

Age Appropriate Restraints For The Right Front Passenger

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Hypothesis

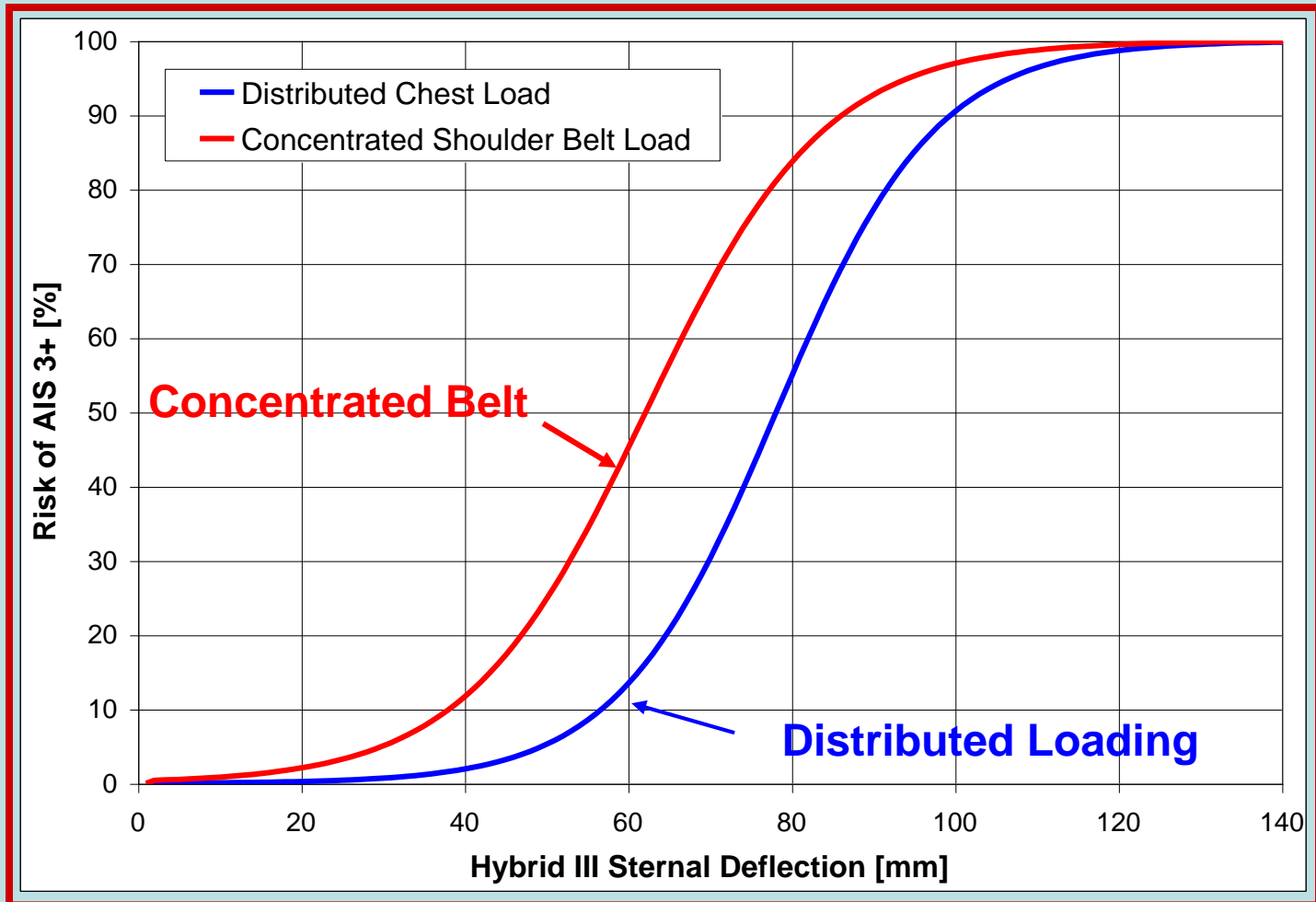
- Right front passengers are more at risk of injury than drivers because the right front occupants are more likely to have a lower injury tolerance
- Age appropriate restraint systems are applicable to right front passengers

