



NHTSA

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Older Occupant Injury in Low- to Moderate-Severity Crashes

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Motivation

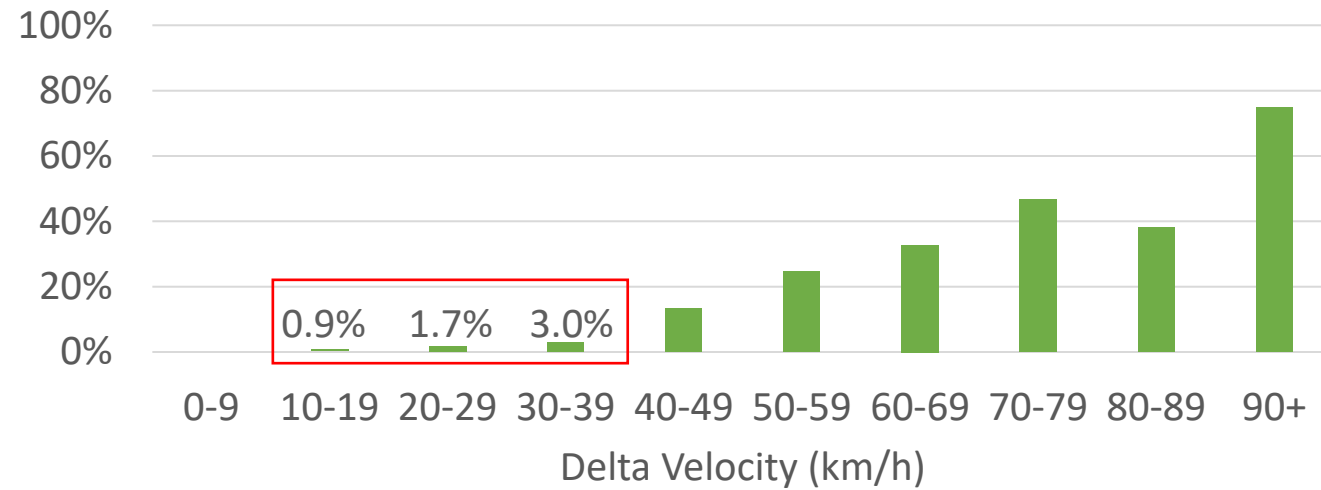
Example: Frontal Crashes

Source Data: NASS CDS 2012-2015
CISS 2017-2022

2

AIS 3+ Injury Rate

Small percentage of lower delta-V crashes result in serious injury to any body region



Motivation

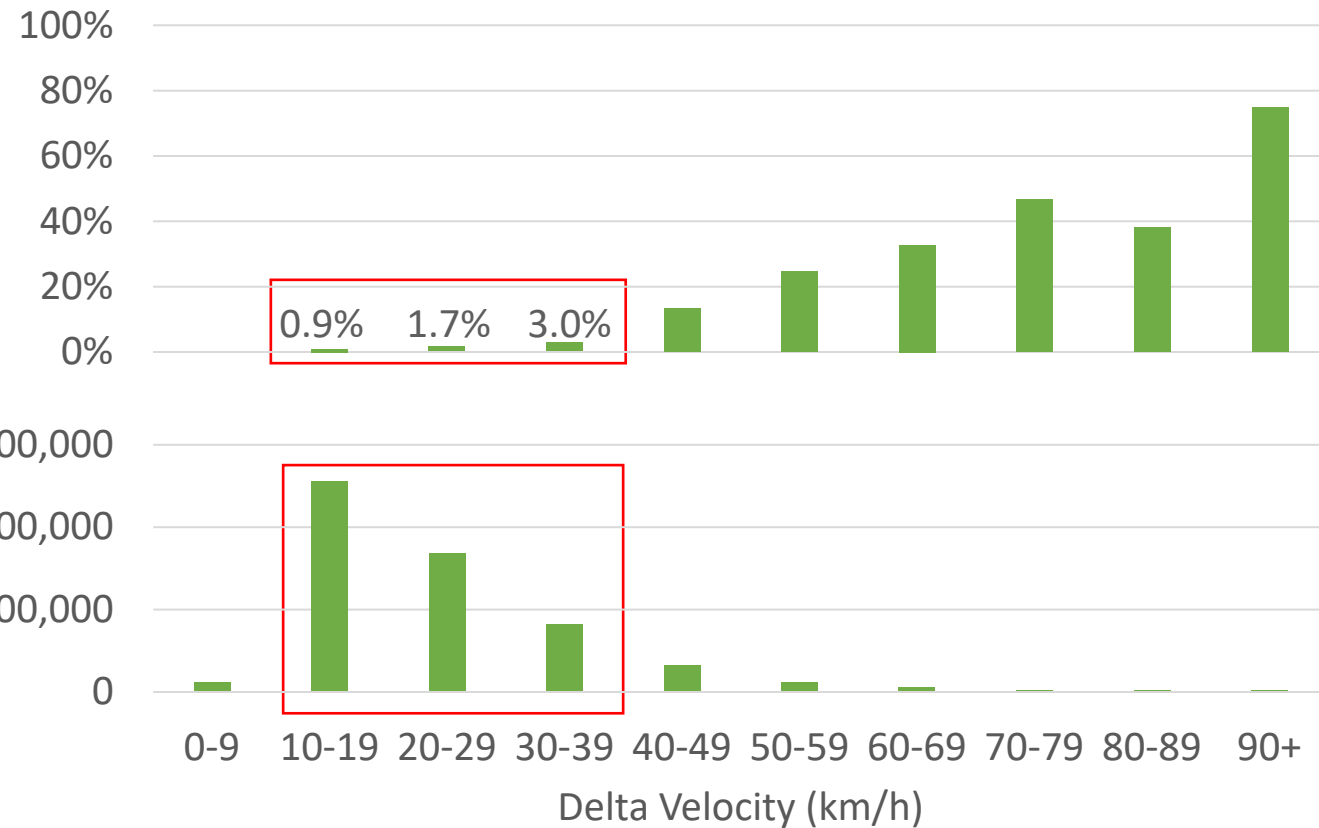
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Number of occupants in crashes

