Examination of Factors Determining Fault in Multi-Vehicle Conflicts Using the SHRP2 Data

Raha Hamzeie, Ph.D. Student

Peter Savolainen, Ph.D., PE

10th International Conference on Managing Fatigue

March 23, 2017

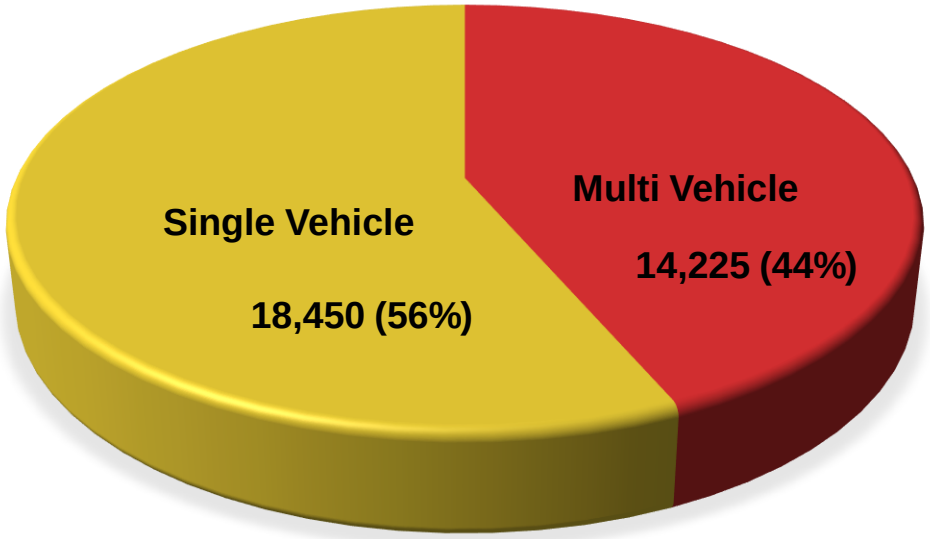
IOWA STATE UNIVERSITY

Overview

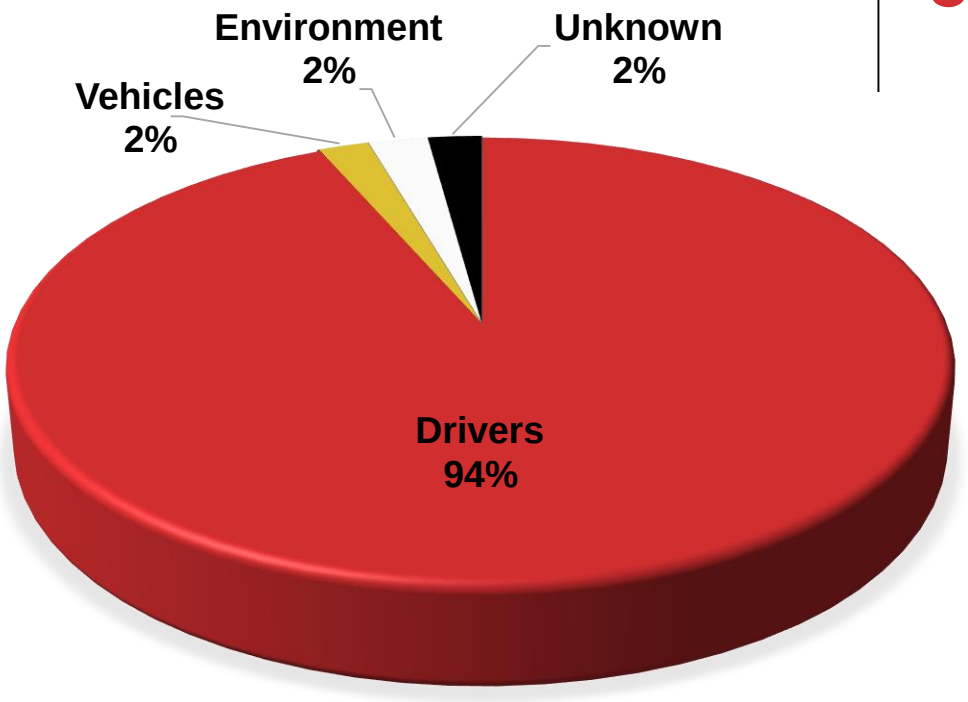
- Introduction
- Literature Review
- Data Description
- Statistical Methodology
- Results
- Limitations and Future Work