Driver and Occupant Motion Comparison

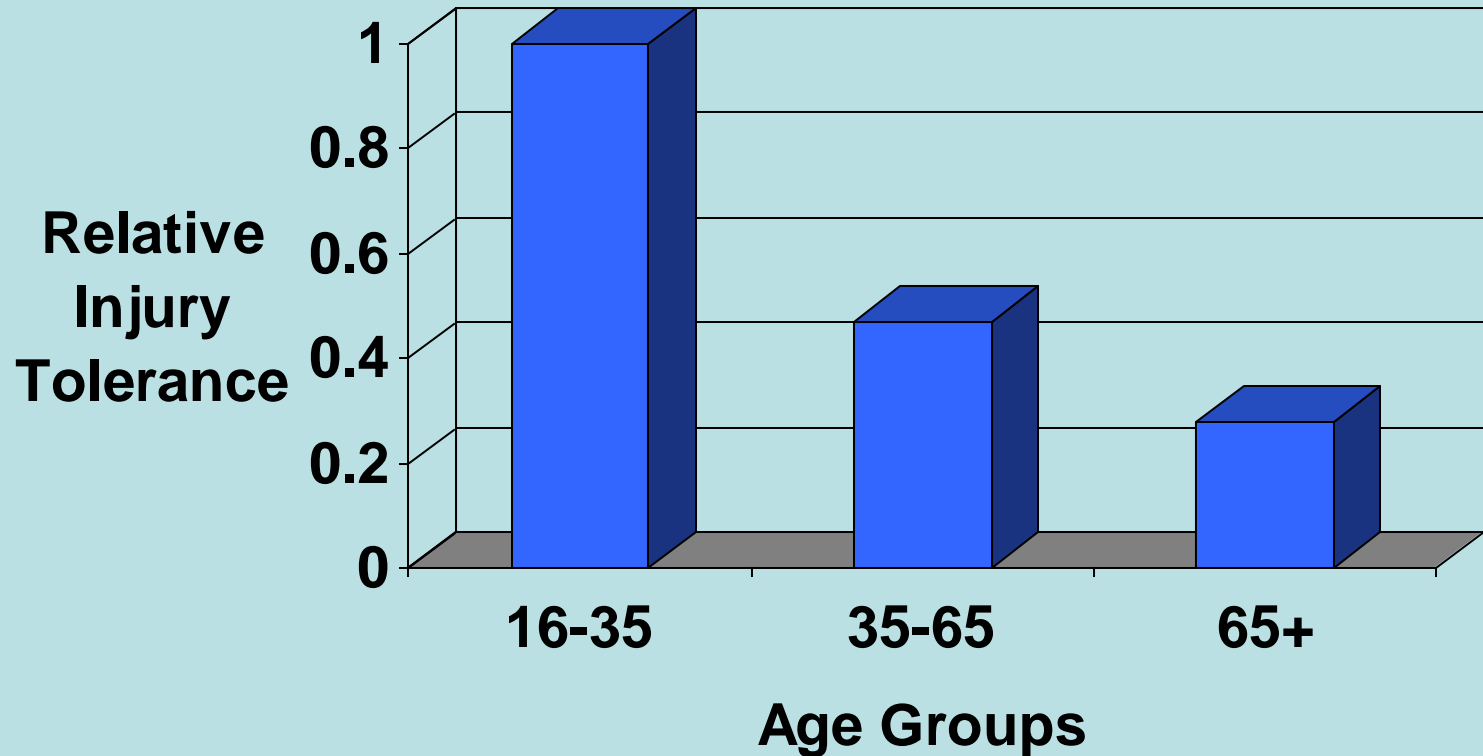


Note that the passenger has much more ride-down distance before contacting the vehicle

Chest Injury Risks for Belts and Air Bags – Young Adults



Chest Injury Tolerance Reduction for Belt Loading by Age



Reference: Zhou, Rouhana & Melvin – SAE 962421

Chest Injury Adjustment for Gender

- Females have about 20% higher injury risk than males for the same crash condition

Approach

- Examine exposure, injuries and fatalities by age, gender & seating position
- Examine risks of injury and fatality by age, gender & seating position

Data Sources

- The National Automotive Sampling System/Crashworthiness Data System NASS/CDS (1997-2004).
- General Estimates System, GES (2003-2005).
- The Fatality Analysis Reporting System, FARS (1998-2005).