Yet, large number of occupants are in lower delta-V crashes

Motivation

Example: Frontal Crashes

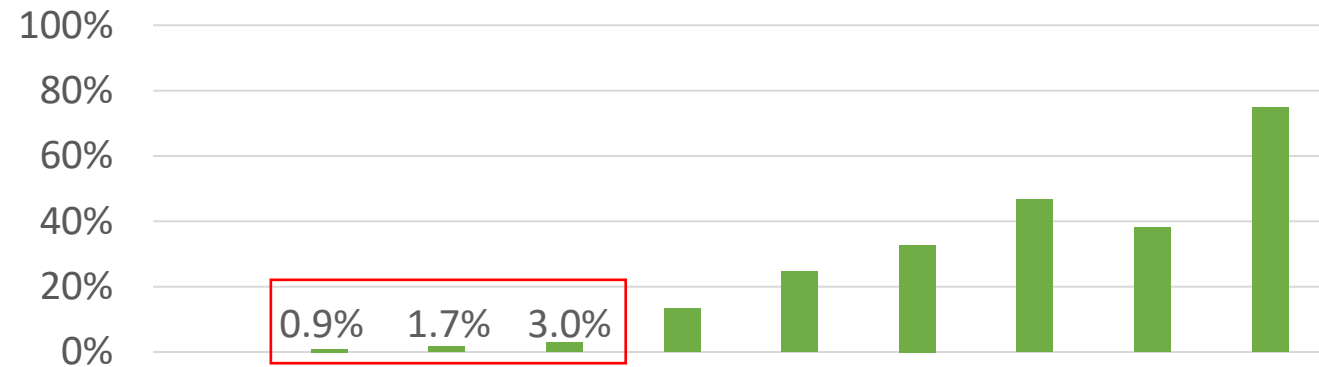
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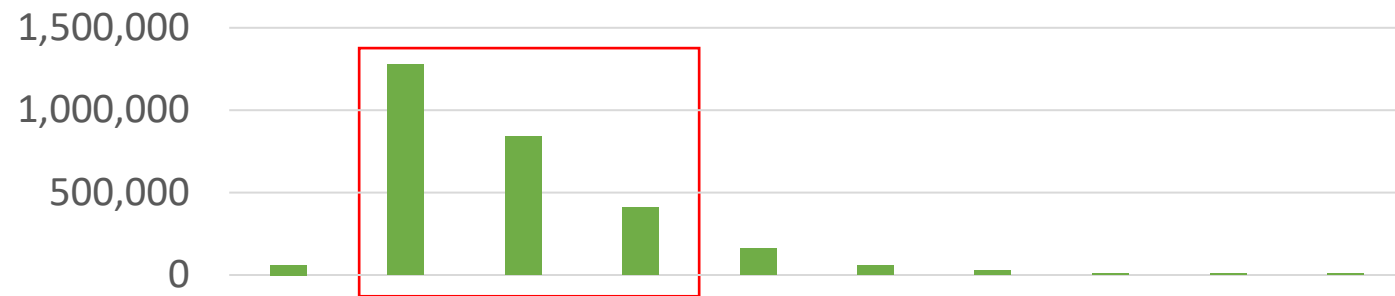
AIS 3+ Injury Rate

Small percentage of lower delta-V crashes result in serious injury to any body region



