Examining the role of body mass index on injury severity in fatal crashes

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Acknowledgments

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Introduction

- BMI (body mass index) is a ratio of weight for height (kg/m^2)
- BMI is typically classified by range:

Under-weight	Normal	Overweight	Obesity Class I	Obesity Class II	Obesity Class III
< 18.5	18.5-24.9	25.0-29.9	30.0-34.9	35.0-39.9	> 40.0

Introduction

- A higher BMI is associated with the risk of several health conditions (National Heart, Lung, and Blood Institute)
- These can include:
  - type 2 diabetes
  - high blood pressure
  - heart disease
  - and certain cancers

Introduction

- Some evidence suggests that individuals with a higher BMI have elevated odds, by as much as 60%, of fatal crash injury (Jehle 2012)

- Differences in pattern/severity of injury and increased medical/surgical complications are suggested as possible reasons for the increased risk of death

Introduction

- However, other evidence suggests that having a slightly elevated BMI may be protective (Arbabi 2003)

- In order to better understand the impact of BMI on fatality risk, consider methodological and statistical refinements of current research

Purpose

- To further explore the association between BMI and crash injury severity after controlling for driver and vehicle factors known to independently contribute to injury severity

Data Source
Fatality Analysis Reporting System

- Information on ALL fatal crashes in the USA since 1975

- Contains detailed information on environmental, vehicular and driver-related factors

Data Source
Fatality Analysis Reporting System

- Height / Weight (used to calculate BMI) first reported in 1998

- We used paired-crash data from 1998 through 2009

Independent crash contributors

- Crash Factors (paired design)
  - Driver Side Impact
  - Seat-belt use

- Vehicle Factors:
  - Vehicle Age, Type, and Weight

- Driver Factors:
  - Driver Age (linear *and* quadratic) and Sex

Analysis I

- Employed binary logistic regression (with generalized estimating equations) examining paired (i.e., two-car) crashes

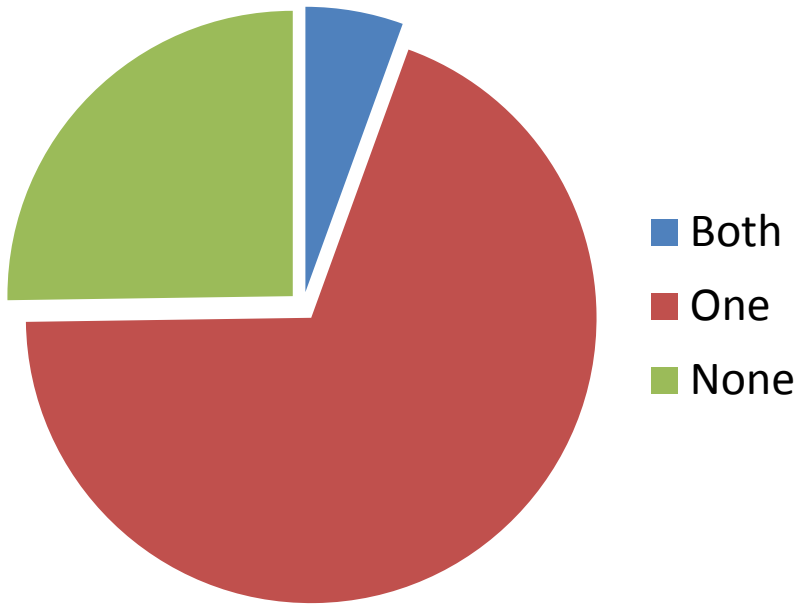
Model	Terms Included
i	Independent crash contributors (listed earlier)
ii	+ BMI + BMI*Age interaction (both linear and quadratic terms)

Analysis II

- Examined Seat-Belt use by BMI level using a correlational approach

Results: Fatal Injury Status

Drivers Fatally Injured	N (%)
Both	1,235 (6)
One	15,437 (69)
Neither	5,625 (25)
Total	22,297 (100)