Size of the Databases

- NASS/CDS Beltd Front Occupants in Frontals
 - 23,718 raw occupants; 1,857 MAIS 3+ injured.
 - 11,606,000 weighted occupants; 167,652 MAIS 3+ injured.
- FARS 1998-2005 Belted Frontals
 - 35,731 vehicles with both the driver and right front passenger seats occupied and both occupants reportedly belted.
- GES 2003 – 2005 Frontal Crashes
 - 148,084 unweighted vehicles
 - 15,387,000 weighted vehicles

FARS Analysis

- Paired comparison of belted front seat occupants by position, gender and age
- Age 65+ threshold for older occupants

Fatality Risk Ratios for Belted Occupant Pairs Involved in Frontal Crashes

Target	Control	Odds Ratio	Lower 95% CL	Upper 95% CL	Significant?
Young Pass.	Young Driver	0.93	0.80	1.08	NO
Old Female Pass.	Old Male Driver	1.19	1.10	1.28	YES

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Old Pass.	Old Driver	1.42	1.18	1.71	YES

Observations from FARS

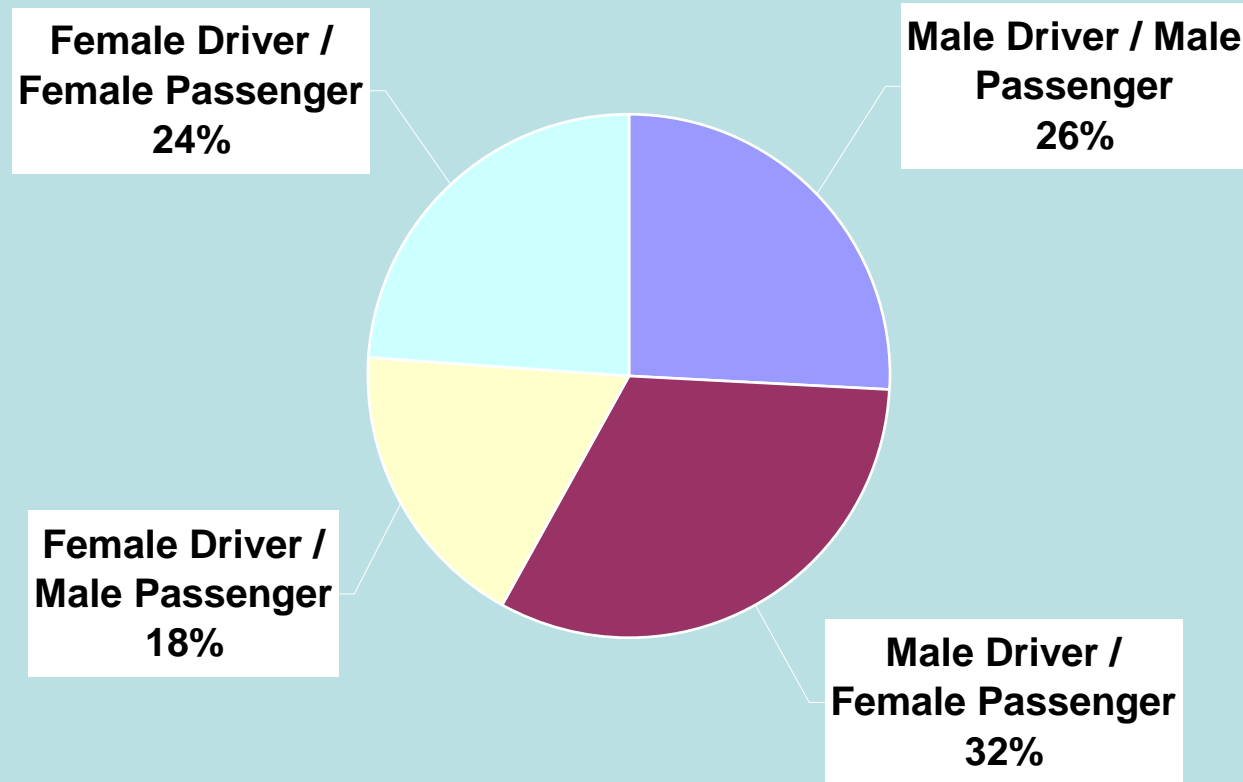
Risk to Passengers vs. Drivers

- No significant risk difference for all young occupants
- Significant risk difference (19%) for elderly occupants based on gender
- When both occupants are elderly, passenger has a 42% higher fatality risk than the driver
- Elderly passengers of both genders are vulnerable to injury