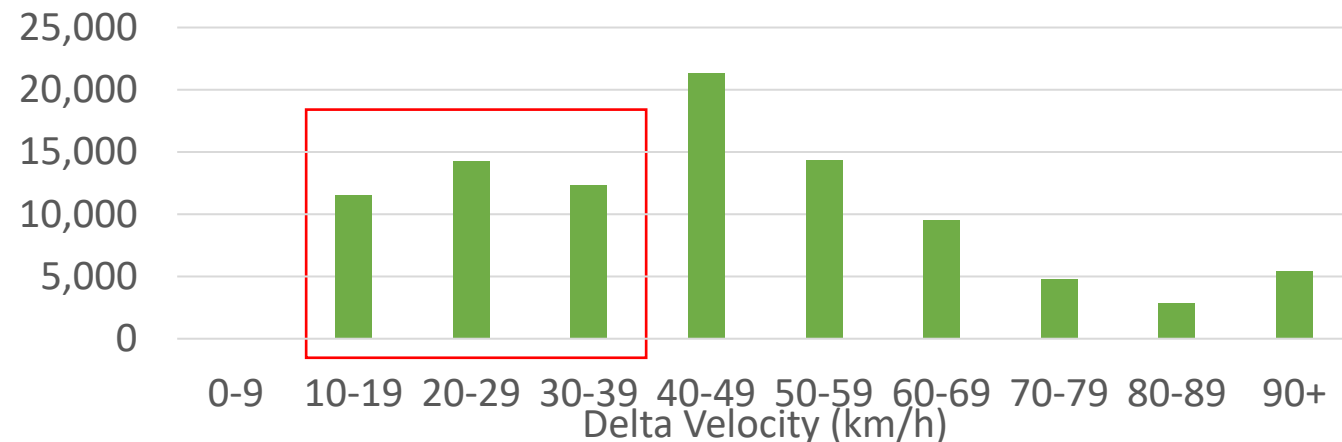
Number of occupants in crashes

Yet, large number of occupants are in lower delta-V crashes



Number of occupants with AIS 3+ Injury

Injury to even small proportion of those very frequent lower delta-V crashes leads to substantial number of serious injuries



Motivation

Example: Frontal Crashes

Source Data: NASS CDS 2012-2015
CISS 2017-2022

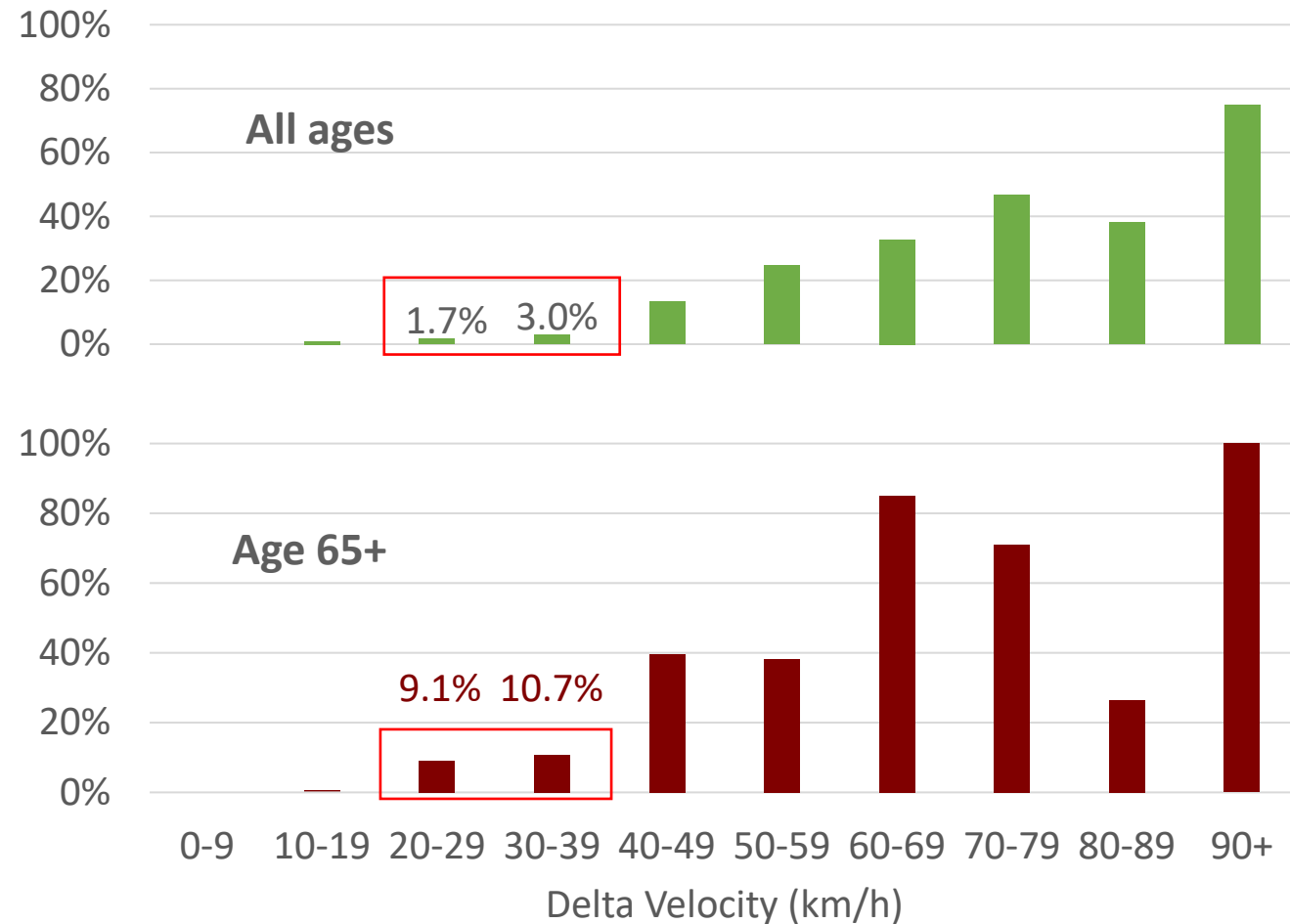
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AIS 3+ Injury Rate