Model ii: Crash Factors

Independent Contributor	N (%) or Mean (SD)	Odds Ratio (95% CI)
Driver Side Impact		
Driver Side	6,166 (13.8)	6.80 (6.32;7.30)
Non-Driver Side	38,428 (86.2)	Referent
Seat-Belt Use		
None	11,466 (25.7)	3.92 (3.72;4.14)
Shoulder	397 (0.9)	2.49 (1.98;3.12)
Lap	387 (0.9)	1.36 (1.09;1.70)
Shoulder and Lap	32,344 (72.5)	Referent

Model ii: Vehicle Factors

Independent Contributor	N (%) or Mean (SD)	Odds Ratio (95% CI)
Vehicle Age		
	8.9 (5.4)	1.12 (1.10;1.14)*
Vehicle Type		
Car	34,848 (78.1)	1.45 (1.31;1.61)
Light Trucks / SUVs	6,696 (15.0)	1.20 (1.06;1.35)
Vans	3,050 (6.8)	Referent
Vehicle Weight		
	3,201 (719.6)	0.43 (0.41; 0.45)**

* Centered: 4 years; 1 Unit Change: 5 years
** Centered: 1500 lbs; 1 Unit Change: 1000 lbs

Model ii: Driver Factors

Independent Contributor	N (%) or Mean (SD)	Odds Ratio (95% CI)
Driver Sex,		
Male	25,352 (56.9)	1.07 (1.02;1.12)
Female	19,242 (43.1)	Referent
Driver Age, mean		
Age	41.98 (20.4)	1.50 (1.16;1.94)*
Age^2	2,178 (2014)	1.24 (1.07;1.42)*