GES Analysis

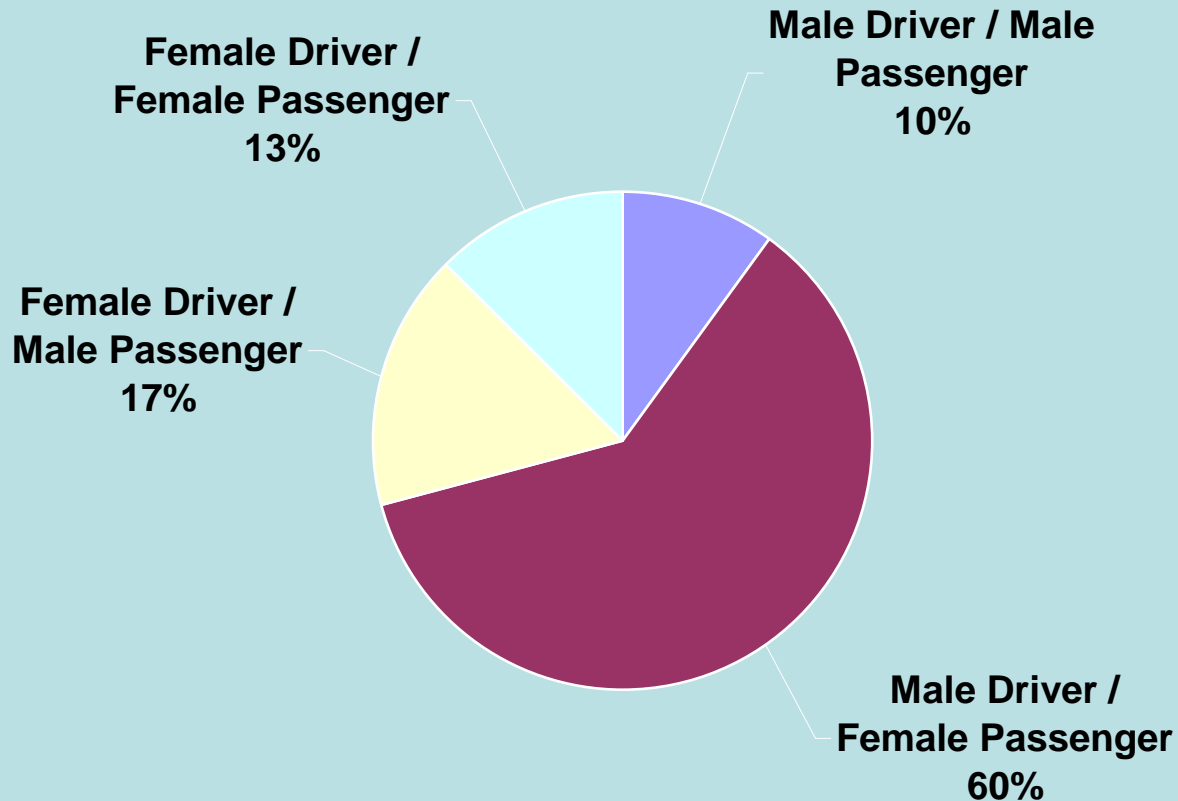
- Distributions of front seat occupants by seating position, gender and age

**Gender by Seat Position-
Two Occupants Present Per Vehicle
(GES 2003-2005- Passenger Vehicles)**



**Female passenger seat occupancy – 56%
All Ages**

**Elderly Occupants (both 65 YO+)
Gender by Seat Position-
(GES 2003-2005- Passenger Vehicles)**



**Female passenger seat occupancy – 73%
(Ages 65+)**

Observations Passenger Seat Occupancy for Ages 65+

- Female occupancy - 73%
- Female driver and Male passenger – 17%
 - NASS case review indicated male is often older than female
- Female driver and Female passenger; Male driver and Male passenger – 27%
 - Often the “most fit” is the driver
- In the vast majority of cases - passenger position appears to have occupant with lower injury tolerance

