

A Review Of Driver Injury Changes with the Introduction of Sled Certified Airbags

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Presentation Outline

- Study Goals
- Methods
 - Data Sources
 - Study Population
 - Statistical Procedures
- Findings
- Discussion
- Conclusions



Study Goals

- Determine if sled certified airbags offer adequate protection to drivers in all crashes and during crashes of high severity
- Identify changes in occupant injuries by body region with the introduction of sled certified airbags



Source Data

National Automotive Sampling System, Crashworthiness Data System (NASS/CDS)

- Sample of minor, moderate and severe crashes where one or more vehicles is towed from the scene
- Approximately 4,500 crash cases annually
- Cases are collected across the country and assigned a weight to reflect the total incidence of crashes across the US



NASS CDS

- Case data sources
 - Detailed crash investigation
 - Vehicle and crash scene inspections performed
 - Occupant Interviews and Injury Data Compiled
- Each case is reconstructed based on scene and vehicle based evidence
- For each case, as many as 650 data elements are coded describing the crash



Injury Data in NASS CDS

- Injuries are coded using the Abbreviated Injury Severity (AIS) code
 - Body region injured
 - Details of anatomic structure involved
 - Severity of the injury
 - Uninjured
 - AIS 1 Minor Injury
 - AIS 2 Moderate
 - AIS 3 Serious
 - AIS 4 Severe
 - AIS 5 Critical
 - AIS 6 Maximum
 - Maximum AIS or MAIS is the highest level of injury sustained



Study Inclusion Criteria

- Crashes:
 - 1997-2005 Crash Years
 - Crash mode is Frontal
- Vehicles:
 - Model year 1994 and later
 - Vehicle Make and Model known
 - Driverside airbag present
 - Airbag type is known



Identification of Airbag Type

- Data sources used to classify sled certified versus first generation systems
 - 2000 NASS CDS Coding and Editing Manual
 - Data from Safercar.gov
 - Vehicle manufacturers information submitted to U. Maryland, NSC
- Airbag presence based on Highway Loss Data Institute (HLDI) vehicle data

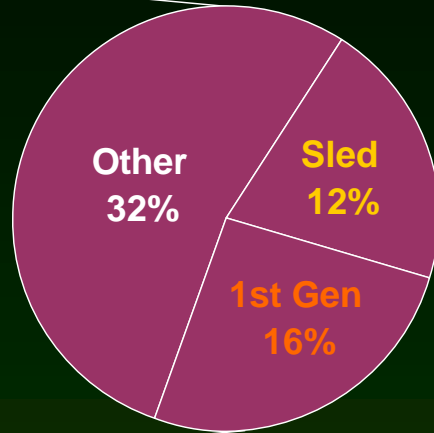
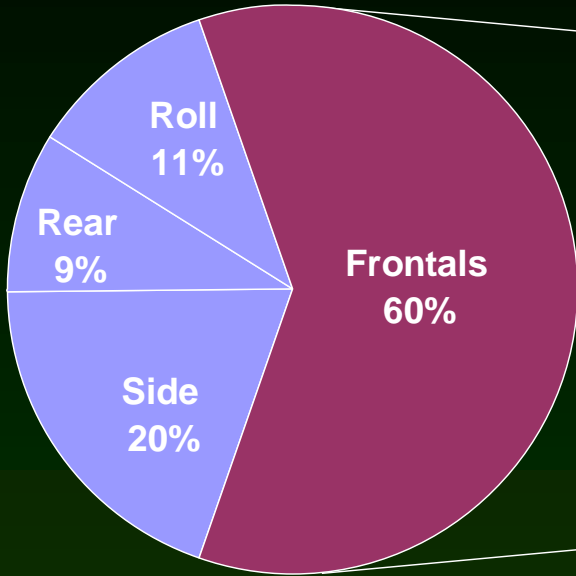


Exclusion Criteria

- Rollover crashes- Any event where one or more quarter turns occurs
- Driver was completely or partially ejected
- Safety belt use was unknown
- Driver age was unknown
- Driver gender was unknown
- Injury of unknown severity



Study Population- Drivers



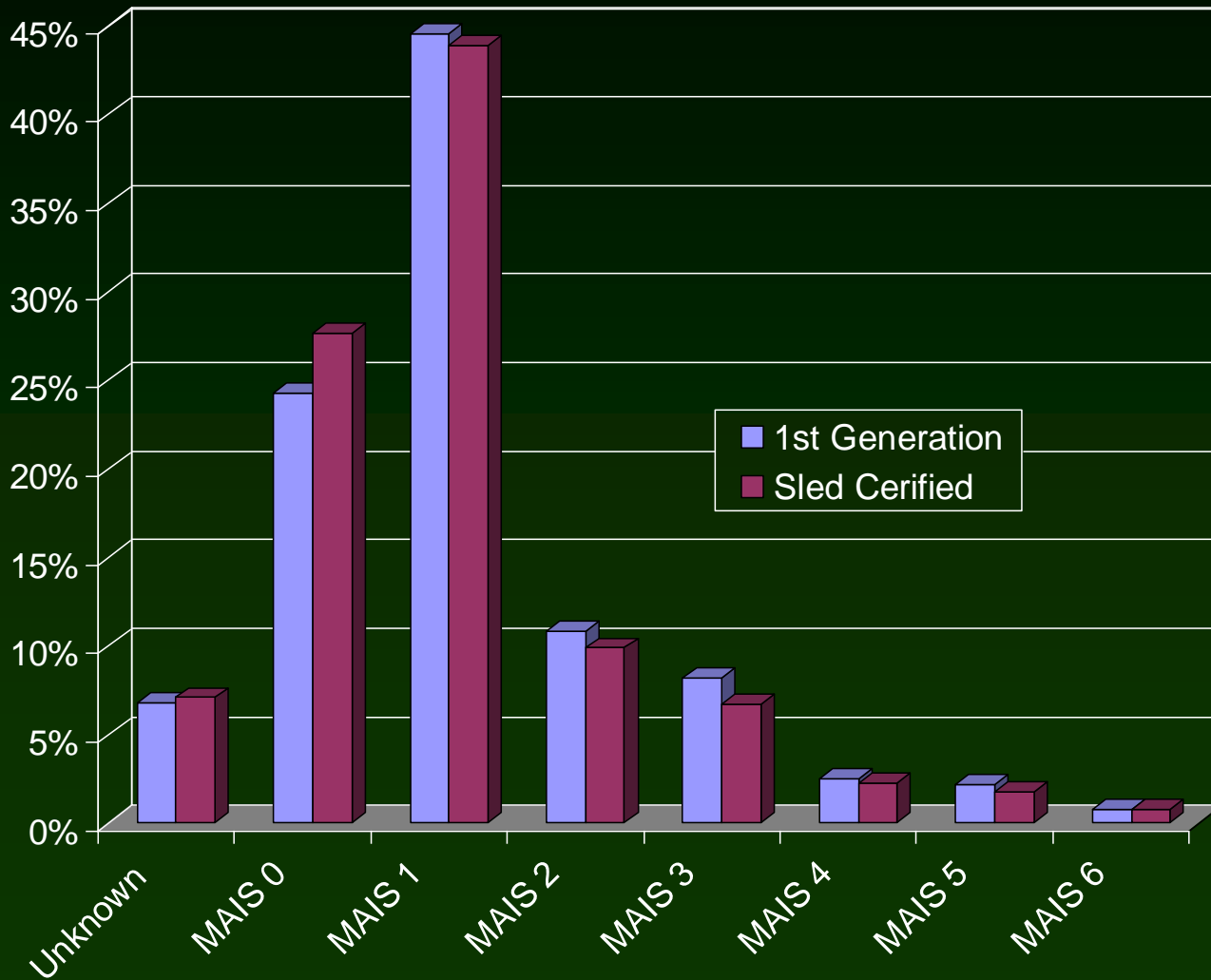
Total 1997-2005 NASS
CDS Population
(tow-away crashes)

Sled Certified Airbags:
2.5 Million
6,295 Unweighted Cases

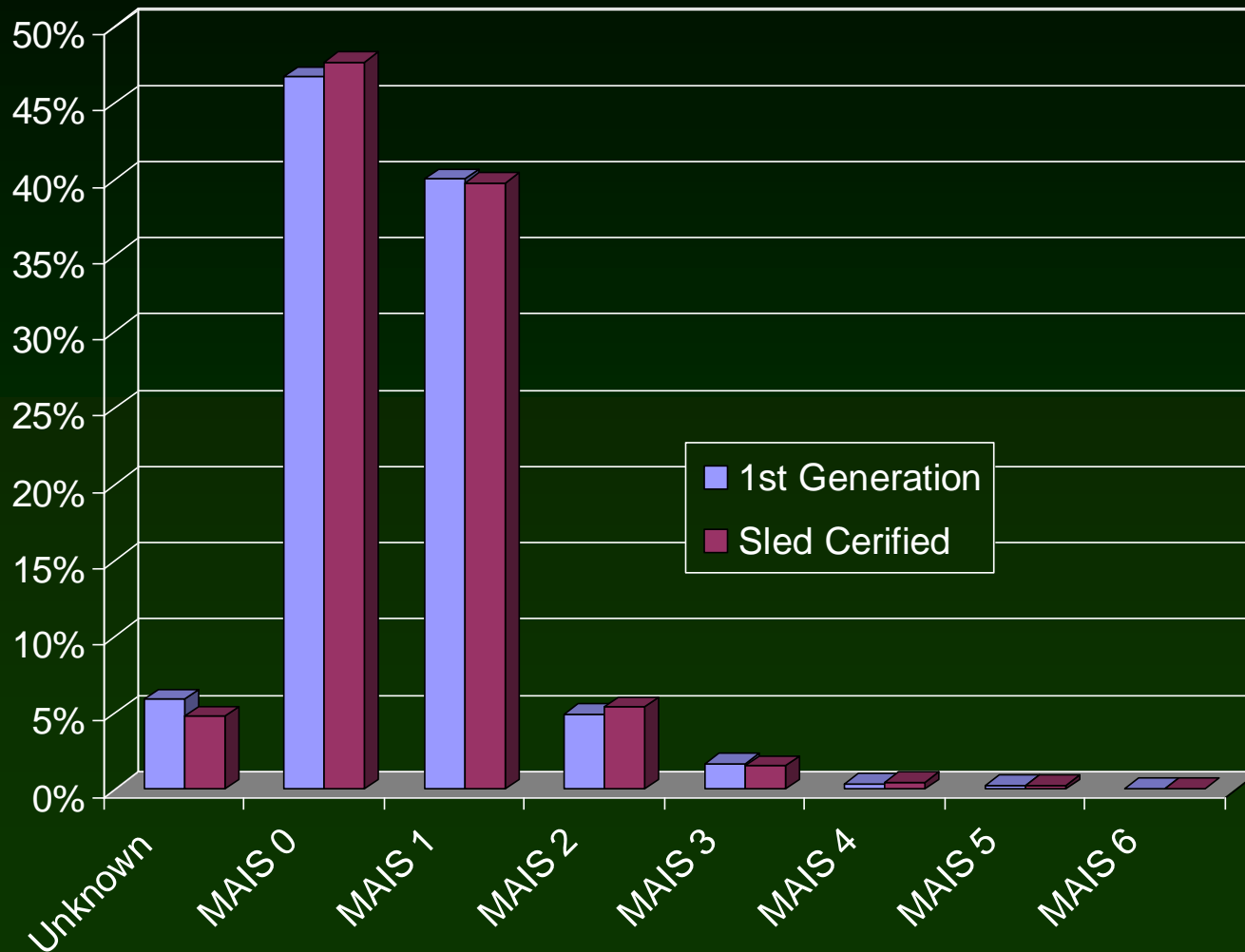
First Generation Airbags Present:
2.8 Million
5,416 Unweighted Cases