* Centered: 45 years; 1 Unit Change: 10 years

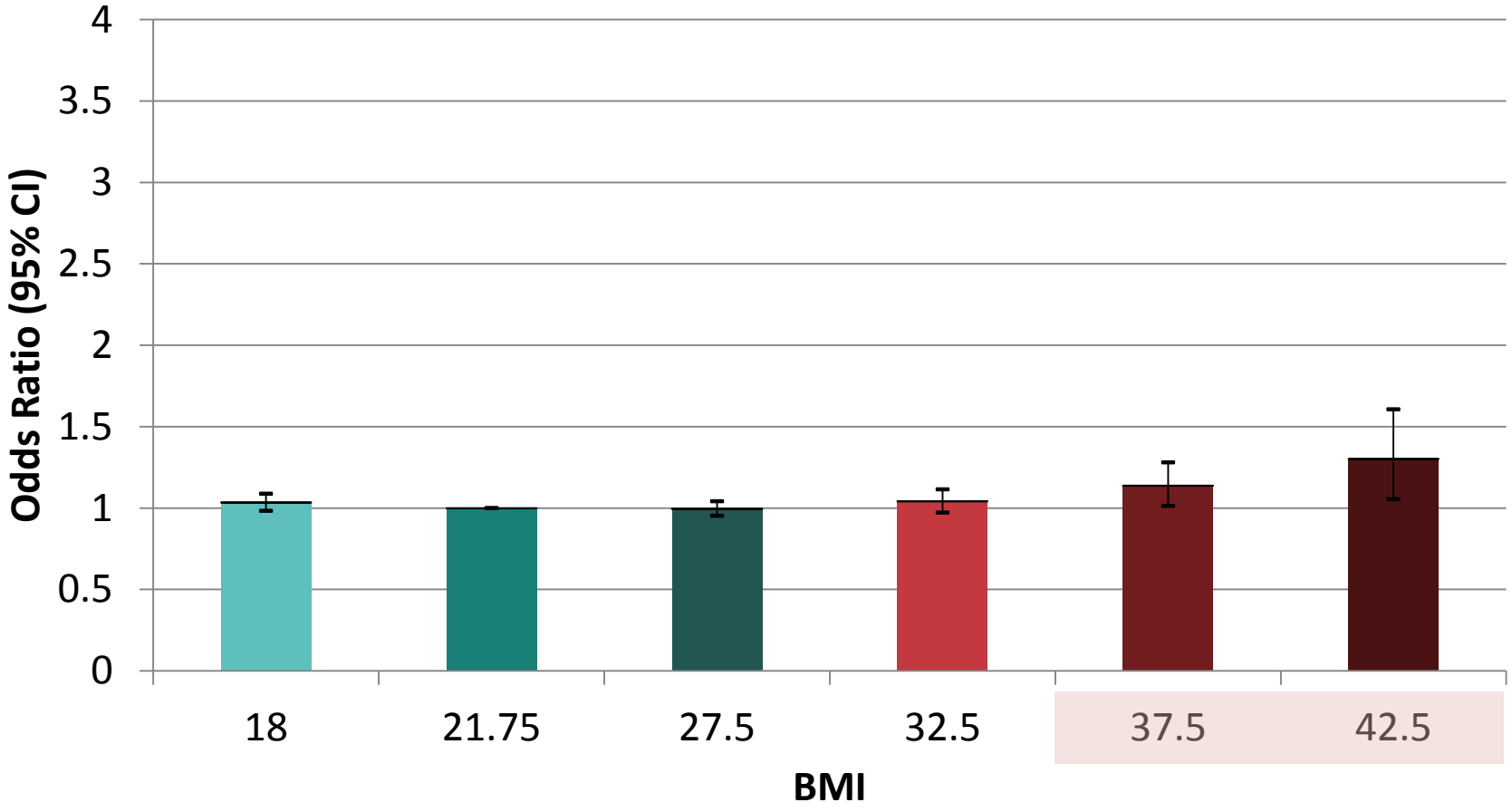
Model ii: BMI

Independent Contributor	N (%) or Mean (SD)	Odds Ratio (95% CI)
Driver BMI		
BMI	25.6 (5.2)	0.99 (0.95;1.03)
BMI^2	681.8 (303.7)	1.00 (1.00;1.01)
Driver BMI*Age		
BMI*Age		0.99 (0.97;1.01)
$BMI*Age^2$		**0.987327 (0.976922; 0.997842)***
BMI^2*Age		1.00 (1.00;1.00)
BMI^2*Age^2		**1.000196 (1.000001; 1.000391)***

