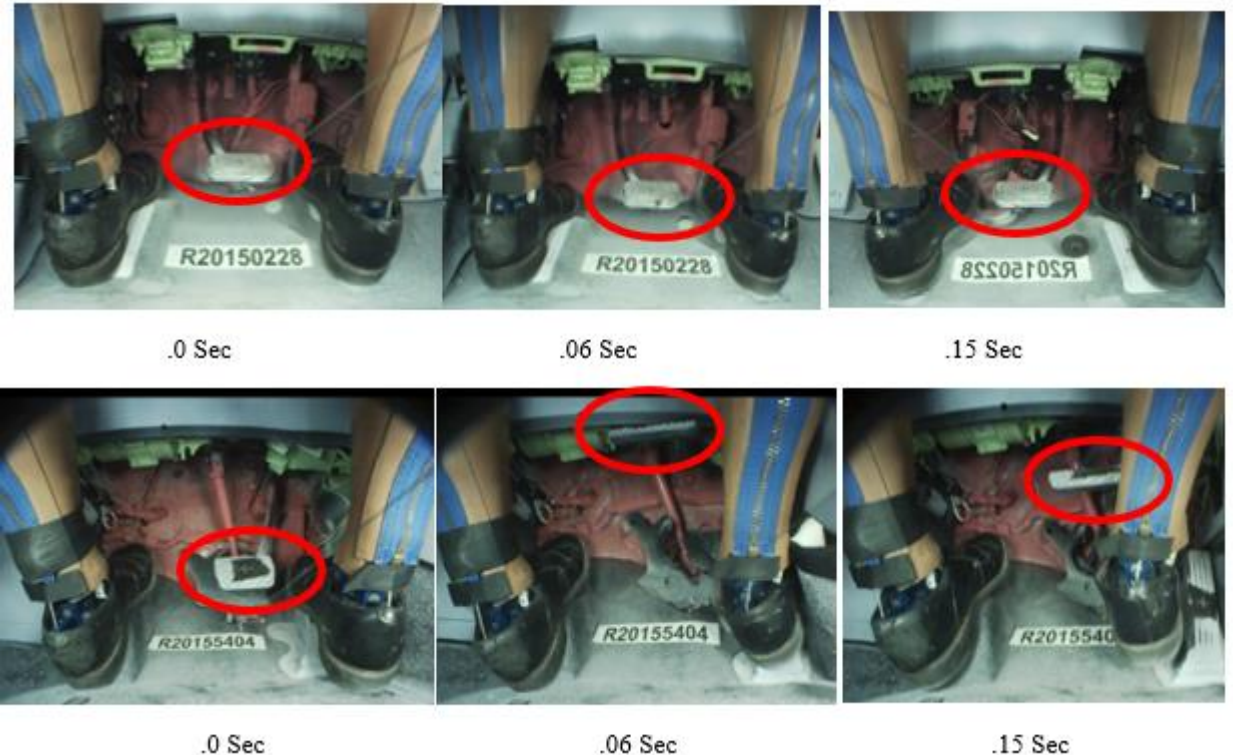
# CISS Documented Injuries to the Foot and Ankle During Braking and Brake Motion During a Crash Test

**70% of Foot/Ankle Injuries During Braking are to the Right Foot**

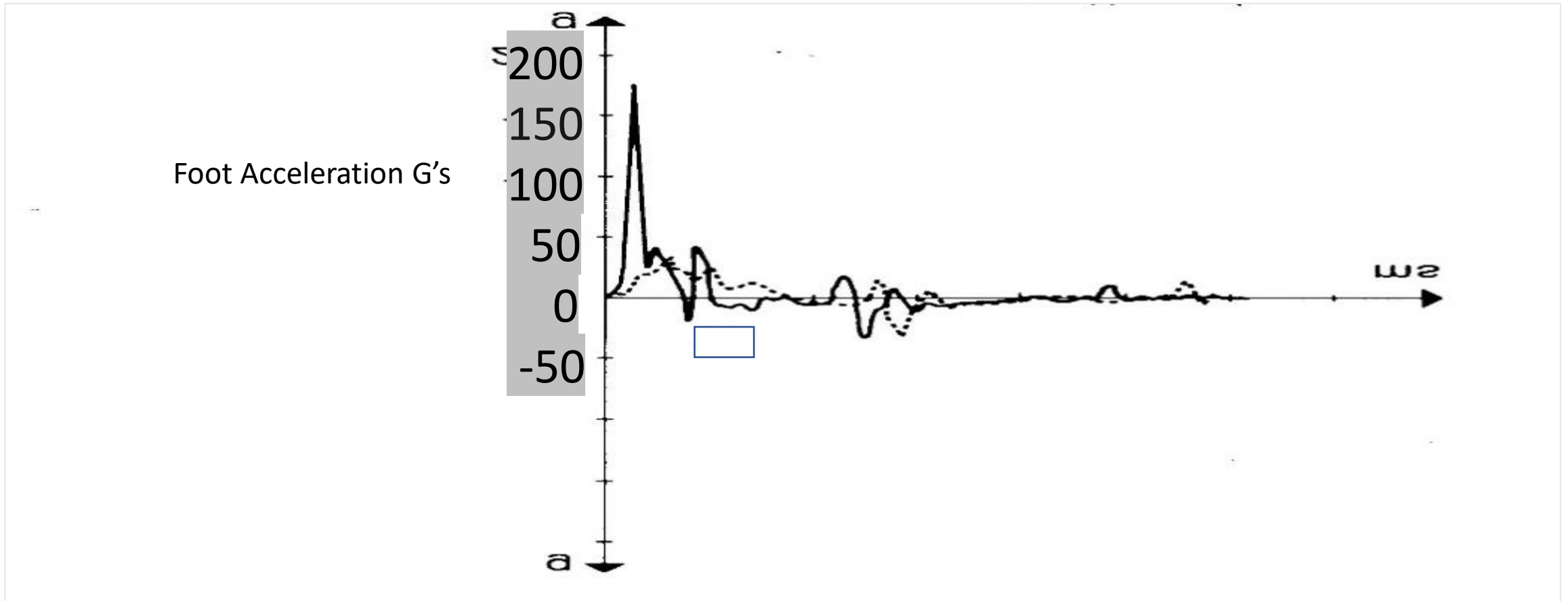
CISS Percent of Right and Left Foot/Ankle Injuries During Braking

FEMALE BRAKING	Foot/Ankle	Foot/Ankle	Percent
Lower Limb Region	AIS 2-6	Percent	On Brake
Foot Left	5	17%	
Ankle Left	4	13%	
Foot Right	14	47%	70%
Ankle Right	7	23%	
All	30	100%	

Brake Pedal Motion During NCAP Test



# Foot Acceleration Reduction with Floor Padding



*Mercedes Crash Test Foot Acceleration With and Without Countermeasure*

# Female NCAP Recommendations

Overall: **Promote Stiffness Compatibility**; reduce crash acceleration in lower severity crashes

Specific:

## 1. Lower Limbs:

- **Vehicle Stiffness Control**; reduces injury risk at lower delta-V's
- **Energy Absorbing Floor**; reduces injury risk at all delta-V's
- **Control Pedal Movement** (Proposed under EURO NCAP)

## 2. Chest:

- Improve Chest Response Monitoring/Measurement
- Improved Load Distribution
- Apply Injury Risk Curve for Older Female