IOWA STATE UNIVERSITY

Introduction



NHTSA Data - 2014



National Motor Vehicle Crash Causation Survey 2005-2007

What factors influence the **likelihood** of a driver being **at fault** when involved in a **multi-vehicle** conflict?

IOWA STATE UNIVERSITY

Literature Review

Fault status

- Odds of being at fault:
  - Higher: Male drivers
    Non-vehicle owners
    Suspended or revoked license
    Unlicensed drivers
  - Lower: Older populations
    Working from home
    Daily commute less than 15 minutes

IOWA STATE UNIVERSITY

Literature Review

Relationship of Traffic Safety and Driver Fatigue

- Philip et al.
  - 10% fatigue-related vs. 23% alcohol-related crashes
  - Fatigue crashes more fatal during daytime
  - Combined fatigue and alcohol OR = 8.6 for fatal / OR =2.6 for injury
- Connor et al.
  - Risk of injury:
    - OR=11 Score>=4 vs. Score=1
    - OR=8 Score>=4 vs. Score<4

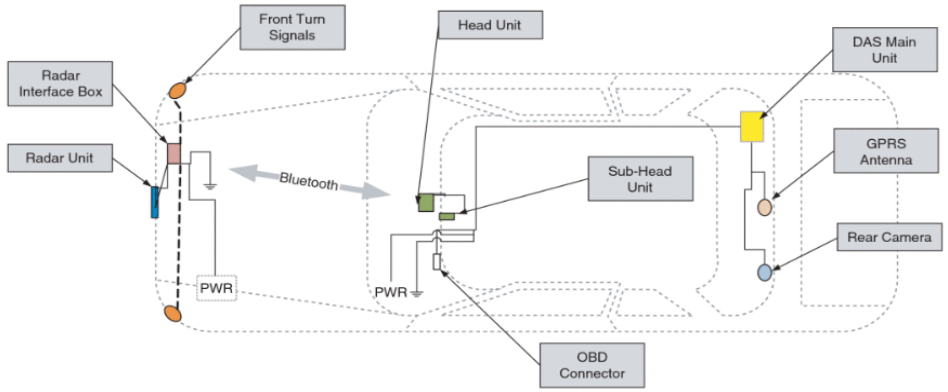
Stanford sleepiness scale

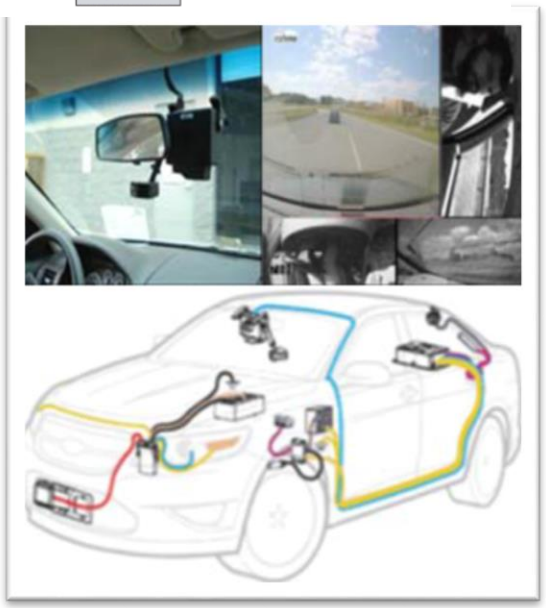
1. Felt active, wide awake
2. Was functioning at a high level but not at peak
3. Felt relaxed, awake but not fully alert, responsive
4. Felt a little foggy headed
5. Felt foggy headed, had difficulty staying awake, was beginning to lose track
6. Felt sleepy, would have preferred to lie down, woozy
7. Could not stay awake, sleep onset was imminent