*p < .05

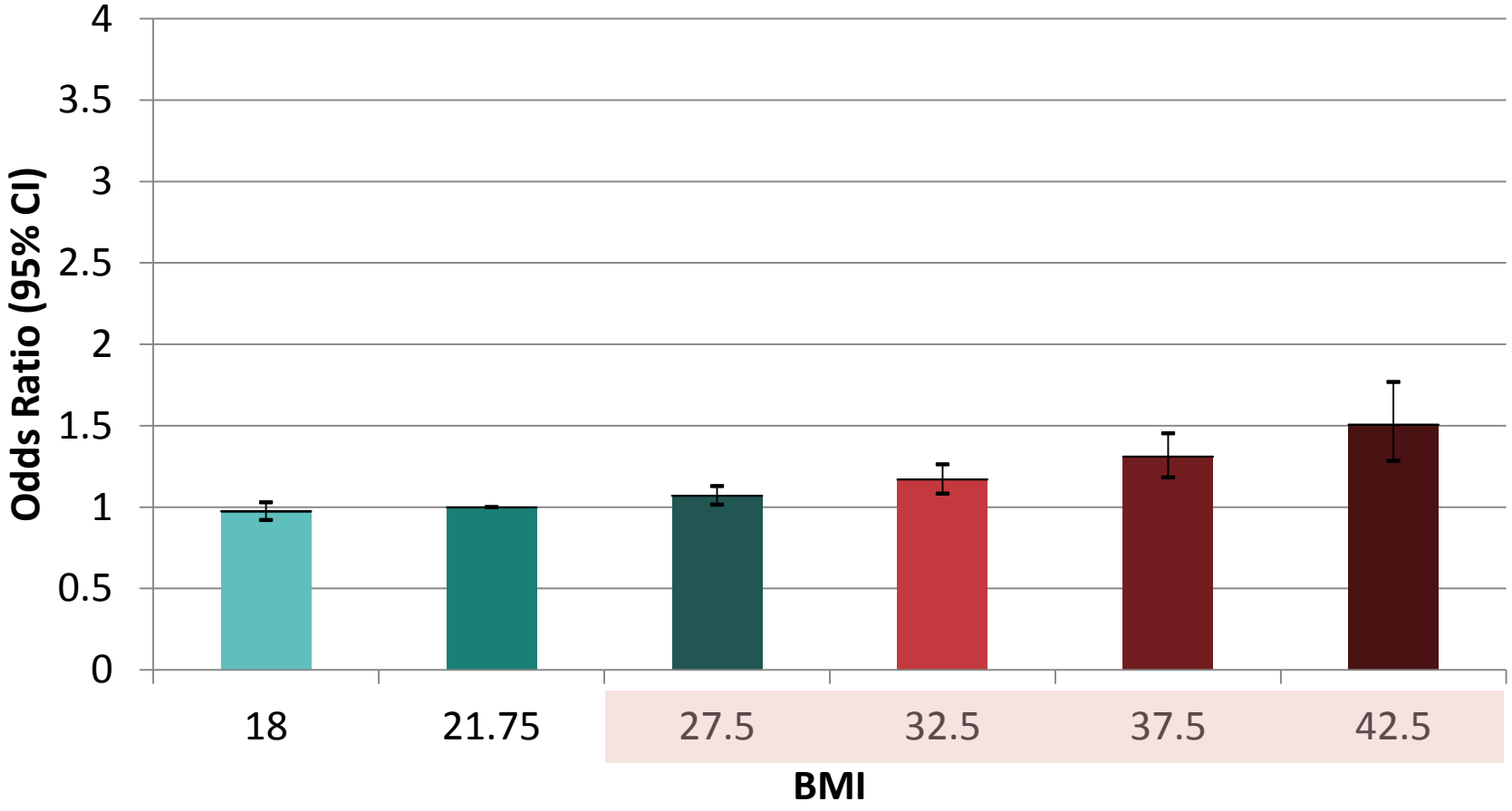
Original Analysis (no interactions)