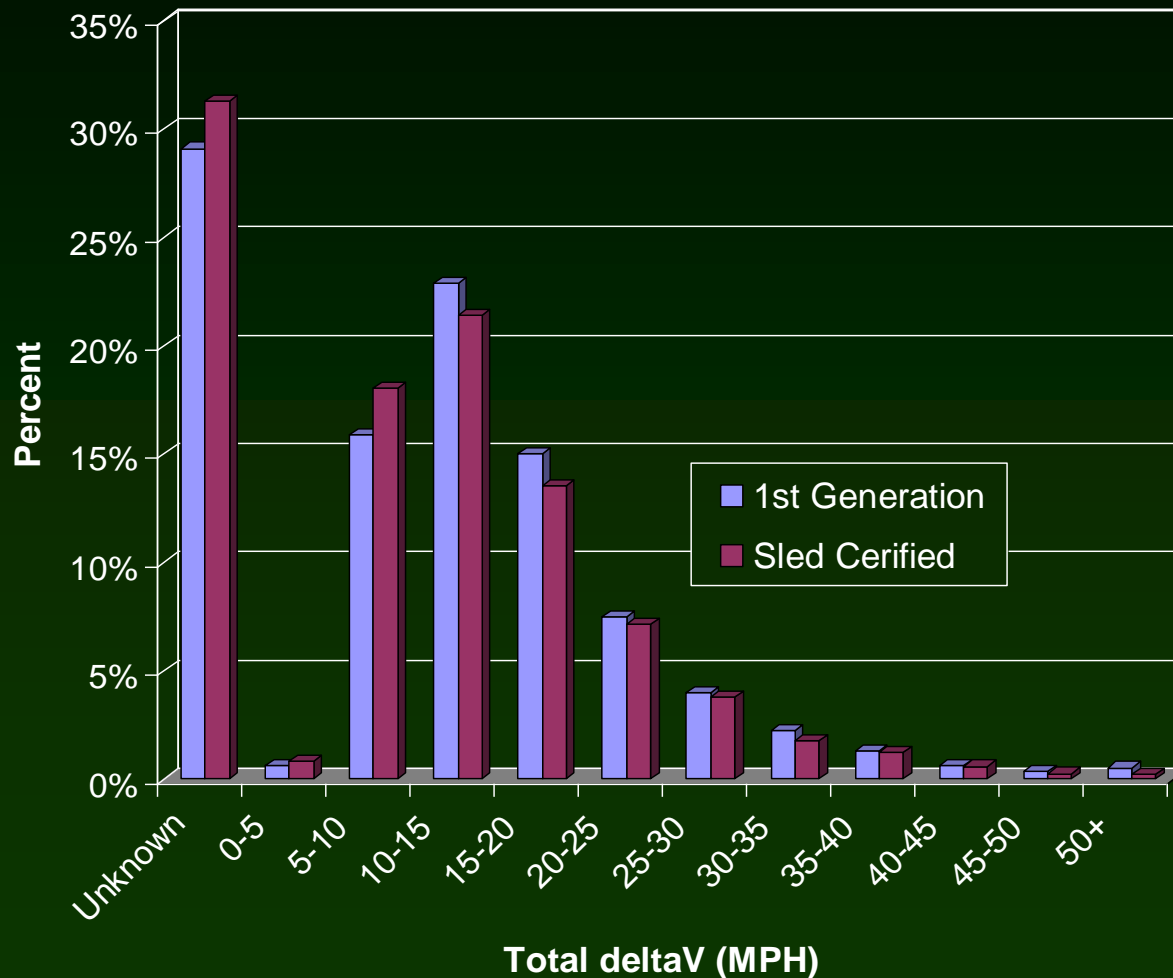
Injured Drivers in NASS CDS- Unweighted Cases



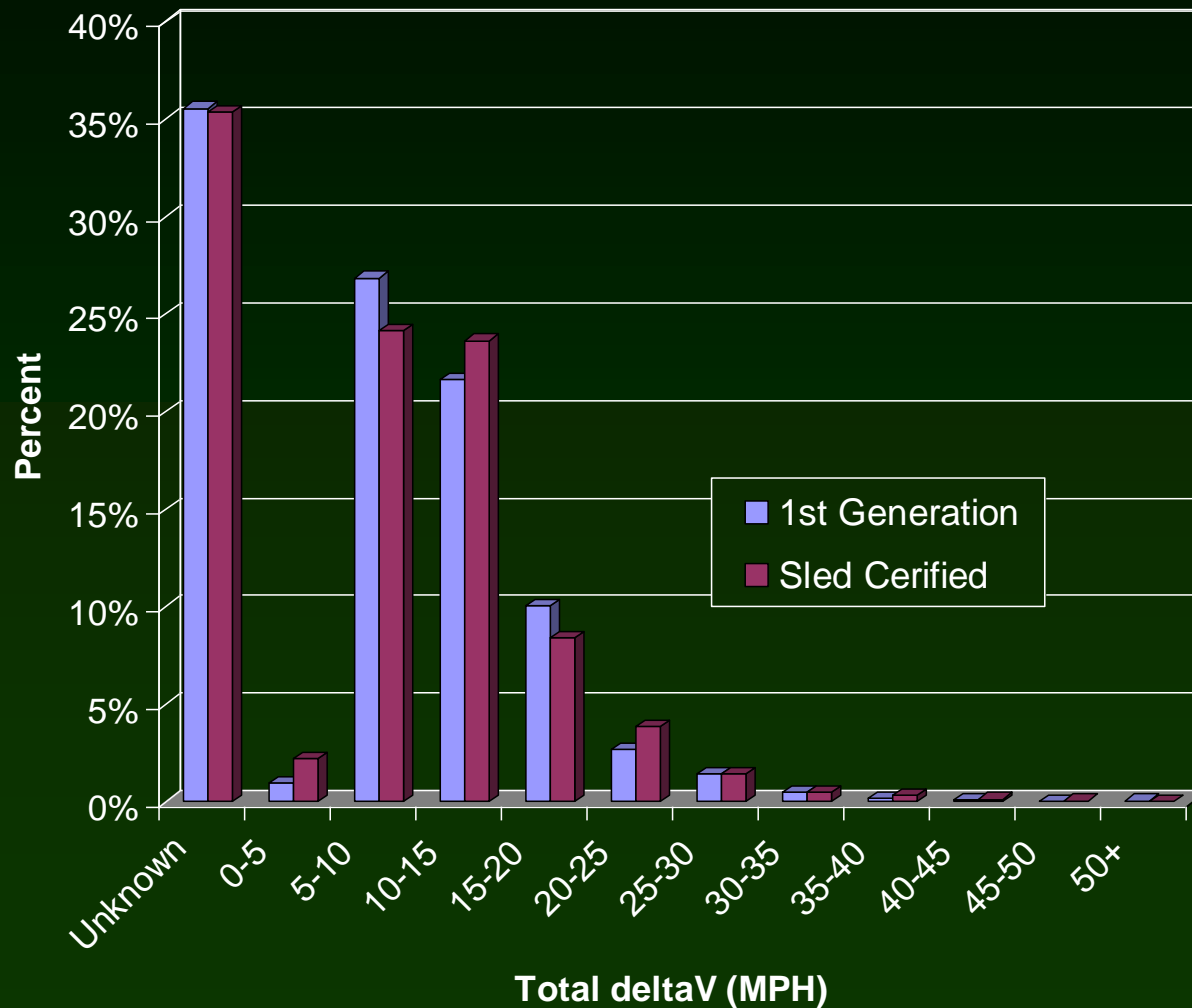
Injured Drivers in NASS CDS- Weighted Cases