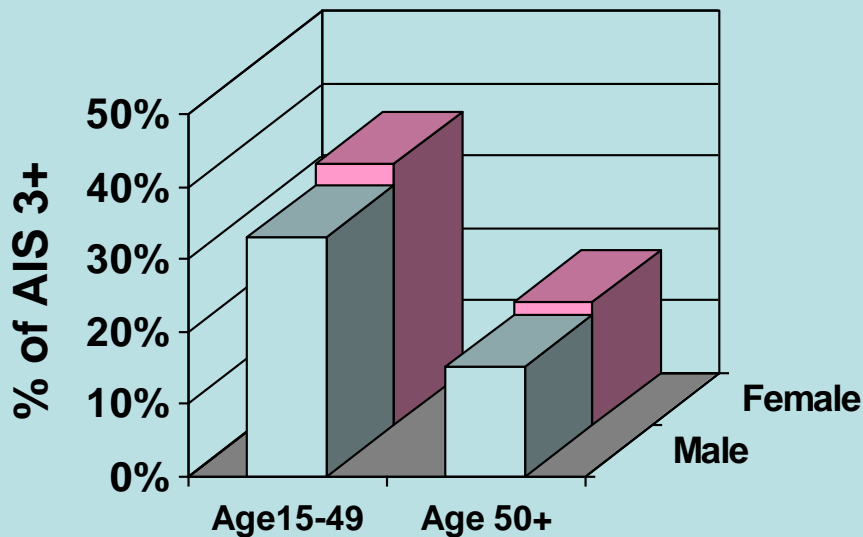
NASS Analysis – Belted in Frontal Crashes

- Examine injury distributions and rates by seating position, age and gender
- 50+ age is threshold for older occupant
- Finding:
 - Overall 74% of MAIS 3+ passenger injuries occur at severities < 40 k/hr
 - 79% of MAIS 3+ injuries to older women passengers occur at severities < 40 k/hr

MAIS 3+ Injuries Front Seat Occupants in Frontal Crashes <40 k/hr

Drivers

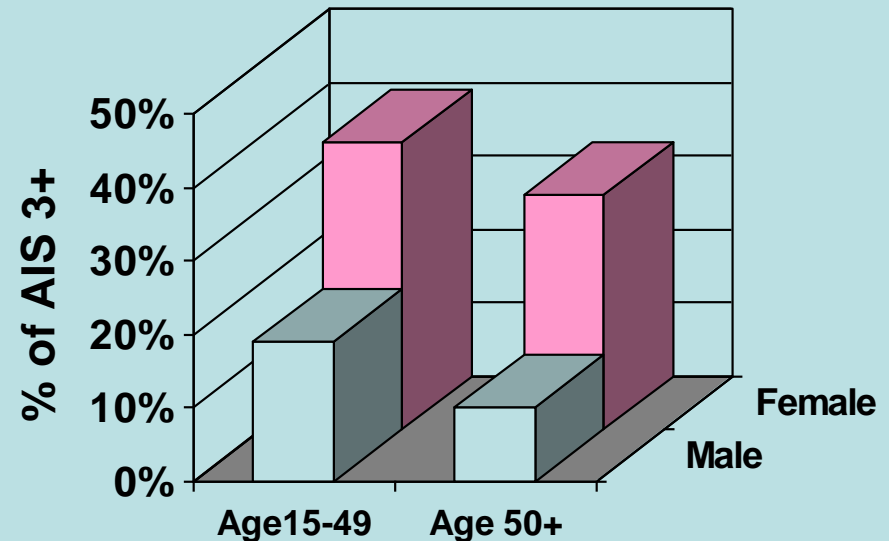
About even genders



Male Female

R F Passengers

Mostly female gender (71%)