IOWA STATE UNIVERSITY

Data

SHRP 2 Naturalistic Driving Study





- 3092 drivers
- 3900 vehicle drivers
- 3 years of data
- 1600 crashes
- 2900 near-crashes

IOWA STATE UNIVERSITY

Requested Data

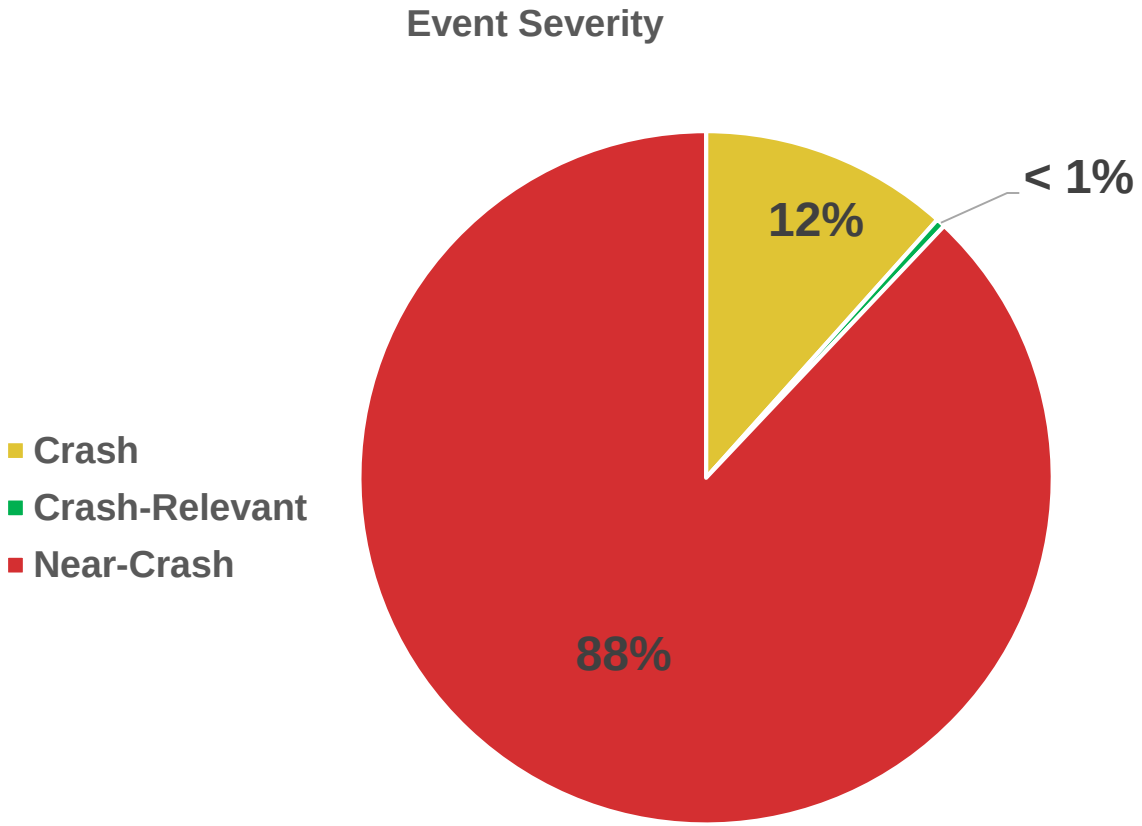
2, 384 multi-vehicle conflicts
1,177 unique drivers