Study Population by Total deltaV- Unweighted



Study Population by Total deltaV- Weighted

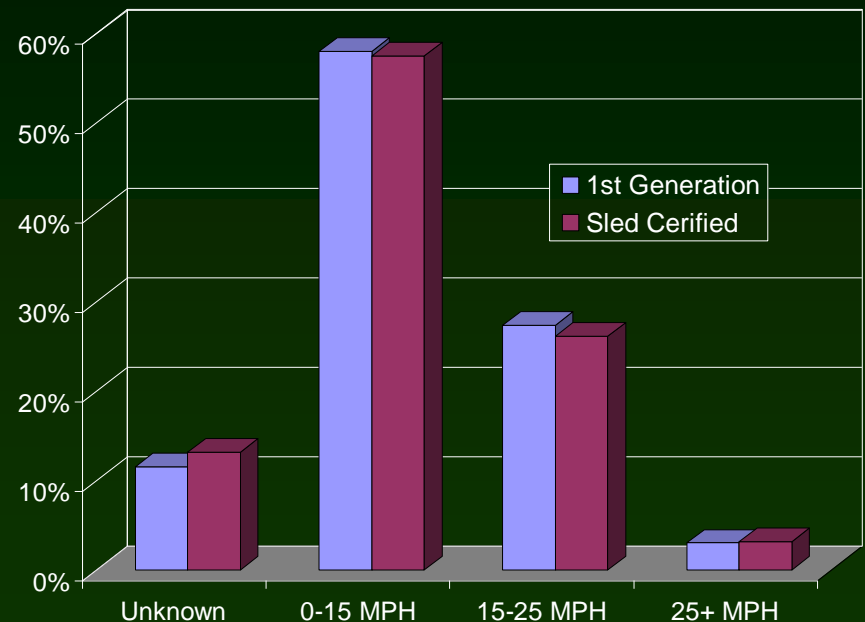


Application of Estimated deltaV's

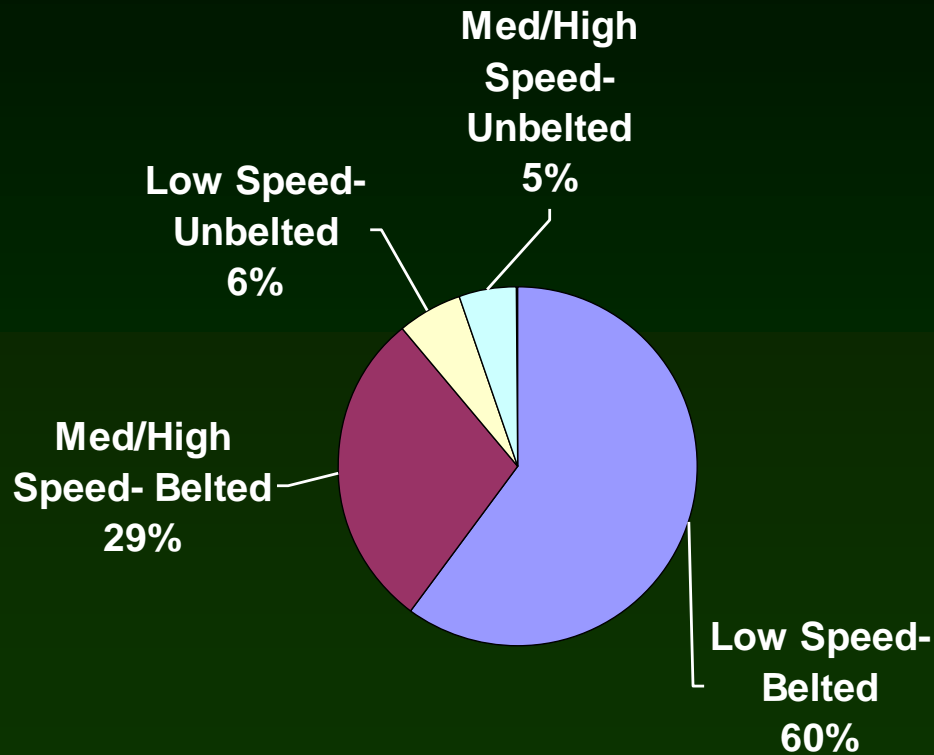
When deltaV is unknown:

- NASS researchers estimate deltaV's and classify them into 1 of 3 categories
 - 0-15 MPH
 - 15-25 MPH
 - 25+ MPH
- By classifying all cases (known and unknown deltaVs) into these categories, we retain ~90% of frontal crash cases for analysis

All Cases: Including Known and Estimated deltaV's



Study Populations by Reported Belt Use and Crash Severity



Within the study population:

- Belted drivers involved in low speed crashes (0-15 MPH) make up the largest percent of the population
- Unbelted drivers involved in Medium to High speed crashes (15 MPH+) make up the smallest percent of the population



Statistical Methods



Injury Outcome Variables (Dependent)

MAIS1

MAIS2+

MAIS3+

AIS1 by Body Region

AIS2+ by Body Region

AIS 90 Body Regions- Head, Face, Neck, Chest,
Spine, Abdomen, Upper Extremity, Lower Extremity





MAIS 1

MAIS 2+



MAIS 3+



Influential Crash Factors (Independent)

Airbag Type

Crash DeltaV

Safety Belt Use

Intrusion

Multiple Impact Events

Vehicle Type

Occupant Age

Occupant Gender



Statistical Procedure

- Logistic regression analysis
 - Odds Ratios Computed- comparing injury risk for drivers with a sled certified airbag present vs. injury risk for drivers with a first generation airbag present
- Regression models control for other influential factors / confounders



$$\text{OddsRatio} = \frac{\frac{\text{Injured}_{\text{2nd}}}{\text{Non_Injured}_{\text{2nd}}}}{\frac{\text{Injured}_{\text{1stGen}}}{\text{Non_Injured}_{\text{1stGen}}}}$$



Interpretation of Odds Ratios

- If the computed odds ratio is less than 1
 - sled certified airbags have a protective effect compared to 1st generation airbags
- If the computed odds ratio is greater than 1
 - sled certified airbags show an increased risk of injury compared to 1st generation airbags



Findings



Overall Findings- Belted Occupants

Overall Injury

MAIS1 Injury for Belted Occupants

$$OR_{\text{Sled:First Gen}} = 0.78 \text{ (95\% CL: 0.67, 0.91)}$$

MAIS2+ Injury for Belted Occupants

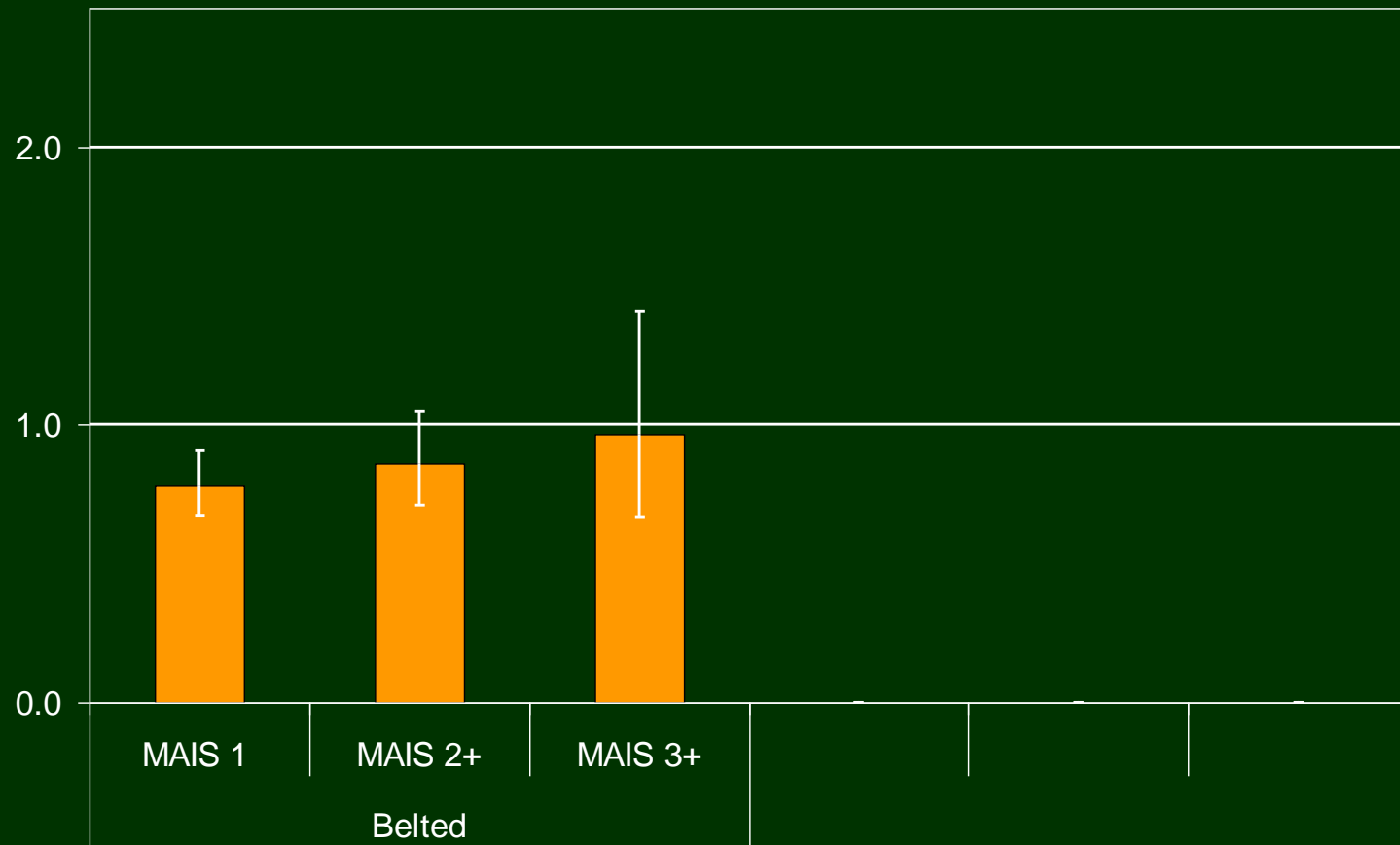
$$OR_{\text{Sled:First Gen}} = 0.87 \text{ (95\% CL: 0.62, 1.23)}$$