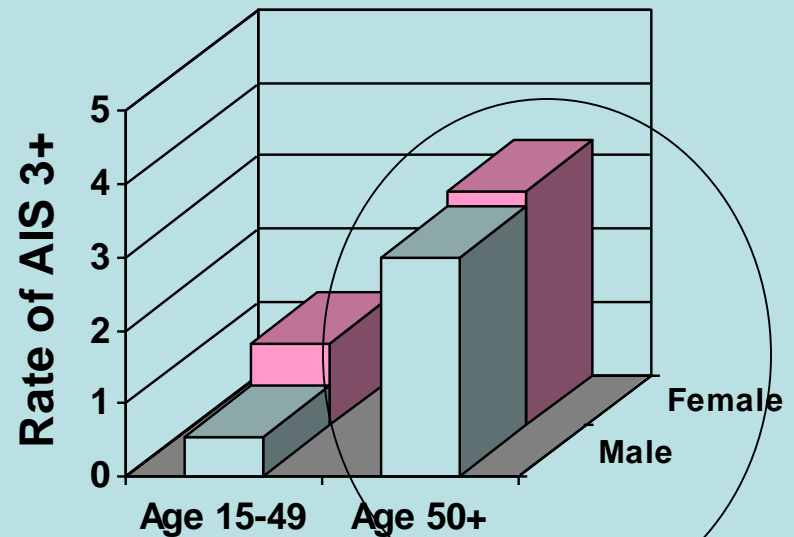
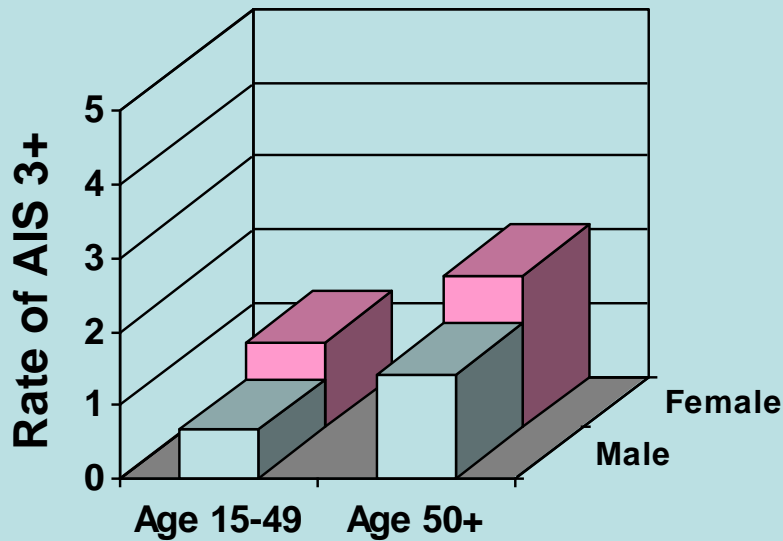
Male Female

MAIS 3+ Injury Rates Front Seat Occupants Frontal Crashes <40 k/hr

Drivers

R F Passengers

AIS 3+ rates are injured per 100 exposed Occupants



About even risks



Risk Ratios MAIS 3+: NASS Analysis

Risk Ratios for Belted Occupants in Frontal Crashes <40k/hr

Target	Control	Risk Ratio	Pass. Risk	Driver Risk
Young Male Pass	Young Male Driver	0.80	1.02	1.27
Young Female Pass.	Young Male Driver	1.15	1.46	1.27
Old Female Pass.	Young Male Driver	3.33	4.23	1.27
Old Male Pass.	Young Male Driver	3.66	4.65	1.27