Odds Ratio of Fatal Injury by BMI Driver Aged 25



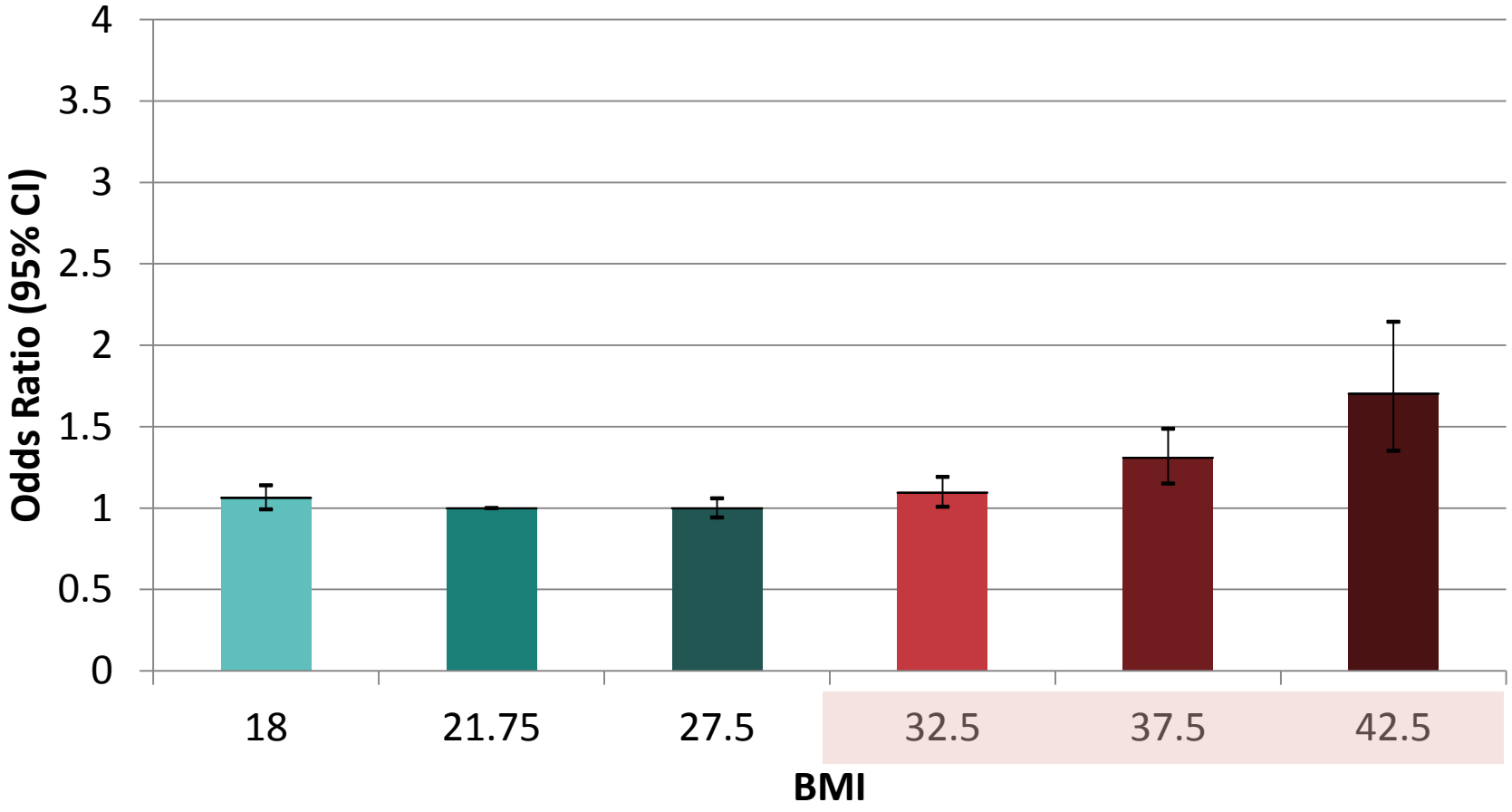
OR	1.03	1.00	1.00	1.04	1.14	1.30
(95% CI)	(0.98;1.09)	(1.00;1.00)	(0.95;1.04)	(0.97;1.12)	(1.01;1.28)	(1.05;1.61)