MAIS3+ Injury for Belted Occupants

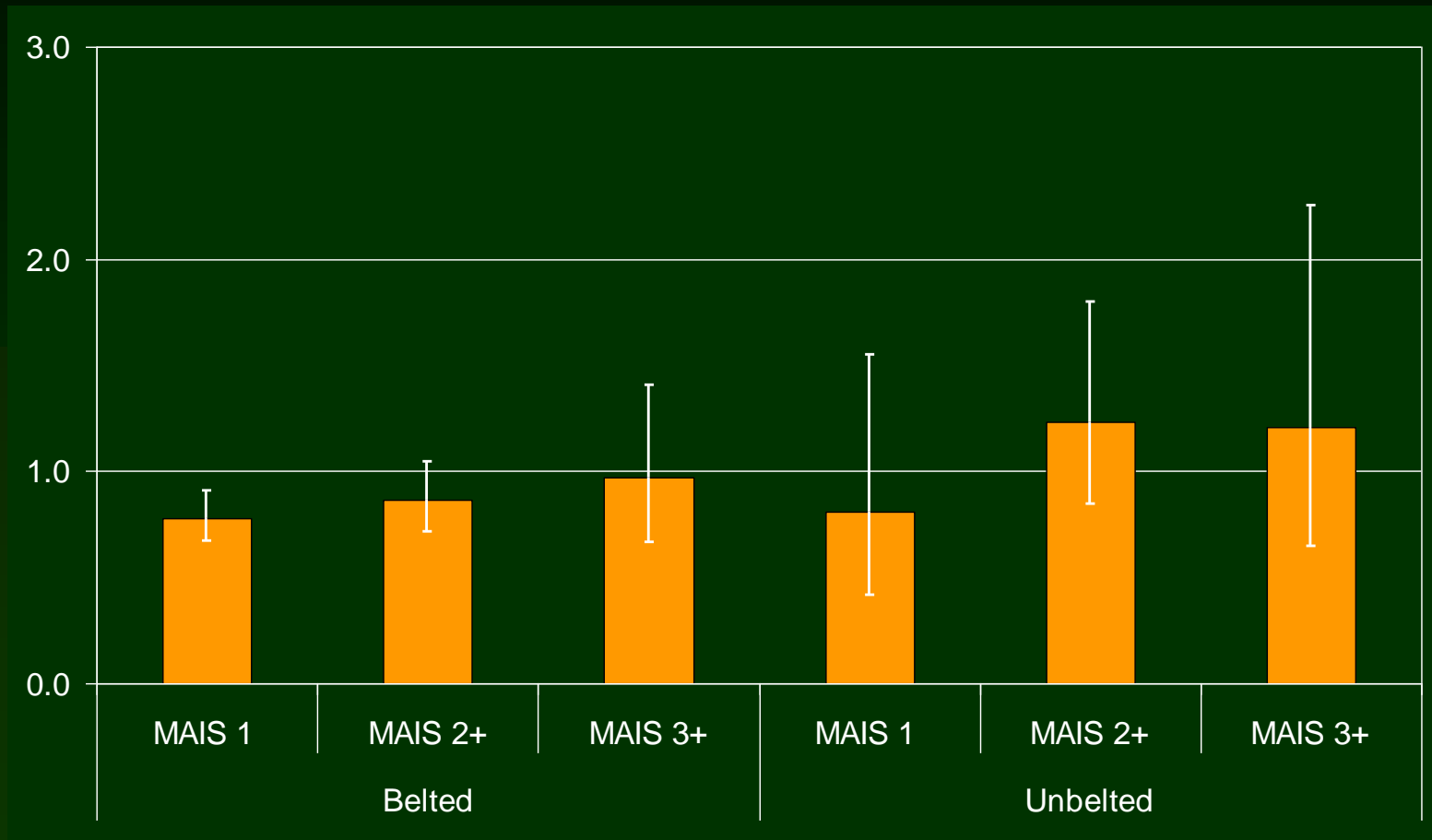
$$OR_{\text{Sled:First Gen}} = 0.96 \text{ (95\% CL: 0.55, 1.67)}$$



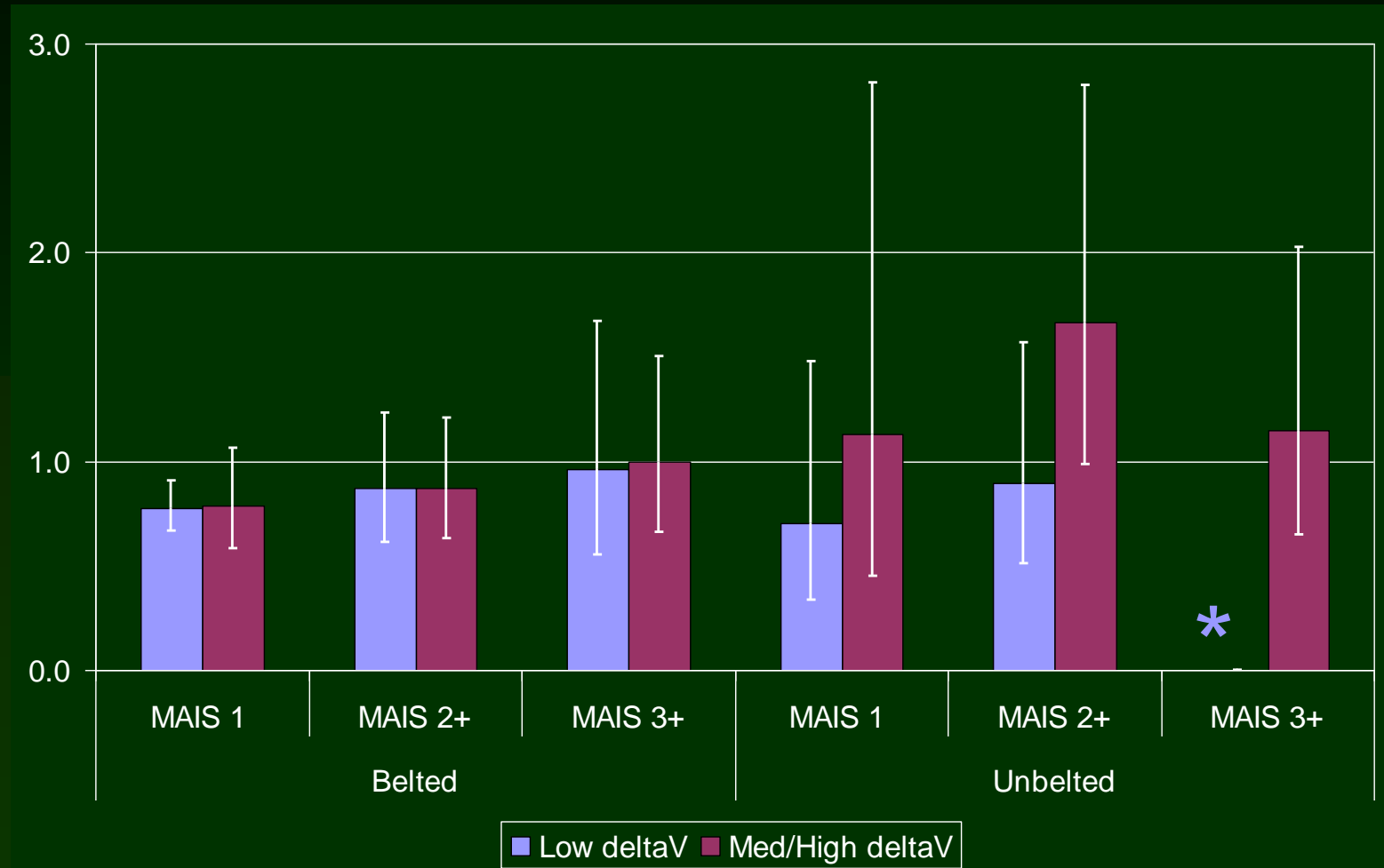
Impact of Sled Certified Airbags on Overall Injury- Belted Drivers



Impact of Sled Certified Airbags on Overall Injury



Impact of Sled Certified Airbags on Overall Injury- by deltaV



* Insufficient Data for Analysis



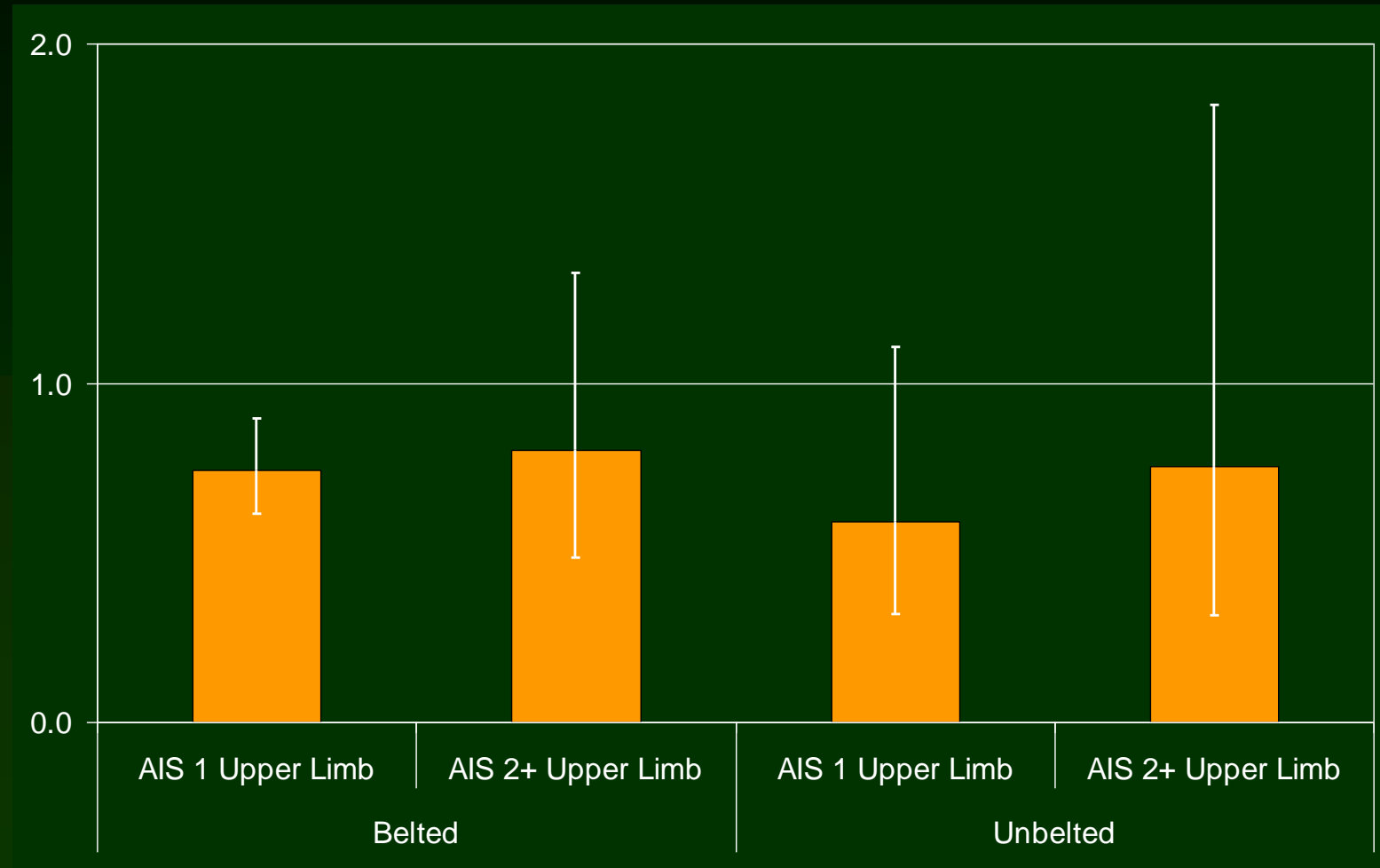
Presentation of Body Region Findings

<u>Body Region</u>	<u>Belted</u>	<u>Unbelted</u>
Upper Limb	✓	x
Lower Limb	✓	x
Face	✓	✓
Chest	??	✓
Head	x	x
Neck	x	x
Spine	x	x
Abdomen	x	x