Small percentage of lower delta-V crashes result in serious injury to any body region

Older occupant AIS 3+ Injury Rate

Older occupants at lower delta-V:
Percentage of occupants with serious injury much **higher** than for younger occupants



Serious injuries can occur at relatively low Delta V **for all ages**
But **older occupants** are especially vulnerable to injury at these
low- to moderate-Delta V

Objective: Compare crash severity in injury crashes in field data to typical crash test severity, with a focus on older occupants

- **Weighted analysis of combined CDS/CISS datasets**

Zhang et al. DOT HS 812 801, 2019

- **Excluded**

- Ejections
- Unknown change in velocity (ΔV) or Age

- **Case Weight >3000 ↓ to mean weight for category**

Mallory et al. DOT HS 813 147, 2021

NASS CDS 2012-2015

- AIS 2005/08
- Vehicles towed due to damage

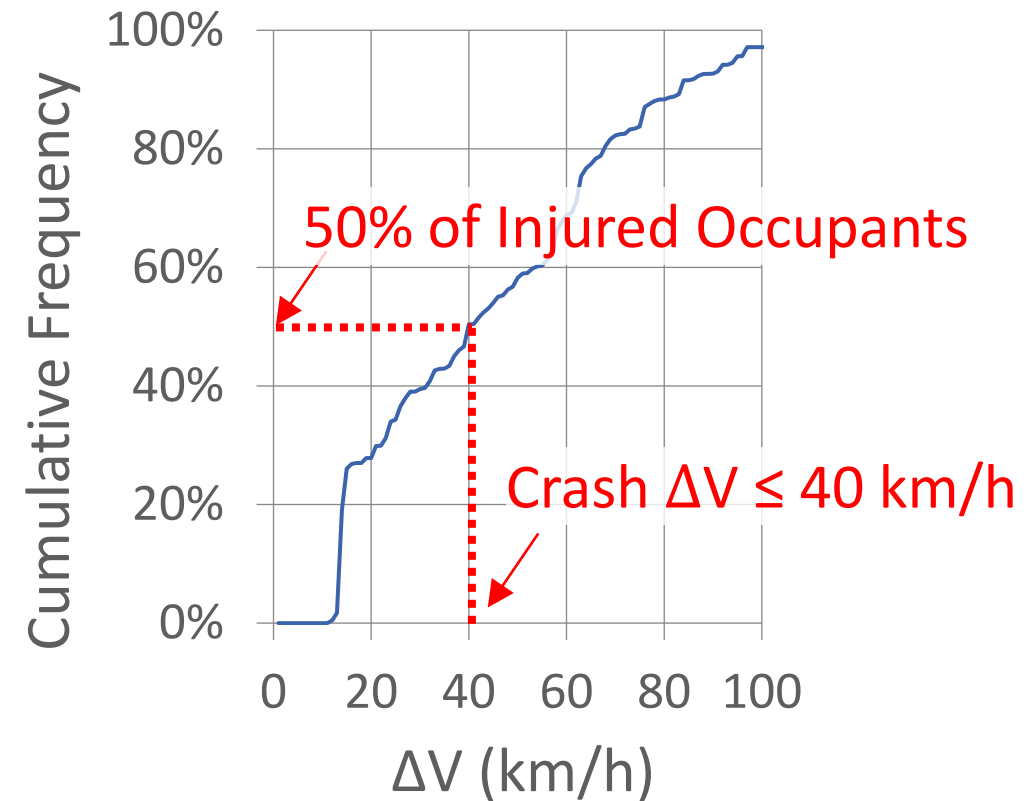
CISS 2017-2022

- AIS 2015
- Vehicles towed

- **Analysis by ΔV**
 - Cumulative injury frequency plots by ΔV
 - Percentage of cases that occur at or below given ΔV
 - Compared crash severity distribution to ΔV in corresponding crash tests
- **Analysis by:**
 - Impact direction
 - Age group
 - Sex
 - Model Year
 - Seat Position
- **Analysis includes restrained occupants only**