Odds Ratio of Fatal Injury by BMI Driver Aged 45



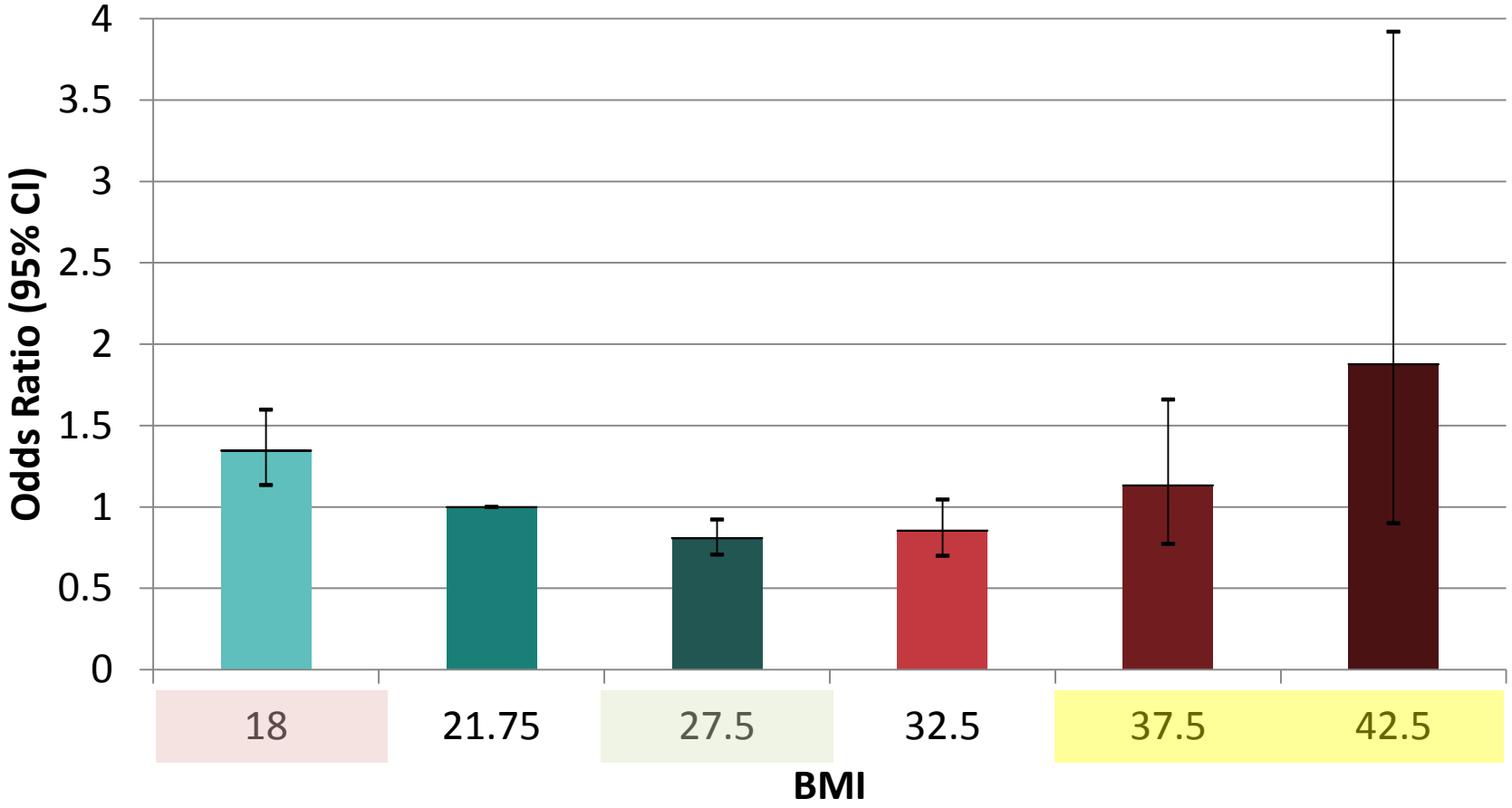
OR	0.97	1.00	1.07	1.17	1.31	1.51
(95% CI)	(0.92;1.03)	(1.00;1.00)	(1.02;1.13)	(1.08;1.26)	(1.18;1.45)	(1.28;1.77)