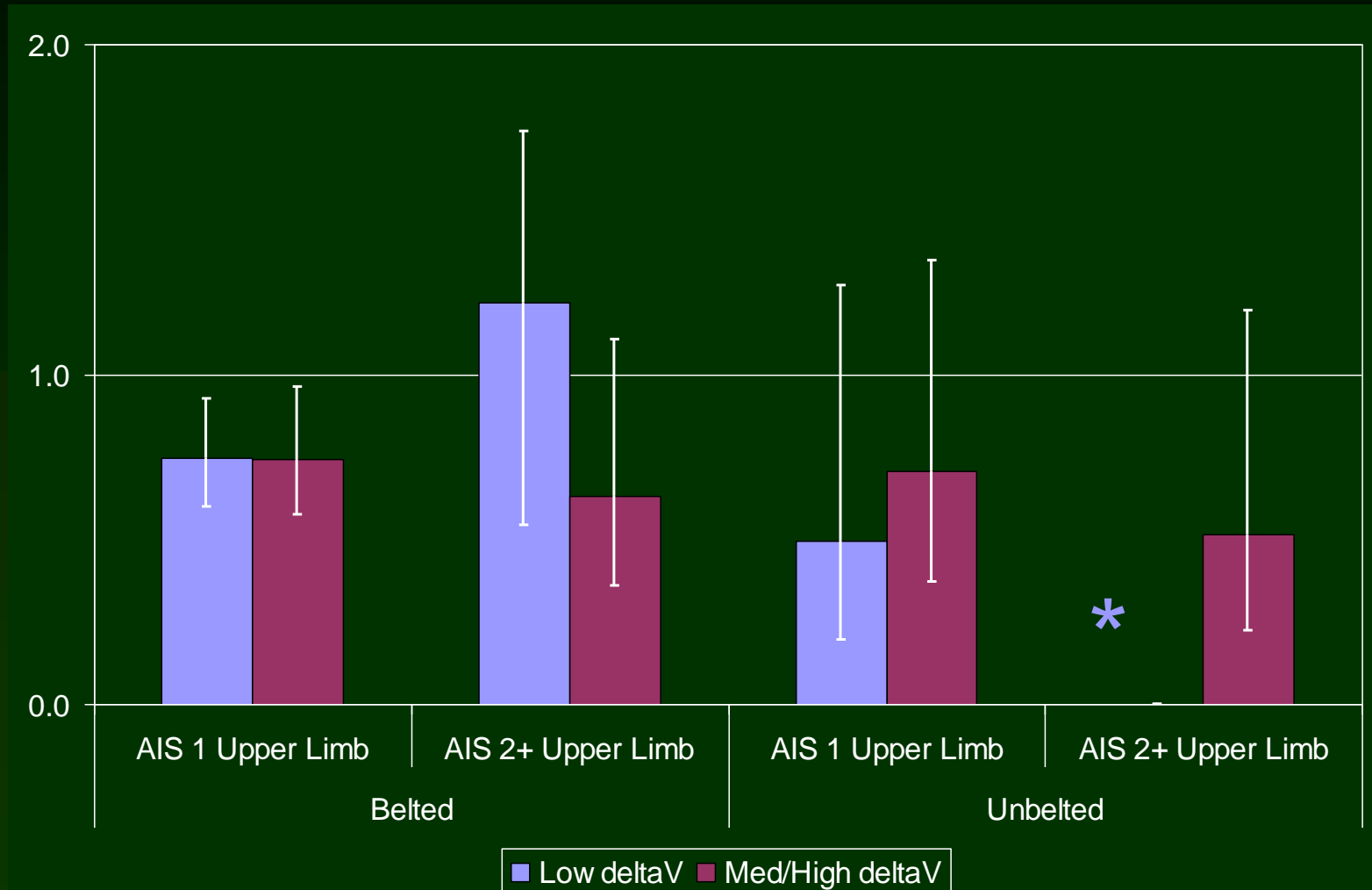
✓ = Statistically Significant Result, x=Non-Significant,
??=Marginal Significance