Example:

Cumulative frequency of injury cases
(in a given crash type)



- ΔV estimates from resultant ΔV in CDS and CISS cases
 - WinSmash ΔV estimates in NASS CDS and CISS can underestimate (Hampton & Gabler 2010; Gabler & Sharma 2017) or overestimate (Johnson & Gabler 2014; Watson et al. 2023) EDR-measured ΔV
- Dataset includes cases involving atypical crashes:
 - Multiple impacts
 - Out of position occupants
 - Unusual crash circumstances
- Ultimately, detailed case analysis needed to understand the specific conditions associated with older occupant injuries in low- to moderate-severity crashes

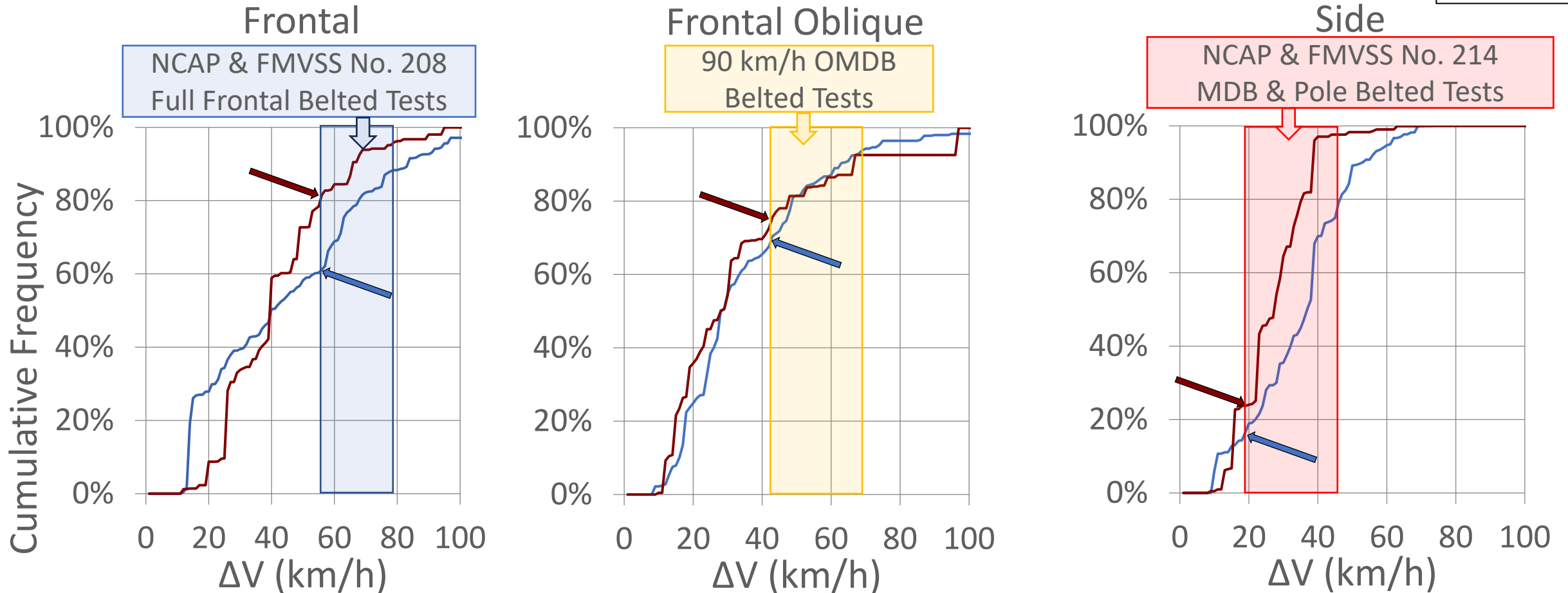
Occupants with AIS 3+ Injuries by Age Group

Results

Belted Occupants with AIS 3+ Injuries by Age Group

13-64

65+



Serious injuries in frontal and frontal oblique crashes:

- All ages: Majority at lower ΔV than typical crash test ranges
- Age 65+: 70-80% are lower ΔV than crash test ranges

Side impact:

- Most serious injury crashes overlap severity range of crash tests

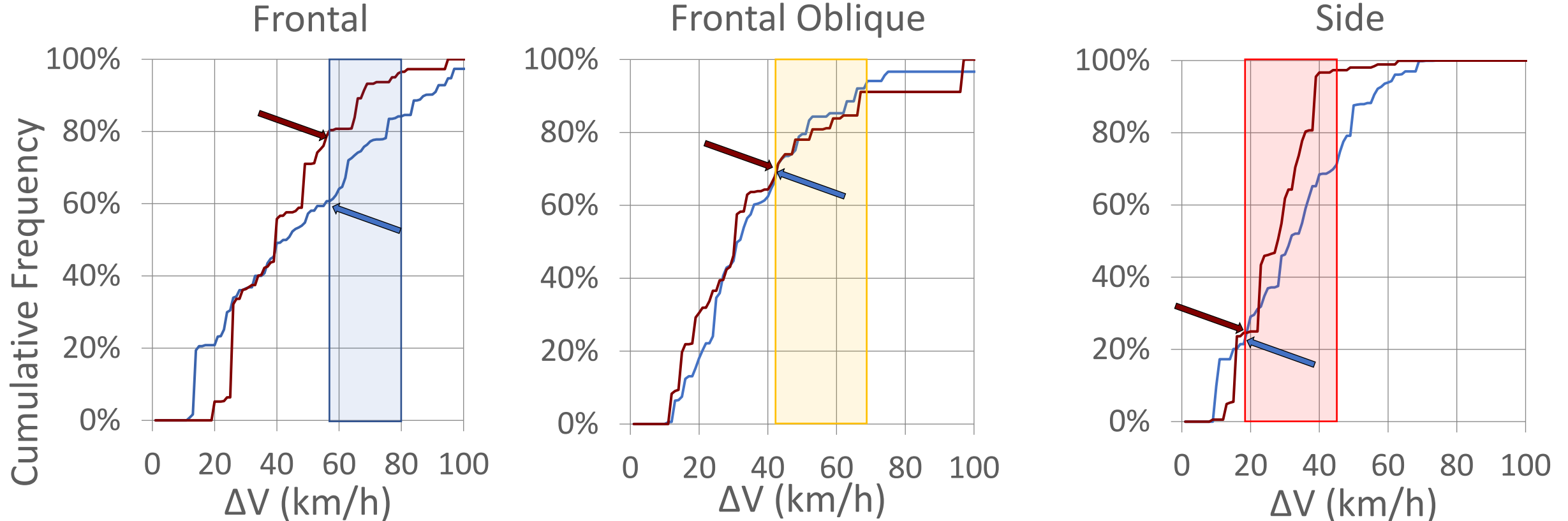
Occupants with AIS 3+ **Thoracic** Injuries by Age Group

Results

Belted Occupants with AIS 3+ Thoracic Injuries

13-64

65+



Frontal & Frontal Oblique

- Majority of AIS 3+ thoracic injury cases $\Delta V <$ crash tests
- Almost 80% of 65+ serious thoracic injury in frontal crashes with $\Delta V <$ crash tests

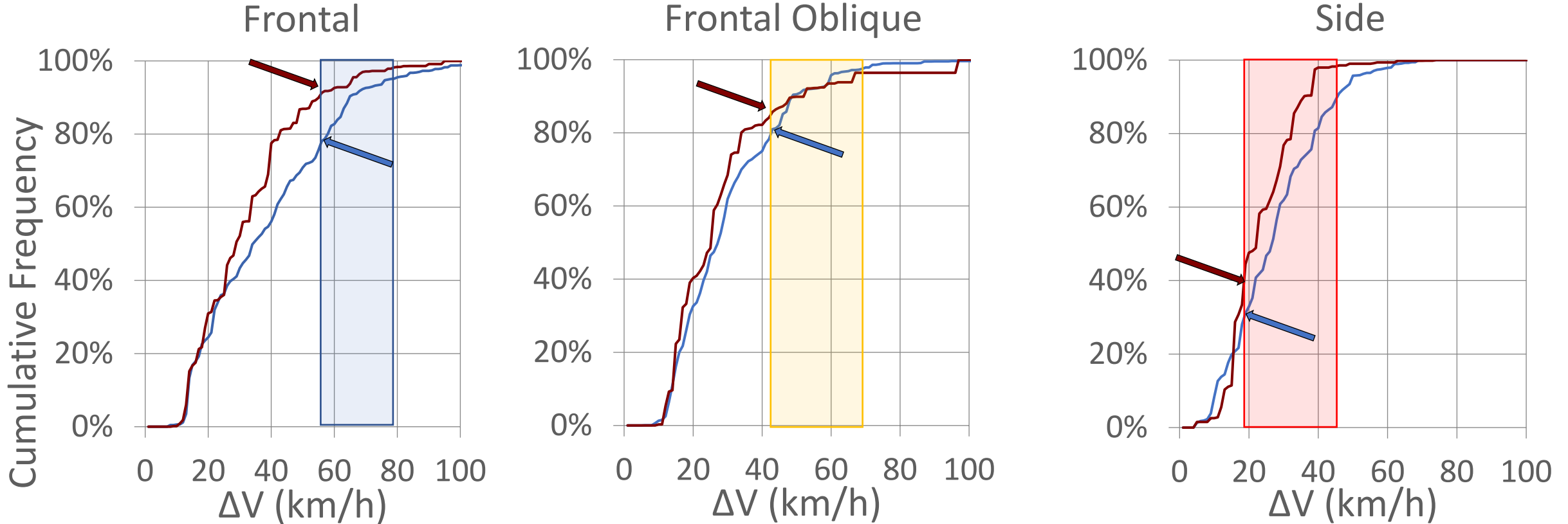
Occupants with AIS 2+ Injuries by Age Group