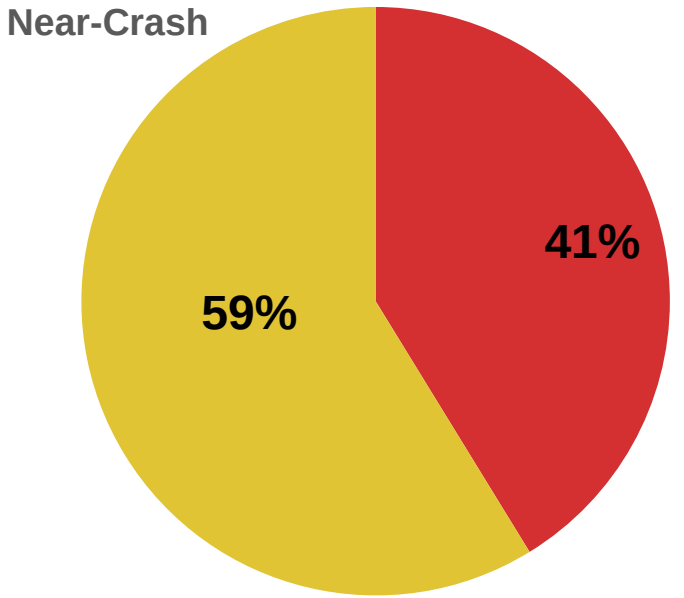
- Driver behavior
- Driver demographic
- Driving history
- Driving knowledge
- Risk perception
- Risk taking
- Sleep habits
- Event characteristics
- Trip information
- Vehicle information

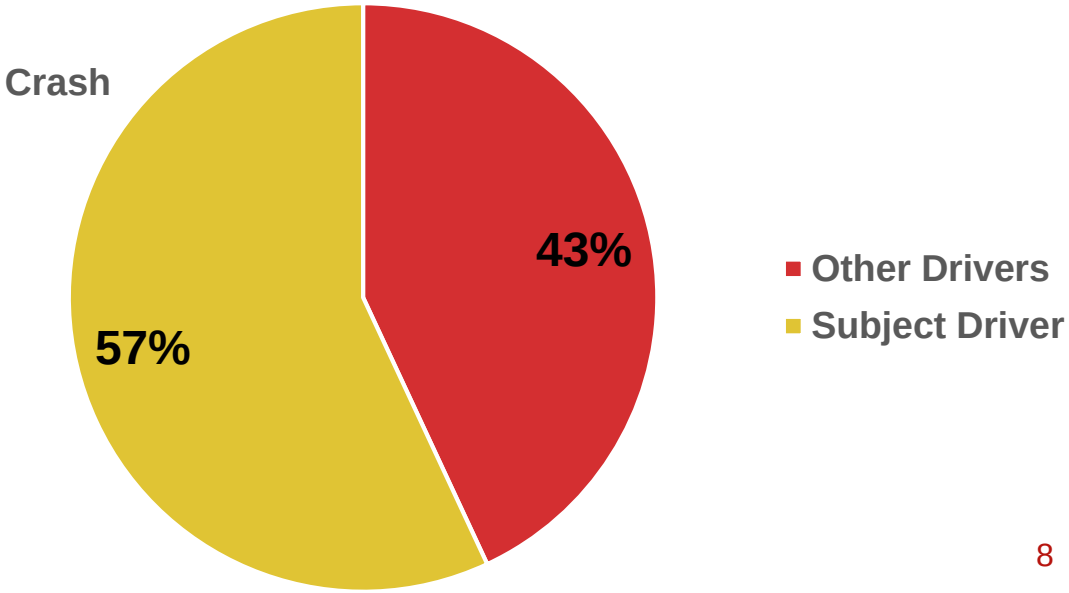
IOWA STATE UNIVERSITY

Requested Data

Event Distribution







IOWA STATE UNIVERSITY

Requested Data

Sleep Habits Questionnaire

How frequently do you use sleep aids in a typical month?

How likely are you to doze off or fall asleep while sitting and reading/watching TV/sitting inactive, in contrast to feeling just tired?

Do you keep a fairly regular sleep schedule?

How often do you nap?

Have you been told that you snore?