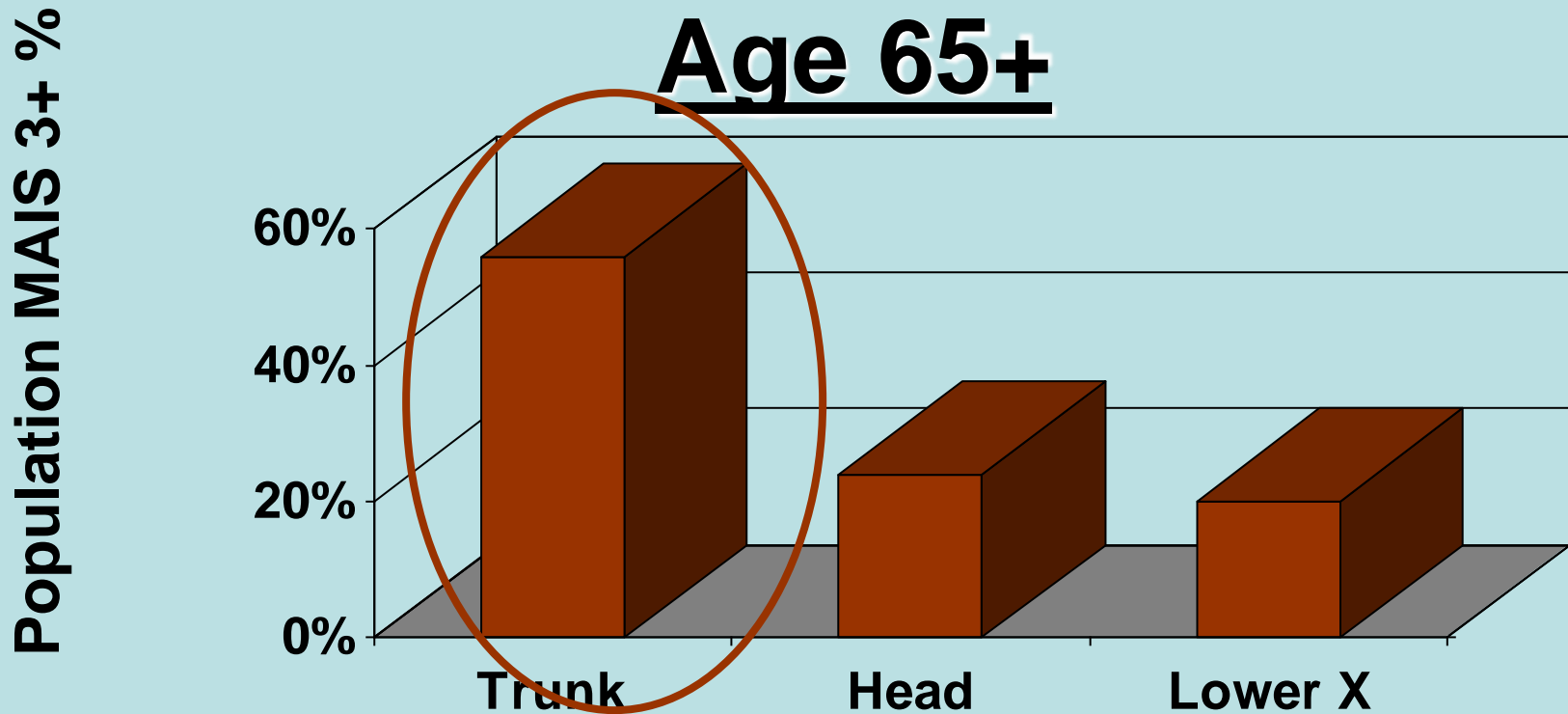
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Old Pass.	Old Driver	1.86	4.32	2.32