Body Region- Upper Limb



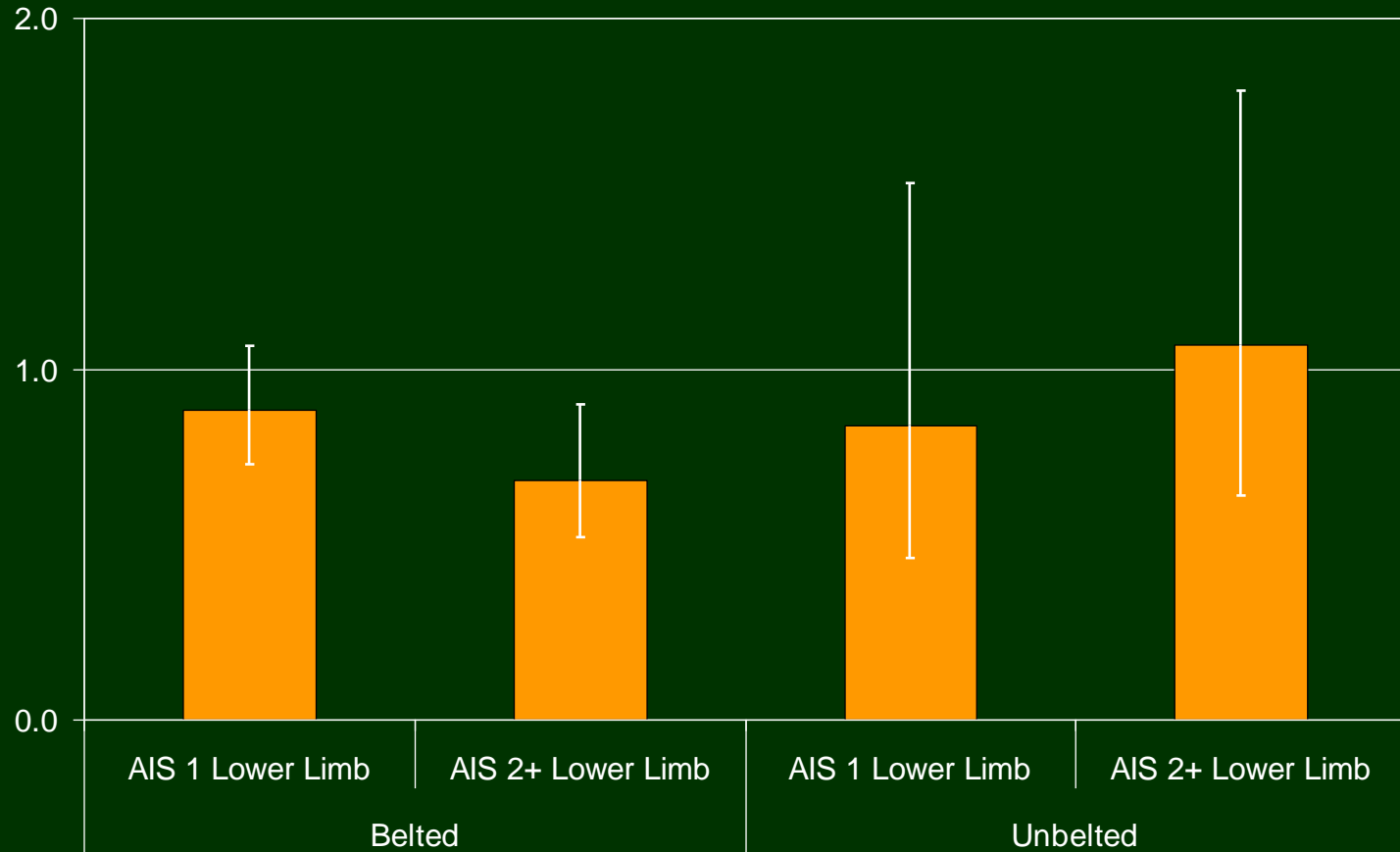
Body Region- Upper Limb by deltaV



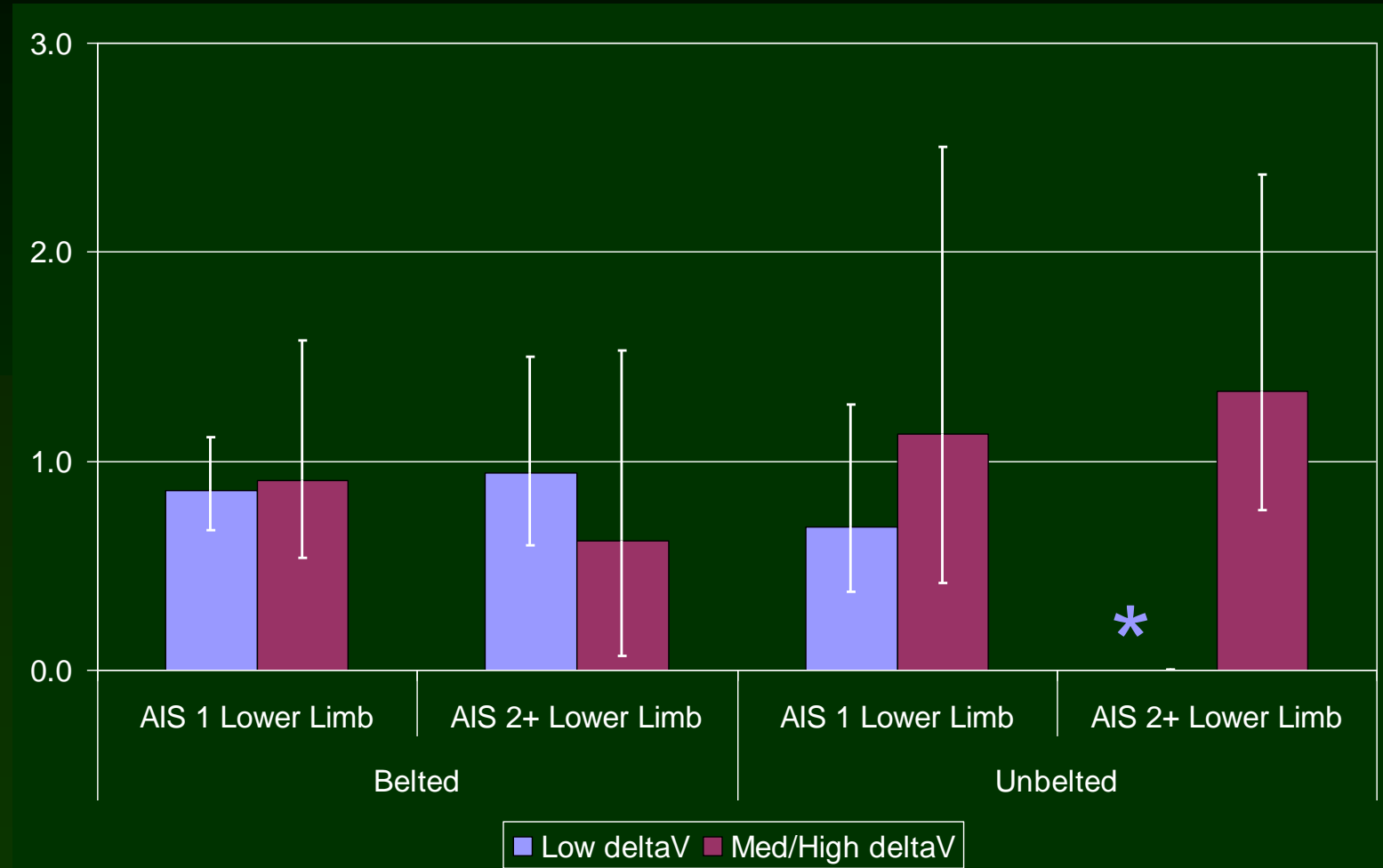
* Insufficient Data for Analysis



Body Region- Lower Limb



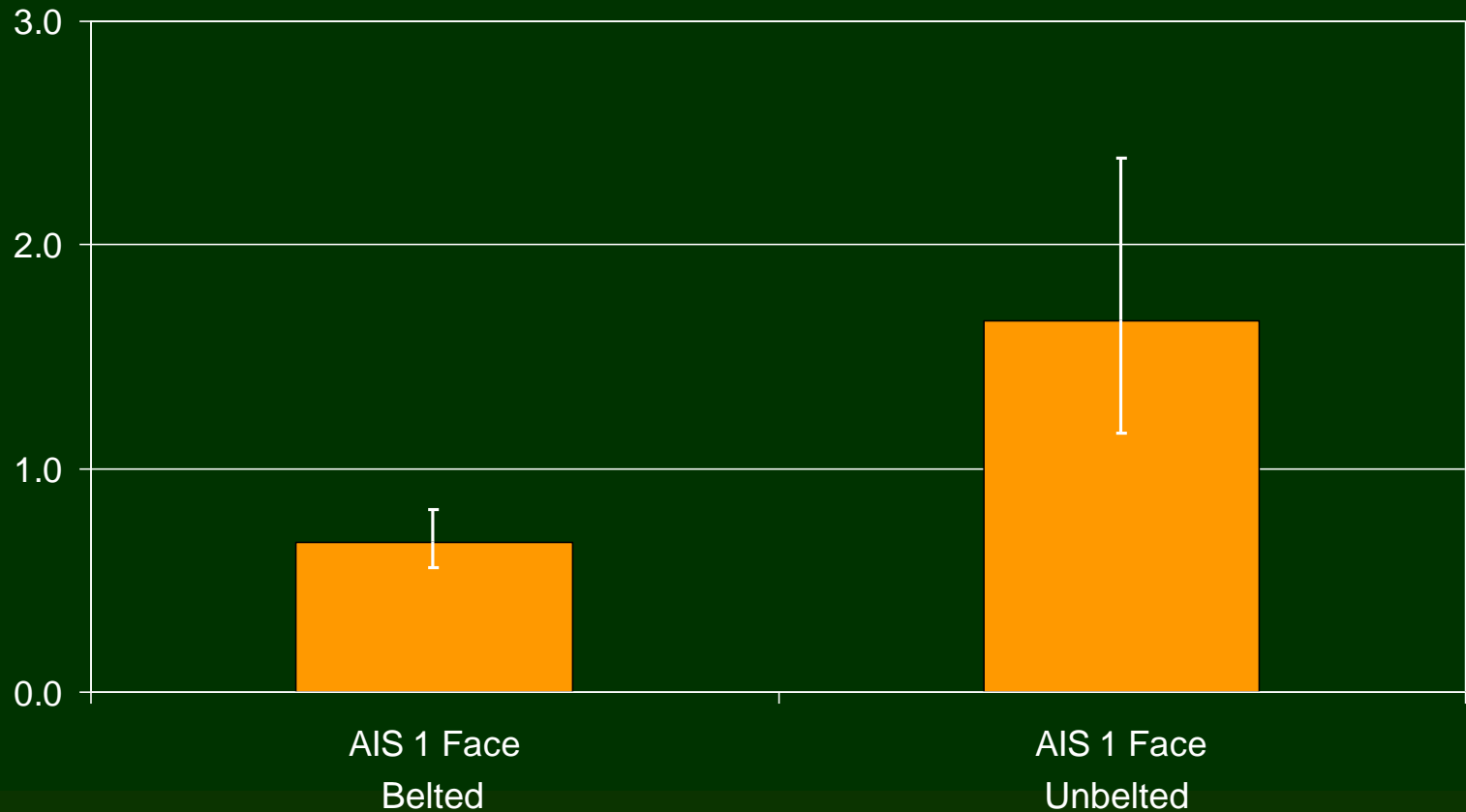
Body Region- Lower Limb by deltaV



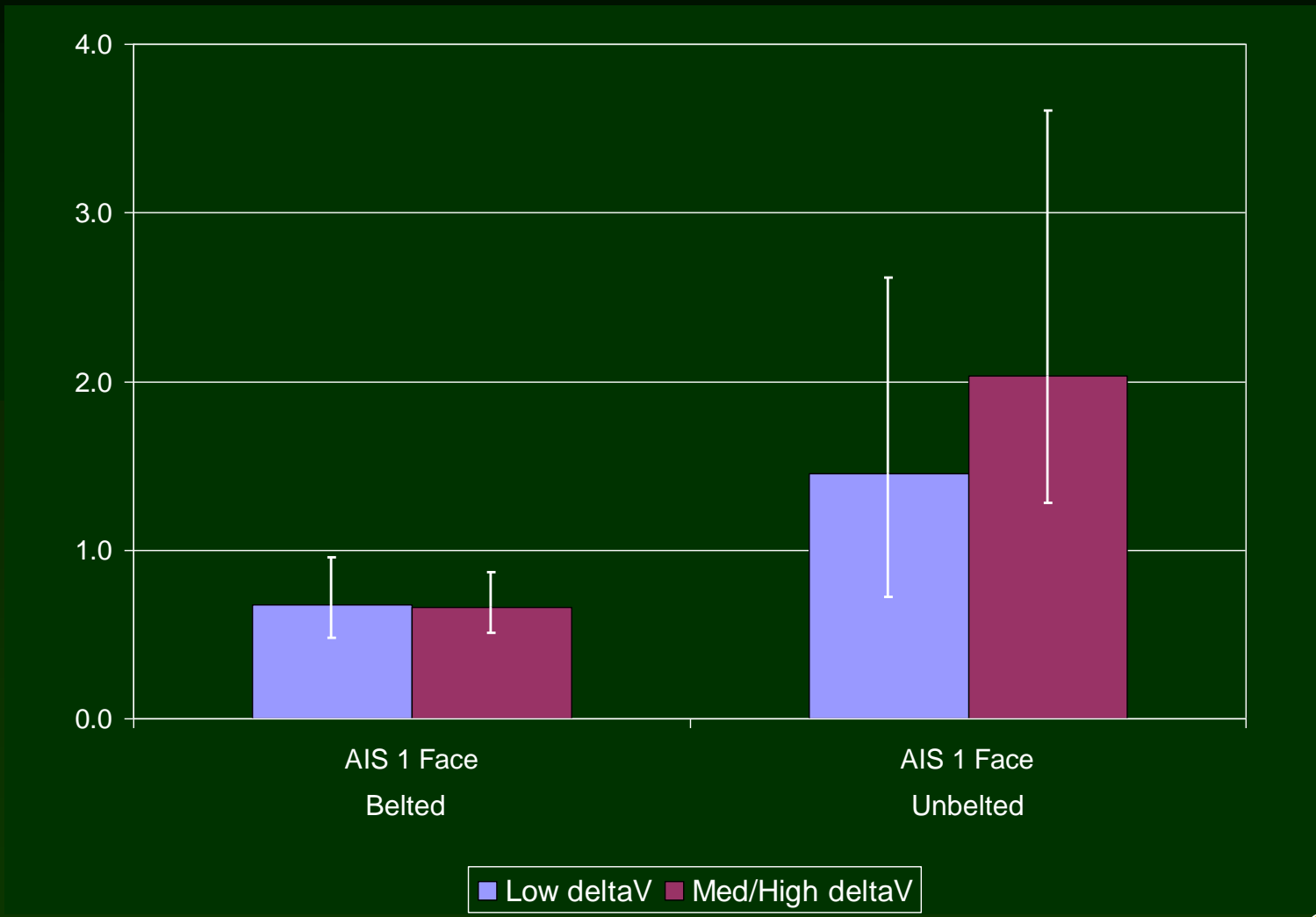
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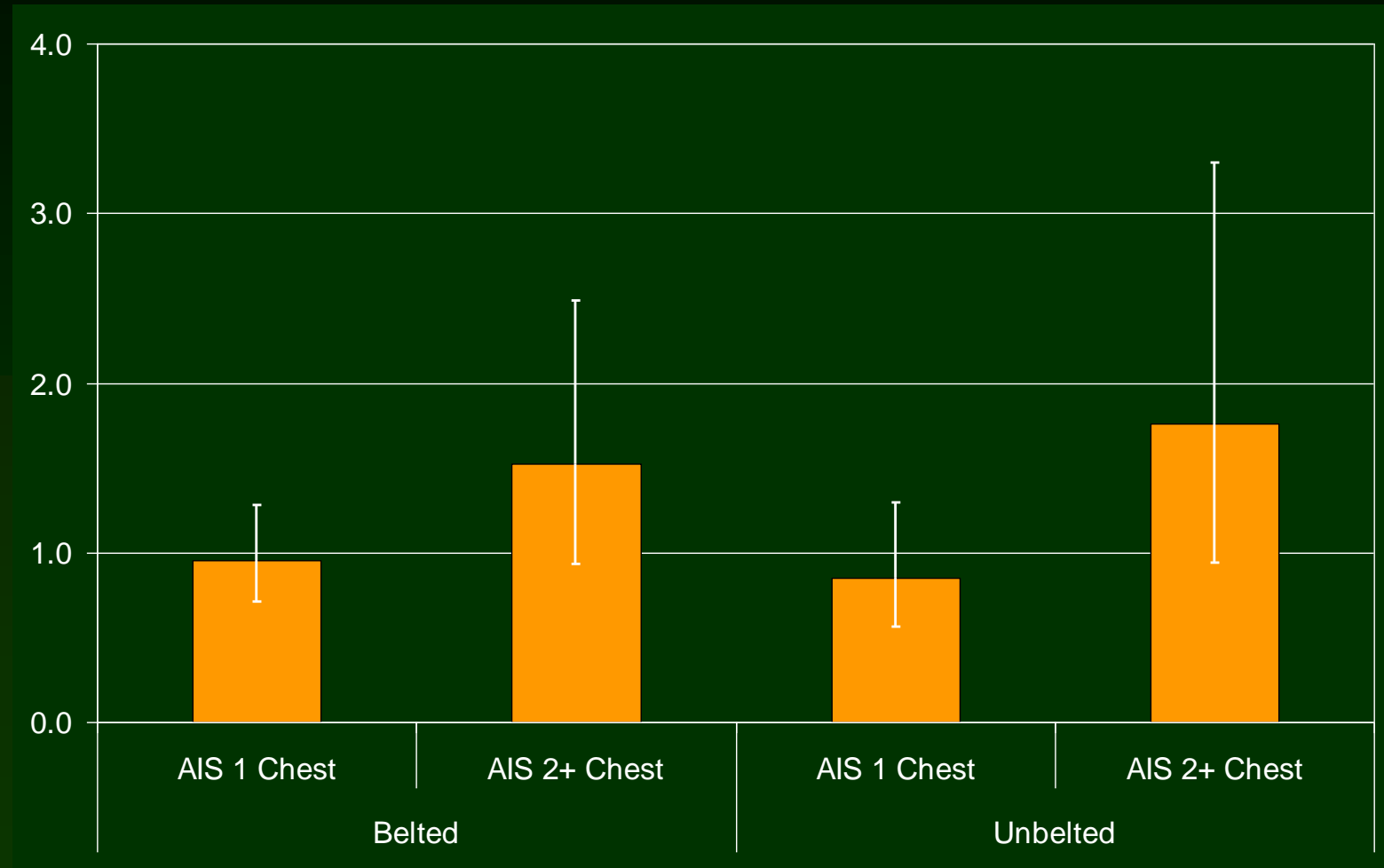
Body Region- Face