IOWA STATE UNIVERSITY

Requested Data

Summary Statistics

Variable	Mean
At-Fault Subject Driver (Yes/No)	0.58
Full Time Worker (Yes/No)	0.41
College or advanced degree (Yes/No)	0.43
No children at home (Yes/No)	0.77
Female (Yes/No)	0.51
Latino / Hispanic (Yes/No)	0.07
Sleeper type – Normal (Yes/No)	0.56
Tobacco use (Yes/No)	0.09
Driver never/intermittently uses sleep aids (Yes/No)	0.80
Driver reported no chance of dozing when reading (Yes/No)	0.18
Driver reported no chance of dozing when lying down (Yes/No)	0.09
Driver reported feeling fatigued nearly everyday (Yes/No)	0.15
Driver reported markedly/very delayed time to fall asleep (Yes/No)	0.17
Driver reported no problem of awakenings after having fallen asleep	0.42
Driver reported intense/considerable sleepiness during awake time	0.07

Statistical Methodology

- Binary logistic regression model:
  - Binary variable=1 if the subject driver is at fault,
  - Binary variable=0 otherwise

$$log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_k x_{ki}$$

- Mixed effect binary logistic regression model

$$p_i = \int \frac{EXP(\beta x_i + \varepsilon_i)}{1+\mathrm{EXP}(\beta x_i + \varepsilon_i)} f(\beta|\varphi) d\beta$$

Results

Univariate Logistic Regression Models

Variable	Coeff.	Std. Error	P-value	Odds Ratio
(Intercept)	0.443	0.065	<0.001	N/A
Driver characterized himself/herself as normal sleeper	-0.222	0.098	0.023	0.80
(Intercept)	0.485	0.091	<0.001	N/A
Driver never/intermittently uses sleep aids	-0.196	0.108	0.069	0.82
(Intercept)	0.390	0.054	<0.001	N/A
Driver reported no chance of dozing when reading	-0.239	0.126	0.058	0.79
(Intercept)	0.260	0.060	<0.001	N/A
Driver reported high chance of dozing when lying down	0.256	0.104	0.014	1.29
(Intercept)	0.310	0.053	<0.001	N/A
Driver feels fatigued nearly everyday	0.250	0.139	0.073	1.28
(Intercept)	0.297	0.053	<0.001	N/A
Driver reported markedly delayed time to fall asleep or never slept	0.299	0.132	0.024	1.35
(Intercept)	0.440	0.065	<0.001	N/A
Driver reported no problem with awakenings after having fallen asleep	-0.217	0.098	0.027	0.80
(Intercept)	0.323	0.051	<0.001	N/A
Driver reported intense/considerable sleepiness during awake times	0.310	0.187	0.098	1.36

Results

Multivariate Logistic Regression Model

Variable	Coeff.	Std. Error	P-value	Odds Ratio
Intercept	0.461	0.091	0.000	N/A
Driver reported high chance of dozing when lying down	0.241	0.104	0.021	1.27
Driver reported markedly/very delayed time to fall asleep or did not sleep at all	0.253	0.133	0.058	1.29
Male Driver	-0.223	0.098	0.023	0.80
Full Time Worker	-0.311	0.100	0.002	0.73

IOWA STATE UNIVERSITY

Conclusions

- Some sleep habits/patterns are associated with risk of being the at-fault driver in a conflict.
- Those who easily fall asleep, as well as those facing difficulties are more likely to be the at-fault driver in a conflict.
- There are correlations between different events of same individuals.
- There are associations between fault status and certain demographic attributes.

Limitations and Future Work

- No information was available for non-subject drivers.
- The questionnaire reflects general patterns of driver habits rather than the conditions at the time of conflict.
  - Use of face video data
- The source of reported sleep disorders/issues are not clear.
  - Develop more comprehensive datasets

Thank You!

rhamzeie@iastate.edu

pts@iastate.edu

IOWA STATE UNIVERSITY

TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES

SHRP2