Results

Belted Occupants with AIS 2+ Injuries

13-64

65+



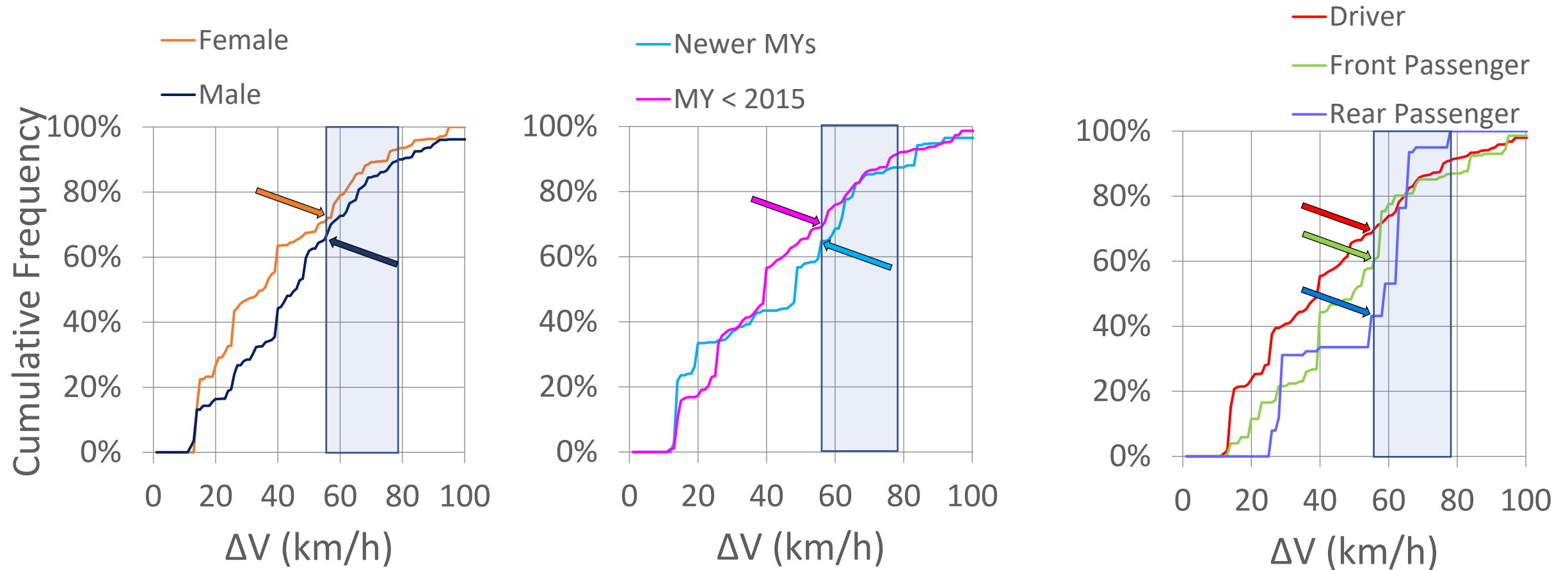
When moderate injuries are included:

- Proportion of older occupants injured at lower ΔV than corresponding crash tests even higher: 90% for frontal crashes and > 80% for frontal oblique

MAIS 3+ in Frontal Crashes:
By Sex, Model Year, & Seat Position

Results

Belted Occupants with AIS3+ Injuries in Frontal Crashes



Proportion of seriously-injured occupants below crash test ΔV range:

- Relatively similar for males/females & early- and late-model year vehicles
- Varies by seat position (* Limited number of cases available for rear-seat analysis)