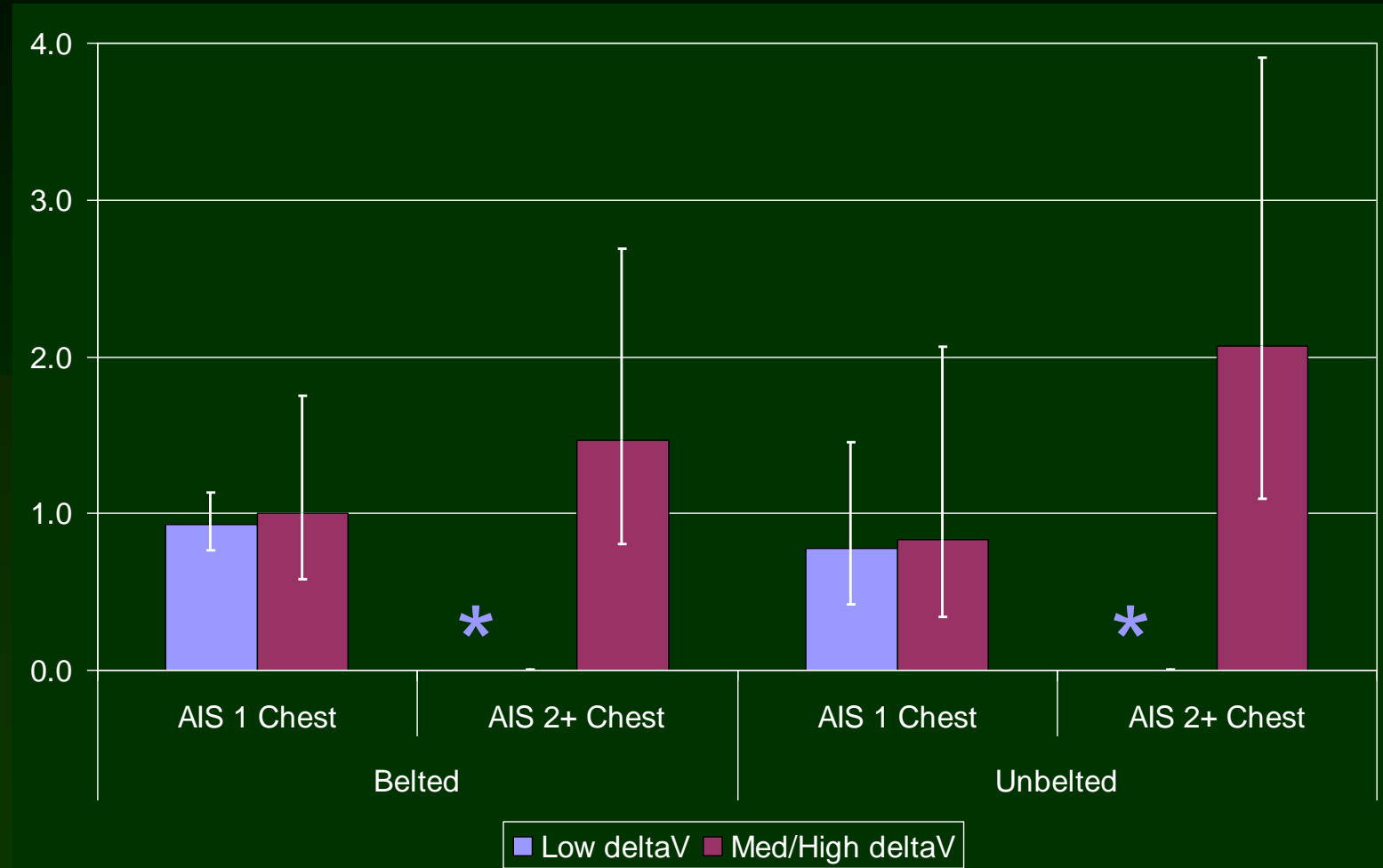
Body Region- Face by deltaV



Body Region- Chest



Body Region- Chest by deltaV



* Insufficient Data for Analysis



Summary of Body Region Findings by DeltaV and Belt Use

<u>Body Region</u>	<u>Low DeltaV</u>		<u>Medium/High DeltaV</u>	
	<u>Belted</u>	<u>Unbelted</u>	<u>Belted</u>	<u>Unbelted</u>
Upper Limb	⇓	x	⇓	x
Lower Limb	x	x	x	x
Face	⇓	x	⇓	⇑
Chest	x	x	x	⇑

- Head, Abdomen, Neck and Spine showed no significant differences by type of airbag present



Discussion

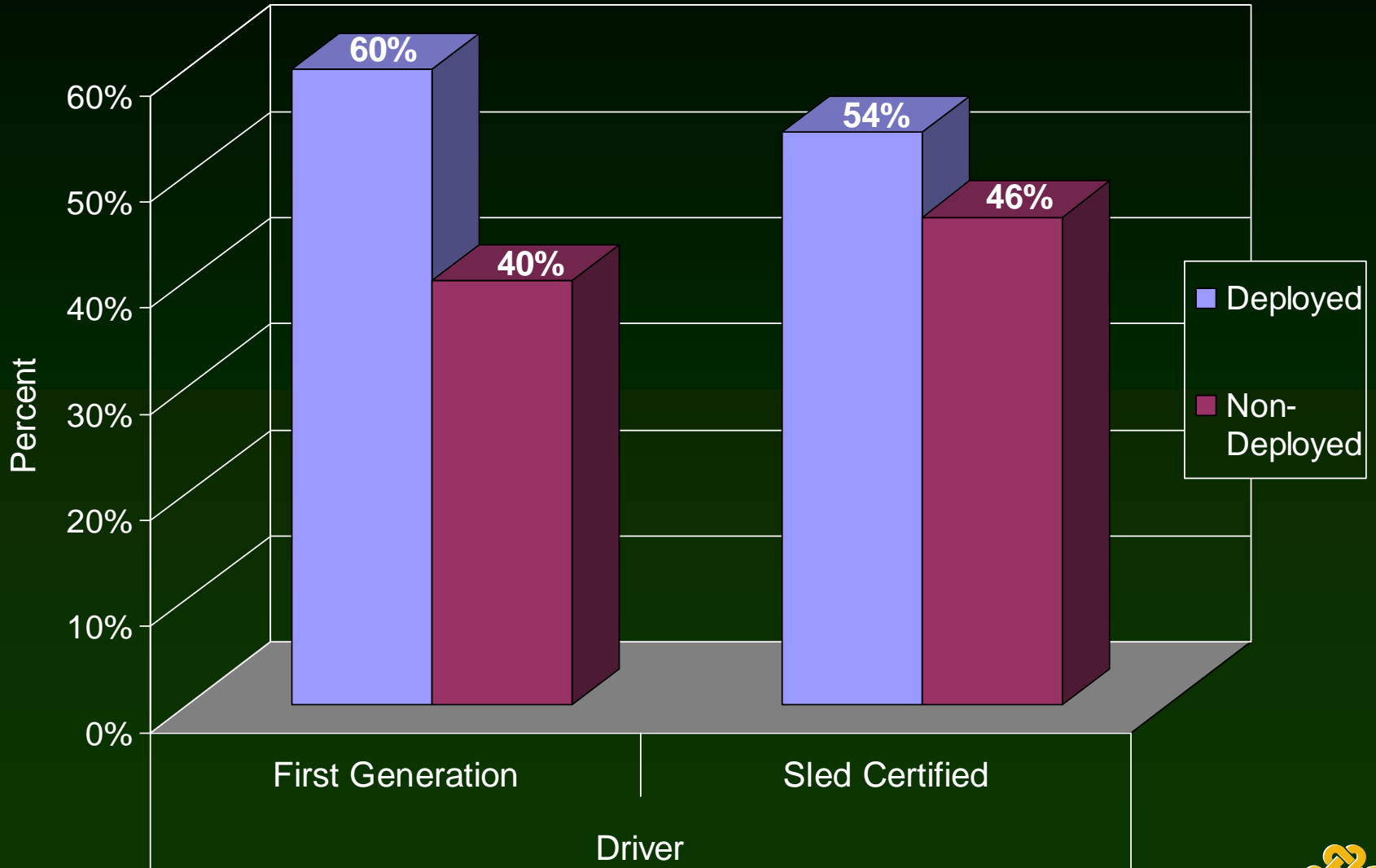


Upper Limb Injuries

- Results indicate significant reductions in upper limb injury with a sled certified airbag present for belted drivers.
- Injury reductions are likely due to reduced aggressiveness of sled certified airbags AND increased airbag deployment threshold as suggested by Segui-Gomez 2003.
- Findings differ from Jernigan et. al. 2005 who identified increased upper extremity injury risk with sled certified airbags present.