Distribution of Belted MAIS 3+ Frontal Crashes LT40 k/hr

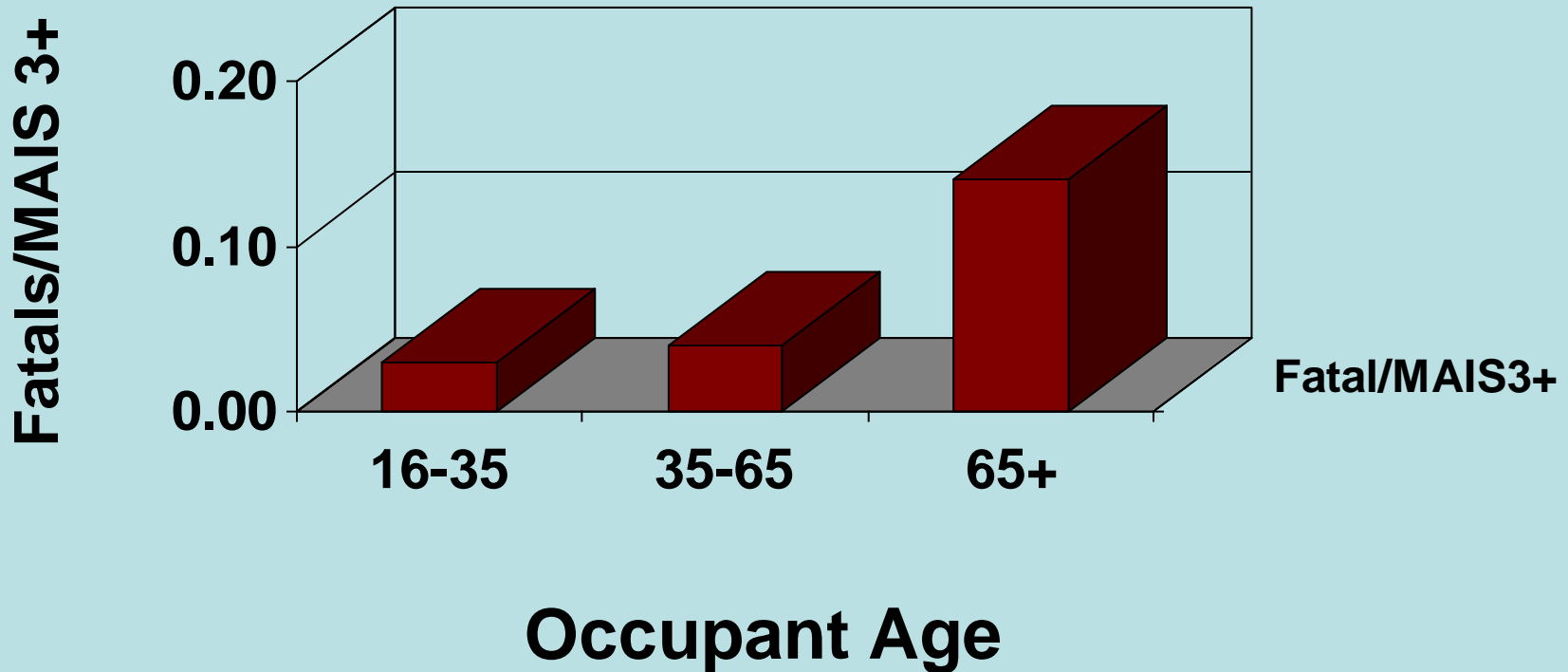
Age 65+



Chest/Abdominal injuries are highest (56%) among elderly

Body Region

Rate of Fatal Injuries Fatal/MAIS3+ Frontal Crashes Less than 40 kph



Observations – Elderly Issues Belted in Frontal Crashes (NASS)

- Given an MAIS 3+ injury, the rate of death for 65+ age is 4.6 times <35 age group
- Chest/abdominal injuries are the most common AIS 3+ injury for elderly
- MAIS 3+ injury risk increases 2.3% per year with age
- MAIS 3+ risk for females is 20% higher than for males in equivalent crashes

Discussion – FARS Analysis Belted in Frontal Crashes

- Fatal injury risk:
 - Young right front passengers vs. young drivers –NO DIFFERENCE
 - Old right front passengers vs. old drivers – 42% higher for passengers
- The difference in fatality risk is principally due to the presence of vulnerable elderly occupants in the passenger location.

Discussion –NASS Analysis Belted Adult Front Seat Passengers with MAIS 3+

- 74% were in crashes less severe than 40 k/hr
- Of these injured occupants:
 - 39% were females younger than 55
 - 42% were males and females age 55 and above.
- Both male and female elderly right front passengers had much higher injury rates than the equivalent groups as drivers.

Discussion –Belted Elderly Passengers in Frontal Crashes Less Severe than 40 k/hr (NASS)

- Older male and female passengers had approximately the same injury rate.
- Older males may tend to occupy the passenger seat when they are less agile than the (female) driver
- The more vulnerable elderly occupant may occupy the passenger seat in excess of 80% of the time

Conclusions

- Restraint systems in the right front passenger position that could be tailored to reduce chest injuries in lower severity crashes would be beneficial
- Largest beneficiaries among passengers with AIS 3+ injuries
 - 42% that are elderly males and females
 - 39% that are females younger than 55
- The benign systems could include higher technology safety belts - air belts, four point belts, age and weight appropriate force limiting belts, etc.

Acknowledgement

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Questions