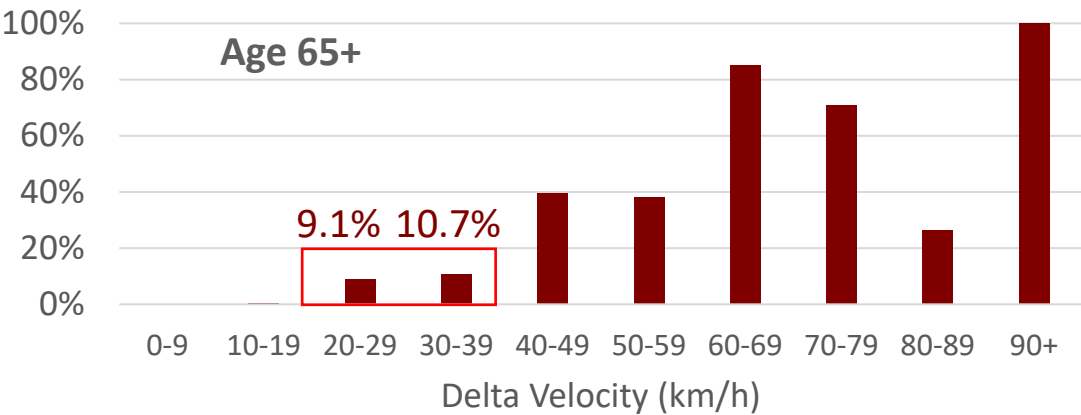
Summary: All Ages

- Frontal & Frontal Oblique Crashes:
 ΔV in majority of injury crashes < crash test ΔV range
 - Among MAIS 2+, MAIS 3+ or AIS 3+ thoracic injury cases
 - In additional frontal analysis: True for male & female occupants, different model year ranges
- Side Impact crashes:
 - Crash test ΔV range overlaps with majority of real-world injury cases

Summary: Age 65+

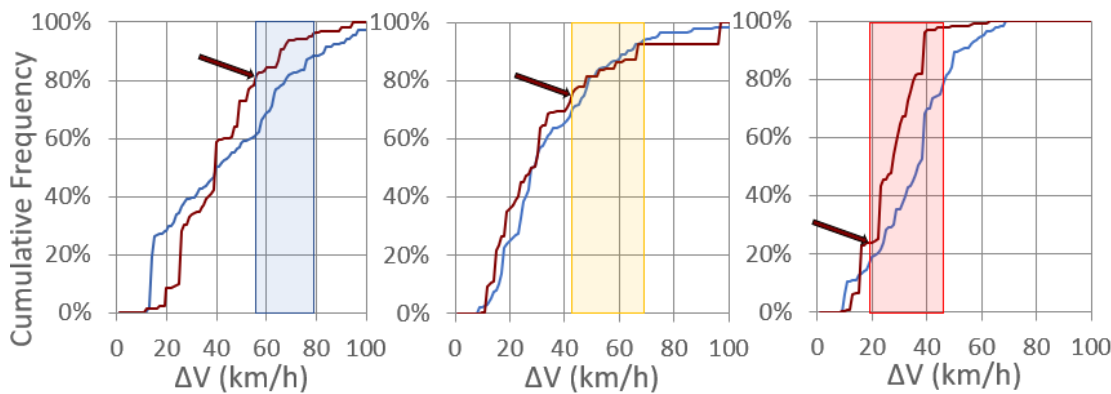
Older occupants:

- Much higher rates of injury than younger occupants at $\Delta V < 40$ km/h
- High-frequency of crashes in that severity range



Proportion of older occupant injuries occurring in crashes less severe than typical crash tests

- Frontal: ~ 80%
- Frontal oblique: ~ 70%
- Side: ~ 20-25%



- Consumer and regulatory crash tests targeting higher-severity crashes have:
 - Motivated substantial improvements in occupant protection
 - Improved crash survivability in high-energy crashes dramatically
 - Improved safety in low- and moderate-severity crashes
- However, even with the low injury risk expected in low- and moderate-severity crashes
 - High frequency of crashes → Frequent injury
 - Older occupants remain particularly vulnerable
- Crash tests at low- or moderate-severity could:
 - Provide insight into older occupant injury risk
 - Evaluate the effects of existing countermeasures developed for higher speed crashes

Needs and Challenges for Low- to Moderate-Severity Testing

- Need detailed field data for lower-severity crashes, particularly among injured older occupants
- Current injury risk curves may not be valid at low risk levels
 - Need improved risk curves or new methods for estimating risk (e.g. Andricevic et al. 2018, Forman et al. 2022 & Lubbe et al. 2024)
- Confirmation of ATD biofidelity, repeatability & reproducibility, and sensitivity for lower-severity loading
 - Lower-severity thorax sensitivity previously verified for THOR-50M and WorldSID-50M (Rhule et al. 2011)
- Crash configurations, risk curves, and ATDs need to be appropriate for assessment of older occupant population



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