Odds Ratio of Fatal Injury by BMI Driver Aged 65



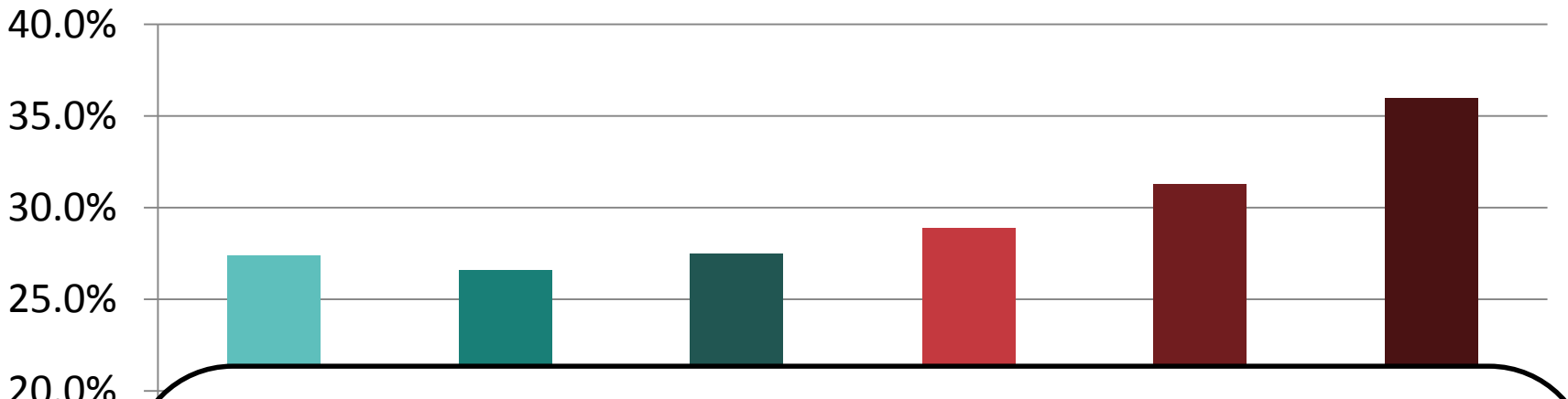
	18	21.75	27.5	32.5	37.5	42.5
OR	1.06	1.00	1.00	1.10	1.31	1.70
(95% CI)	(0.99;1.14)	(1.00;1.00)	(0.94;1.06)	(1.01;1.19)	(1.15;1.49)	(1.35;2.14)

Odds Ratio of Fatal Injury by BMI Driver Aged 85



	18	21.75	27.5	32.5	37.5	42.5
OR	1.35	1.00	0.81	0.86	1.13	1.88
(95% CI)	(1.14;1.60)	(1.00;1.00)	(0.71;0.92)	(0.70;1.04)	(0.77;1.66)	(0.90;3.92)

Improper Seatbelt Use



Test	Value	DF	p-value
Pearson Chi-Square	51.441	5	<.00001
Likelihood Ratio	49.73	5	<.00001
Linear-by-Linear Association	39.673	1	<.00001
Deviation from Linearity	11.768	4	0.019
Overall Linear Effect	77.12%		

Pearson Chi-Square indicates seat-belt usage differs by BMI category.

Linear-by-Linear association indicates the difference is linear (i.e., we see improper usage increasing by BMI category), 77% of the overall effect is linear.

Discussion

- After controlling for several known independent contributors to injury severity:
  - There was a statistically significant association between BMI, age, and odds of being fatally injured

Discussion

- After controlling for several known independent contributors to injury severity:
  - Increased odds of being fatally injured were associated with higher BMIs for younger drivers but lower BMIs for older drivers

Discussion

- After controlling for several known independent contributors to injury severity:
  - Drivers most impacted by higher BMIs were those between 45-65 years of age

Discussion

- After controlling for several known independent contributors to injury severity:
  - Further, an “overweight” BMI was associated with reduced odds of being fatally injured for older drivers

Discussion

- Proper seat-belt usage (a highly protective factor) was associated with lower levels of BMI

Implications

- As the normative weight for society increases, so does the responsibility of understanding the relationships between BMI and fatality risk

- With better information, policy makers and vehicle manufacturers can work towards ensuring that motor vehicles are safe for all occupants, regardless of age or weight

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ADDITIONAL SLIDES

Examining the Role of Body Mass Index on Injury Severity in Fatal Crashes

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Background

Body mass index (BMI) is a ratio of weight for height (kg/m²):
Underweight BMI < 18.5
Normal BMI 18.50 → 24.99
Overweight BMI > 25
Obese BMI > 30
Obese Class I BMI 30 → 34.99
Obese Class II BMI 35 → 39.99
Obese Class III BMI >40

Higher BMI is associated with several health conditions.