Airbag Deployments By Airbag Type



Lower Limb Injuries

- A reduction in AIS 2+ lower limb injury was found for belted drivers.
- This result is unexplained.
- Vehicle design improvements in recent model vehicles may be responsible for trend and are not controlled for in regression models.



Facial Injuries

- A reduction in belted driver face injury was found.
- Depowering of airbags with sled certification, improved fold patterns, changes in airbag materials and increased deployment threshold could be responsible for reduced face injuries for belted drivers.
- Increases in unbelted driver face injury was found.
- Reduced pressure in sled certified airbags could allow subsequent contacts of driver face.



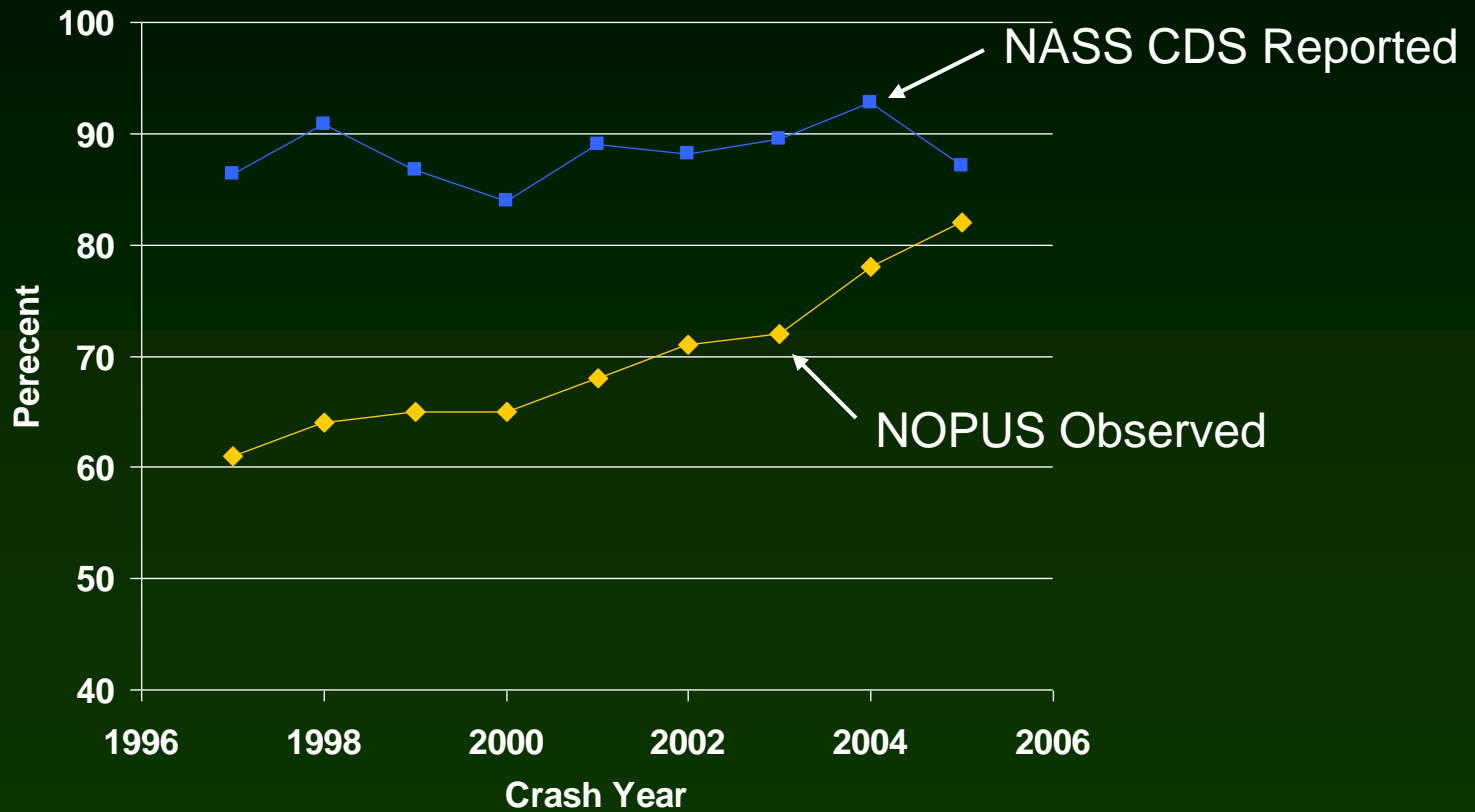
Chest Injuries

- Increased risk of AIS2+ chest injury for unbelted occupants during medium/high deltaV crashes
- Tendency toward increased AIS 2+ chest injuries for belted occupants- unexpected finding
 - Safety belt over reporting may introduce a bias in belted occupant results

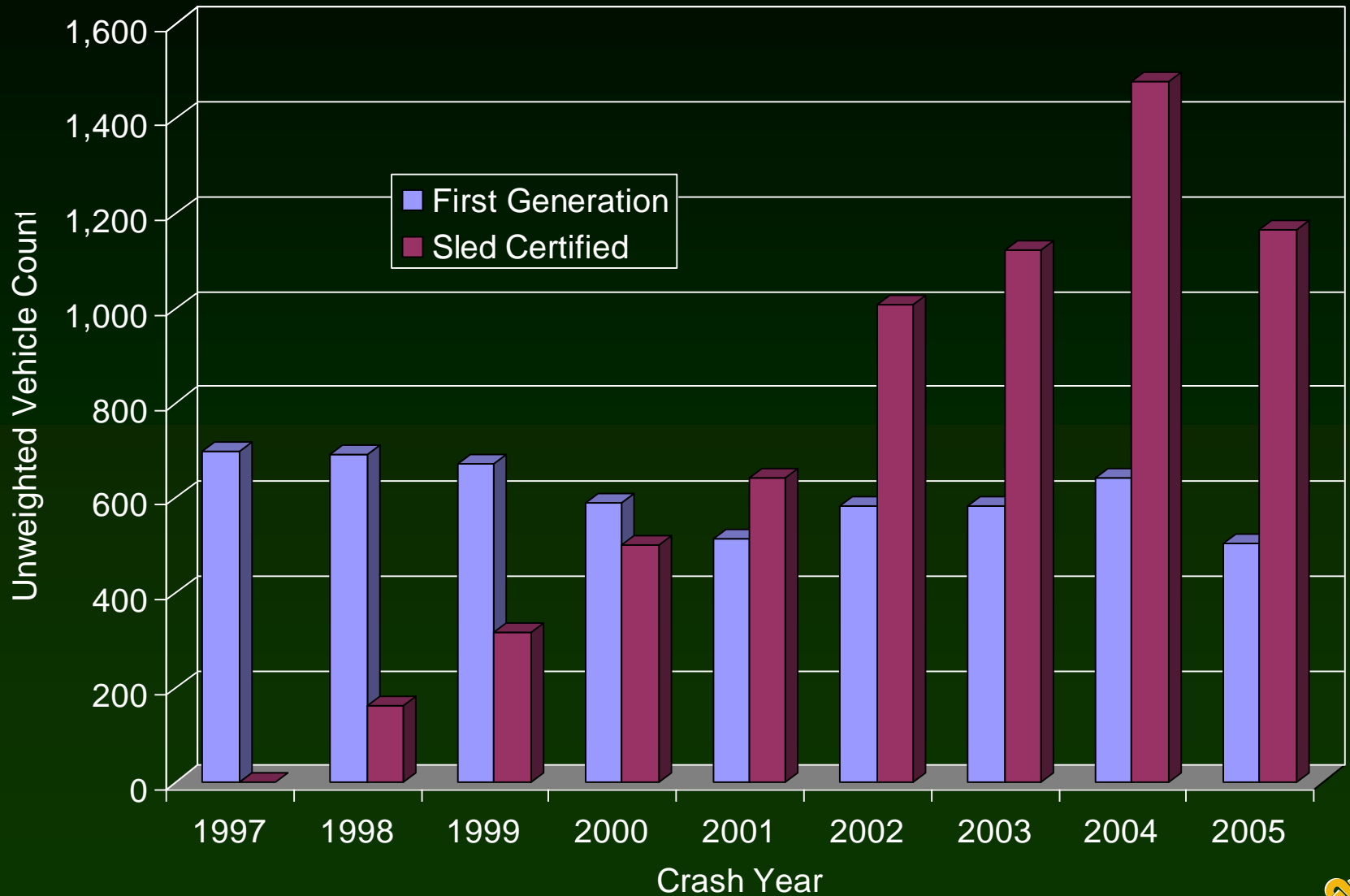


Impact of Safety Belt Reporting

Safety Belt Usage: Observed versus NASS/CDS Reported



Population of First Generation versus Sled Certified Airbag Equipped Vehicles by Year



Unclassified MY 1994+ Vehicles= 1,208



Effect of Overreporting of Safety Belt Use on Injury Odds

$$\text{OddsRatio} = \frac{\frac{\text{Injured}_{\text{sled}}}{\text{Non} - \text{Injured}_{\text{sled}}}}{\frac{\text{Injured}_{\text{1stGen}}}{\text{Non} - \text{Injured}_{\text{1stGen}}}}$$

- Non-injured drivers with 1st generation airbags are more likely to overreport belt use compared to uninjured drivers with sled certified airbags present.
- Overreporting of belt usage (more likely during earlier crash years) will inflate the odds of injury for belted drivers



Conclusions

- **Belted Drivers-** Sled certified airbags appear to offer the same or better protection when compared to first generation airbags in preventing injuries.
- **Unbelted Drivers-** In most cases, sled certified airbags provide protection equivalent to first generation systems. For a small subset of crashes involving unbelted occupants, sled certified airbags provide reduced protection for some body regions.



Acknowledgements

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QUESTIONS

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