Evidence also suggests higher BMI may be associated with elevated odds of death following a motor vehicle crashes.

Objective

To explore the association between BMI and crash injury severity after controlling for driver, vehicle, and crash factors known to independently contribute to injury severity.

Methods

We used the Fatality Analysis Reporting System to examine paired crashes between 1998-2009 that reported driver's BMI.

For this presentation, Injury Severity was categorized as Fatal or Non-Fatal.

Driver, vehicle , and crash factors were examined using a multivariable logistic regression model.

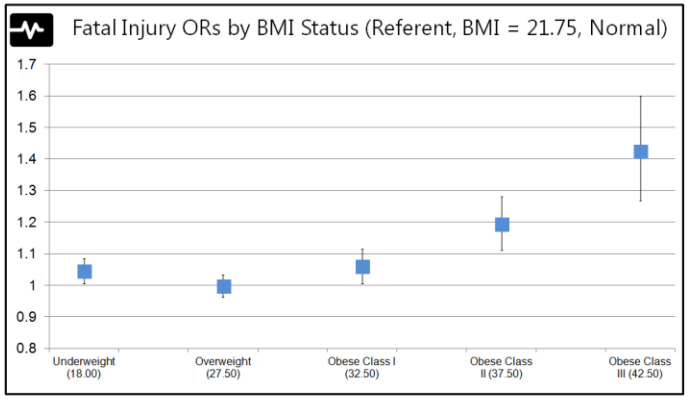
What We Learned

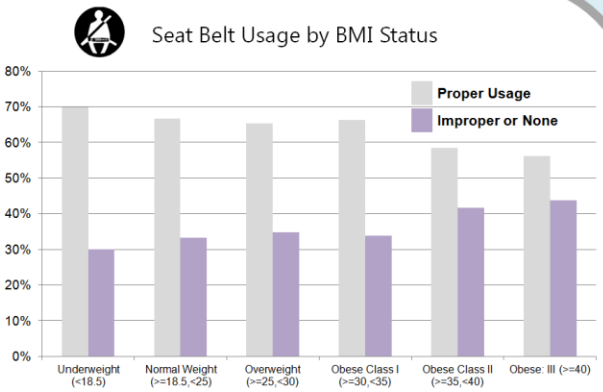
There were 22,297 crashes extracted for the analysis. Mean BMI was 25.81 for those fatally injured and 25.44 for those not.

Prior to including BMI in analyses, the following factors were associated with increased odds of resulting in a fatal injury: female driver, older driver, no seat-belt, driver-side impact, lighter vehicle weight, older vehicle, and driving a car (versus van/truck).

After including BMI in the analyses, individuals with elevated BMIs had an increased odds of being fatality injured in a crash. Further, proper seat belt usage (a highly protective factor) reduced as BMI increased.

Results





Driver Factors

Factor (Referent)	OR (95% CI)
Female (Male)	1.07 (1.02;1.12)
Driver Age (20 Years, in decades)	1.33 (1.32;.135)
Driver Age²	1.02 (1.01;1.02)

Vehicle Factors

Factor (Referent)	OR (95% CI)
Vehicle Weight (1500 lbs, per 1000lbs)	0.43 (0.41;0.45)
Vehicle Age (4 Years, per 5 years)	1.12 (1.10;.115)
SUV or Light Truck (Van)	1.20 (1.06; 1.35)
Car (Van)	1.45 (1.31; 1.61)

Crash Factors

Factor (Referent)	OR (95% CI)
Seat Belt (Lap and Shoulder Belt)	
• Lap Belt	1.36 (1.09;1.70)
• Shoulder Belt	2.48 (1.98;3.11)
• Not-Used	3.92 (3.72;4.13)
Driver Side Impact (Non-Driver Side)	6.80 (6.33;7.30)

For more information, please contact Aislin Mushquash at mushquaa@tbh.net

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